2. Literature Review

This chapter presents relevant literature for the study, and begins with lean manufacturing in a historical context, its definition and its relation to firm performance. The chapter continues with difficulties and benefits of implementation, and ends with an overview of the current manufacturing industry and earlier studies of different management practices related to lean manufacturing in a Swedish context.

2.1 Historical Foundation

The basis of lean production, or lean manufacturing, is the Toyota Production System (TPS) that was developed after WWII. Toyota had to create a flexible manufacturing to be able to meet a variety of demand for a small market, where the customers did not have the amount of money to pay much. Toyota needed to create a fast and flexible process that could give the customers what they wanted, in the time they wanted it, to the highest quality and to an affordable cost (Liker, 2004).

The main goal of TPS was to increase profit by reducing cost, while at the same time get higher turnover ratio over capital and increased productivity. The system had three sub-goals; quality control, quality assurance and respect for humanity. Since all goals influence each other they must all be achieved together, through the process of continuous improvement (Monden, 1983).

TPS was developed by Toyota during three decades and was formally transferred to the United States in 1984, when Toyota entered a joint venture with General Motors (GM) (Holweg, 2007; Shah and Ward, 2007). The joint venture achieved a productivity level fifty percent higher than a comparable GM plant, and the quality was the best among GM's US operations (Holweg, 2007). However, TPS spread to other Japanese companies during the oil-crisis 1973 and different parts, concepts and tools of the system spread from Japan to the rest of the world during a long period, which lead to a partly implementation and a slow understanding of the whole system as a management philosophy (Shah and Ward, 2007). Lean techniques were implemented on the shop-floor, but the lean-mindset and culture was lacking behind (Hines, Holwe & Rich, 2004).

2.2 Definition of Lean Manufacturing

Together with the fact that lean has evolved during time, the timely and partly introduction of lean production has led to lack of a clear definition (Hines et al. 2004, Shah and Ward, 2007). Without a clear definition it will not be possible to know that the correct actions are taken towards lean manufacturing, nor to measure that progress is made (Karlsson & Åhlström, 1996). In a literature study by Pettersen (2009) several characteristics was found as the most common associations with lean manufacturing: continuous improvement, setup time reduction, just in time (pull production), failure prevention (poka yoke) and production levelling (heijunka). Pettersen also found that human resource management (HRM) characteristics such as team organisation,

cross training and employee involvement; supply chain management; statistical quality control; and total productive maintenance (TPM) were important concepts of lean production, but not to the same extent as to the above.

The most central part of TPS is to eliminate waste, referred to as Muda in Japanese, which means to remove all non-value added activities (Liker, 2004). The seven wastes, as originally identified by Ohno, are inventory, overproduction, defective products, over-processing, transportation, motion and queues (Heizer & Render, 2008).

The following section tries to explain how the tools and techniques of lean production comes together as a whole and is based on information from Cua et al., (2006); Heizer and Render (2008); Karlsson and Åhlström (1996), Liker (2004) and Schonberger & Gilbert (1983).

Inventory is a waste that must be reduced in the lean production system. As inventory is reduced it will reveal the reasons for keeping it, such as bad quality, unsatisfying delivery from suppliers and time used to search for tools or material. All these reasons, the root causes for having high inventory levels, have to be solved. One example is machine down-time, which can be reduced by applying TPM.

To create a more flexible production, the batch sizes have to decrease. With smaller batches and the same set-up times as before, the total lead-time in production will increase. This means that the machine set-up time must be shortened, which can be done by using a tool called single minute exchange of dies (SMED). Small batches will also lead to improved quality for purchased material. With small batches, deviations will be discovered quickly, and the impact will be less severe.

Just-in-time (JIT) also reduces inventory by delivering the right material at the right time in right quantities. A central part of JIT is to use a pull-production system, which can be managed by the use of Kanban. By only producing exactly what is needed, the waste of overproduction will be eliminated. The JIT system is sensitive for disturbances, such as variability or quality problems. Continuous improvement, referred to Kaizen in Japanese, with the goal of perfection, is used to be able to find and eliminate the waste. A way to involve employees in continuous improvement is the use of quality circles. Cross-functional team has knowledge within many areas, and can identify if products are processed more than necessary.

To be able to keep short lead-time, transportation is a waste that does not add value to the products. All types of motions should be held to a minimum, whether it is by equipment or by people. One example is wasting time looking for tools, which can be reduced by using the tool 5S (refer to Appendix A).

Reduced set-up time, smaller batches, lower inventory, pull-production and improved quality will reduce queues, which also are considered to be waste. In a lean organisation, training and information is of highest importance. Responsibilities are pushed to the lowest possible level and to be able to sustain improvements and continuously learning, human capital is one of the most important resources.

Today companies focus on one or several tools that are used for lean production, such as JIT or 5S, but they fail to see lean as a system that must be reflected by the entire organisation. TPS should not be seen as a toolbox, but as a "sophisticated system where all parts contributes to a whole" (Liker, 2004, p. 34). The lean organisation culture is reflected by learning, employee empowerment and continuous improvement (Heizer & Render, 2008).

2.3 Measurement of Lean Manufacturing

As presented above, there is no common definition of lean production, which implies that there are also no common measurements used to measure the state of implementation. Shah and Ward (2007) have created an instrument to measure the state of implementation of lean, which they recommend future studies to use. The instrument is based on eleven earlier research studies, and the most used measures are put together to create a new instrument.

The advantage to use an already established instrument is proven content validity and Cronbach's Alpha is above 0.7 for all factors. The instrument consists of three constructs; see Figure 2.3.1, with a total of ten operational constructs and 41 operational measures.

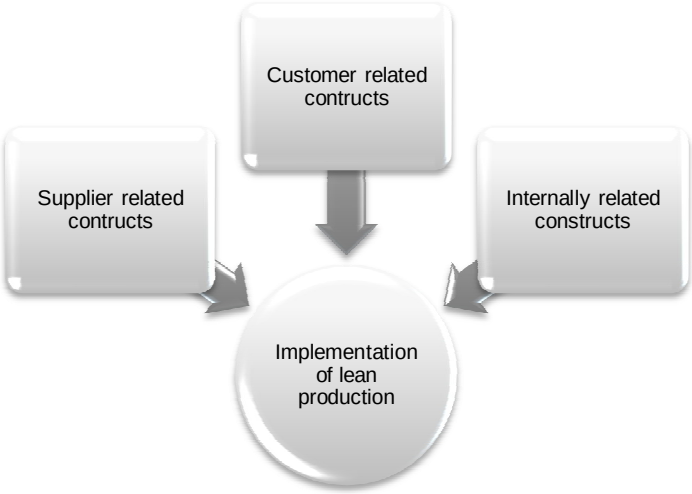

Figure 2.3.1. Constructs to measure lean manufacturing (based on Shah and Ward 2007, p. 799)

2.4 Relation to Financial Performance

The reason for implementing lean production is increased productivity, reduced costs and improved quality (Cooper, 1995; Liker, 2004; Karlsson & Åhlström, 1996; Monden, 1983). A literature study made by Mehra and Inman (1992) suggests that the success of a JIT implementation should be proven by reduction in machine downtime, inventory and workspace reduction, increased quality, higher utilisation of labour and equipment and increased inventory turns. Schonberger (1996) suggests that sustained bottom line result will occur when employees are involved, customers are well served, and systematic data are used for decision making.

2.4.1 JIT and TQM

Many studies measure either JIT or TQM's effect on firm performance. Only a very few actually measure the total concept lean manufacturing. This means that most studies investigate the relationship between one aspect of lean (JIT or TQM) and performance, with mixed result. Ahmad et al. (2004) did a study on 86 members of American Production and Inventory Control Society and found that JIT did not lead to improved financial performance. The financial performance and growth was measured by operating profits, profit to sales ratio, cash flow from operations, return on investment, sales growth rate and market share.

Boyd et al. (2002) looked at publicly available data at 31 manufacturing companies in the United States and found that JIT had greatest impact on return on assets, inventory turnover and labour utilisation. Claycomb et al. (1999) found that JIT with customers led to improved efficiency and financial performance. The authors did a survey on 200 manufacturing firms who were members in the Council of Logistics Management in the United States. JIT with customers was defined through proximity of customers' facilities, daily ordering by and deliveries to customers, shared production plans from customers, less inspection on outgoing goods, small lot size selling, informal plant visits from customers, certification from customers of product quality and finally joint product development with customers. Efficiency was measured by outbound inventory on hand and financial performance was measured by return on investment, return on sales and profit.

Inman and Mehra (1993) did a research of 114 manufacturing firms in the United States that were known to be using JIT according to literature, and got the result that JIT explained almost half of the variance in the financial success. Financial success in this case was measured by improvements in return on investment, improved service and decrease in total costs.

Fullerton et al. (2003) did a survey on non-JIT versus JIT firms and found a positive relationship between JIT and return on assets, return on sales and cash flow margin. Kinney and Wempe (2002) found that JIT implementation led to increased profit margin and higher inventory turnover. An explanation to the mixed result is given by Fullerton and Wempe (2008), who believe it depends on inconsistency in methodology, the partly adoption and contextual factors.

As for TQM, the result is somewhat similar. Hendricks and Singhal (1997) found that companies that have won quality awards, and thus have established effective TQM programs, had better operating performance and higher sales growth. Terziovski and Samson (1999) found that TQM has a positive effect on performance, while Powell (1995) found a mixed result.

Arawati (2005) could not find a direct link between TQM, product quality and business performance. In a literature study made by Wayhan and Balderson (2007) the authors found that there are lacking elements in the empirical

research of TQM and that the relationship between TQM and financial performance is still to be established.

2.4.2 A More Total Concept

After reviewing literature of JIT, Goyal and Deshmukh (1992), conclude that JIT should be applied as a holistic approach, rather than implement only some parts, to be able to realise the full benefits, such as higher quality and enhanced productivity.

Sakakibara et al. (1997) are early investigators of JIT together with other parts of the organisational infrastructure, such as quality management, manufacturing strategy and human resource management. They did a survey study on 41 plants in the United States within electronics-, machinery and transportation components industry. The authors did not find a relationship between JIT and manufacturing performance, but a strong relationship between JIT and the organisational infrastructure and the two together led to improved manufacturing performance. Manufacturing performance was measured by inventory turnover, cycle time, lead time, and on-time delivery. Flynn, Schroeder, Flynn, Sakakibara and Bates (1997) found that JIT and quality management creates synergies in combination and that infrastructure practices forms a foundation for both JIT and quality performance.

Cua et al. (2001 and 2006), Olsen (2004) and Shah and Ward (2003) investigates implementation of lean based on several practices. JIT, TQM, TPM and HRM are included instead of just one or two of the practices, and the authors conclude that all aspects must be considered and aligned since they create the lean system together.

Hines et al. (2004) considers TQM and TPM as concepts that are not part of the lean methodology, but concepts that are able to support the lean strategy. For the interested reader Pettersen (2009) identifies the difference between TQM and lean production, which he founds have a lot of differences, but also some similarities. Cua et al. (2006) finds that a common theme of JIT, TQM and TPM is that they stand for elimination of non- value added activities and continuous improvement and Cooper (1995) believes that TQM is a concept within lean production.

2.4.3 Lean Manufacturing

Cua et al. (2006) establish that implementing lean practices leads to improved manufacturing performance, which they define as volume flexibility, low unit cost, on-time-delivery and conformance quality. Moreover, the practices have to be used together and not as single practices (also identified by Shah and Ward, 2007). The research was carried out based on data from a world class manufacturing database with 163 plants in Europe, United States and Japan.

Olsen (2004) did a research on 48 manufacturing companies in the United States and found a positive relationship between lean production and ROE, but no relationship to stock return or sales growth. The collected financial information was publicity available. Shah and Ward (2003) found a relationship to organisational performance, which in this case included productivity, cycle time, finished product first pass quality yield, scrap and rework costs, manufacturing cost per unit and customer lead time.

Financial performance is often used to measure the effect of improvement efforts (Ahmad et al., 2004). As noted in the literature review many different measurements of performance have been used in earlier studies. Whiting (1986) recommend that the strategic ratios a company should follow are: quality, delivery and orders outstanding, level of service, training and education, market share and growth.

A successful lean manufacturing implementation should give result in both operational performance and bottom line result and for this research firm performance is measured by seven items based on Mia and Clarke (1999). The items include both financial and non-financial items: productivity, cost savings, product quality, on-time delivery, sales growth, operating profit and market share.

Capon, Farley and Hoenig (1990) did a meta-analysis based on the results from 320 conducted studies and relate organisational, strategic and environmental factors to financial performance. The result supports that growth and a high market share is related to profits.

2.5 Difficulties and Benefits of Lean Implementation

In a study by Wafa and Yasin (1998), JIT was found to be beneficial in relation to customer service, relationship with suppliers, product quality and cost savings. However, the concepts of lean manufacturing are not easy to implement, due to the need for organisational change. The production system, the operating procedures and the organisational culture must change to create lean as a new organisational philosophy. The authors found that the implementation would not be successful if following elements were lacking: management support, training programs, cooperation with unionized workers and suppliers' cooperation. Other risks of failures are fluctuation in product mix, suppliers that cannot deliver according to JIT and inflexible transport companies (Boyd et al., 2002). Ahmad et al. (2004) adds that failures can depend on the length of time it will take before the result will show and on employees, who fail to see the reasons for the improvement efforts.

Taj (2008) did an assessment of 65 manufacturing firms in China. The lean implementation assessment was based on three to six questions within the respective areas: team approach, inventory, maintenance, processes,

suppliers, layout, quality, set ups, and scheduling and control. The lean practices were starting in the 1970s in China, which is earlier than in Europe and the United States, but the implementation in the sample firms were low and the author concludes that lean manufacturing is not very common in China. The average score of lean implementation was 55 out of hundred, ranging from 31 (minimum score) to 77 (maximum score). The most implemented concepts were within maintenance and scheduling and control, while the least implemented practices were within inventory and supplier practices.

Wong, Wong and Ali (2009) did the first study on lean manufacturing implementation in the electrical and electronics industry in Malaysia. The authors investigate lean adoption, the understanding of lean, usage of different tools and benefits and obstacles of implementation at 44 companies. The authors found that 30 percent of the companies had used lean manufacturing for more than ten years, 18 percent between five to ten years and 52 percent for less than five years. The greatest benefits identified were reduced costs, improved productivity and reduced waste in mention order. The most common tools were 5S, Kaizen and Standardised work. The largest obstacle was “backsliding” to the way of work before lean implementation, second and third largest was employee resistance and budget constraints respectively.

Wu (2003) conducted a research regarding whether differences can be found between lean and non lean suppliers. The research was conducted in United States and the sample was first tier suppliers within the automotive industry, with more than $100 million in yearly sales (this criterion was used to limit the sample to large firms). The variables used to evaluate the degree of lean manufacturing practices were pull system, short lead time, level production, continuous flow and high inventory turnover. The author found that lean suppliers performed better than non lean supplier on almost every aspect measured. The lean suppliers had lower inventory on the road, shorter delivery time, higher frequency of preventive maintenance, lower time of unscheduled downtime in the machines, and fewer quality defects. The lean suppliers also had had a longer relationship with their customers, with higher information sharing and the lean suppliers enjoyed a more stabled demand from the customers.

2.6 Swedish Industry Context and Lean Manufacturing

Very few earlier researches within lean manufacturing have been found in the Swedish context. Taylor and Taylor (2009) present a study of published articles within operation management research between 2004-2009 in the ‘International Journal of Operations and Production Management’. Only four percent out of 310 articles had Swedish origin. Another journal, the ‘Journal of Operations Management’, had as little as zero articles out of 283 articles with Swedish origin during the same period.

With globalisation and movement of production facilities to low cost countries, it is crucial for manufacturers to be cost efficient and effective to stay competitive. Sweden manufactures high technology products and as some of the labour intensive production will move to China and India, the knowledge intensive production is expected to increase (Bjurvatn, Norman & Orvedal, 2008).

Statistics from the Swedish Trade Council 2008 shows that 69 percent of all goods from the manufacturing industry in Sweden are exported. The biggest part of all exports from Sweden, 40 percent, is to Western Europe and 25 percent to the other Nordic countries.

2.6.1 JIT

A comparison of Japanese and Swedish companies in accordance to JIT was made by Storhagen (1995). Storhagen identified four different elements in JIT and they were classified as:

1. Process factors (human factors that are related to organisational change and development, for example high performance teams, job rotation, responsibility for everyone, life time employment and management involvement)

2. Interaction factors (networks to improve interaction along the material flow, for example geographical nearness, modularisation, quality and certified suppliers)

3. Structural factors (administrative techniques and methods for changes in physical resources, for example Kanban, short setup time, right the first time and increased automation level)

4. Effect factors (outcomes from the above factors, performance measures, such as higher quality, reduced waste, fewer control stations, improved visibility etc.)

The author found that while Japanese companies had their strength in process factors and their weakest part in structural factors, Swedish companies had their strength and weaknesses vice versa. This means that to be able to succeed with JIT implementation in Sweden, more focus has to be put on human resource factors.

Japanese companies had higher value of all factors than the Swedish companies, but the Swedish companies saw no reasons for not using JIT the Japanese way, except for differences in regulations for working hours and similar issues. Other findings from the study were that JIT is adaptable irrespective of industry and the implementation of JIT must be on a broad approach with different factors in parallel. The implementation of JIT is

specific for each company and JIT should be used according to the conditions and the environment in the company.

2.6.2 TQM

Poksinska, Pettersen, Elg, Eklund and Witell (2010) did a survey which included 118 companies in manufacturing-, service-, trade- and construction industries. The topic was quality improvement activities in Sweden. Eight percent of the respondents were large companies with more than 250 employees. The authors found that the main drivers for quality improvement were cost reductions, improved competitiveness and increased market share. They found a positive attitude towards quality improvements, and quality was to a high extent deployed in the strategic plans.

An interesting outcome from the survey was that the use and knowledge of lean tools were more common than TQM tools. For example were lead time reduction, JIT, 5S and Kanban more widespread than FMEA, PDCA, SPC and Six Sigma. 46 percent said that they were not using quality circles, and the authors draw the conclusion that the time for quality circles has passed. The top ranking of positive influences from quality improvement was employee motivation, customer satisfaction and flow in internal processes. Out of the 118 companies, 30 percent said they worked with lean production to a high or a very high extent.

Hansson and Eriksson (2002) did a study on companies that had received quality awards in Sweden. They investigated the financial performance four years before the award and two years after the award and compared it to competitors and branch indices. They found that it was not possible to find that the recipients of the award had had better financial performance before receiving the award, but after having received the award they performed better than both competitors and branch index. The indicators that were measured for financial performance were return on assets, change in sales, number of employees and return on sales. The authors conclude that with a successful implementation of TQM, an improvement in financial performance will follow.

2.6.3 TPM

The importance of maintenance increases as inventories decreases, since the impact of disturbances will be high. Alsyouf (2009) did an investigation on 118 manufacturing companies in Sweden that had between 37-2,400 employees. He found that maintenance personnel had very long working experience and that people is the most important resource in the maintenance department. Some of the results were that more than half of all companies were organised so that maintenance was organised as a part of the production department and 28 percent had no maintenance strategy or policy. About 50 percent of the maintenance department's time was spent on planned tasks and 37 percent on unplanned tasks. Time spent on training was about four percent.

On the question on how much emphasis that was placed on maintenance approaches, TPM scored low.

2.7 Summary of the Literature Review

Lean manufacturing was developed in Japan during decades through continuous improvement. It should be seen as a philosophy that affects the whole organisation instead of merely a set of tools and techniques, and it should be implemented as a broad approach. The most important concept is Muda, or waste, which means that all activities and processes that do not add value to the customer or the product should be removed.

The outcome of lean manufacturing is increased quality, improved productivity and reduced costs and everything what it involves and relates to, for example increased customer satisfaction. Some of the difficulties of implementation are lack of management support, suppliers that do not manage to deliver according to JIT and employee resistance.

Much research has been carried out regarding JIT, but only few studies look at lean manufacturing as a total concept. In these studies lean is often defined by covering practices within just in time, total quality management, human resource management and total productive maintenance, but all of the studies have different measurements of how to assess the lean implementation. Three different techniques have been found in this literature study:

1. Self assessment of JIT or lean
2. Companies have been chosen due to that they are known to be using the practices according to literature
3. Companies are divided into non-JIT/lean and JIT/lean

Performance has been measured through different measures and ratios within operational performance, financial performance and firm performance. Performance has been evaluated by either:

1. Self assessment
2. Publicity available financial information

The relationship with performance has given mixed results, probably due to the fact that different concepts of lean manufacturing are measured and different contextual elements might affect the result. This study applies a validated comprehensive measure of lean implementation, where the studied companies make a self assessment, both of lean practices and firm performance. The research methodology is presented in more detail in the next chapter.