Lean Implementation in Rosti AB: *Improvement Opportunities and Challenges*

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Upphovsrätt

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Abstract

Lean production has become a widespread production system to address the need of being more productive. Since three decades ago that some big automotive manufacturers started to adopt lean, many SME’s has adopt it and enjoy the outcomes. Literature have investigated the successful implementation of lean in these organizations, yet, very few papers have addressed the challenges toward adopting lean.

In this thesis research a plastic package manufacturer is chosen as the case of study to implement some initiatives of lean production and study the challenges and outcomes of lean adoption. The efforts during the making the changes were focused on adopting the SMED and Root-Cause Analysis techniques, and also to reduce defect rate in one of the products.

The findings indicate before any effort to implement lean production techniques, some social issues must be considered to reduce the risk of failure. The Rosti AB case indicated that promoting motivation among operators and resolving mistrust between managers and operators is essential to encourage them to participate in improvement changes.

In order to promote motivation and eliminate mistrust to encourage operators to participate in improvement changes it is necessary to empower them in decision makings in improvement implementations.

Keywords: Lean production, Empowerment, Participation, mutual trust, Plastic molding.
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1. Introduction to study

In this chapter, we start with an introduction about the subject of the research. Then we investigate the problems Rosti Primpac AB was face with, in the problem section. After introducing the problem in general, the research purpose and questions are discussed; and finally the limitations of the research have been investigated.

1.1. Introduction

Lean production philosophy invented and developed by Toyota in 1950s. The main purpose of lean production is to remove waste (muda) from the production process, by eliminating activities that do not add value to products; because those non-value-added activities add extra costs on the product which is not desirable by customers.

Many companies over the last three decades have implemented lean production to address the need of being more productive. Since lean production has become more and more popular, many papers have given details of how lean can benefit companies by implementing lean techniques. They presented many examples of how implementing lean production (LP) has resulted in boosting productivity, by presenting number and values.

A large number of publications in this field have dedicated themselves to explain the details of lean techniques (Pettersen, 2009). Still not many papers addressed the details of their LP adoption process. According to Chakravorty et al. (2010) just few studies have addressed the human issue and their resistance in LP implementation. The reasons many companies fail to adopt LP has not been investigated thoroughly.

Rosti AB had been in crisis for seven consecutive years and they would like to improve their productivity, they had before adopted some techniques to improve their productivity (e.g. 5S) before 2011, and then they decided to applying lean production in a broader scale in their company. However, they were aware of the resistance from their employee.

Management in many organizations, Rosti AB included, perceiving blue-collars as barrier against applying improvement transformations (Beer and Eisenhower, 2000). Lean implementation at Rosti AB started with this negative perception of the employees from managers’ point of view; managers seemed hopeless to achieve a successful implementation from the beginning of the project.

In Toyota, even though the top management is responsible to lead productivity toward perfection, at the end it is the employees who make improvements, because they know the details of the process in depth. It is a mixture of top-down and bottom-up management system. Therefore, unlike mass production, it is essential to study the human side of lean production more in detail.
1.2 Problem statement

Rosti AB has been shrinking in both turnover and number of employees over that last 7 years. In a meeting with Rosti’s production manager and lean specialist to discuss the project (Implementing lean at Rosti) details, they argued that they have many wastes and inefficiencies and they would like to remove them and improve their productivity. When I and my thesis supervisor Dr. Langstrand, visited their company, it was very obvious for us that they have a great potential to improve, through LP adoption. For example they had very long mold and line setups, high defect rates, lots of inventories and big warehouses and etc.

In 2003 Rosti AB has been awarded as the best company in Norrköping, but from 2004 it started to lose its market gradually because the PET packing market became mature and the price became market winner. Furthermore, some of the customers decided to have their in-house production lines, and this resulted in even more decrease in profit margins. PET bottle manufacturers, such as Rosti AB, had to offer lower price to save their customers; this means that their profits shrunk considerably since then; at Rosti the financial balance became minus since 2007.

The company production lines were overwhelmed with lots of wastes and inefficiencies and eliminating these wastes could eliminate lots of costs and consequently increase the profit margins. The company had long changeovers (up to 48 hours), high defect rates (7% for the biggest product), low equipment effectiveness (equipment high downtime rate), spacious warehouses (6 warehouses in Norrköping) to stock manufactured bottles (i.e. just the rent of warehouses in Norrköping cost 6 million SEK yearly) and etc.

When the profit margin became narrow the Rosti’s managers knew that it is time to increase the production productivity to address the financial crisis. They implemented OEE (Overall Equipments Effectiveness) software to measure their productivity and to improve it in 2004.

1.3 Purpose and research questions

The purpose of this thesis is to investigate what were the improvement opportunities in production department in Rosti AB, and how Lean Production techniques could be applied to improve the productivity of the company. Moreover, the study will argue what were the challenges and how these could be overcome.

To satisfy the purposes of this research, the following research questions should be answered:

Research Question 1: What were the main sources of inefficiencies?

Research Question 2: How could Lean Production practices help to amend these problems?

Research Question 3: What were challenges during the implementation process?

Research Question 4: How could the challenges be overcome?
2 Theory

The theory chapter has formed of three main headings. In the first section the five principles of Womack & Jones LP adoption method are reviewed. In the second part, the lean techniques I attempt to implement are presented. Finally, some of the issues and challenges in LP have being reviewed.

2.1 Womack and Jones LP implementation model

There are several LP adoption models which describe the steps toward being lean. With no doubt the most cited is the 5 steps by Womack and Jones (2003); this method is the approach I used in my attempt toward applying at Rosti AB.

The method suggests 5 steps toward adopting LP, as it is presented below:

1. Specify value
2. Identify the value stream
3. Flow
4. Pull
5. Perfection

During the first step, specifying the product value, it is essential to rethink about what the actual value of the product is, specifically from the customers’ point of view. In fact, the value are characteristics and reasons that customers buy a product and willing to pay for it, at a specific time.

After identifying the product value, then it is time to map the activities that add those values to the product. The value stream consists of three critical management tasks; the first one is to map all the activities in developing new products from concept to the actual production; the second one is to map the process from order taking to the final delivery; and the last one is the entire process to shape the raw material into the final product.

In this step all the activities are mapped and it becomes possible to identify value-added activities from non-value-added activities or Muda. Now it is time to plan for eliminating the most obvious wastes and take some actions.

After eliminating a number of major wastes, it is possible to create product flow by reducing batch sizes and doing the activities in line or cell. SMED is a central technique to create the flow and to reduce the batch sizes as much as possible. Still to create a smoother flow it is critical to continually eliminate wastes.

In the next step, in LP adoption, instead of pushing the product into the market, the pull system should be established, to let the products being pulled by customers. It means instead of producing and keeping the products in the warehouses, we wait for the orders from
customers and then as soon as we sell a specific amount we produce the same amount to refill it. Kanban system is used to transfer the information in Pull system. Finally in the 5th step, it must be tried continuously to look for wastes and eliminate them from the processes to achieve more perfection.

2.2 Lean production techniques

A wide variety of lean practices have been addressed as lean techniques in different literature. However, some of these practices are being addressed in almost all of literature that has studied lean techniques. Twenty six of these techniques have been addressed in all the nine most cited books that have discussed lean concepts (Pettersen, 2009). In this section Value Stream Mapping, SMED, Standardization, OEE, Root cause analysis and Fishbone diagram concepts are being reviewed, to help us with the results analysis in the analysis chapter.

2.2.1 Value Stream Mapping

“The value stream is the set of all the specific actions required to bring a specific product” (Womack and Jones, 2003, p.37). Value Stream Mapping (VSM) is an important step in LP implementation. It helps us to recognize wastes from value-added (VA) activities. VSM is the second step in Womack and Jones LP adoption model. In their models VSM comes right after that the value is defined, and before attempts are made to remove wastes (Create the flow).

In VSM three types of activities are recognized (Hines and Rich, 1997).

1. Non-value adding (NVA);
2. Necessary but non-value adding (NNVA); and
3. Value adding (VA).

The first type must be removed to promote efficiency. And the second type is NVA but is necessary in a process (e.g. opening packages by operators).

2.2.2 Single Minute Exchange of Dies (SMED)

The nature of the production processes at Rosti demanded many setups for molds and lines. Sometimes they were faced with 5 setups in each week that could easily occupy 30% of the production capacity.

A core idea in LP is the Just in Time (JIT) system; sometimes it is referred as small lean. In JIT, many wastes are removed by manufacturing whenever a customer asks for a certain amount of certain product in a certain place and time. In order to be flexible enough to produce as soon as a customer leaves an order, it is essential to reduce the batch sizes to the ideal one piece.

To achieve the one piece flow it is essential to reduce the setup times to zero (ideally). “Setup refers to the activities related to the changing of a production process from producing a
batch of one product or product variant to producing another batch of, usually, product or product variant” (Olhager, 2010,p.4). The longer a setup is a bigger batch has to be manufactured to satisfy the changeover costs (Equation 1). It is the reason why Single Minute Exchange of Dies (SMED) has been invented, as a core technique, by Toyota and Shingo Shingo.

In 1970 when Shingo Shingo reduced the setup time on a 1000-ton press from 4 hours to 2 hours, the management asked to reduce the setup time even further to 3 minutes. Shingo applied 8 techniques and within few months they achieved the 3 minutes exchange target. Below we study these eight techniques:

1. **Separate Internal from External Setup Operations**: In SMED first internal and external setup elements must be recognized; while changing over a mold or die, the activities that just can be carried out while the machine is shutdown are called *internal setup elements* while the activities that can be accomplished while the machine is running is called *external setup elements*.

For example, moving the new mold and tools to the operation location is an external setup element while mounting the mold on the machine is an internal setup element. By separating internal setup elements from external elements, setup time can be reduced between 30 to 50 percent (Shingo, 1989).

2. **Convert Internal to External Setup**: This is the most powerful principle toward achieving Single Minute Exchange of Die. It is essential to reduce the amount of tasks that have to be accomplished while the machine is shut down. For example, pre-heating mold to reduce the trial time; or interring the new product processing parameters before stopping the machine (but not running them) can reduce the adjustment time considerably.

3. **Standardize Functions, not Shape**: Standardizing molds to reach the same height can add an unnecessary cost, but “function standardization requires only uniformity in the parts necessary for the parts setup” (Shingo, 1989). For example by adding a certain thickness of a palate to the edge of the mold can allow using same clamps in different setups.

4. **Use Functional Clamps or Eliminate Fasteners altogether**: Screws and bolts are not the only way to fasten molds and fixtures on machines. To eliminate fasten and unfasten times some functional clamps can be designed that can reduce fastening time to just some moments. For example a screw with 15 threads have to be turn for 15 times, while practices shows that just the last turn is enough to fasten it, so the threads can be reduced to 2. Shingo (1989) brought some of the examples of functional clamps in his book (pages 49 and 110).

5. **Use Intermediate Jigs**: For some products, to process them they needed to be centered on the mold for further process; intermediate jigs can be used to fix the next component on it, while the machine is processing the previous component; after the ready jig can be mounted in molds or machines.
6. **Adopt Parallel Operations**: In many setup operations when the molds are big or the setup have to be carried out in two side of a machine (e.g. Injection molding, die-casting and etc.), the setup time can be carried out with two or more operators. The setup time can be reduced by at least 50% because some unnecessary movement can be eliminated.

7. **Eliminate Adjustments**: Adjustment and trial runs account for 50 to 70 percent of internal setup time (Shingo, 1989); therefore, eliminating them can reduce the setup time considerably. Usually adjustments demand more skills and experience, but it can be eliminated if for example gauges are used. For example in positioning limit switch it is very beneficial to use gauges to locate the precise position of the switches.

8. **Mechanization**: Mechanization is often necessary in moving big molds and dies. Hydraulic and pneumatic pressure can be applied in this technique. However, it should be considered that mechanization is the last technique that should be used, because using other techniques can considerably reduce the setup time to minutes and mechanization just reduce it for few more minutes.

![Flow chart for applying the eight SMED techniques](source)

*Source: Shingo, 1989, p.54*

### 2.2.3 Standardization

“Standardized work is our playbook; the safest, easiest and most efficient way of doing the job that we currently know” (Dennis, 2002, p.47). The standardized work has given the details of the sequence and timings of doing a task. There might be different sequences to complete the job, but the standardized work is the safest, easiest and most efficient way to do the job with the current understanding and technology.

Rosti AB had 5 different shifts, and in each shift each operator carried out many different tasks; therefore, studying how standardization can be useful to bring discipline to the work.
environment become important in this research. Furthermore, standardization can assist also other techniques such as SMED and Continuous Improvement.

Standardization of tasks has become a science since mass production invented. In mass production system, industrial engineers were always timing the fastest possible method to accomplish a job and based on that expecting other operators to manufacture a certain amount of components over a certain time. The problem with this system is that operators always try to keep standards low to reduce the expectations from their managers. Furthermore, in this system since the focus is on quantity the quality can be affected negatively, which is not desirable (Liker, 2004).

In contrast to what standardization is in mass production, lean production standardization is the foundation for continues improvement. When a task is standardized then it provides the opportunity to measure how changes in the sequence and the way a task is done affect the results; in fact by standardizing tasks we can compare different ways to complete a job and then choose the best one. It is why standardization is the basis of continues improvement. (Liker, 2004).

*Today standardization ... is the necessary foundation on which tomorrow improvements will be based. If you think of “standardization” as the best you know today, but which is improved tomorrow-you get somewhere. But if you think of standards as confining, then progress stops* (Henry Ford, 1926).

As we discussed in the previous paragraph, Toyota consider the standardization as the same way Henry Ford had been expecting in the quote. In lean production it is the employee who decides about the best way of carrying out a job (i.e. of course under the supervisory of their engineers). Below we review five benefits of standardizing tasks, from Dennis (2002):

1. *Process stability.* "stability means repeatability"; therefore, it is necessary to achieve a certain level of productivity, quality, cost, lead time and safety daily. Standardization is a valuable help to achieve this aim.

2. *Clear stop and start points for each process.* By being aware of market demand and consequently Takt time, it is possible to know which cycle time we need and then measure where in the schedule we are; for example whether we are behind or ahead of the plan.

3. *Organizational learning.* “Standardized work preserves know-how and expertise. For example, if an expert employee leaves the company, we won’t loss his/her experience”.

4. *Audit and problem solving.* Standardization makes it possible to assess current condition and identify problems.

5. *Employee involvement and poka-yoke.* Since the team member develop standardize work, they can also find inexpensive solutions for the error-proofing.
2.2.4 Fishbone diagram

One of the quality tools which have widely used to locate problem cause is the Fishbone Diagram (Figure 2), which also is called Ishikawa diagram or Cause-and-effect diagram. The tool doesn’t specify the root cause of the problem, but it assists to review different possible sources of a problem.

Montgomery (2002) listed Cause-and-effect diagram in the forth step of his “Magnificent Seven” tool to “identify improvement opportunities and to assist in reducing variability and eliminating wastes”. The Cause-and-effect diagram is used after Pareto chart, in which the problem has been identified. Therefore when the problem was located, it is time to identify the problem cause(s) from different potential resources in Fishbone diagram (Figure 3).

Figure 2. Fishbone diagram

![Fishbone Diagram](image)

Source: Ahmed (2009), p. 16

2.2.5 Root cause identification

One of the principals in Toyota is to “base decision on a long-term philosophy, even at the expense of short-term losses”. It is why in LP emphasis always has been on solving the root cause of the problems, rather than just getting rid of the problem. Root cause identification may demand more effort, time and money to solve a problem but, by identifying the root cause of a problem it prevent the problem to happen again.
In order to identify the root cause of the problems, in LP, 5Whys analysis is applied. In this simple and effective method, 5 consecutive questions are asked, in which in each question we questioning the answer to the previous question. The answer to the fifth question is the root cause of the problem that must be removed.

Figure 3. Practical Problem-Solving Methodology

Source: Liker (2004), p. 256
In the Figure 3 you can see the methodology that is used to solve the problems. In this practice, first the problem must be explained and clarified thoroughly; then through using the Fishbone-Diagram, possible causes of the problem must be located; subsequently the most probable point of cause should be chosen. After that, the 5-Whys is applied to investigate the root-cause of the problem. After identifying and implementing the corrective actions, some measurements are performed to see if the action had been effective in the results. If the results are satisfactory, then some standardization toward that must be decided to prevent the same problem in similar situation.

Now after studying some of LP major techniques and before study some of the social issues of lean, it is good to learn also about OEE (i.e. Overall Equipments Effectiveness) for two reasons. The OEE can be used to measure how lean techniques implementation has made changes in the productivity results. Furthermore, since the Rosti AB was using OEE to illustrate its performance, it is good to study that in theory chapter.

### 2.2.6 Overall Equipments Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is a tool to measure production performance by measuring the values of availability, performance and quality. The OEE is usually used after implementing lean production to measure the improvements; however, in many companies OEE is the tool to measure the improvements in Total Productive Maintenance (TPM) (Bulent, 2000).

**Calculations of OEE components:** The first measured term is machines or processes availability. “The availability element of the OEE measure is concerned with the total stoppage time resulting from unscheduled downtime, process set-up and changeovers, and other unplanned stoppages” (Bulent, 2000).

\[
\text{Availability(\%)} = \frac{\text{Actual Operating time (mins)}}{\text{Planned operating time (mins)}} \times 100\%
\]

Where

\[
\text{Planned operating time (mins)} = \frac{\text{Total Shift time (mins)}}{\text{planned maintenance (mins)}}
\]

And

\[
\text{Actual operating time (mins)} = \text{planned operating time (mins)} - \text{unplanned maintenance (mins)} - \text{minor stoppage (mins)} - \text{changeover (mins)}
\]
The second element which is measured is Performance Efficiency. “This measures the ratio of the actual speed of the equipment to the ideal speed” (Bulent, 2000).

\[
\text{Performance Efficiency} \% = \left( \frac{\text{Net operating rate} \times \text{Operating speed rate}}{100} \right)
\]

Where

\[
\text{Net operating rate} = \frac{\text{No. produced} \times \text{Actual cycle time}}{\text{Operation time}}
\]

And

\[
\text{Operating speed rate} = \frac{\text{Theoretical cycle time}}{\text{Actual cycle time}}
\]

Quality rate is the last element we measure, which is the proportion of number of non-defected products per total number of manufactured products.

\[
\text{Quality rate} \% = \left( \frac{\text{Total no. produced} - \text{No. scrapped}}{\text{Total no. produced}} \right) \times 100
\]

2.3 Lean production and challenges

Lean adoption is not just techniques but also social aspects. Under this headline, we investigate some of the social issues that were visible at Rosti AB. First we review the contextual factors that can hinder lean adoption attempts; then we review some strategies to encounter change barriers and resistances. After that we review some literature about employee participation and empowerment; and we also review some practices to empower employees. Since, empowerment and participation are highly linked with employee motivation, both internal and external motivation theories are presented at the end of this chapter.

2.3.1 LP Contextual factors

Shah and Ward (2002) have investigated three internal contextual factors that possibly inhibit lean adoption within organizations. These three factors are unionization, age of the plant and size of the plant. It is important to study them in this chapter, since these factors can be quite significant in assessing the challenges we were faced with at Rosti AB.

The outcome of the paper demonstrates that among these three factors size of the plant can significantly influence lean adoption. In fact, the smaller a plant is the more difficult will be to implement lean.
However, the age of the plant can just influence some a few practices of lean production implementation. The more the age of a plant is, the more difficult is to adopt practices such as cross-functional workforce, cycle time reduction, JIT, maintenance optimization, reengineered production process and self-direction work team.

Finally, the third factor, unionization can negatively influence lean implementation. From the 22 practices that have been investigated in their study, 6 of them show negative relation with unionization; therefore, the stronger unionization is in a plant, the more probable is that an improvement implementation fails.

2.3.2 Strategies to confront change challenges

Transforming from mass production to lean production is a radical change. Making changes always have been tough for some reasons, therefore, it is important to investigate how we can prevent barriers and resistance toward changes before starting any transformation.

Beer and Eisenstat (2000) address six barriers against strategy implementation and their interaction, and then they suggest some initiatives to avoid them; while in the second and the third papers study lean barriers briefly and then offer some steps toward applying changes more successfully.

By comparing the papers from Beer et al. (1990) and Kotter (1995), it is revealed that their procedure to create successful changes is very similar and in most steps there are some overlaps, with some differences (Figure 4). Below we review these steps:

1. Establishing sense of urgency: Before starting any change effort there must be an important reason for change, otherwise people would not commit in the change activity. Both authors argued the importance of diagnosing crises, potential crises or improvement opportunities. Kotter has more emphasis on establishing sense of urgency in compare to Beer et al.

2. Forming a powerful guiding coalition: Kotter has argued that it is very critical to make a powerful coalition at least in the department that the changes have to be implemented; and then once the coalition is formed, the coalition members must be encouraged to work together, by applying some techniques. Forming coalition or change core group is discussed in the first step of change implementation by Beet et al (1990).

3. Creating a vision: Kotter discusses that after forming the coalition a shared vision must be created. The vision is essential to align employees toward the vision and a clear vision reduces the confusions and conflicts. Once the vision was made, appropriate strategies should be chosen and then based on strategies we plan to achieve the desired results. Beer et al. suggest creating the shared vision in the second step.
4. Communication the vision: In order to reduce the risk of misunderstanding and to consolidate the new vision, it must be communicated widely in daily activities. The communication must be not just verbal but also by deed.

Figure 4. Steps toward transforming successful changes; a comparison between Beer (1990) and Kotter (1995)

5. Empower others to act on the vision: Obstacles that block the vision implementation must be eliminated. The obstacle can be the organizational structure, policies or etc., and it is a big error to underestimate them, because they can ruin the change efforts. Employees must be empowered to implement apply the vision and the obstacles must be eliminated to help them to move toward the vision direction with the least barriers. The empowerment provides the opportunity to apply vision without pushing it from top.

6. Planning for and creating short-term wins: It is useful to have some short-term wins which can motivate employees and reduce the resistances. Therefore, it should be possible to measure improvement progress results. Furthermore, those employees who have
been involved in the improvements must be recognized and rewarded. Beer et al. barely have discussed creating short-term efforts.

7. Consolidating improvements and producing still more change

8. Institutionalizing new approach

2.3.3 Empowerment and participation

Since lean production has been defined as the excellence in processes, therefore, participation of the operators, who know the process better than anyone else, is critical. The changes we were planning to implement at Rosti were supposed to be implemented on production floor; therefore, it is important to study the theory of participation and empowerment in this thesis.

Participation and empowerment are two terms that accompany each other (Johansson et al., 2004). It is important to have first a definition of these two terms.

Participation is the totality of forms and intensities...by which individuals, groups, collectives secure their interests through self-determined chose among different possible actions in the context of organized interaction; or, a process in which influence on decision making is shared between hierarchal superiors and their subordinates... (Wagner and Gooding, 1987, p.524).

From the above definition, participation is influencing on the decisions which are made in different levels of the company. It can be technical decisions, which is directly involved with work, and it can be interest decisions that are related to the interest of the participants (Heller, 1998).

In a paper by Lincoln et al., (2002) the meaning of Empowerment is defined under different titles of non-management and management disciplines. Non-management discipline can cover empowerment of women, minority groups, education, social work and community care and politics. In this research when we discuss of empowerment we mean the second title which is management discipline. The definition of the empowerment is different from point of view of employees and managers. Mangers perceive empowerment as a tool to involve employees in the hierarchal low-level improvements, but employees perceive empowerment as the possibility of influencing in higher levels of the organization (Hill and Huq, 2004).

Empowerment has been identified as the pre-condition initiative in creating excellent enterprises and has been addressed as the foundation TQM has been built on it. By empowering employees are given the authority to plan, check and decide about improving their work and be responsible for them; through this (empowering) employee benefit both themselves and their companies (Dahlgaard and Dahlggaard-Park, 2006). In TQM the continues improvement activity should be practiced by those who are involved in the processes, for this purpose a bottom-up organization have to be exist to empower employees in problem solving (Hill and Huq, 2004).
The authority in decision making by employees, in lean, is essential to have more rapid and reliable decisions which can be made whenever there is an issue in production lines. Actually, by leaving the responsibility of the job to the frontline employees, they don’t need to refer any issue to top of the organization and then wait for a reply from them (MacDuffie, 1995). Other researchers (Appelbaum, 1997; Cappeli et al., 2000) also mentioned that in contrast to traditional mass production, front-line workers must be allowed to participate in decision makings. “Rely heavily on transferring decision makings to individual employees-empowerment- and using teams as substitutes for management structure” (Cappeli et al., 2000). Åhlström and Karlsson (2000) have also addressed the importance of the decentralization and decision making during changes.

The success of the quality strategy (Lean, Six Sigma and TQM) depends on participation of all employees that become possible through empowerment and partnership. This participation takes place when there is an organizational excellence (Dahlgaard and Dahlgaard-Park, 2006).

In order to make organizational excellence, trust has been focused more than other elements which help to make excellent organizations. Dahlgaard and Dahlgaard-Park (2006), addressed trust as “prerequisite for communication and dialog, building people relationships, building competencies and capabilities and for building a co-operative culture”. If managers demand employees trust, they must trust first on their employees. At the absence of trust, that is a central element in Core Values (CV), employees can lose their motivation by feeling their voice have not been respected in the process. Even though, they might have opportunity to participate in decision makings (Dahlgaard, 2009).

This empowerment and autonomy in decision making can improve motivation among employees when they use their imagination, creativity, enthusiasm and intimate knowledge of their particular job (Appelbaum, 1997). However, some other researches argue that empowerment and employees involvement do not necessarily improve motivation and job satisfaction (Wagner, 1994; Vidal, 2007a); Vidal (2007a) argue that the outcome of employees involvement on job satisfaction depends on the employees desire for opportunity to get involve. MacDuffie (1995) also addresses that employee’s empowerment is sufficient enough to promote motivation among them.

Vidal (2007b) has investigated whether it is necessary to empower employees to adopt lean practices or not. He has classified previous studies in this field into three categories:

The first group of scholar has argued that employee empowerment is irrelevant to lean production. They have argued that the reason employee participate in lean practices is because of the “intensification and better process control”. Some other researchers have linked the involvements of the employees in lean production into the cultural and ideological issues. They believe that despite of decentralization in lean systems, the organizational hierarchy remains intact and “intense managerial domination” makes employees to participate in lean practices without bureaucratic control. The third perspective argues that empowerment is not a necessary elements of lean, however, some it becomes important to carry out some of lean practices.
The findings in a research by Vidal (2007b) support the third perspective. He argues that some limited levels of empowerment is enough to become lean, without the need to restructure the organizational hierarchy; however, in order to become a world class lean plant, higher levels of workers empowerment is essential, which to achieve it restructuring organizational hierarchy is unavoidable.

Now that we have studied the importance of employee empowerment and its relation with participation, motivation and trust, it is time to investigate how employee can be empowered. In the text below we review some of the techniques that can be applied for this purpose.

**Decentralization:** Empowering employees can take place by decentralization problem solving and decision making responsibilities. However, since lean production demands lots of decision makings and engagements from workers it is essential that worker have the skills and knowledge to identify the root cause of the problems and solve them. In other words, by having the knowledge and skills, they have the capacity to make right decisions. He also argues that employee’s empowerment is sufficient enough to promote motivation among them (MacDuffie, 1995). Like MacDuffie, Dahlgaard and Dahlgaard-Park (2006) also addressed training employees as an initiative to empower them.

**Delayering:** The traditional hierarchy of command and control is not flexible and suitable for the new markets which demanding more flexibility and better quality (Hill & Huq, 2004). Delayering organizational hierarchy levels also has been introduced to push the responsibility and authority to the lowest level of any organization to empower frontline employees. In an investigation by Åhlström and Karlsson (2000) they have offered that delayering should take place in early steps of LP adoption.

Åhlström and Karlsson (2000) argue that delayering improves communication and coordination; responsibility also moves down to the multifunctional teams; it also speed up decision processes, and finally it promotes employees participation which has motivating effects among them and is necessary for further improvements.

**Standardization:** Liker (2004) has addressed standardization as an initiative to empower employees. In the Toyota standardization model, employees are not faced with the bureaucracy that has overwhelmed in Taylor standardization style, nor they have to follow the standard papers that have been written by their engineers; in Toyota employees follow the standard works that they have decided about them in team. “Standards help them to control their own work”.

**Continuous improvement:** some researchers have named CI as method to empower employees and benefit the organization from the outcomes (Dahlgaard & Dahlgaard-park, 2006; Hill & Huq, 2004; Dennis, 2002). The best known practice to involve employees in lean practices is Kaizen circle activity teams (Dennis, 2002). Continuous improvement is not practical if not all the employees participate actively in (Brown, 2003). And we know that without employee empowerment they cannot make improvement changes.
2.3.4 Motivation

**Herzberg’s Job Enrichment Theory:** In the Herzberg’s two-factor theory of satisfaction and motivation, work intrinsic factors (e.g. recognition, achievement, responsibility, advancement, personal growth) are acknowledged as motivators. These internally motivators, stimulate employees to have a greater effort in carrying out their jobs (Hackman and Oldham, 1976).

In contrast to intrinsic factors, we have “hygiene factors” which are extrinsic (e.g. company policies, supervisory practices, pay plans, working condition and etc.). To motivate employees both intrinsic and extrinsic factors should come into focus. Only focusing on hygiene factors is not enough to motivate employees (Hackman and Oldham, 1976).

**Behavior Modification:** A method to motivate employees to do an action or not to do an action is “behavior modification”. In behavior modification employees are aware of the consequence of specific actions, and therefore they try to do or avoid some actions. The results of the action for example can be rewarded (positive stimulate) or be punished (negative stimulate) (Miljkovic, 2007). There are some criticisms on the idea, especially on punishment. Many researchers believe punishment could have negative reflect (Martin and Pear, 2007).

**Goal Setting:** “A review of both laboratory and field studies on the effects of setting goals when performing a task found that in 90% of the studies, specific and challenging goals lead to higher performance than easy goals, "do your best" goals, or no goals” (Locke et al., 1981). Therefore, one effective way to promote motivation among employees is to set specific, measurable, achievable, realistic, and time-targeted goals (Latham et al., 1942). “Goals affect performance by directing attention, mobilizing effort, increasing persistence, and motivating strategy development” (Locke et al., 1981).

**Hackman and Oldham (1976)** have offered a model (Figure 5) in which the design of the work helps employee to become more motivated, through addressing motivation theories (e.g. Herzberg’s job enrichment) in practice. As it is illustrated in the graph below the degree of skill variety, task identity and task significant a job demand influence on the meaningfulness of a job. The more autonomy increases the responsibility of employees for the outcomes of the job; and if employees know how they have affected the results of their jobs than it increase the work activity. All these factors (Core job dimensions) if designed appropriately can lead to a higher internal motivation, work performance, job satisfaction and lower absence at work.
**Figure 5.** The job characteristics model of work motivation

Source: Hackman and Oldham, 1976, p. 7
3 Methodology

In this chapter, first we review qualitative research methodology that has been used to collect data in this research. After that how I did participated at Rosti AB to carry out the implementation job is presented.

"Quantitative research is a situated activity that locates the observers in the world. It consists of a set of interpretive, material practice that makes the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recording and memo to the self. At this level qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of meanings people bring to them" (Denzin et al., 2005, p.3).

Qualitative research is very popular in social sciences and marketing researches, where understanding human behavior in depth is essential. There are five different approaches in qualitative researches (Creswell, 2007): narrative research, phenomenological research, grounded theory research, ethnographic research, and case study research.

3.1 Case study

The definition of case study is to study of an issue by studying the by studying one or more cases within a bounded system (Creswell, 2007). Some researchers argued that case study is not a methodology but a chose to study what (Stake, 2005). There are three different types of case studies (Creswell, 2007):

Single instrumental case study; in this type of case study, researcher(s) choose a single case to study a specific problem or issue. A good example is our Rosti case of study.

Collective case study; numbers of case studies are chosen usually to study an issue or problem. Sometimes collective case study is chose to give comparative results, it is very important when the results are desired to be generalized.

Intrinsic case study; in intrinsic case study, the case study is chosen because it is different from other cases and the purpose of study is to focus on the case itself.

According to Creswell (2007), there are five steps in doing a case study qualitative research. In the first step it must be investigated if the case study is a suitable methodology to study the research problem. In the second step, the case study must be chosen. It is very important to choose an appropriate type of case of study regarding the problem.

Since lean implementation has mainly performed on production lines, therefore, I chose Rosti AB because I was familiar with their production processes, since my bachelor is in Polymer Engineering and I have three years of work experience in molding industries. I sent
my thesis proposal to 9 plastic manufacturers in Linköping and Norrköping and Rosti AB was interested in the thesis proposal. How to collect data in the case study is the third thing it should be decided. The data collection can be interviews, direct observations and etc.

In the fourth step it should be decided whether the whole case of study is going to be studied (holistic analysis) or just some particular aspects of the case study will be investigated (embedded analysis). In the Rosti case, the attempt was to implement the improvements just in the production department and not the whole company. And finally, it must be addressed whether the findings have come by accomplishing the study or if the findings are the results of the specific situation of the case study.

### 3.2 Qualitative research interview

“The qualitative research interview seeks to describe the meanings of central themes in the life world of the subjects. The main task in interviewing is to understand the meaning of what the interviewees say” (Kvale, 1996). Because many times interviewees do not frankly address what they feel about an issue, therefore, this is the interviewer job to grasp the themes behind the words.

This sort of interviews can be structured, semi-structured or unstructured (Figure 5). In the structured interviews same questions in the same order are questioned from different interviewees. This kind of interview is mostly used for quantitative researches, for example for gathering statistical data (Ekholm, 1992).

In the semi-structured interviews, we have a more flexible interview in compare with structured one. In this type of interviews, which is broadly used in social science, new questions can be added or changed during the interview; however, the topic of interview must be thought in advance. Unlike the structured interview we have unstructured interviews, in which questions and topic are not prepared in structure, and the topic can be changed by the interviewees’ degree of understanding and belief. The use of such interviews is limited and they usually are used to collect data when the research subject is sensitive (Wiesner and Cronshaw, 1988).

Rosti AB have been investigated widely as a case study for this research, and large amount of data collected through formal and informal interviews with many employees and managers. Moreover, some information also is my interpretations from the observations I had at Rosti Primpac.
All the interviews carried out in English. In fact, from 65 employees just two of them couldn’t speak any English and many of them could speak fluently that was very helpful since I cannot speak Swedish. Some of them seem to be very eager to speak and it seems to me that they are happy for practicing and using their English knowledge.

**Figure 6. Different methods for data collection**

<table>
<thead>
<tr>
<th>Unstructured</th>
<th>Direct</th>
<th>Spontaneous Observation</th>
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<td>Inqury with Open questions</td>
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Source: Ekholm (1992)

### 3.2.1 Semi-structured interviews

I interviewed Rosti Primpac employees with prepared questions and writing down their answers to questions while they were exposing their ideas. The main part of the interviews that I had with managers was semi-structured.

An interesting observation from interviews was the majority of white-collar employees seem to be more confident to be interviewed in semi-structured style, and they tried to explain all details that may be helpful, but in contrast, the blue-collar felt more shy and uncomfortable to semi-structured interviews.

### 3.2.2 Unstructured interviews

Many interviews performed in unstructured style. In the unstructured interviews we had conversation about different subjects such as the company future, improvement opportunities, challenges about implementing improvements and etc. Blue-collar were very open to these conversations, especially when they were fluent in English. Actually they may come across at our conversations as a friendly discussion rather than an interview.

By the time passed I found more close friends at Rosti Primpac. This was very valuable because when we had discussions about the company and their feelings about issues and people inside the company they went deeper and revealed their true feelings they never expressed before.
Every time after the unstructured interviews I wrote down all the important points from the dialogue. In many cases they made a point about an issue indirectly and I tried to grasp all these and have my interpretation.

### 3.2.3 Observations

An important fraction of the information, in this research, is my own observations in the company. As the famous proverb says: “actions talk louder than words”. Many times I was standing or walking on the production floor and taking note of whatever seemed important or interesting.

There was many challenges in adopting changes at Rosti AB. Below I have some examples of them:

In applying a change in a routine we were faced with two barriers; first the manager needed to be satisfied that applying a new concept will improve the productivity, and then operators must be motivated enough to apply the decided changes on the routines.

Management was thinking that the thesis is an experimental job and we are testing a new method there and this issue made them to not to take risk on making big changes; therefore, I always had to explain that LP had been adopted by many companies and enjoying the benefits and that what we are doing is not testing a new method.

If I was one of their employees, I could have more power, trust and authority to transform changes. Finally, the company was suffering financially, therefore, in making changes we always were limited financially and this made sources (manpower, money) always limited. In sum making improvement changes were much tougher than what I expected at the beginning of the project.

### 3.3 OEE data

I had access to the OEE results from a computer in production floor. The data from OEE was used to identify problems and the magnitude of problems. The data of the OEE also was supposed to be used in illustrating the improvement progress.

The data from OEE system was reliable both for *performance* and *availability*. However, the data for *quality* was not that reliable, because, operators really didn’t counted the number of defected parts, since it demanded a plenty of time, and they deducted the number of packed products from the number that the machine was shown as the number of produced pieces.

The quality of data from the interviews with operators are highly reliable, because they expressed their comments in unstructured interviews, as two friends discussions, that is more honest than a structured formal interview. However, the data from interviews from managers may not be as reliable as operators, because it was more formal and semi-structured, but still they can be classified as reliable data.
The company condition may have affected the results of the implementation. Two months before I start the project at Rosti AB, they were acquired by their rival in Scandinavia. There was this rumor that the new owner is going to shutdown the company and transfers the equipments to its facility in another city. The situation may have affected on the motivation level of both operators and managers and made the implementation more difficult. Besides, the project carried out in a single case of study that makes the generalization of the thesis difficult; however, we should notice that except some gaps between literature and the finding of this research (which are explained with details in analysis chapter), the rest of the findings can be supported by literature. Therefore, we can generalize the findings by caution.

In the implementation process my responsibility was to plan improvements and to carry out them in collaboration with the production manager and a lean specialist. Identifying improvement opportunities, planning for them and tutoring operators with the concept of lean that were planned to be implemented were my responsibilities.

In order to analysis the outcomes and challenges of the project, first the improvement opportunities in Rosti are investigated; then these opportunities have linked to lean techniques. In the third section, the challenges are investigated and then the theory assisted the results to analysis the challenges more in depth and have some suggestions to overcome them. Identifying gaps between theories and the empirical data is an important section of this thesis, since it helps to us identify why some LP implementations may fail.
4 The company background & PET technology

The company established in 60s in Malmo for food packing purposes. Rosti Primpac AB had been owned by a big Danish company, which is active in oil industries. In 80s the company moved to Norrköping, to its current site. 25 years ago when they moved to Norrköping they were manufacturing mostly PVC packing for food industries, but since 20 years ago, by introduction of PET technology, PVC bottles gradually vanished from market and therefore, Rosti AB also shifted to the new market.

The market’s demand for PET bottles grew until 2004. As a result, the number of operators (blue-collar employees) soared up to 110 between 2000- 2003. In 2002 Rosti made some investments to increase its production capacity. They added one big injection machine and one big fully automated blowing machine. They cost about 70 MSEK (Rosti AB was sold for around 50 MSEK in 2011). They also established a sister firm in Stuttgart, Germany, since they had some big customers in Germany, such as EBD. Many others in this segment of market were also investing to increase their capacity, because the market was growing. In 2003 Rosti was the best company in Norrköping and the number of employees was at its peak.

In 2004 the PET demand growth, for Rosti AB, not only halted but it also declined; this mainly happened because of three reasons. First, the products’ life-cycles the market for PET bottles, matured in 2004. Furthermore, some big customers decided to have their in-house bottling lines; and finally, some of the customers changed their supplier, such as Coca-Cola. Coca-Cola, the biggest customer for Rosti products, changed its supplier, because Coca-Cola demanded a lower price on bottles.

Since then the Rosti AB sales shrank and the Rosti had to lay off some employees yearly. In 2007 the number of operators falls to 60 and in 2009 this became 51. From 2007-2010 the company financial balance was negative over three consecutive years, though, in 2010 it became slightly positive after dismissing 18 more employees.

In fall 2010, Rosti was sold to Petainer AB, the biggest Rosti AB’s rival in Scandinavia, which is controlled by a British financial firm. The new owner shut down the company by Aug 2011. The new owner transferred the Rosti AB equipments to its site in Lidkoping.

4.1 Products

The variety of the products was not wide. It was product family of the PET bottles with different designs, raw materials (i.e. the grade of the plastics) and different levels of quality demands. They can be classified into standard and customized bottles.

4.1.1 Standard bottles

Many big customers using standard bottles (products), for their beverage packing, because these products are cheaper in price and a wider range of manufacturers producing them regularly. The economy of scale is the reason this products are cheaper. Almost all managers
who I interviewed believed they cannot compete with other bottle producers in standard bottles market. Others rivals were offering cheaper price for standard products.

Rosti managers mentioned two reasons for Rosti inability of offering cheaper price for standard bottles. One the one hand they believed, since some competitors have bigger machines and molds, therefore, they can produce cheaper, or in another words because of the economy of scale (EOS) competitors can offer a lower price. On the other hand, they thought new competitors from Eastern Europe can produce cheaper because the labor cost is lower in their countries.

4.1.2 Customized bottles

The biggest deal Rosti was faced with, in manufacturing customized product, was their order volume. Customized bottles usually have low volume, compared to standard products. However, the Rosti machines were designed for mass production. As a result, it was not economical to manufacture a small order on a big machine. For example, in one case they received an order to produce 300,000 of one of the bottles; the changeover lasted for 55 hours and then the production lasted for less than two days (the throughput of the machine was about 12000 bottles/hour). The company was accepting all these orders since they had overcapacity.
4.2 PET bottling technology

PET (Polyethylene Terephthalate) bottling technology is almost a young technology. We all can remember that not many years ago almost all beverages’ packing was glass or aluminum, still some are. But, PET market has garbed a big share of beverage packing market. The new markets for PET are still introducing, for example some countries going to use PET for alcoholic drinks packing (especially for beers). A big consideration about PET bottles is the environmental impact of this material, which has limited its application in some areas or countries.

To manufacture PET bottles two main processes are used in consequence. First the raw PET material is formed to a so called Pre-Form, using injection molding process, then the pre-forms are blew in blow molding process.

4.2.1 Injection Molding Process

Injection molding process have widely used in plastic industries since 50’s. The majority of plastic components are formed through this process. In this process the melted raw material (plastic) injected to a mold and the mold cavity forms the components and then after solidifying the plastic component(s), they are ejected from the mold. It is an economical process when the production volume is high enough to cover the mold price; because, sometimes the mold costs even more than an injection machine.

The quality of manufactured components highly depends on 4 factors: 1. Quality of injection machine, 2. Quality of injection mold, 3. Plastic raw material quality, and 4. Injection parameters setting (temperatures, pressures, speeds and etc.). Once the three first factors met quality levels and the fourth factor (parameters) set correctly, the components can be manufactured within the quality boundaries and no operator to be needed to take care of the machine and quality.

Figure 8. Borche injection molding machine

Source: www.borch-machinery.com
4.2.2 Blow molding process

Blow molding process is used not only for PET materials but also for other type of plastics’ blowing. In this process, and for PET blowing, the pre-forms from the previous step (injection molding) are feed to the blowing machine (Figure 9) and then they heated to help softening them so by blowing air into the pre-forms, the pre-form expand until it reaches the mold walls, and then it shaped the mold form. Here again the first three aforementioned factors plus the quality of pre-forms determines the quality of the finished products. Blow molds prices are much cheaper compared to injection molds. Thus even small quantities of a bottle can economically cover the mold price.

Figure 9. CPSB molding machine

Source: www.sidel.com
5 Results

In this chapter I present the results in two sections: technical and social. In the technical section we review the outcomes of applying the first three steps of Womack & Jones LP adoption method at Rosti AB. Once the sources of the inefficiencies identified in the third step, we study the nature of the most important inefficiencies in detail. In this chapter we can spot how visible and huge were inefficiencies.

Finally, we study the challenges of LP adoption at Rosti and for this purpose the interviews with managers and operators are present. Even though they may seem not as important as technical aspects, but they will widely used in the analysis chapter.

5.1 Lean Production Implementation

Under this heading we study the first three steps of the Womack and Jones (i.e. Specify value, value stream mapping and create the flow). After that we investigate some of important improvement opportunities on the production floor.

5.1.1 Step 1, Specify Value

The interviews with the CEO and marketing manager indicated that value could be different for standard and customized bottles. For standard bottles, customers expected that products already have met some quality levels and flexibility in delivery time and satisfying the two criteria the offered price becomes the order winner. However, for customized products, the flexibility in design and development of a new product in the shortest possible time with small batches of orders were recognized as significant as price by the customers.

5.1.2 Step 2, Value-stream mapping

Polyethylene Terephthalate (PET) is produced in petrochemicals from Terephthalic acid and Ethylene glycol. Rosti AB bought most of its needed PET from Netherlands. Different grads of PET were used for different bottles with different physical and chemical characteristics. The raw material transported to Norrköping by trucks. Rosti AB has two different styles to stock the raw materials. The raw material can be either stocked in big silos or be kept in 2 tons containers.

Prior to feeding injection machines with PET material, PETs are required to be dehumidified at 125°C, for about 4 hours, in order to cut the possible moisture content below 0.02%. After degassing raw materials are transferred to injection machines through vacuum pipes from silos or containers.

The raw PET then get melted and injected to the molds, using “Hot-runner molds”. Each mold had between 12-48 cavities. This means in each injection between 12 to 48 pre-forms were manufactured. The more cavities the mold has, the bigger and more expensive the mold is and the bigger injection machine it needs. After each injection the plastic melt solidify and
forms the cavity shape. After that, the mold halves open (separate) and a robot detach pre-forms from mold cavities and lay them down on a conveyer. Then the conveyer transfers them to a container. The production cycle-time here is between 15-60 seconds, depending on the product type. Once the container reached its capacity, an operator makes it ready and puts a label on it which contains the product and production specifications. A lift-track transports the container to inventory.

Some customers buy pre-forms directly and blow them in-house, therefore some pre-forms transport to customers after sometime from being stocked. The length of the time they may be stocked highly depends on the product. Some products are standard, and have more than one customer, therefore, are produced regularly over the year. For such products they usually stocked for 3 weeks demands. But, for the customized pre-forms which usually have one customer, they are manufactured once they receive the order from customer; such products have to be stored for a short length of time.

However, the majority of the pre-forms are manufactured to be blown in blow molding process. Again, the length of the time the pre-forms may wait to be transferred to blowing process highly depend on if they are standard pre-forms and can be blown for different customers or if they just manufactured for a specific customer. If they are standard products usually it take about three to four weeks to be socked in order to be sent to blowing process, but this time span is one to two weeks for non-standard pre-forms. Another important issue about pre-forms waiting time in stock is that since blow molding machines can process faster than injection moldings, pre-forms have to be manufactured some days in advance to ensure blow molding process would not be out of pre-forms.
**Production Control**

- **Standard products (MRP)**
- **Customized products (irregular planning)**

**Weekly Scheduling**

**Indorama Co. (Netherlands)**
- 60 tones (one grade)

**Injection Molding**
- C/T = 2 Sec
- L/T = 40 mins
- Uptime = 70%
- 3 shifts
- EPE = 7 days

**Blow Molding**
- C/T = 60 sec
- L/T = 3 hrs
- Uptime = 60%
- 3 shifts
- EPE = 5 days

**Shipment**
- Shipping to warehouses
- Shipping to customer

**Value Stream Mapping at Rosti Primpac AB**

**Figure 10. Value-Stream Mapping at Rosti AB**

- *Indorama Co.*
- *Production Control*
- *Weekly Scheduling*
- *Injection Molding*
- *Blow Molding*
- *Shipping to warehouses*
- *Shipping to customer*
Once pre-forms bottled in blowing machine, they automatically are transferred to palletizer to be packed. All the blowing and palletizing process accomplish automatically in one line, without the need of any operators to do anything manually. However, some of the palletizes were required to be supplied with the packing materials by operators every 20-40 minutes. The whole process from the moment a pre-form is feed to blowing machine until the pallet completes, takes between 20-60 minutes, depending on the size and machine throughput.

Pallets then labeled by an operator and then transferred to inventory by lift-tracks. Once again the length of the time the pallets kept in the inventory differs for standard and customized products. But it usually was less than what we had for pre-forms because, bottles occupy much bigger space compared to pre-forms and therefore, they call for a vast space to be stored. Pallets were delivered to customers by trucks.

5.1.3 Step 3, Create flow (waste elimination)

After accomplishing VSM and reviewing all the activities on the value stream, in collaboration with employees, it was time to review the production process in more detail to identify sources of inefficiencies.

Here we review three issues of mold setups, equipment effectiveness and defect rates in detail to have the opportunity to have a more robust analysis in the next chapter (i.e. Analysis). Having bachelor in Polymer Engineering and three years of experience in plastics’ molding industries was very helpful for me to present the process details in this part.

Since these three issues of setup times, equipment effectiveness and defect rate have a great influence on the OEE, which was the tool to measure the productivity at Rosti AB, below we study the details of these concerns at Rosti.

5.1.4 Setups and details

The most evident inefficiency at Rosti AB was too long changeovers. The changeovers last between 4 to 72 hrs depending on the machine, line, product and operator. The data from their OEE (Overall Equipment Effectiveness) shows that in 2010 setup times included 17% of their machines capacity. Interviewing with managers revealed that it is a big problem and setup times should be reduced. One of the engineers told me that from the time he was working there, since 10 years ago, everybody says that the setup times must be reduced, but the situation has not been improved over these years.

Changeovers on injection machines were very different from blowing molding machines. On injection machines usually first a big mold and the robot required to be setup and adjusted and then the process parameters were adjusted to have products which meet quality specifications.

Usually a complete mold was not required to be replaced. Depending on the product specifications, different segments of the mold were required to be replaced. For example, in some molds it was required to replace the mold cores, which usually didn’t last more than 5
hours, but if the mold’s *hot runners* were needed to be replaced then it usually took over 24 hours to be installed.

Rosti AB had two experienced operators who were responsible for accomplishing injection molding setups. They didn’t follow any standard procedure to carry out setups, and each operator had its own way to perform the job. Normally setups were carried out by one operator.

I noticed that a large fraction of the times, meanwhile changeovers, operators were not working on setup task. Almost always they had to interrupt the changeovers because they had to solve a problem or situation on another machine such as: looking for a tool, coffee breaks, lunch time, long conversations and etc. It seemed to me that the least important activity at Rosti is to do the changeovers in the shortest possible time, and everything has priority over it.

After installing the new product mold on injection machine, the injection process also required to be adjusted in order to have a smooth production process and produce products which meet quality specifications. These parameters were speeds, temperatures and pressures, on different segments of the machine, mold and the robot. The numbers of them were exceeding 200 figures; and all these process parameters were adjusted by experience, regarding the product, mold, raw material and injection machine, by a technician.

The technician had to spend a long time on changing figures on the machine panel to remove the process and product problems and to make sure that the machine will run smoothly with no defected products.

Changeovers on blow molding machines (bottling machines) were different from injection molding. In order to shift from one product to another one in addition to the installing new molds, and not just a single mold, the line also had to be adjusted with the new product and robots also required to be tuned more extensively. The number of molds on each machine varied from 3 to 10. In most cases the setup didn’t terminated by setting up the molds, lines and robots, and many stops happened in the bottling process after each changeover and operators had to recognize the source of the problems and remove them to have a smooth production. Sometimes it took up to one week to vanish all the error sources on a big machine and a product typically was running on a big line from 1 day to 3 weeks depending on the order size.

*SMED* was the first tool we decided to implement. First I prepared the improvement plan; then, I discussed them with the Production Manager and the Rosti’s Lean Specialist. They agreed upon the planes and we decided to perform some changes toward implementing the above initiative.

The first step to implementing SMED was to teach operators and supervisors the concept of SMED. The tutoring sessions took place at the beginning of evening shifts meetings, where employees met to discuss the production issues. It was not difficult to help operators understand the above concept, since they could understand how it could be beneficial with
real example from their company. They discussed the concept and seemed to be enthusiastic. At this point I was happy because it seemed to me we were going to have a successful improvement in setups. A distinctive issue was that the production manager was absent in all the tutoring sessions because there was always a task to be done.

**Table 1. Changeover on Injection and Blowing Machines**

<table>
<thead>
<tr>
<th>Changeovers on injection molding machines</th>
<th>Mold(s) setup</th>
<th>Process adjustment</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5 hrs</td>
<td>4.5 hrs</td>
<td>This is just an example and it is not true for all the changeovers at Rosti</td>
<td></td>
</tr>
<tr>
<td>Changeovers on blow molding line</td>
<td>3 hrs</td>
<td>5 hrs</td>
<td>This is just an example and it is not true for all the changeovers at Rosti</td>
</tr>
</tbody>
</table>

The next step was to apply the theories we had on paper in practice. As starting point I asked operators to do all the changeovers in team (i.e. the routine was to do the changeovers individually); it didn’t need any special technique and training.

Unfortunately we couldn’t permanently do the setups in team, because on the one hand, they have to stick with their machines since error alarms on machines chronically went off and they had to fix the problems right away, on the other hand operators seemed to be extremely unmotivated to participate actively in SMED and their managers were not serious to persist and pursue the improvement initiatives; in fact, they were also kind of unmotivated mixed with laziness.

**5.1.5 Equipment effectiveness**

As it is mentioned before, all the manufacturing processes were almost fully automated and ideally the only job operators were supposed to do was to fill the palletizer with packages and to label the finished pallets. But, in practice it was totally different and operators had to stick to their machines waiting for an alarm to go off and they run to fix it.

The data from the OEE system indicated that downtimes included 9% of their capacity in April 2011. Machines were stopped or had to be stopped chronically; sometimes over 15 times per shift and each time for about 10 minutes. In fact it had become the production routine. For examples: the palletizer couldn’t leave the packages on the right place; quality problems on the products; bottles fall from the pallets and operators had to stop the line to put them in place; a bottle blocked the conveyer; a wrong preform in a batch of 80,000 preform could cause a big trouble and shutting the line for hours; and lots of other stories.

Many employees mentioned that since the company has been in financial crisis for a long time, on the one hand they haven’t invested in new machineries; and on the other hand many employees in the service and maintenance department have laid off and as result they have a weaker maintenance in compare to the years before crisis. I noticed that operators do not fix
the root cause of the problems and just want to get rid of the alarms and run the production line with the least hesitation. Since each operator was responsible for one machine in each shift, they were responsible for the productivity rate of the line during their own shifts. Operators were trying to reduce the down times as much as possible and leave the problem for the next operator in the next shift. They didn’t trouble themselves with dealing with the source of the problems.

It was interesting that they didn’t have a reference troubleshooting manual to look for the root of the problems and once they found the solution to a problem they never document that solution for the next time the same problem occur for themselves or other operators. I remember once an alarm went off the operator couldn’t find the solution and he told me he had the same problem last week but he can’t remember how he had the problem solved; he had 15 years of experience at Rosti AB.

The management seemed not to have an explicit strategy to reduce down times and still they were pushing operators to improve OEE results with their actions. Every week they had a meeting and they illustrated some graphs from the OEE outputs and they just compared the results with the previous weeks’ results; they never made a strategy to improve the results.

5.1.6 Defect Rate

Since the profit margin for PET bottles is very low, it is essential to keep the defect rate as low as possible. The data from Rosti’s OEE system shows that in January 2011 the average defect rate in the injection molding process (Pre-forms production lines) was about 3.6% and defect rate in blow molding process (bottles forming lines) was 1.6%; therefore, the defect rate was about 5.2% in sum (i.e. because to process a bottle both processes come in sequence; please see the VSM, Figure 9).

The defects rates were different for different products, depending on many factors such as mold, material, machine, the demanded quality levels from customer and etc. The highest defect rate was about 7% for one of the products; such a defect rate can simply vanish the narrow profit margin. It is interesting to know that this product with 7% of defect rate was the biggest order of the company (i.e. the order size was about 12 millions piece per year), and still the company was not only able to reduce the defect but also it could not stop increasing the defect rate over years.

5.2 LP implementation and social issues at Rosti AB

An important part of my observations at Rosti AB was the human side of LP implementation. These observations are the results of the conversations and interviews which I had with employees and managers, or they are my own interpretations from what I heard or saw.
Interviews with CEO:

In the first meeting that I had with the CEO, we started to talk about the situation at Rosti and the problems the company was faced with. I asked him what are the reasons that Rosti get into financial crisis? He addressed the market change and manufacturers overcapacity in PET market have made it mature and now they have to sell in lower price. Then my question was what their strategy has been to get out of crisis?

CEO: we have laid off many employees and the financial balance has became positive;

Me: But this is a short term strategy, what has been your long term strategy?

CEO (After some moment he thought about question): We have started to implement 5Ss and right now with you we are working to implement Lean.

He also added: we also thinking about moving into more customized products such as bottling for chemicals industries.

He continued: “employees are the biggest barrier toward making improvement changes”. In the conversation he gave me some examples of the change planes they had but they were refused by the union. He mentioned that the unions are very powerful (i.e. both the union inside the company and also the labor union of Norrköping that have the membership of some of the Rosti’s employees). The CEO was very disappointed in making changes and was referring the employees as the second source of the crisis beside the market crisis.

The CEO believed that motivation is a big problem in their company. Many employees do not involve in improvement activities such as 5S since they are highly unmotivated. To solve the motivation problem, management decided to change the salary system, so they can pay based on the performance and reward those employees with higher performance. The decision was refused by the union and the union asked for the same salary for all the employees and yearly rise of the salary for all of them not just certain employees. The union had believed that the incentive based salary would increase the stress among employees.

During the 70 days I was working on my thesis at Rosti AB, I was never witnessed the CEO and a number of (more than one blue-collar) employees have a meeting in group and discuss the situation they were face to (i.e. since the company was acquired by another PET manufacturer and employees were worried about their future). The CEO spent about 80% of the times in his office and most of the time he met or had conversation with their customers.

5.2.1 Production Manager

The production manager was a young man about 33 years old. He started his career as operator in the company some years ago and then he left the company to study in psychology, but then he didn’t finish his studies and started to work at Rosti again but this time as production manager.

In the conversations and meetings I had with him, we discussed how lean production can eliminate wastes and promote productivity in their company. Any time I had an improvement
strategy (e.g. SMED, 5Whys and etc.) I prepared a presentation file and illustrated how the change in the routine can be beneficial and then I requested for resources to implement the changes. He always accepted the changes and coordinates the plans with supervisors. However, many times while we were already decided and planned to do a job he asked to do the job in the traditional way and because there was always some reason to postpone the actions into another day. For example the setups on blowing lines decided to be carried out in a team of three operators, but when it was planned to implement the new method in a certain setup, he had to call away operators to another job. It seemed to me that he is not serious and he didn’t want trouble himself with the new changes and actions.

He also addressed the employees as their biggest problem and he gave me some examples of how some employees act and they can never fire them. Since he was the production manager, he had a room on production office, but he rarely was leaving the room to see what is going on production floor and usually they had long conversations in his office with supervisors and quality staff.

5.2.2 Supervisors

Most of the activities on production floor were coordinated and controlled by shift supervisors. Two supervisors worked in the company while there were 5 shifts (teams) active; therefore, three shifts were always without supervision. The production manager mentioned that the OEE results showed that those shifts with supervisor have higher performance in compare to those shifts which run without supervisory; but they had to lay off three supervisors because of financial problems.

Supervisors believed they were very friendly and close to blue-collars. They believed lack of motivation was the most serious reason in keeping the performance low. In the discussion with one of the supervisors, he mentioned that employees are the real assets of the company and not the equipments, and since many experienced employees have left the company it was also another reason that why the company can’t improve its productivity.

5.2.3 Operators

The names in this section are fictitious

Viktor

Viktor had worked for 15 years for the company. When I discussed about lean Production and the idea of reducing inefficiencies, he admitted when he had started his career at Rosti he had many improvement ideas and many suggestions but nobody had listen him; he gave me some example of his suggestions. Sometimes, when the supervisors and managers didn’t apply the improvement ideas he had, he discussed the suggestion with the CEO but even the CEO didn’t practically apply his suggestions. And now he had no motivation to do it anymore. He said they never say they don’t implement your suggestion and they say they like it, but then in practice they do nothing.
In another conversation, he told me that the management did not like him and there were some certain employees which were their (management) favorite, it was why they wanted to based salary on reward to reward those favorites. Viktor was considering the CEO and the management team as the source of the crisis and he believed they were making many wrong mistakes. He believed after 15 years of experience at Rosti he did not need somebody (supervisors) to tell him what to do and what not to do.

From those 15 years, he has worked as technician for 7 in maintenance department, but they relocate him as operators again. He always wanted to work in maintenance department, but the CEO wanted him as an operator. He was looking for a new job outside Rosti.

**Erik**

Erik had been worked for 12 years for Rosti. He was operator in blowing lines. He had some background about Lean Production and he gave some examples that how LP can solve some of the problems. Erik also give some examples of the suggestions he had but they never been applied by managers. In one of the suggestions he asked for an increase (1 centimeter) in pallet size to eliminate a problem they were faced daily on the packing line. In another suggestion he asked to use a bigger buffer in the line between blowing machine and packing machine so when a problem occur on the packing machine they would have enough time to solve the problem (i.e. packing machine speed is more than blowing machine).

He believed the CEO has made many mistakes and he always gave some examples of this kind of mistakes. Erik thought they needed a stronger CEO in words, and he thought their manager was very shy to speak frankly with suppliers who did not carry out their job properly. He liked other operators and he believed having accompany of other operators was the best thing they had at Rosti. Erik believed that the lack of motivation problem is not monetary, because they were paid well enough (18000 SEK net per month).

**Carl**

He was working for the company for the last 7 years. An interesting conversation I had with him was about motivation. He also believed that lack of motivation was a serious problem at Rosti; and when I told him that the problem could be addressed with incentives, he strongly denied my reason for the problem and he believed the motivation problem was not about money. He believed their managers saw themselves better than employees and the management team never felt close to them. He added, “*when an operator says we, he means the operators and not the management*”. He gave me some examples of the company he was working before and the managers had breakfast with operators in the same kitchen.

**Daniel**

Daniel was working for Rosti for 18 years. He seemed pretty unhappy about the management team and specifically the CEO. He believed the wrong decisions the CEO had made over years lead the company to the current situation. When I discussed about LP adopting and the outcomes for Rosti, he argued that the Rosti managers would not pay attention to improvement suggestions.
He gave some examples of the suggestions he made and they never were implemented. For example he mentioned about a common problem they had when operators mistakenly connect the water pipe to the oil valves in molds and then all the oil has to be disposed and be refilled with clean oil, and sometimes the water can explode because it evaporate in hot oil. So he made this suggestion that the oil pipe and water pipe, that are in nearby each other, become labeled with colored labels so operators could easily recognize them, but their managers never implemented the suggestion. He also believed that the best thing about working at Rosti is meeting the blue-collar and the worst thing was having those managers.

5.2.4 My observations

Not only operators, but also the managers were highly unmotivated or either lazy. They seemed like to be hopeless in creating any significant change and to save the company from crisis. They knew and admitted they have lots of options to improve but then they were very slow to make the changes. Although the managers and operators didn’t like each other, but they never had a frank conversation between the two teams (operators and managers) to clarify what they feel toward each other and how to overcome the problem.

Operators may never say that they don’t do a job, but like their managers they simply don’t do it. For example operators were supposed to use 5Whys methodology to solve the root cause of problems on the production lines, but then they never practically applied it. In addition, we invested a large time on preparing standard tasks for operators to use them in order to accomplish setups, but then again they followed the same routines they were using before.
6. Analysis

In this chapter we seek answers to the research questions. For this purpose first we identify the main sources of inefficiencies in Rosti AB, and then we investigate how lean practices could help us to eliminating wastes from those particular sources. After that, the challenges we were faced with during applying the mentioned practices will be reviewed. And in the last research question, we investigate how we could overcome these challenges. At the end of the analysis chapter, two of the gaps between findings from Rosti AB and the theories are being studied.

6.1 Research Question 1: What were the main sources of inefficiencies?

Under this headline we will identify the main sources of inefficiencies in Rosti AB. For this purpose, after accomplishing VSM and reviewing all the activities on the value stream, it was time to recognize the sources of inefficiencies. These inefficiencies are prioritized based on two factors of, magnitude and the energy and money was required to eliminate that waste (Table 2).

The table completed by myself based on three elements:

- The estimated effect of improvement on the whole system.
- Detailed investigation of the process.
- My experiences and background from molding industries

<table>
<thead>
<tr>
<th>Source of inefficiency</th>
<th>Impact</th>
<th>How easy to solve the problem (money and energy)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long setup times</td>
<td>High 3</td>
<td>High 3</td>
<td>9</td>
</tr>
<tr>
<td>High downtime rate</td>
<td>High 3</td>
<td>Medium 2</td>
<td>6</td>
</tr>
<tr>
<td>High defect rate</td>
<td>High 3</td>
<td>Low 1</td>
<td>3</td>
</tr>
<tr>
<td>Unused blue-collar creativity</td>
<td>Medium 2</td>
<td>Low 1</td>
<td>2</td>
</tr>
<tr>
<td>High employee’s absence rate</td>
<td>Low 1</td>
<td>Low 1</td>
<td>1</td>
</tr>
<tr>
<td>Unnecessary transportation</td>
<td>Low 1</td>
<td>Medium 2</td>
<td>2</td>
</tr>
</tbody>
</table>
In the table, the bigger the impact is and the less energy and money it demand, it receive higher priority for action.

**Figure 11. Sources of inefficiencies at Rosti AB**

![Figure X. Sources of inefficiencies at Rosti AB](image)

It should be noticed that many other wastes at Rosti AB were linked to the above items; and if they could be improved the above inefficiencies, then we could have eliminated some of other wastes too. For example, excess inventory and overproduction was mainly because of the long production lead times. And the long production lead times can be reduced by reducing setup and downtimes. Another example is that if we can reduce defects rates, then it would be possible to reduce over-processing.

**6.2 Research Question 2: How could Lean Production practices help to amend problems?**

In this section how the lean production practices could be applied to address the above sources of inefficiencies and to promote the productivity being investigated. Findings in this section are in fact the answer to the second research question.

**6.2.1 Setup times reduction at Rosti AB**

*Standardization:* one significant reason setup times were unusually long at Rosti was that the setup’s sequences and timings hadn’t been standardized. Each operator was doing the job in his own way. A standardized changeover can reduce the setup time because the sequences and timings in a standard process are decided by a group of employees as the best way to accomplish a job. As you can see from theory (Liker, 2004) the standard works can be a basis for further learning and improvements, because “at the absence of an standardized
process the variations hide the link between the how the work is done, and the results and the learning and improvement will be limited” (Ning, 1999).

**Documenting data from previous production runs:** A big mistake at Rosti production floor was that they didn’t record the data and process parameters, when a production line was running smoothly. The data could be used for the next time the line was getting setup for same product. If they could have data from previous production runs, the changeover could be done faster, because normally in each changeover they had to do adjust all the process parameters by experience and try & error which may last for days. The recorded information could be updated each time a better result from the production was achieved; the data also could be used as basis for improving the processes continuously.

**Team work:** At Rosti AB operators did the setups individually, but in lean manufacturing it has been recommended to do the setup processes in team of at least two people to accelerate the setup (Shingo Shingeo 1985). At Rosti AB each machine belonged to a specific operator and they were responsible for it; any problem or changeover on other machines was not their responsibilities. On injection machines 2 employees could cooperate to perform the job; one on the mold and the other on the adjusting the robot and inputting the injection parameters.

Performing changeover in team on blow molding lines is even more sensible since, the blow molding lines have more space to work on it. For example, one of the operators can do replace molds (3 to 10 molds), while the others can work on replacing bottle holders, conveyers, packing machine and robots. So we can see that 5 employees could be working simultaneously on a changeover on one bottling line. This means the setup times on bottling lines could be reduced by 80%.

You may ask why Rosti didn’t follow this simple recipe; when the idea was discussed with the production manager, he was against it for two reasons. First he believed each operator is busy with his machine. My observations reject this clam. The whole line for the bottling process was fully automated and the operator just had to refill the palletizer and labels the pallets. Each pallet required 2 minutes of effort by operator every 15 to 35 minutes; therefore, about 86 to 94% of the operators’ time was wasted and created no value for the firm. However, one main reason operators were dedicated to one machine was that they were there waiting for errors in production lines.

Furthermore, since sometimes more than one changeover was scheduled in the same time, the production manager believed it is better to run the setups simultaneously. Here I bring an example to show it is more efficient to setup one line and then move to the next line.

Imagine, three changeovers are scheduled, on three different lines, in the same shift; each

![Diagram of Changeover Times](image)
changeover will last for 9 hours, and 3 operators are available to perform the task. In the first model, the Rosti routine, each employee does the setup individually on his machine (Figure 12) it takes 27 hours in total to complete all the three setups (non-value-added activity) and then run the line.

In the second model all the three operators start from one of the machines and after finishing the first setup run the production on the first machine, and then move to the second and finally the third line (Figure 13).

The above graph illustrates that the non-value-added activities, setup and idle times, can be reduced to 18 hours. This means the setup times have been reduced 33 percent just by doing the setups task in team.

Recognizing internal and external changeover elements: “the activities in every changeover fell into two categories by Shingo Shingo; they are muda (i.e. the work that had to be done while the machine is shut down) or something that could done while the machine still producing; the first one is Internal and the later is External Changeover” (K. Liker, 2004).

In order to specify the internal and external changeover elements at Rosti AB let first look at the procedure of a changeover, on an injection molding machine. The first action the machine operators did was to turn off the machine once the order was completed; then the operator run to the production manager to coordinate the new order details and to complete some paperwork; after getting the new batch order details, he transferred the new molds and auxiliary equipments to the station, where the changeover is supposed to carry out. The previous batch mold was unloaded and the new mold was installed. After installing the new mold, raw materials were transferred to the feeding station and the machine was adjusted with the process parameters and finally the trial processing toke place.
To indicate the importance of recognizing inside and outside setup times, let consider our example with some figures. In SMED what have been tried to be reduced is the actual setup time or what we called before internal changeover elements (Shingo, 1989); the example (Figure 14) gives us a good understanding about the inside and outside setup elements, and indicates that how recognizing them can be helpful in reducing the actual setup time. 25% of reduction in actual setup time can be achieved by distinguishing the inside and outside setup elements, in our example.

**Figure 14.** Internal and External Setup Elements

Further improvements are possible when the elements of the setup times are recognized. For example the process parameters can be inputted into the machine’s controlling system and memory while the mold is installing on the machine, which requires doing the setup in team; or for example if records of the previous production process parameters were in hand, the trial
production could be shorten and the first work of piece of the batch could meet the quality levels.

**Capacity, the potential problem:** One reason the Rosti manager and employees were not concern much about their long setup times, was that they had excess capacity; therefore, they didn’t feel urgent to put effort on reducing their setup times. The sense of urgency is critical to create change in routines, and it has been mentioned as the first step in creating any change (Kotter, 1995). However, the SMED is not just about increasing production capacity, and it has been invented at the beginning to reduce the production lot sizes. Figure 15 shows that increase in capacity is just one of the advantages of SMED.

Since stocking bottles and Preforms needs lots of space, Rosti had to pay a lot on renting warehouses. Just in their plant location, 70 percent of the space was dedicated to inventory. Beside this warehouse Rosti had rented 6 other warehouses in Norrköping for inventory purposes. Just the rent for their plant building was 6,000,000 SEK per year.

**Figure 15. Reducing Setup Time- Increasing**

Source: Olhager (2010, p. 21)
By practicing SMED cash flow also could be reduced considerably, because Rosti always had to have large amounts of inventories of almost all products in hand; because, they were not able to produce as soon as they receive an order. And if they were out of stock for a product the customer may tried a different manufacturer and it was possible they loss that customer forever.

6.2.2 Equipment low effectiveness

As I explained in the results from Rosti, down times were a regular problem, happening over and over. In order to remove the root cause of the problems I decided to use Toyota’s practical problem-solving process from “The Toyota Way” by Liker (2004) in Figure 2; and model was translated it into a format (Appendix A) to be completed by operators whenever they were facing a problem.

In the new document forms, operators first should give an explanation of the problem and clarify it thoroughly; then using the Fishbone-Diagram they should located the possible causes of the problem and then decided on the point of cause. After that, using 5-Whys, they tried to investigate the root-cause of the problem. After identifying and implementing the corrective actions, they were required to perform some measurements to see if the action has affected the results. If the results were satisfactory, then the improvement became standardized to prevent the same problem on similar situations.

A good example of when decisions are made at the absence of 5-why:

In the bottling lines a chronic problem operators were facing was the palletizers. If there was an error with the palletizer and it stopped working the lines and conveyers spaces became full of unpacked bottles and there was no more space for the coming bottles from blowing machine, and since the bottling machine didn’t stopped producing, the bottles were disposed automatically. Many O.K. bottles were disposed in this way. The decisions Rosti had made to solve the problem, on two of their lines, were to increase the conveyers and the line lengths to increase the buffer size, Work in Process (WIP) inventory. Such a change had increased the setup time considerably for those two lines, because a lengthier production line had to be setup each time.

Solving the problem by applying 5-Whys:

1. Why the bottles were disposed was because the line were full
2. Why the line was full was because the bottles were not packaged.
3. Why the bottles were not packaged was because palletizer stopped working.
4. Why the palletizer stopped working was mostly because the packages were not big enough for some bottles; therefore, some bottles were falling during packing.
5. Why packages were small was because Rosti was using the same size of packages for all of their products.
As you can see at Rosti previous attempt to solve the problem, they just had answered the first “Why”, therefore, their solution had caused other problems. But, by answering more whys, the root cause of the problem was recognized clearly. In the second attempt to solve the problem, they ordered a number of packages which were 1 centimeter bigger in dimensions to measure the effectiveness of the decision. The number of stops on palletizer reduced about 60 percent with the new packages.

In order to teach the employees the new problem-solving process, I used the real examples of the problems that operators were facing daily at Rosti AB. First I explained one example and then I encouraged them to practice the method on a problem they knew and discuss the results in their next group meeting.

Operators were obligated to complete the format in teams of at least 3 employees. The teams must consist of a technician and two operators. Each operator who suggested a root-cause solution for a situation or problem, was responsible to make sure that the corrective actions would be performed in regard to the decisions have been made in the format by their team.

When I was discussing the above problem-solving process, they were all agree that it is essential to practice such a methodology at Rosti but the problem was that their managers always push them to meet deadlines and therefore, they had to remove the problems just from surface. Then, when we discussed the situation with the production manager, he believed that this can reduce their production efficiency. He might be right for short terms. Probably since he compared the production’s OEEs reports daily and weekly, therefore, he couldn’t see how essential it is to “base managerial decisions on long-term philosophy, even at the expense of short-term financial goals” (Liker, 2004).

Even though operators believed solving root cause of the problems is essential to prevent chronic occurrence of the problems, they never applied this method in practice. They seemed to be extremely unmotivated and not feeling obliged to do it.

5.2.3 High defects rates

The last inefficiency we review is the high rate of defect rate at Rosti. The high amount of defect rates not only reduced the products’ profit margins directly, but also it could cause other problems too. There were some reasons for such a high defect rate at Rosti; below I have mentions some of the most important:

Non-stable process: Again lack of standardization in production process was a central cause in another problem on production floor. Each time a product was set upped on a line, all the process data had to be adjusted by experience and therefore, there was always some parameters which hadn’t been adjusted correctly and could generate non-conforming products. From the time the machine operator recognized a quality problem until the time he could find the source of the defects and corrects it, large piles of non-conforming products were manufactured. Thus, it was critical to standardize the production process to eliminate the risk of any mistake in process parameters adjustment.
Furthermore, standardization is necessary for further improvements; because lack of standardization creates a non-stable process and from the Statistical Process Control we know that before deciding on any improvement the variances in a process should be within the control limits.

**Weak maintenance:** Since many employees were laid off at Rosti, the number of employees who were doing the maintenance was reduced from 6 to 2 while the numbers of equipments still was the same and was required to be kept in good condition. When I was discussing with Rosti employees many of them admitted that their maintenance quality has been reduced and that this is a serious problem for their production. If a component in a machine, line or mold breakdown, it had the potential to manufacture defected products. For example, in one of their molds, which had 24 cavities, one of the cavities was destroyed; therefore, one of the produced Pre-forms in each shot was defected. Operators had recognized the problem after 180,000 Pre-forms were produced, and since it was almost impossible and time consuming to separate the not-ok products from the ok ones, the entire batch (180,000 Preform) had to be scrapped.

Moreover, since the company financial balance was not weak over the last six years, the company hadn’t invest on new equipments and their equipments have became old; therefore, the need for a more scheduled and tougher maintenance was fundamental to keep the equipment in good condition. Reducing the number of maintenance technicians was done to reduce the production costs, however, in long term the consequences costs surpassed the initial saves.

**Lack of data from previous production runs:** In order to start with reducing defects at Rosti AB, I decided to start with focusing on one of the products which had the highest defect rate which was about 7%. Surprisingly, it was the biggest sale of the Rosti and they were selling 12,000,000 Pre-forms, yearly, to one of the customers in Germany.

Several sorts of defects were forming the defects in this product (e.g. burning marks, flow marks and etc.). So, in order to be able to focus on the most important defects, we required plotting the defects frequency based on their causes (Pareto Diagram). But unfortunately neither Quality nor Production departments had any records of such information; therefore, we were not able to act upon the problem without information.

Furthermore, the detailed records from production history are essential to map how the figures have changed after any action. It is not possible to distinguish if a change in routines or procedure has improved the performance once we do not know how the performance (i.e. figures, defect rates and etc.) has been before the action.

Let make the above condition clear with an example: imagine there is a person who wants to go to a location, but he don’t know where in the map he is located. When he moves he cannot say whether the move he has made getting him closer to his destination or not. Thus, measurement is a decisive tool to quantify the effectiveness of any action.
**Lack of periodical controlling:** Since it is very difficult to check 100% of the manufactured products to make sure they have met quality levels, like many others Rosti also had the schedule of checking the quality periodically. At Rosti the manufactured products were supposed to be investigated every 3-4 hours by operators. But many times operators didn’t do the task appropriately. Imagine for a 48 cavity mold which manufactures 48 Preforms in each injection (every 30 second), if a quality problem occur, in 4 hours 23,000 defected Preforms could be manufactured. Maybe instead of regular coffee breaks, they were better to plan a more regular quality inspection.

**Other sources of defects:** One of the sources of the defects was molds. Since the hot material is injected into the molds and also the mold's halves open and close repeatedly, under high hydraulic pressure, mold depreciate over time and therefore, some components require to be replaced regularly (e.g. the mold cavities). The maintenance plan specifies how frequent each component should be replaced.

Raw material can also be a source of defects. First, the right grade of the plastic material must be chosen for a specific product with a specific application and process. Then, the material should be stocked and preserved under certain condition (e.g. warehouse air moisture content should be below some defined levels). Third, the material should be dehydrated properly right before being processed with injection machine.

Injection machines are the most important source of defects. If the process parameters in the machines were not set properly then they can produce products which do not meet quality specifications. These parameters can highly be different for different products, materials and molds (e.g. temperatures, speeds, pressures and etc.).

6.3 **Research Question 3:** What were challenges during the implementation?

From the results and answer to the second question it is clear that the Rosti LP transformation was an example of failure. The results didn’t satisfy the project expectations. No improvement was made in practice in the company, and none of LP techniques was implemented.

The implementation was incredibly tougher and much more difficult than what I did expect at the beginning of the project. In contrast, teaching employees about LP techniques was much easier than my early prospects. Even though, I was tutoring them in a different language, they could easily understand and grab LP ideas. In fact, not being lean was already a part of their problem; therefore, they could give me many examples of how LP techniques can facilitate their jobs. Below we review some of the challenges that hindered the improvement attempts.

**Top-down management style:** Even though Rosti AB was a small company, the organization was structured in a top-down management style. From the results we can observe
that employees had not the opportunity to send their voice to the top and then receive a feedback on it. The above situation along with the feeling that the CEO and the production manager are making wrong decisions, have made the employees to resist against the decisions which were made in the top, and employees used their power to undermine them.

This top-down style had created a big gap between management team and blue-collars. From the interviews in the result chapter it is clear that operators didn’t like their managers and were blaming them for the crises; in contrast the management team had the same feeling toward their employees and perceived them as barriers toward making desired changes.

**Employee Participation:** according to Liker (2004) Toyota’s top-down Bottom-up managerial style is essential to encourage employees to participate. In Rosti employees have the power to not to participate and not get fired. Through this they could undermine any change effort by just simply do not participate in it; to make any improvement on the production floor employees’ participations were essential. The situation had made an ineffective management team that couldn’t response the market changes with their decisions and strategies. The resistance and lack of participation from employees made the management to see their employees as the barriers against changes. This situation had shaped a big gap of mistrust between managers and employees.

**Motivation:** This attrition war has made both sides extremely unmotivated; on the one hand, the management was hopeless of successful application of their strategies, and on the other hand, employees were unmotivated by knowing that they have not the power to make their desire changes and having the responsibility of their production floor. According to Hackman and Oldham (1976), having the responsibility of the task you carryout can promote the motivation among employees.

**Poor vertical communication:** The gap between management and blue-collars never was filled over years and in fact it had become even worse by time. A big challenge was that both parties never had a frank-honest discussion. Beer & Eisenstat (2000) stated this barrier as a core barrier since not only it is destructive for any strategy implementation but it also avoids other barriers to be discussed. Kotter (1995) classified communications in two categories; Verbal communication and communication through deeds, so both sort of communications must be developed by managers.

In Rosti AB the both parties never expressed what they feel, in words, in order to find a solution and to compromise over the issues they demanded. In fact this was the management responsibility to start an honest vertical conversation, but they never attempt it because they didn’t want to give credibility to the operators that were resisting against their wills.

As it can be seen the above challenges are highly interrelated; for example the reason employee didn’t participate was because they were either unmotivated or resistant against managers. And the reason for being unmotivated and resisting against management decisions was that they didn’t trust on management and they were also powerless and didn’t have the authority to apply their improvement ideas.
6.4 Research Question 4: How could the challenges be overcome?

As we reviewed in theory, studies show that mistrust is generated at the absence of consultation, participation and empowerment (Morgan, 2003). Exactly the same reasons were caused the mistrust at Rosti AB. Lean production (LP) has consists of the toolbox (techniques) and the culture (social side). During implementation process it is not wise to implement one side and neglect the other side. In fact LP had been evolved in a certain organizational culture; therefore, for a perfect implementing both side of LP must be implemented. Empowerment has been an important part of LP social side which promotes employees participation and motivation.

Lean implementation models, barely paid attention into the importance of consulting and empowering employees to embarking into lean system. In these models the changes are scheduled and decided at the top and then the decisions are pushed down and operators must implement the new changes. These models has paid lots of attention to implementing LP techniques, but neglected that in the same time they have to make some social readiness in order to adopt with the new culture, the culture of trust and participation.

Even one single blue-collar was not invited in the presentation we had before the project commence, where we discussed how lean can be helpful for the company. Blue-collars were just informed about the results of the decided changes. Since the company was small with a simple production process and employees who had a long history of employment in the company and were very skilled, they silently wanted to be participated in decision makings; they were feeling they are capable of making right decisions.

“Empowerment essentially is an on-going interpersonal relationship that fosters mutual trust between employers and employees” (Khan et al. 1997); in order to eliminate mistrust it is necessary to empower employees (Andrews et al, 1994) and then by empowering employees it is possible to make improvement changes (Khan et al, 1997). At Rosti AB operators were powerful in not to obey the orders, but in the same time they were powerless in creating improvement changes whenever they recognized an improvement opportunity. This has made them unmotivated and resistant against changes which were pushed from top. Blue-collars wanted a bigger share of power to take responsibility of their production floor to transform some changes to improve it.

In the interviews Rosti managers always addressed the employees and union as the biggest barrier against improvement changes, but in contrast to what they believed, employees were the key to stay competitive; they just needed to be empowered and trusted.

6.4.1 Empowerment, involvement and motivation

Beside mistrust on management another reason that blocked improvement changes was the lack of motivation among operators (i.e. which is highly linked to mistrust). This issue was admitted by both managers and operators. Empowerment can enhance motivation and job satisfaction among employees, by relying on transforming decision making on individuals and
teams and also decentralizing problem solving and decision making responsibilities (Cappelli et al., 1997; MacDuffie, 1995; Appelbaum, 2000).

On the one hand, empowerment addresses two top levels of the Maslow’s hierarchy by satisfying Esteem (e.g. respect by others and confidence) as some of the employees confessed that they want their management respects and they don’t like the feeling that they are lower than their managers; and on other hand, empowerment promote the Self-actualization by providing the opportunity that employees can use their creativity and problem solving spontaneously.

Furthermore, empowerment promotes internal motivation by providing the ground for some of the intrinsic factors that are addressed by Herzberg. These factors are: recognition, responsibility and advancement. Empowerment deducts the responsibility and recognizing the importance of the role of the front-line employees, and therefore, employees are encouraged to have a greater involvement in their jobs. Employees can be motivated to a higher degree once they observe the result of their achievements (e.g. the results form OEE). According to Hackman and Oldham (1976) the above factors (i.e. role importance, autonomy and feedback) could promote the internal motivation among operators, that could lead to higher participation.

Empowerment also promotes the external motivation among employees once that a goal is set, by trying to achieve that measurable goal. This of course requires the management collaboration to set some strategies and help front-line employees to progress toward that goal. Liker (2004) argues that in Toyota motivation improves when employees can measure the results of their involvements in improvements and by observing that they are continuously getting closer to the common goal.

The above statements indicate that lack of motivation and participation at Rosti could be healed if the management gave more power to operators through autonomy in decision making and problem solving. But before that the management required to set a common goal in collaboration with employees, so everyone move toward that goal or vision. The results from Rosti show that they didn’t have such a goal that could align them, once the mistrust was healed.

6.4.2 Methods to Empower Employees

Poor vertical communication has been addressed as the core barrier in strategy implementation, because it also prevents discussing on the other barriers (Beer et al. 2000). Even though Rosti AB was a small organization, it was clear that the honest vertical communication was very weak and this has generated a big gap of mistrust between management and operators.

Management could fill this gap by consultation with front-line employees so they could feel that they have been involved in decision makings. Many times employees confessed the management wrong decisions is the main reason for Rosti AB’s failure; therefore, management could resolve this mistrust by involving them in decision making; if they were
being consulted by management, they could feel they are also responsible for the problems and have to participate in solving problems. Literature has argued that involvement in decision makings improves participation, for example according to Appelbaum (1997) and Cappeli et al. (2000) front-line employees must be involved in decision making to encourage their participations.

It may seems that it is not wise to involve operators who have no managerial experience in decision makings, but, even if the management didn’t involve employees in decision makings they have to be involved undesirably in the last step by asking the Union permission for the decided changes at the absence of employees. Therefore, why not involving them in the first step to benefit the company with the following consequences:

Employees at Rosti AB felt their management doesn’t like them and do not spend enough time with them. They felt they know enough to be eligible in being involved in decision makings. Therefore, even if employees were attended silently in a meeting that some decisions are made they could feel that they are participated in decisions and they are responsible for the outcomes because the decisions are made at their presence and they had the chance to propose their ideas. This is an example of bottom-up companies.

The CEO of Rosti gave many examples of the decisions they have made and then were rejected by the Union. Involving employees in the first step of decision making may intensify negotiation and as result prolong the timeframe which all groups conclude an agreement, but this could anticipate that in next steps the least contradictions would happen.

At Rosti AB many employees believed they don’t need shift supervisor, because they have a long history of employment at Rosti and they know details of their job. Organizational delayering has been an initiative to empower employees and facilitate vertical communication in LP. The importance of delayering in the first stages of LP implementation has been demonstrated (Åhlström et al., 2000); therefore, it is essential to empower employees early in adoption of the LP.

All the above three consequences can improve trust on management and motivate employees. By consulting and involving employees in the first step of decision makings the Rosti AB could offset the destructive power the Union and employees into a constructive one.

6.5 Gaps between theory and Rosti AB case

In this thesis two gaps between the finding and the theories have identified. First, in organizational change literature, coalition among managers is addressed as an important step in transforming successful changes; while, my findings show that, in order to have a successful LP implementation at Rosti AB production floor it was essential, first to make strong coalition among managers and blue-collars. Second, theories say that “unionization status does not have a significant impact on extensive implementation of lean practices.” (Shah and Ward, 2003). However, the Rosti AB case shows that under certain circumstances
unionization has a great influence on lean implementation. Below we investigate these two gaps in more details.

### 6.5.1 Coalition

Lean implementation has been addressed as a way to achieve superiority over competitors though excellence in process (Liker, 2004). This excellence in process can be attained by implementing lean toolbox and removing wastes. At Rosti case the process of the activities on production floor was determinant in shaping the destiny of the company, since almost all value added activities were accomplished there and consequently most wastes came from there too. Therefore, if somewhere was required to be changed first, it should was the production floor, the production floor which was running by the opposition, blue-collars.

The theory however has more emphasis on powerful coalition among managers, sometimes managers in different departments. In theory, in order to form a powerful coalition, the managerial rank and seniority has been always put into attention (Kotter, 1995). However, Beer and Eisenstat (1990) stated that after forming a core coalition from senior managers, then the coalition should be expanded and employees from different levels of the organization must be included into the collation.

The Rosti case indicate that even though the management were tightly united and were supporting each other, the change efforts were failed because the blue-collars were not in the same line with them. In fact in the contrary of the management coalition, blue-collars had a very strong coalition between themselves. The management had tried to implement 5S and incentive based salary and recently Lean Manufacturing which all was failure mainly because they didn’t had strong collation with blue-collars and the Union.

### 6.5.2 The possible reasons for this gap

*The changes have to be implemented on production floor:* As aforementioned, we started LP from production floor because most activities were accomplished there and most inefficiency came from there too. The change had to be carried out on the spot of blue-collars; therefore, it was very essential that the management first attain their attention for the coming changes or in another word, to make a strong coalition with them.

The CEO had some plans to move into customized bottles market and for this reason they needed some different type of machinery. For this change they didn’t need to make coalition with operators because it was outside of their influence and they couldn’t affect on it, but for this case (i.e. change in market) they needed to have the board approval so they had to make coalition with the owners.

*Small size company:* The results of the cited theories in organizational change are collected in big organizations, which probably can be different from small organizations. In SMEs the distance between the lowest level of the hierarchy is not far from the CEO; furthermore, in Rosti case the production and organizational process were not complicated and everyone could understand it and challenge the management decisions.
**Labor regulation**: The Swedish labor regulations and unions overwhelmingly support employees and employers are not allowed to be punished or fired for not obeying the orders from top. This has empowered employees against management and they can confront management and orders if they didn’t like them.

### 6.5.3 Unionization

Another gap between theory and the results from Rosti AB was the Unionization influence in LP implementation. The Theory suggests that Unionization has not a great contribution in hindering LP implementation (Shah and Ward, 2003), however, as we discussed, in the Rosti case the Union power was a big barrier toward LP adoption.

There are two possible reasons for this dissimilarity. On the one hand, the mistrust on management from employees and union members had made them defensive against any decided change from top. On the other hand, the changes were supposed to be implemented in the spot of employees on the production floor and they could easily resist against it with the support of the union.

### 6.6 Lean Implementation Models and the absence of employees’ empowerment

In the book *Lean Thinking*, by Womack and Jones (2003), after introducing steps toward lean and reviewing each step in detail, the thickest section of the book is dedicated to some examples of successful implementations by applying the same methodology. Neither in introducing the steps for implementing lean production, nor in the detailed examples of the book, Womack and Jones never have addressed the importance of empowerment or at least the importance of operators in lean adoption.

Many cited literature and books have focused mostly on the upper side of LP iceberg and many neglected the importance of employees’ involvement in shaping lean production. In a research by Pettersen (2009) in defining lean production, at least 89% of the books and articles he has investigated have addressed Kaizen, SMED, JIT, Kanban, Pokayoke, Heijunka, 5S and Standard Work, while just 44% of them addressed Employees Involvement. Dahlgaard and Dahlgaard-Park, (2006) also has conclude that in Lean Production quality strategy, techniques and training people have been too much focused in compare with understanding the human factors.

The above discussions indicated the importance of front-line workers empowerment, in promoting mutual trust, employee involvement and motivation; however, many cited literature and books have focused mostly on the upper side of LP iceberg (Techniques and tools) and many neglected the importance of employees’ involvement in shaping lean production.
7. Discussion and Conclusion

Long setups, Low equipment effectiveness and high defect rate were the main sources of inefficiencies in Rosti AB. The problem with the long setups could be addressed by SMED techniques. For example by recognizing internal and external setup elements, converting internal setup elements to externals, standardization and teamwork setup time had the potential to be reduced considerably.

Equipment availability could be improved by identifying the root cause of the errors in production lines. The defect rates could be reduced by implementing a quality control process, which periodically checks the quality of the manufactured products, and documents the quality records to use them in statistical tools for further improvement strategies.

However, applying the above solutions is not feasible at the absence of front-line employee involvement. In fact this was the main reason Rosti couldn’t make any improvement change over 7 years, once the PET packing industry changed. The reason employees didn’t participate in lean and other change efforts was that they didn’t like their managers and didn’t trust on them; besides, they were also highly unmotivated.

Unlike the available LP implementation models that have almost all of their concern over adopting tools and involving management in the implementation process, the results from Rosti illustrate that front-line employees empowerment is essential to achieve sustainable successful results not only during the implementation process but also in continues improvement.

Empowerment improves the mutual trust between managers and employees, and consequently a stronger coalition can be made that is necessary for any successful change effort. Empowerment also promotes motivation among employees by giving the autonomy and responsibility of decision making and involving them in improvements efforts and let them to be responsible for the outcome of their actions.

The findings show that mutual trust, empowerment and motivation in LP are similar to foundation for lean techniques. Therefore, before embarking into LP transformation, it is essential to have an early assessment on mutual trust (among managers and operators), empowerment and motivation. Based on the results of the assessment further decisions on the techniques and extent of the empowerment should be made. Therefore, early efforts, in LP adoption, should be focused to improve these three factors to make sure that everybody’s involvement will be feasible in implementing LP techniques. If the above three factors don’t meet the acceptable levels then any effort to implement lean techniques will be failed.

The above discussions indicate that unlike many literature that have centered their focus on LP techniques more than social aspects, it is critical to consider and balance both side of lean. Therefore, the first step of any LP adoption must be cultural assessment.

Since the findings of this research has been collected from a single case study, it might not be appropriate to generalize them to other companies, but since the findings supports the
empirical findings by Dahlgaard and Dahlgaard-Park, 2006 from a Danish case study, to some extent we can generalize the findings to other companies which wish to adopt lean production.

However, probably the empowerment role becomes more critical in LP implementations, when companies are small in size, with a simple process and products, and have employees with a long history of employment in the company; this become even more critical when employees have a powerful unions and have support by the labor regulations, in countries like Sweden.
8. References

8.1 Journal article


8.2 Book


9. Appendix

Rosti AB Problem-Solving Format
Initial Problem perception

Fishbone Diagram

Point of Cause (POC)

5-Whys
1.
2.

3.

4.

5.

Results after implementing new changes:

Are the new results satisfactory?

Yes ☐  No ☐