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Linking Leadership Styles to Leanness: Examples from the Swedish Chemical Industry

Master of Science Thesis in Quality and Operations Management

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ABSTRACT

For manufacturers to be successful in today's global market, it is important to be competitive. Lean Production can be a great tool for increasing competitiveness, but many western companies have trouble implementing and sustaining Lean initiatives. Research indicates that leadership is an important key for successfully implementing and developing Lean in companies. Therefore, the goal of this master thesis is to evaluate how leadership can affect leanness in six Swedish chemical companies. The method used for the evaluation of the relationship was two scientific questionnaires addressed to leaders in the participating companies: the first questionnaire evaluates leadership styles and is called the *Multifactor Leadership Questionnaire (MLQ),* the second questionnaire evaluates how Lean companies are and is in this study named the *Leanness Questionnaire (LQ).* The data collected from the two questionnaires was processed in SPSS, in order to find possible relationships. The main result from the study is that transformational leadership is positively correlated with leanness. Neither transactional- nor passive/avoidant leadership are statistically significant enough to make any conclusions about their potential relationship to leanness. However, this thesis also presents detailed data and reflections from the two questionnaires. The data reveal, among others, that the six Swedish chemical companies have reached 64% of their leanness potential and that they are leaner at customer activities than internal- and supplier related activities. Furthermore, the data also provide detailed information of what leadership styles the six Swedish chemical companies perceive they practice and how frequent each leadership skill is used; a self-perceived leadership profile. The purpose of presenting and reflecting around the data is to provide a benchmark for the participating companies, but also to display how lean and what type of leadership some of the companies in the Swedish chemical industry practice.

The report is written in English

Keywords: Lean Production, Lean Leadership, Leanness, MLQ, Questionnaires, Process Industry, Chemical Industry.

PREFACE

The main part of this master thesis was carried out from August 2015 to March 2016. The data gathering was performed in collaboration with AkzoNobel, Bimkemi, Borealis, Kemira, Nynas, and Perstorp. Therefore, I would like to begin thanking my contacts at the participating companies: Magnus Fransson, Anders Rietz, Jörgen Lantz, Lennart Albertsson, Anna Keereweer, Helén Ljungqvist, and Thomas Haraldsson. I would furthermore like to thank my examiner at Chalmers University of Technology, Professor Mats Winroth for his valuable comments and support.

Last but not least, I would like to thank all anonymous respondents from the participating companies.

Gothenburg, April, 2016.

John Svärd

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1 INTRODUCTION

For manufacturers to be successful in today's global market, it is important to be competitive. One way to increase a company's competitiveness is quality improvement, since higher quality both can increase customer satisfaction and lower cost through more efficient processes (Karlöf, 1994). Quality-development has therefore played an important part in many companies' strategies and has led to different quality awards, such as, Malcolm Baldrige National Quality Award and the Swedish Quality Awards (Karlöf, 1994). Leadership and continuous improvement (CI) is recognized by representing a substantial part of the scores in these quality awards and can therefore be considered important when it comes to improving quality. Many companies aim to improve their quality by introducing Lean Production, but reports claim that many of these companies' struggle with successfully implementing their Lean Production initiative (Hancock & Zayko, 1998; Koenigsaecker, 2005).

The chemical industry is not an exception when it comes to struggles of implementing Lean Production (Melton, 2005). In addition, the theory of how Lean Production should be implemented and developed in the chemical industry is limited. Furthermore, the application of the Lean Production principles in the chemical industry does also inherently have some fundamental translation issues compared to the traditional manufacturing industry. The reason is the differences of how the chemical industry operates compared to the traditional manufacturing industry. Two important differences are according to King (2009):

- *Demand variation*- customer demands are different in the way that the chemical industry has longer time-frames, sometimes weeks and months, compared to hours and days in many of the traditional manufacturing industries.
- *Difficult and costly product changeovers*- since continuous chemical reactions can not start and stop swiftly to make new products, site-production must be accommodated to support longer campaigns of continuous production of a single product.

Even though there are operational differences between the traditional manufacturing industry, from where the Lean Production methodology origins, and the chemical industry, one thing unites all industries that struggle with the implementation and development of Lean related activities: trouble with the willingness to change and adopt new ideas (King, 2009). Both the people operating the processess and managing the business need to buy in to change in order for a transformation to be successful (Melton, 2005). The leaders are the ones responsible for guiding their followers in why and how the followers need to change (Slack & Lewis, 2011). Therefore, it seems reasonable to suspect that when introducing and working with Lean Production, leadership should play an important part if an implementation or development initiative is successful or not.

So, is there a connection between leadership and successful implementation of Lean Production? A recent study concludes that some significant correlations exist between the two concepts, where active leadership supports a higher degree of Lean practices in the American semi-conductor industry (Wochl, 2011). The conclusion from the article is that if a company struggles with implementing Lean practices, it may do so because leaders do not practice enough active leadership styles. If a higher degree of active leadership could lead to improved Lean practices within companies, it suggests that training leaders to become more active, may improve companies' implementation and development of their Lean practices, and thereby improving quality and indirectly their competitiveness. Could active leadership styles have the same effect on the degree of Lean practices in the chemical industry? If so, it might improve the implementation and development of Lean Production initiatives that the Chemical industry struggle with.

1.1 PURPOSE

The purpose of this master thesis is to study the relationship between different leadership styles and leanness in Swedish chemical companies. By understanding the relationship, the studied companies is given the opportunity improve their work with Lean related activities through addressing management training and organizational focus. The goal is that the result will contribute to an enhanced knowledge of how leadership at chemical companies in Sweden should be carried out when they are working with Lean related activities. Answering this study's research questions properly can therefore indirectly help the studied companies and hopefully other chemical companies to increase their competitiveness, by improving their leanness through properly addressing leadership activities.

1.2 PROBLEM ANALYSIS & RESEARCH QUESTIONS

This study is only focusing on the Swedish chemical industry and no other industry or business. Further explanations on why this industry has been chosen can be found in the methodology chapter.

To be able to answer the purpose of this master thesis, three research questions were made up in a logical order were the third question builds on the first and second questions.

1. ***What leadership styles do leaders in the Swedish chemical industry practice?***

The first research question presented suggests that leadership styles will be measured to see what type of leadership styles the Swedish chemical industry practice.

2. ***How Lean is the Swedish chemical industry?***

The second research question presented suggests that leanness will be measured to find out how Lean the Swedish chemical industry is overall and in different areas.

3. ***Is there a relationship between leadership styles and leanness in Swedish chemical companies?***

The aim of the third research question is to distinguishing if different leadership styles affect the leanness differently in the Swedish chemical industry.

2 THEORETICAL FRAMEWORK

The objective of theoretical framework is to ensure that the reader has the basic theoretical knowledge to understand the result of the thesis but also explain today's best practice and theoretical and knowledge. Therefore, this chapter focus on describing the concepts and measurement methods of *Lean Production*, *leadership styles* and *Lean Leadership*.

2.1 LEAN PRODUCTION

Lean Production origins from Japan and more specifically Toyota, the car producer. Initially was the Lean Production approach solely associated with the car manufacturing industry, but has evolved from the manufacturing environment and are now also widely and successfully adopted in organizations and industries outside manufacturing (Slack & Lewis, 2011; Stone, 2012).

The purpose of the Lean approach for any manufacturing organization is to deliver "exactly what the customers want (perfect quality), in the exact quantities (neither too much nor too little), exactly when needed (not too early or too late), exactly where required (not to the wrong location), and at the lowest possible cost." (Slack & Lewis, 2011, p. 89). The optimal Lean process should therefore result in items flowing rapidly and smoothly throughout the organization's processes, operations and supply networks.

A good illustration of how the Lean mechanism should work in theory is the *five elements of Lean*. Figure 1 illustrates *The five elements of Lean* and is an elaboration of Slack and Lewis (2011) The *four elements of Lean.* Waste elimination is the ultimate goal and reflects a well-functioning Lean production system in an organization (Slack & Lewis, 2011). Fuijo Cho, President, Toyota Motor Corporation advocate all organizations to work with each element in figure 1, but in order to practice Lean Production great, every element needs to be working together, simultaneously and every day as a whole system (Liker, 2004).

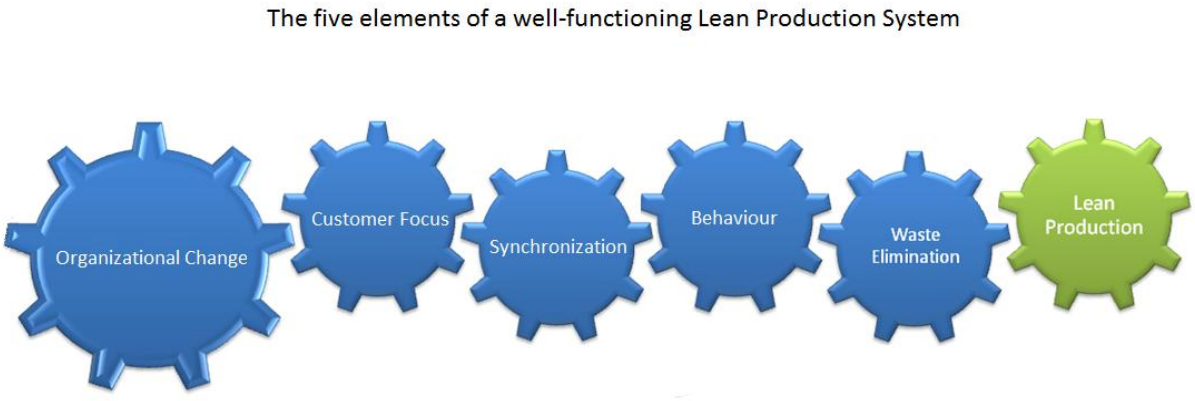

Figure 1. The five elements of a well-functioning Lean production system. Note: Figure 1 is an elaborated design from Slack & Lewis's (2011, figure 3.5, p. 91).

2.1.1 Organizational change

In order to explain the path of creating Lean in an organization, one must understand that the will to change must always come from within the organization itself. In other words, it is crucial that the whole organization gets involved in the change, especially the highest leaders who have the responsibility not only to participate, but also to mediate the understanding of why the change is necessary, how it will affect employees, and how they are planning to carry out the change. (Slack & Lewis, 2011)

The organization must also understand the effort it takes to become a Lean organization. Implementation and sustainability of Lean can be troublesome for large companies, but sometimes even harder for small and medium enterprises (SME) due to higher vulnerability of outside competitors since the entery barriers tends to be lower where many SME's operate, and at the same time do SME have little power to dictate their need to supplier compared to larger enterprises. When the need of "staying alive" is more urgent than developing the operation itself, the Lean implementation and development efforts is put aside. (Achanga et al. 2006)

Therefore is it essential that an organization has a plan of how their Lean work should and can be carried out, both financially and strategically. Lenders and Patton (2010) argues that the plan should consist of an organizational platform where the Lean work is driven from. Furthermore, should the platform also create strategic alignment of the Lean work and be clearly linked to the organization's overall strategy.

2.1.2 Customer focus

When an organization wants to become Lean and understands the amount of commitment it requires an organizational platform of the Lean strategy should exist or be created. The purpose of the platform is to shift the organizational focus to the customer, since the Lean Production methodology always and solely defines value from the perspective of the organizations end-use customer (Emiliani, 1998). Identifying all activities that create value means to understand specifically what activities that is required to satisfy the end-use customer. The viewpoint of the end-use customer is critical because it helps the identification of activities that add value, do not add value and do not add value but can not be avoided (Emiliani, 1998). The most important parts to consider in the value stream: cost, time, quality, and flexibility (Vermeulen et al. 2013). In other words, identifying the organizational Value Stream is the cornerstone of customer focus. Every activity that does not add value to the end-use customer is called waste.

When a Value Stream has been identified and mapped, the next step is to synchronize the stream of the sequential value adding activities, meaning that parts or information should *flow* within the organization without interruptions and one-piece/one operation at a time. This flow production method could be hard to implement in a mature manufacturing business because it can challenge the conventional manufacturing practice. It may do so since the flow-methodology has a customer focus while the traditional western methodology rely on batch and queue manufacturing, which performs solely for the benefit of each operational producer within the organization. One of the problems with the batch and queue mindset is that each activity has to consider and make forecasts and estimate productivity from adjacent activities in order to handle their own production. Forecasting and estimations are pure waste since it is time consuming and often inaccurate and should therefore be removed. (Emiliani, 1998)

In order to move away from a batch and queue mindset an organization have to change its focus from working with buffer inventories to only work when there is a demand from the internal/external customer. The use of a pull system where the end-use customer starts the pull eliminates the need of forecasts and estimations within the organization (Emiliani, 1998). To illustrate the difference between the push and the pull system, figure 2 *Push (a)* shows a traditional push approach of an organizations supply network or processes, where each stage is buffered from the next stage downstream and where the items are pushed forward to the next stage whether they required it or not at that time. The purpose with this way is that if one stage stops working for some reason, the next stage can continue to work using the buffer. One of the main downsides to the traditional push approach is that the throughput of items is slower due to waiting time in the buffers, but more importantly, does it give incitement to just work with firefighting (temporary fixes) of problems rather than solving problems

that may be caused by one or many stages (no incentive for fixing the system as a whole) when downtime occurs within a stage. In a pure Lean pull system, shown in Figure 2 *Pull (b),* an item only flows from one stage to another when the subsequent stage requests them and skips the middleman and the deliveries therefore moves from stage 1 to stage 2, and stage 2 to stage 3, without getting stuck in a buffer. This kind of process flow exposes problems at the stages and since the problems are now shared among the stages, there is a common need and responsibility to fix them. Forza (1996) adds that since one of the goals of Lean is to have customers focus and therefore produce on demand rather than to achieve a smooth mass production lines it requires the workers to be able to handle many different production tasks in order to reduce downtime when some workers has to solve acute operational problems in a stage. (Slack & Lewis, 2011)

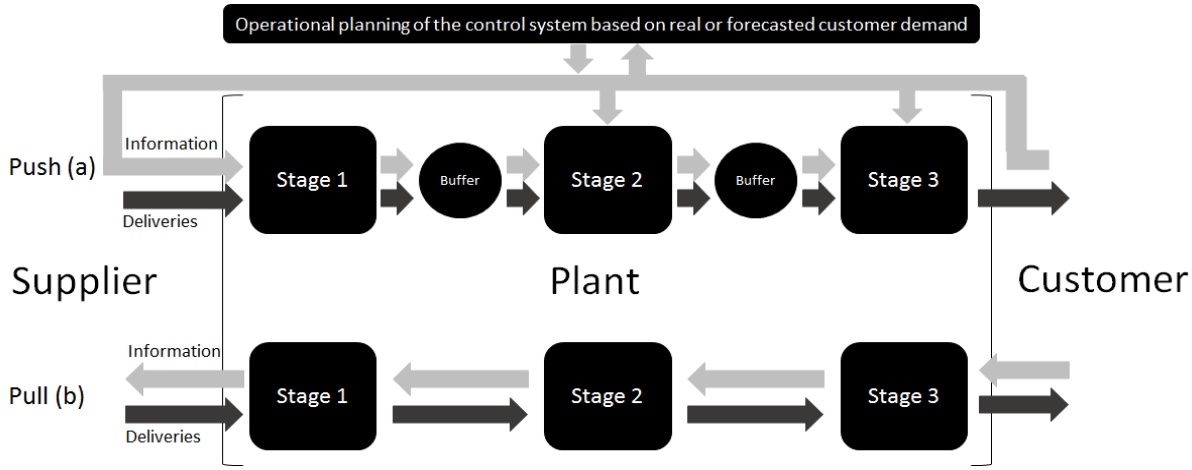

Figure 2. Illustration of the differences between pushed and pulled production. Note: An elaborated version of Slack & Lewis (2011, figure 3.4, p. 90).

2.1.3 Synchronization

When the cog-wheel of customer focus is spinning, the main focus should be shifted to creating a *synchronized flow* between the stages in figure 2 *Pull (b)*. Lean synchronization requires that the items or operations flows smoothly and fast through processes, operations and supply networks, and aims to meet internal customer demand instantaneously, with perfect quality and no waste (Vermeulen et al. 2013). This might sound easier said than done, and it demands a fast and all-embracing information system. This cog wheel is therefore a function of how inventory stockpiles within the operation. The bigger inventory, the slower the wheel turns, the less synchronized the flow is. The result of a smaller inventory is that it becomes easier to expose irregularities of how the flow works which may be treatable symptoms of underlying organizational problems. (Slack & Lewis, 2011)

To increase the synchronization and thereby lower the inventory buffer, a Just-In-Time (JIT) system can be implemented. JIT is a system that aims to meet demand exactly when it is needed and in the right amount. An example, could be a stage that has different internal suppliers, and for the stage to avoid delays and have a continuous production all their internal suppliers has to deliver their product at the right time and in the right quantity. The JIT system can be incredibly efficient when everything runs perfectly but are also fragile to synchronization problems of internal and external factors (Forza, 1996).

External factors of JIT can be congested urban areas, which essentially causing waste when workers are stranded in traffic and manufacturing plants that has to shut down waiting for components. But there are also other problems with a too extreme focus on Lean principles that is related to external factors, such as, physical distance of suppliers or shortage of workers. The point here is to respect that

some external factors can not be dealt with without adapting to the environment or change the environment. (Cusumano, 1994)

Much of the success factors of working with JIT depend on the willingness of workers to collaborate (Forza, 1996), but also to strategically align the Lean synchronization performance between the internal departments and stages, both within the organization and outside (Vermeulen et al. 2013).

2.1.4 Behavior

One of the biggest challenges in implementing a successful Lean program is to ensure that the initial benefits sustain over the long run. According to a Capgemini survey, a peak of worker-dissatisfaction are reached 1-2 years after a Lean initiative launch, as seen in figure 3. According to Lenders and Patton (2010) may thus not be surprising since they found that Lean initiatives often initially focuses on introducing the Lean tools and methodologies, that quickly gives positive operational results but avoids including the corresponding Lean behaviour in the initiative. Therefore are often pessimism emerging throughout the organization if the changes of Lean behaviour that corresponds to the Lean methodology is not embedded in the Lean initiative. The behavioural window of opportunity is at 1-2 years into the initiative, where the organization either embeds the needed behavior changes and succeed to sustaining the Lean initiative or ignores the required changes and fall back to old behavioral habits and sees the Lean initiative fall victims to other initiatives that might come along. Therefore is the behavioral element a critical Lean component for success. The problem is that the behavior takes longer time to change than implementing and using the Lean tools and methodologies. There are two main barriers that prevent and/or slows the Lean initiatives down according to Lenders and Patton (2010): organizational resistance to cultural change and lack of focus or commitment for operational excellence. (Lenders & Patton, 2010)

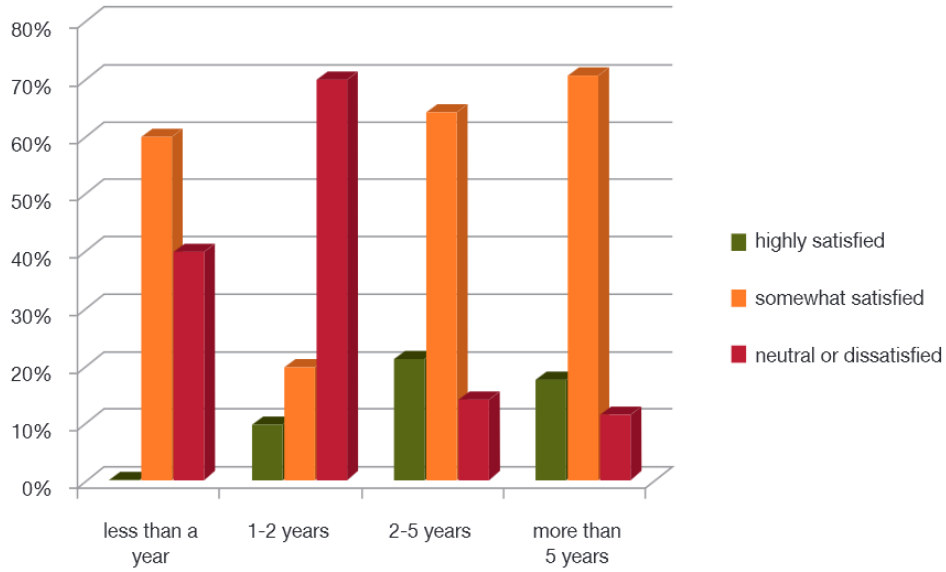

Figure 3. Level of satisfaction with Lean program relative to duration of current program. Note: Figure adapted from Lenders and Patton (2010, p. 4).

Liker and Convis (2012) and Byrne (2013) add that many implementation attempts of Lean has faltered to sustain its initial achievements due to Lean fatigue. The reason for the fatigue is that organizations has neglected the importance of top leadership commitment and their responsibility of creating a culture where people in the organization has a horizontal focus where the customer is in the focus rather than a vertical focus where the performance of each functional department is rewarded. Forza (1996) argues that much of the Lean concept relies on well functioning teams in were all workers that

are part of the team are performance-evaluated as a team rather than individuals. In a teamwork focused environment, decentralized decision must be allowed which consequently facilitates problem solving and affect variance and uncertainty since they can be easier managed.

2.1.5 Waste elimination

The last part of the five elements before describing a functioning Lean production system is the waste elimination process. This step may be the most significant part and goal when implementing Lean Production. Waste is defined as any non-value-added activities that exist in any part of an organization. But in order to eliminate waste, it must first be identified. Liker (2004) has identified 8 types of waste that this paper has narrowed down to two broad categories. The first is *stage wastes*, the second is *inter-stage waste.* Stage waste is waste that each stage in figure 2 can find and fix independently of each other while inter-stage waste only can be found when the stages are asynchronous and fixed by collaboration between stages.

2.1.5.1 Stage waste

1. *Overproduction*- means that a stage is processing items even though there is no order for that item. This could generate waste in the form of overstaffing, transportation- and storage costs, Overproduction may be one of the worst wastes, since it could be a cause of most other wastes. The reason for this is because when an organization is creating buffers between the stages the material (capital) are just waiting to be processed in the next stage. This leads to an asynchronous flow between the stages which lead to suboptimal behavior, like reducing employee motivation to continually improve the operation. Why improve something in the stage when a small breakdown does not affect their customers, since we have a buffer for it? Another reason not for not using buffers is when a process goes wrong, for example, a stage are creating defective parts, a large buffer makes it difficult to fast find out that something is wrong since the lag time between process and customer are time wise long. Overproduction can be reduced by using a Pull system, since pull systems reduce the need for buffers. (Liker, 2004)

2. *Waiting*- could be waste created when employees are waiting for a mechanized machine to work, waiting for the next processing step or just are out of work to do because of processing delays, machinery downtime and capacity bottlenecks. (Liker, 2004)

3. *Incorrect processing or/and over processing*- waste is created when the process are taking unnecessary steps in the processing of an item or/and when the item holds a higher quality than needed. (Liker, 2004)

4. *Unnecessary movement*- could be physical movement of employees during work that does not add value. Other examples are unnecessary long walking distances between equipment or reaching/looking for tools. (Liker, 2004)

5. *Defects*- are scrapped or repaired products because it does not hold the required quality. Defect products cause waste due to increased material use, inspection time and equipment time. Noteworthy is that a lower defect rate may decrease the need of buffers between stages. (Liker, 2004)

6. *Unused employee creativity or lack of collaboration*- is waste that arises when the employees' full capacity are not used in an organization or when disruptive personalities spread negative energy in an organization/work-team. Such waste could be losing ideas, competence, possible improvements or negative comments about colleagues. (Liker, 2004)

2.1.5.2 Inter-stage waste

1. *Unnecessary transport or conveyance*- is a waste when products in the process are carried longer distances than necessary, the transport of the products are inefficient, or the finished products move in and out of storage between processes. (Liker, 2004)

2. *Excess inventory*- are waste created when an excess of raw material, items in process, and/or finished items are causing the system to have long lead times. Overproduction could affect excess inventory, but the effect may be transportation and storage costs, delay, higher volume of defect products, and ignorance of hidden problems, such as, production imbalances, equipment downtime and long setup times. (Liker, 2004)

Liker (2004) argues that the goal is to reduce waste, and the best way is to create stages with one-piece-flows where the products or services flows through various operations within the stage, one unit at a time, at a rate determined by the customer (pull flow) and with as little delay and waiting time as possible. Many of the eight wastes described above can be reduced by doing so.

So why are not all organizations using this stage system with one-piece flow? There may be two reasons for that. Firstly, an organization may have to sacrifice some of its capacity utilization. The reason for that is when organizations work in a traditional system and a stoppage occurs, buffers allow the stages to work independently of each other and thereby can the whole organization achieve higher capacity utilization. The system may not necessarily produce more since the additional production just goes into buffers. But in an organization that highly value stage capacity utilization, a switch to Lean Production may initially be hard to accept and approve. Secondly, the point is not to blindly apply the theory of creating stages without thoroughly thinking it through. If a stage does not fit in with the next and the one before, the stage might be contra productive to its purpose. This can lead to an unsynchronized flow, crashes of the system, and disbelief in the Lean production system. Therefore is it important to have the whole system in mind when introducing Lean Production. When an organization transforms itself, it empirically appears that the transformation goes more smoothly when the implementation is strategically aligned throughout the organization (Stone, 2012). (Slack & Lewis, 2011)

2.1.6 Possible benefits of Lean Production

Lean Production helps to improve cost reduction, operational efficiency and customer service within an organization (Lenders & Patton, 2010). Furthermore, Koenigsaecker (2005) argues that leaner companies has balance sheets with a much higher inventory turnover, often lower receivables, and better fixed capital efficiency. The higher fixed capital efficiency comes from using the equipment better, but also does the Lean work redesigns processes so that they fix to the Lean requirements (Koenigsaecker, 2005). In conclusion, Lean Production can be seen as an instrument to increase competitiveness through CI (Vermeulen et al. 2013) that improves and help to create a high operational productivity, quality and manufacturing (Cusumano, 1994).

2.1.7 Possible downsides of Lean Production

The positive aspects of introducing Lean sound fantastic, but are there any downsides? Since the aim of the Lean production system is to help organizations meet their demand immediately, with no waste and perfect quality, mainly three possible downsides have to be taken into consideration according to Slack and Lewis (2011). Firstly, *fluctuation of customer demand* is probably the major weakness of the Lean production system. Extreme and unpredictable fluctuations are devastating, since the Lean system builds on a pull system with a small or absent buffer. Secondly, the aim to reduce the buffers causes vulnerability to *stage-external factors*. Even though all the stages in the organizations are

working perfectly, external factors, such as, lack of key parts from suppliers due to factory fires or earthquakes can force the whole organization to temporarily shut down. Thirdly, *cultural factors* between Japanese and Western people management can cause problems in implementation and friction when using the Lean production system. This is due to that the Lean methodology orgin from an autocratic Japanese leadership style. (Slack & Lewis, 2011)

If not dealt with properly, these three downsides has a huge potential to destroy an organizations attempt to implement a Lean production system. This paper will focus on how a western organization should deal with leadership style when using the Lean methodology that advocates an autocratic leadership style. *Lean Leadership* is a compromise that aims to utilize all of the leadership potential in a Lean production system and works in western located organizations. (Slack & Lewis, 2011)

2.2 HOW TO MEASURE LEANNESS

There are many ways and studies where researchers have tried to measure implementation or progress of Lean Production (Schonberger, 2008). Many articles has studied and provided the literature with different ways how one can measure and quantify Lean progress (Åhlström & Malmbrandt, 2013; Åhlström & Karlsson, 1996; DeWayne, 2009; Bayou & Korvin, 2008; Wan & Chen, 2008). Shah and Ward (2007) have criticized some research articles for being too narrow in measuring Lean Production and that the articles too often only described how to measure specific components of Lean Production rather than the whole systems. Schonberger (2008) is, for example, emphasizing inventory turnover as a the ultimate tool to measure sustainability of leanness. To fill the gap in the literature, Shah and Ward (2007) created a multi-dimensional measurement questionnaire of Lean Production as a system. The master thesis uses their questionnaire which is provided in appendix 1 (the English version in appendix 5) and further calls the questionnaire the "leanness questionnaire" (LQ). The LQ is based on a conceptual and empirical mapping of Lean Production (table 1) and constitutes of 10 dimensional factors of the Lean philosophy. The LQ allows researchers to measure the leanness of an organization and to test hypotheses of relationships between leanness and other firm characteristics, such as leadership styles (Shah & Ward, 2007).

Table 1. Conceptual and empirical mapping of Lean Production philosophy (Shah & Ward, 2007).

Main concept					Lean Production								
Underlying Constructs (index)		Supplier related			Customer Related				Internally Related				
Operational constructs (dimensions)	Supplier Feedback	JIT Delivery	Developing Suppliers		Customer Involvement		Pull	Flow	Low Setup Time	Statistical Process Control	Production Maintenance	Employee involvement	
Operational Measures (# of items)	3	3	6		5		4	4	3	5	4	4	

The questionnaire consists of 41 measured items that builds ten different dimensions. The ten dimensions are subsequently building three indexes that together are constructing the main concept which is the measurement tool for Lean Production. Shah and Ward's (2007) 10 dimensions consists of:

1. *Supplier Feedback* - measures how well an organization provides regular feedback to their suppliers about their performance.
2. *JIT Delivery* - measures that a supplier can deliver a product in the right quantity, to the right place, and at the right time, predicated on that an organization provides suppliers with feedback about their quality and delivery performance

3. *Developing Suppliers* - is important to measure so that the organization's suppliers can give better feedback and thereby more accurate JIT deliveries. Furthermore is the training and development of suppliers crucial for their involvement in the organization's production process.
4. *Customer involvement* - is necessary for an organization if the organization what to satisfy their customer's needs. The dimension measures if the organization focus on their customers' needs and accurately predict the customer demand.
5. *Pull*- production is a facilitator for a JIT production. The dimension measures how much of organization's production that is customer-driven and how the organization works with, for example, Kanban cards to improve their customer-driven production.
6. *Flow* - measures mechanisms that eases continuous flow of products within an organization, if products are grouped according to product families, and if equipment is placed in an order to improve a continuous flow of products.
7. *Low Setup Time* - measures if the organization are reducing, for example, downtime between product changeovers, which allows organizations to increase the number of products being produced and prediction of process output.
8. *Statistical Process Control (SPC)* - measures if the organization uses methods to lower production variance with the aim to continuously have a defect free production.
9. *Production Maintenance* - measures how well the organization ensures that they avoid frequent stop-and-go operations, downtimes, and has a high equipment availability, the equipment should undergo frequent and regular preventive maintenance.
10. *Employee Involvement* - is necessary in the organizational role of fast and effective problem solving. The dimension measures, for example, if the organization has cross-trained and self-directed employees.

According to Shah and Ward (2007, p. 800) it is the "*complementary and synergistic effects of the 10 distinct but highly inter-related elements that give Lean Production its unique character and its superior ability to achieve multiple performance goals. While each element by itself is associated with better performance, firms that are able to implement the complete set achieve distinctive performance outcomes that can result in sustainable competitive advantage*.". The challenge is for an organization to implement and sustain many different dimensions at the same time, but also makes it hard to imitate which can lead to a competitive advantage (Shah & Ward, 2007).

2.3 LEADERSHIP STYLES

It exists many different models to evaluate a leader's leadership styles within the literature. One model that has gained most influence and impact on the theoretical modeling of leadership styles is Bernard Bass and Bruce Avolio's research on their transactional – transformational leadership paradigm. According to Bass and Avolio (2009) can leaders display three different types of leadership styles, ranging from active to passive leadership: transformational-, transactional-, and passive/avoidant leadership styles. Each leadership style consists of separate leadership skills that corresponds to each leadership style. The leadership skills are based on practicing leadership behaviors. It is important to point out that all managers may display all leadership styles, but it is the frequency of how often a leader displays each leadership style that matters (Kirkbride, 2006). The individual leadership skills and the corresponding behaviors will be more extensively explained later on, but first a walk-through of the main leadership styles.

2.3.1 Transformational leadership

The transformational leadership style is a fusion of four leadership skills: Idealized Influence (II), Inspirational Motivation (IM), Intellectual Stimulation (IS), and Individualized Consideration (IC).

According to Bass and Avolio (2009) is transformational leadership a process where the leaders change followers awareness of what is important and at the same time give them opportunities to reach the stated goals and visions. Furthermore, the transformational leader is proactive, has a performance that is above what is expected, and at the same time hold a high level of moral and ethical standard. This enhanced leadership performance can be seen in transformational leadership when the leader has affected their followers: interest in their work, awareness and acceptance of the group's purpose and mission, and willingness to transcend their own self-interest for the good of the group (Seltzer & Bass, 1990). The underlying influence process of transformational leadership is to make followers aware of the importance of task outcomes and thereby motivating them to focus more on what's best for the organization rather than their own self-interest (Yukl, 1999).

2.3.2 Transactional leadership

The transactional leadership style is a fusion of two leadership skills: Contingent Reward (CR) and Management-by-Exception (MBE-A). The transactional leadership focuses on the informational exchange between the leaders and the followers (Bass, 1996). This informational exchange could involve discussing conditions, setting and defining expectations, and promoting the followers performance to reach stated goals (Bass & Avolio, 2009). In other words, transactional leadership can occur when a leader rewards or disciplines a follower for the follower's performance, and where the follower's performance accuracy defines the leader's transactional response (Bass, 1996). Bass and Avolio (2009) state that transactional leadership is associated with typical "management" behaviors in an organization and are therefore involved in both constructive and corrective actions.

2.3.3 Passive/avoidant leadership

The passive/avoidant leadership style is a fusion of the leadership skills: Management-by-Exception Passive (MBE-P) and Laissez-Faire (LF). Some researchers would probably argue that passive/avoidant leadership is a non-leadership behavior rather than a leadership style, but this paper will call it a passive/avoidant leadership style and classify MBE-P and LF as leadership skills, since Bass and Avolio (2009) does it.

Passive/avoidant leadership is passive and reactive leadership style where a leader does not respond to situations and problems systematically. This behavior occurs when a leader avoids specifying agreements, clarify expectations, and provide goals and standards to followers. Not surprisingly does this type of leadership have a negative effect on desired outcomes (expected and intended from the leader). (Bass & Avolio, 2009)

2.3.4 The 8 leadership skills and their correlation to performance & effectiveness.

The transformational, transactional and passive/avoidant leadership styles consist of 8 types of leadership skills. These leadership skills, their corresponding behaviors, and correlation to team performance &effectiveness are summarized from different sources in table 2.

Table 2. Describes leadership styles, leadership skills and their corresponding behaviors and correlation to performance.

Note. Data for Typical behaviors *from: Riggio & Bass (2006), Bass (1997), and Bass (1996). Data of what typical behaviours* can lead to *from: Riggio and Bass, (2006) and Bass (1996). Data for* Correlation to performance of the leader *from Kirkbride (2006). Data for* effectiveness of the leader *from Lowe et al. (1996).*

Leadership Styles	**Leadership Skills**	**Typical behaviors (The leader….)**	**Can lead to...**	**Correlation between leadership and Performance (P) & Effectiveness (E)**
Transformational Leadership Styles	Idealized Influence (II)	Is admired, respected, trusted and act as a role model for his/her followers. Take stands on difficult issues and demonstrates unusual work related competence and highly value work commitment. Hold high ethical and moral conduct by, for example, sharing risk with followers, consider followers' needs before his own or avoiding using power for personal gain and only when needed.	Superior performance through crises and problems. A collective sense of purpose throughout the organization.	P: + 0.45-0.6 E: +0.71
	Inspirational Motivation (IM)	Creates an optimistic vision of a future that the followers accept and articulates it in an exciting and compelling manner. His/her vision motivates and inspire the followers by providing meaning and purpose of their work. Displays enthusiasm and challenge their followers through clearly communicated work related challenges and expectations.	Motivating followers to superior performance.	P: + 0.45-0.6
	Intellectual Stimulation (IS)	Stimulates and allows their followers to think and act through problems on their own by questioning old assumptions, re-framing problems and approaching old situations in new ways. Allow followers to have deviated opinions and does not allow public criticism of individual mistakes. Stimulate new ideas and creative problem solutions from followers, who also are included in the process of addressing problems and finding solutions to them	Followers develop their own abilities. Increase innovation and creativity.	P: +0.45-0.6 E: +0.602
	Individualized Consideration (IC)	Create a supportive environment through addressing each follower's need for achievement and growth by listening attentively and acting as a coach or mentor. Assign projects based on the follower's individual ability and needs and encourages a two way exchange in communication. Practice "management by walking around" and monitors followers with the purpose to see if help is needed/wanted rather than checking up on them.	Above required performance by followers. Self-development of followers.	P: + 0.45-0.6 E: +0.61
Transactional Leadership Styles	Contingent Reward (CR)	Makes clear what the followers can expect and receive when performance goals are met/not met. Provides support and resources for the followers so that they can reach the demanded goals.	Performance is on the required level and the followers meet the specified targets and objectives.	P: +0.44 E: +0.41

Table 2. (continued)

Leadership Styles	Leadership Skills	Typical behaviors (The leader….)	Can lead to...	Correlation between leadership and Performance (P) & Effectiveness (E)
	Management by Exception Active (MBE-A)	Actively monitor that rules and standards are met by their followers and intervenes when necessary. Is keen on enforcing rules to avoid mistakes, but teaches followers about how to correct a mistake when one Is made.	A negative relationship to innovation and creativity within the organization. Performance on the moderate standard	P: +0.22 E: +0.05
Passive/Avoidant Leadership Styles	Management by Exception Passive (MBE-P)	Focus on maintaining status quo and only take action when mistakes or deviances from standards or assignments are brought to their attention.	Tendency to a relatively wide performance acceptance rate and poor performance when it comes to monitoring systems.	P: +0.13
	Laissez-Faire (LF)	Avoids taking decisions by shifting attention from hard choices. Often abdicate his/her responsibilities. Avoids expressing their own views on important issues.	Low productivity and lack of innovation. More conflict and less commitment.	P: -0.28

In figure 4, a graphical visualization of the relationship between MLQ scales and the leader's performance & effectiveness from table 2 are presented. According to Seltzer and Bass (1990) are transformational leadership consistently outperforming transactional leadership when it comes to operational effectiveness, a result that also agrees with the visualization in figure 4.

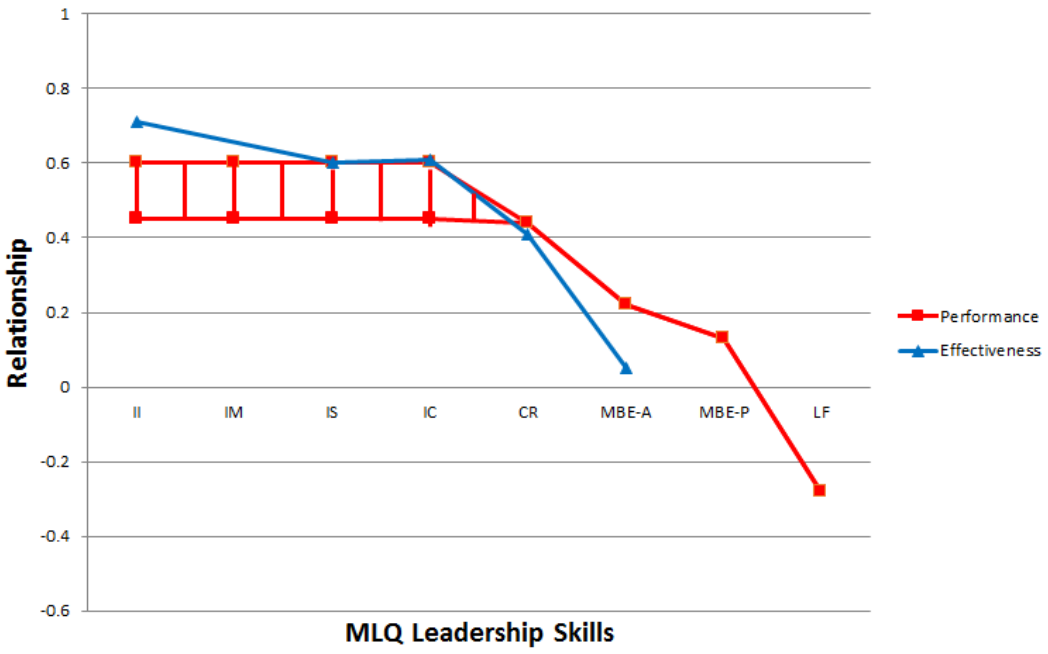

Figure 4. Visualization of the relationship between MLQ scales and leaders' performance & effectiveness, from table 2.

The measurement “Effectiveness” in figure 4 is a combination of two effectiveness criteria related to the MLQ scales and the result based on a meta-analysis. The first effectiveness criteria is the follower’s perception of the leader’s effectiveness. The second criteria measure different performance objectives of the leader’s unit, such as, reached goals (%), financial performance of work unit, pass-rate on followers’ educational competency exams, but also supervisory ratings and number of promotion recommendations. (Lowe et al. 1996)

The “Performance” data in figure 4 comes from Kirkbride (2006) whom refers to Coleman et. al (1995) unpublished manuscript that displays the correlation between leadership skills and leadership performance.

Bass (1996) states that the most effective leaders have the ability to display all of the leadership skills to some amount, but the importance is how frequent each leadership skill is displayed. The optimal leader displays their transformational leadership skills more frequently than their transactional.

2.4 How to measure leadership styles

To measure the different leadership styles, Bernard Bass and Bruce Avolio have developed the *Multifactor Leadership Questionnaire* (MLQ). The development of the questionnaire started already in 1985 and is today one of the most reliable and validated questionnaires evaluating leadership styles. The theory of the MLQ builds on earlier leadership research, such as, autocratic versus democratic leadership, task-versus relationship oriented leadership, and directive versus participative leadership. However, one of the biggest differences is that much of the previous research has focused on what Bass and Avolio call Transactional leadership while the MLQ theory has expanded the leadership dimensions to include earlier key factors, such as, Inspirational Motivation. Another advantage of the MLQ compared to other leadership surveys is that the MLQ includes items that measures the leaders effect on both his/her personal and intellectual development of his/her self and others. (Bass & Avolio, 2009)

The concept of the transformational-transactional leadership paradigm is universally applicable in the way that the studied leaders can, through a MLQ measurement, be created a profile of transactional and transformational scores. These scores can reliably and validly be assessed and compared to the norms for his or her group, organization, or culture. The mean of individual leader’s scores can be a subject to variation when a leader moves from one context to another. The reason for this could be that certain values, norms, thought processes, beliefs and behaviors are prevalent in one culture but not in another and therefore moderates the leader-follower relations. With this logic should the comparability of the MLQ be higher if the study is carried out in the same culture or cultures that are similar. Bass (1997, p. 137) borrows from Podsakoff et al. (1990) and Shamir et al. (1993) articles that “to refute the transactional-transformational distinction will require finding conditions, cultures, and organizations in which trust between the leader and the led in unimportant and the led has no concern for self-esteem, intrinsic motivation, consistency in self-concept, actions taken for the leader, or meaningfulness in their work and lives.”. These types of contexts are probably more likely to be exceptions than rules. (Bass, 1997)

The universality of the transformational leadership theory does also extend to individuals outside the upper management of organizations and can therefore also be used on, for example, middle management. Furthermore, the transferability of MLQ scores are higher when comparing within the in the same organization than between leaders that comes from different organizations, but caution has to be taken when geographical or organizational differences cause substantial cultural differences. (Bass, 1997)

Although the MLQ is covering many aspects of leadership behavior, critique is directed towards the questionnaire for excluding empowering behaviors, such as, consulting, delegating, and sharing sensitive information. The questionnaire has also left out the evaluated leader's interaction with peers, superiors, and outsiders. These interactions are important when it comes to sharing information, cooperating, and political support that may be essential for a group's performance. (Yukl, 1999)

The questionnaire is in its most recent form called 5X-Short and consists of two questionnaire forms: the self-rating form where the leader does a self-evaluation of his/her leadership, and the Rater form, where followers, associates, the leader's leader and can evaluate the leader's leadership (Bass & Avolio, 2009). More on how the MLQ is used in this master thesis is provided in the methodology chapter.

2.5 LEAN LEADERSHIP

Since there are many articles covering Lean Production and leadership styles separately, it is also important for the understanding of this master thesis results to investigate articles that focus more specifically on the combination of the two theories. Lean Leadership can be described as the leadership that preferably should be used by leaders when implementing, working, and handling Lean related activities (Sörqvist, 2013). Liker and Franz (2011) describes Lean Leadership as tough and challenging without being mean or destructive, by being "demanding, with high expectations, and constantly giving feedback, encouragement, direction and education." but also have leadership commitment and vision of how they want the future to be.

Lean Leadership helps followers to enhance Lean behaviors and work activities. Lean behaviors minimize waste associated with "arbitrary or contradictory thoughts and actions that lead to defensive behavior, ineffective relationships, poor co-operations, and negative attitudes" (Emiliani 1998, p. 619) between members of an organization. By avoiding wasteful verbal or gestural content in conversations, Lean behaviors are enhanced and waste minimized. Lean behavior is, in other words, all about creating a work environment with good interpersonal relations that focuses on work relating matters together with Lean activities. (Emiliani, 1998)

2.5.1 Differences between leadership in western organizations and Lean Leadership

But what is Lean Leadership more concrete and why are there so few organizations that successfully make a Lean transformation? There may be many valid explanations that concern the matter, and some explanation does concern the area of leadership (Sörqvist, 2013). While the key principles of Lean Production are simple, the issues may occur when trying to integrate the principles into the daily managerial behavior in western organizations (Koenigsaecker, 2005). The Lean concept is for example designed on a "one-piece-flow" of products. The system may be easy to grasp and visualize, but does the organization have any administrative management system that integrates with the one-piece-flow fashion (Koenigsaecker, 2005)? Van Landeghem et al. (2013) continues on the same theme and states in table 3 differences between east and western management styles. The differences in table 3 reinforce Koenigsaeckers argument that it may be hard to integrate Lean key principles into an organization without changing its management style as well. Van Landeghem et al. (2013) goes further by stating that the stereotypical western style of management is totally incompatible with the Lean Leadership requirements of Lean and argues that a western organization has to completely change to Lean Leadership if they successfully what to make a Lean transformation.

Table 3. Differences between the Western style management and the Lean Leadership. Note: The table is adapted from Van Landeghem et al. (2013, table 1)

	Western Style Management	Lean Leadership
Time scale	Short: weeks to quarters	Long: months to years
Main driver	Acute problems	Root causes
Solution approach	Treat the symptoms	Improve the process
Management Information Support	IT based, Enterprise Resource Planning	Limited IT use, visual management
Indicators	Financial performance	Operational performance
What does management do	Lead by decree thru office meetings	Lead by doing through Gemba meetings
Where does management spend time	In the office	On the shop floor
Sustainability comes from	Management system in place	Behavioral change in people

Lean Leadership is different from the conventional leadership styles because it emphasizes elements that just simply can not be delegated down (Mann, 2009). Spear (2004) point out two such different leadership elements:

- *Direct observation by Gemba walking* - can not be substituted. When the leader solely relies on indirect information, such as, reports, interviews and aggregated data, the big picture may be lost. Imagine a soccer coach that does not participate at the soccer field. The coach has instead isolated himself in the locker room the reading statistics on the computer and talking to the second coach on the phone trading information and giving him orders. Do you think there is a risk to lose the big picture of the match, but more importantly gain the trust of the players?
- *Consistently uses the scientific method in problem solving* - by experimenting using a hypothesis and then accept or reject that hypothesis based on the result. The leadership style must allow followers to identify problems caused by causal relationships, present possible changes that fix the root cause, implement the change, measure the fixes effect on performance, and finally if the fix is successful, standardize the procedure. This methodology requires a hands-off leadership approach and a leadership climate that allows it, where the leaders have confidence in their followers and act as their teachers and facilitators. The teacher does not say how the followers should fix the problem, but rather give him/her the methodology, directions and opportunities of how to solve problems. Such directions or opportunities could be to study this machine or that person while looking for various types of stress or faults. The more senior the leader is the more teaching responsibility should he/she take on and therefore acting as a project enabler.

The factor that is most essential for a true Lean-learning organization, but also the hardest to integrate is key changes in leadership behavior. The reason for the hardship is that even though it is easy to talk about changing behavior of leaders and the way to do it may seem straightforward, the reality is that it can be extremely hard to adapt, since the needed Lean Leadership behavior is in conflict with the stereotypical western culture of how to deal with organizational management. An example can be

found in table 3 where, for example, root cause problem finding is in conflict with acute problem solving. Koenigsaecker (2005) provides an example on how the western management style differs from the Lean Leadership style when they approach efficiency gains. An organization has improved their efficiency, which has led to that a six person team can do the same work with only five people and produce the same. The western organization will now free up the lowest performing follower of the team. It seems like the right thing to do, and it is, when solely focusing on the performance of the team. But when the focus is on the organization's end-customer, focus should be the opposite, in other words, free up the best and most flexible team member to the rest of the organization. The reason for this is that it opens up talent for the rest of the organization, but also aviods building pools of low performers. What team would like to take on the freed up employees if they know that they are low performers? So the issue here is to make leaders change their behavior from personal performance to focus on the organization's end-customer. This can only work if such behavior is consistently encouraged from higher organizational levels. Management systems that encourage Lean behaviors are a good way to encourage Lean Leadership and focus on customer needs. (Koenigsaecker, 2005)

2.5.2 Connection between the 8 leadership skills and Lean Leadership

In order to better understand and evaluate the connection between the MLQ leadership skill's behaviors and the behaviors of Lean Leadership, table 4 was constructed. Table 4 counts how often and which Lean Leadership behaviors are mentioned in Lean Leadership literature, and in the last column, connect Lean leadership behaviors with behaviors that exist (if it exist) in the MLQ leadership skills paradigm described, inter alia, in table 2. Note that table 2 is a summary of each leadership skills' behaviors and therefore does not describe all behaviors that each MLQ leadership skill incorporates.

Table 4. 1. Liker & Michael (2008) 2. Liker & Franz (2011) 3. Van Landeghem et al. (2013) 4. Liker & Convis (2012) 5. Sederblad (2013) 6. Liker (2007) 7. Emiliani (1998) 8. Bodek (2008) 9. Testani & Ramakrishnan (2011) 10. Spear (2004) 11. Mann (2009) 12. Koenigsaecker (2005) 13. Glover et al. (2011) 14. Emiliani (1998) 15. Liker (2004)

Lean Leadership behaviors - the leader…	**Sources**																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	**Sum**	**Leader-ship skill**
trusts followers (to do the work correctly and to delegate tasks)	1	1			1				1	1		1		1		7	II
supports the followers with what they need e.g. business strategy, long term planning, training, Continuous development	1	1						1	1	1		1				6	CR
creates visions and a way to meet the vision by aligning goals with the means	1	1			1			1	1						1	6	IM
values coaching and teaching	1	1		1		1				1					1	6	IC
gives realistic challenges	1	1		1				1		1						5	IM
values a well-functioning teamwork	1				1		1		1						1	5	IC
is passionate about work, customers and quality		1		1	1						1		1			5	
is dedicated in becoming an expert in root cause solving	1	1	1							1		1				5	
energize, invigorate, motivate and inspire others	1	1											1		1	4	IM
initiate and sustain CI (also through using follower expertise)	1	1		1	1											4	IS
thinks beyond short term financial considerations by making operational excellence a goal	1	1	1											1		4	
knows his/her business inside and out	1	1		1											1	4	
values people that dedicate themselves to both self- and work-improvement	1	1		1							1					4	II
actively uses Gemba-meetings (work floor meetings)			1	1						1	1					4	IC

Table 4 (continued)

Lean Leadership behaviors - the leader…	**Sources**																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	**Sum**	**Leader-ship skill**
fosters self-accomplishment in followers	1	1		1												3	IC
respect followers (and their expertise)	1						1		1							3	
improves herself as a leader and person by setting an example		1		1							1					3	II
put the organizational needs before egoistic	1	1										1				3	II
thinks that sustainability comes from behavioral change in followers			1								1			1		3	
holds followers accountable for their own actions as well as his/her own	1	1														2	II
has a spirit of challenge	1	1														2	
focus on visual management			1	1												2	
is process oriented	1			1												2	
confirms the process rather than searching for mistakes from followers (when monitoring)	1															1	IC
solution approach is to improve the process			1													1	
focus on operational performance			1													1	
creates a work environment with good interpersonal relations that focuses on work relating matters							1									1	IC
only delegates task that the leader can understand												1				1	

Trust is the single most important Lean Leadership behavior in table 4. Trust is a behavior that can be found in Idealized Influence (II). Figure 5 was constructed to visualize what types of MLQ leadership skills that a Lean leader should "in theory" focus on practicing. Figure 5 is based on the information from table 4 and constructed through adding the sums of each Lean Leadership behavior to the corresponding MLQ leadership skill, after which the sum of the leadership skill has been divided by the total sum. For example, is II calculated by "(7+4+3+3+2)/SUM(of LF to II)". The result from the calculations is a frequency visualization where for example II in figure 5 can be interpreted: Lean leaders should, in theory, practice II leadership behaviors a little bit more than 30 % of his/her time interacting with followers.

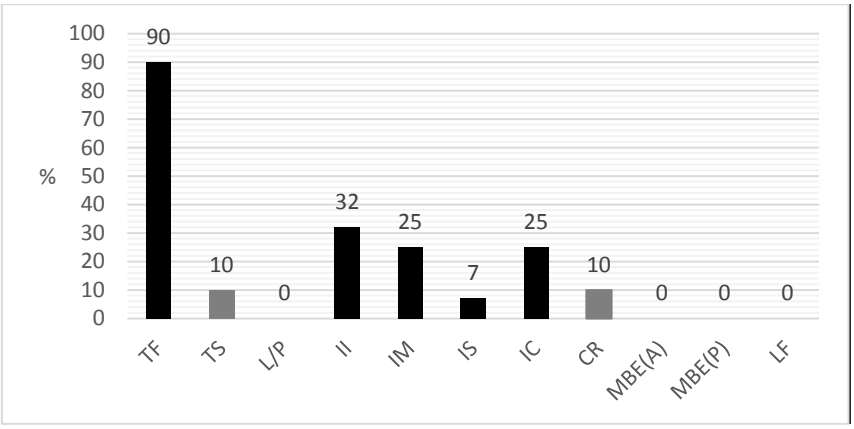

Figure 5. A visualization of how much time a leader should spend practicing (in %) the different leadership styles and skills when working with Lean related activities. TF stands for transformational leadership, TS stands for transactional leadership, and L/P stands for passive/avoidant leadership.

2.6 How to develop and sustain Lean initiatives through leadership activities

Leadership and committed financial support from top management seems to be the cornerstones for a successful Lean implementation according to Achanga et al. (2006) when they interviewed ten small to medium enterprises (SME). The article concluded that leadership accounted for 50%, financial capabilities 30%, and organizational culture, skills and expertise accounted for 10% of the proportional Lean success factors. The preferred leadership styles or qualities were in the article: clear vision of the preferred future, strategy initiatives, good level of education (business knowledge), commitment to Lean iniatives, and permitting a flexible organizational structure (Achanga et al. 2006). Leadership could therefore be one of the most important aspects for long term durability of Lean initiatives and to aviod "Lean fatigue", that can occur 1-2 years in a Lean initiative. To sustain Lean initiatives when it comes to leadership activities, literature seems to highlight three different aspects: Senior leadership, creation of a Lean management system, focusing on leadership transformation, and understanding and recognizing the challenges of becoming Lean.

2.6.1 Senior leadership

Koenigsaecker (2005) argues that very few western-companies has achieved a successful Lean transformation because they lacked involvement from the senior-leadership. Liker (2004) adds that it is a prerequisite for a successful Lean transformation that top management has a general understanding and urgent drive to become a Lean organization.

According to Lenders & Patton (2010) have senior leaders mainly three important leadership aspects to consider when working with Lean in order to sustain their Lean initiatives:

1. *Leadership characteristics*- the senior leaders should always lead Lean initiatives by example. In other words, does it imply that the senior leaders sets guiding principles that establish ideal behaviors and making sure that these behaviors gets established throughout the organization by setting an example. Furthermore, should a senior leader making sure that the management systems are driving the right behaviors in the reports, which is important for including middle managers to shift to a Lean focus, since their leadership behaviors also have to change.

2. *Recognition and support*- the senior leaders do also have to make sure that the followers that possesses Lean expertise and embrace the Lean initiatives also gets recognition and support, through for example, promotions or overt praise. This sends the right message of the importance of the Lean program throughout the organization.

3. *Active and visible leadership*- The senior managers' leadership has to be active and visible to make sure that all followers know their roles and what is expected from them.

Delegation is a big part of a senior leader's workload and is a skill that a successful leader must master since a leader can not do everything and are still expected to run a team or organization. But delegation must be dealt with differently when an organization is undertaking a Lean initiative. A senior leader has to have the knowledge necessary of how work and implement Lean in order to successfully manage a Lean transformation. In a Lean transformation that requires change management, a senior leader can not expect to delegate change management on followers lower in the hierarchy and therefore have less power to manage the politics of change. It is therefore important that the senior managers are well prepared, enlightened of the necessary Lean knowledge and attending in the transformation. (Koenigsaecker, 2005)

One of the most important Lean activities for senior leaders to be aware of and participate in is a Value Stream Analysis (VSA). By building and participating in a VSA the senior leaders often realizes and grasp

how much time the organization spend on non-value adding activities. In other words, the time when nothing happens to a processing product in a manufacturing environment or data in an administrative process. Many times are the non-value adding time in the range of 90% and the value adding time around 1% in a process. In a case like that, hopefully does the senior leadership, then fully realize how much waste that is built into the organizations value adding process, which then can further stimulate the senior leader's involvement and motivation for Lean activities (Koenigsaecker, 2005)

Glover et al. (2011) adds that meetings between followers and senior leaders regarding progressive Lean activities, such as, Kaizen events increases followers work area attitude and commitment. A conclusion from this can be that an active leadership style from leaders encourages a positive attitude from their followers towards lean activities. This means that an active management role is preferable and should be encouraged from senior leaders when pursuing behavioral changes in the organization. (Glover et al. 2011)

2.6.2 Create a Lean Management System

An organization that wants to sustain their Lean initiatives should value a Lean Management System (LMS) as one of the most important components of their Lean program (Lenders & Patton, 2010). According to Mann (2009) does the implementation of Lean tools only represent 20% of an organization's effort in a successfull Lean transformation, the remaining 80 % is invested in changing their leaders' leadership practices and behaviors. Not even a perfect use of Lean tools can produce a lasting organizational transformation or improvement without changes in the organization's leadership practices. The senior managers hold the role of establishing the essential organizational conditions for Lean to thrive and a LMS is the base where senior leaders can lay their foundation on how they want their Lean Leadership to work in the organization. A LMS should include an organizational structure of what roles different organizational levels have and what their responsibilities are. Mann (2009) separates leaders at three organizational levels in table 5 and argues that each level must play complementary roles in order for a Lean initiative to succeed and sustain its gains. The areas of contribution, tasks and responsibilities overlaps between adjacent levels and strengthen the endurance of new practices in the organization since it demonstrate the top-down management support. (Mann, 2009)

Table 5. Organizational Roles and Contributions to sustain a Lean initiative. Note. The table is adapted from (Mann, 2009, p. 16)

Leadership Roles in Sustaining Lean				
Organization Level	**Primary Contribution**	**Tasks**	**Secondary Contribution**	**Tasks**
Strategic: Senior (CEO, Sr. VP)	Governance; Steering and oversight	Support for a cross-boundary perspective	Measurement; Adherence to post-project processes	Monitor intersection measures; Gemba walks
Programmatic: Function (VPs, Directors	Accountability	Meet project commit-ments; Manage inter-section performance	Disciplined adherence; Commitments to processes post-project	Collaborate in process management; Gemba walks
Tactical: Depart-ment (Managers, Supervisors, team leaders)	Tactical Lean Management System	Disciplined adherence; Gemba walk	Associate engage-ment; Continuous improvement	Teach, practice root cause problem solving

Mann (2009) further argues that a Lean organization's leaders should depending on their position divide their time as follows:

- *Team leaders*- should spend 70-80% of their time making sure that predefined procedures within their areas are followed. The remaining time should be spent on troubleshooting and improvement work.
- *Supervisors*-should spend around 50% of their day on standardizing work procedures, like for example, reviewing the team leaders standard work documents or verifying executions of procedures/practices from the team leaders.
- *Department managers*- should spend around 25% of their days on standardizing work procedures, like for example, analyzing spot-checks of supervisors executed procedures/ practices or reviewing supervisors standardized work documents.
- *Directors and above*- should also spend some time on standardizing work, but more in the form of having a checklist when they visit their group work areas. This checklist should focus on areas where value adding work takes place and includes verifying procedures and practices to make sure that the standardized work documents are correct and truthfully completed. Their main contribution should be their physical presence to show support of the Lean system and practices. When executives regularly Gemba walks where the actual value adding activities occurs, they show their support and adherence to the Lean process design, but also set an example of how the Lean Leadership should permeate the organization. A leaner leadership does progressively develop throughout the organization when the senior leadership consistently are engaging themselves in the Lean initiative and thereby allowing a Lean culture to grow

When a senior leaders are implementing or developing an organizational LMS structure, it is essential that the LMS is compatible with the organization's long-term vision of their value producing process and the plan to get there through the existing means (Koenigsaecker, 2005; Mann, 2009). For example, is it important to include new or maintaining old process-focused measures in a LMS system in order to measure both the value process and the change of Lean initiatives (Koenigsaecker, 2005; Mann, 2009).

2.6.3 Focusing on leadership transformation

Sederblad (2013) argues that a visionary, committed, and attending leadership may be necessary in order to successfully implement Lean in an organization. Furthermore, it is also important that the implementation has a top-down approach, where Lean is initiated and committed to in the highest hierarchal level of the organization. All too often is the implementation of Lean limited due to lack of knowledge, attention and commitment from the top-level management. It is essential that the management recognizes that when introducing Lean, the leadership role within the organization has to change in order to embrace *Lean Thinking*. The leaders must be allowed to delegate some of their responsibilities of the daily operational work to their co-workers or followers in order to focus on problem solving, using Lean principles. This means that the leaders have to find a balance between controlling the daily workload and leading the development work through CI within the organization. Figure 6 is a theoretical illustration of the previous reasoning and shows the benefits of allowing the leaders to spend more time on improving the organization trough CI. By having Lean leaders less time is spent on fire fighting and maintaining status quo, and more time is spent on improving the organization. Senior leaders have a responsibility to allow higher initial cost, in the form of higher number of production disturbances, in order to really fix problems root causes.

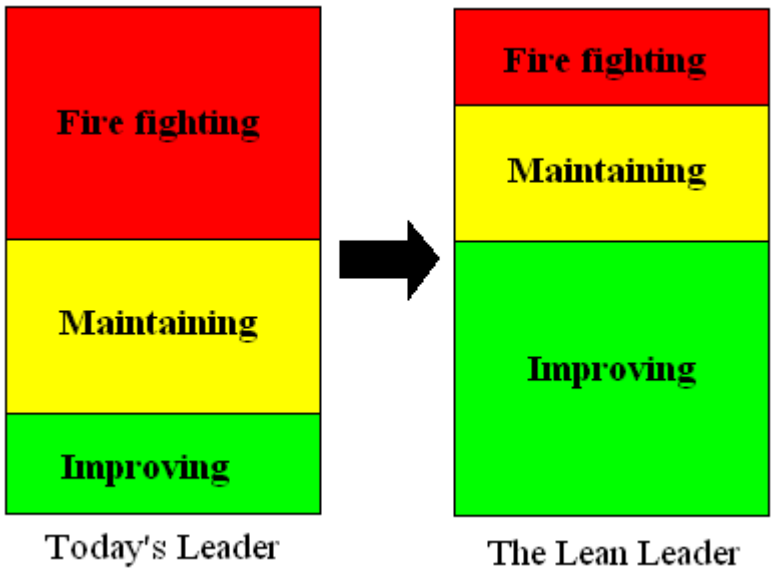

Figure 6. Visualization what can differentiate a leader compared to a Lean leader.

To have true Lean leaders in an organization may require that the leaders within the organization change their leadership styles to become more transformational, because implementing and developing Lean Production requires that the leaders change their management style from supervisors to facilitators, co-ordinators and trainers (Forza, 1996). This puts a lot of pressure on the leaders since the new team organization often is more demanding (Forza, 1996). Not all leaders are comfortable in changing their leadership style to becoming a transformational leader, and may need help through training. (Sederblad, 2013)

When implementing and sustaining Lean, one should expect Lean applications to require a high level of attention. This depends on two reasons: firstly do people in organizations prefer to carry out their work in the way that they always have, in order to change behaviors and habits consistent reinforcement is needed. Secondly, Lean applications need attention due to the design of the Lean applications themselves. The applications are designed to spot process variances such as defective inputs or scrambled timing sequences. (Mann, 2009)

Emiliani (1998) concludes that a senior leader need to have in mind that even though the personal behavioral transformation can change in two to four years, it is a five to ten year challenge for a well established organization to adept even the most fundamental capabilities for a sustainable practice of Lean behaviors. In other words, a successful and sustaining Lean transformation includes changes in the organizational culture. It implies that the organization must change their leaders behaviors and practices if it does not match with the preferred leadership style for Lean. Since many failures of Lean initiatives can be pinned on organizations inability to change their leadership practices, it is crucial to for a Lean transforming organization to emphasize and communicate the importance of the preferred leadership style throughout the organization. (Mann, 2009)

2.6.4 Understand and recognize the leadership challenges of becoming Lean

Due to neglecting challenges in switching an organization's managers into Lean leaders, only 5 to 7 percent of organizations are truly successful with their Lean transformation. The difference between introducing Lean and other transformational programs like a new accounting system is that introducing an accounting system has a beginning and an end, while a Lean transformation only have a beginning and after that it relies on visionary and committed leadership to sustain. However,

visionary leadership always starts with commitment from senior leaders, because without commited and engaged senior leaders, most Lean iniatives are doomed to fail in the long run. (Byrne, 2013)

Liker & Michael (2008) explains that leadership is the strongest tool for sustaining Lean changes since it exist very few self maintaining systems. The reason is that the concept of entropy also can be applied in a cultural context. Entropy is the second law of thermodynamics and say that chemical systems strives to reach the state that has the lowest energy level. The metaphor is that unless an organization is continuously feeding the cultural system with new energy, the cultural system will decay over time, and leaders are the tools and the energy source to raise and maintain the energy level. (Liker & Michael, 2008)

Liker and Franz (2011) agrees to that it is the organization's leaders and their leadership qualities that sustains and supports the needed cultural changes in Lean initiatives. Leadership qualities such as building well functioning teams, resource supporting, and individual coaching and teaching of the business or operation to followers seems to be especially important. These qualities are often hard to find outside of the organization and is therefore required to be developed within the organization. This may be one of the reasons why Toyota emphasizes internal promotion rather than bringing in new individuals to higher positions within the organization. (Liker & Franz, 2011)

3 RESEARCH STRATEGY AND METHOD

This study uses a quantitative research method in the form of two scientific questionnaires. Using questionnaires makes it possible to, for example, identify evidence regarding cause and effect relationships and provide evidence for logical conclusions to the research questions (Bryman & Bell, 2011)**.** Therefore is one of the questionnaires purpose to evaluate the manufacturing leader's leadership styles (appendix 1), while the other questionnaire evaluates the leanness of the leaders organization (appendix 1). Each questionnaire is answering the first and second research question. When combining the data from these two questionnaires, a possible relationship between leadership style and leanness can be identified, which is answering this study's third research question.

Transferability and external validity is increased by producing a master thesis with a thick description (lot of details) and a comprehensive analysis of the study results in order for readers to make their own judgments of the transferability to their own situation. Dependability and reliability is assured though the adoption of a "recording" approach in order to ensure that important data is saved and stored properly, in the case of a data review of the study. (Bryman & Bell, 2011)

3.1 PRE-INVESTIGATION

The pre-investigation of this master thesis was made up by a secondary source study of theory about leadership styles and its association with Lean Production. Used sources were library books and articles. The intention was to find existing research and knowledge about the association between leadership styles and successful implementation of Lean Production. The initial search of relevant literature led to the formulation of this study's research questions.

3.2 LITERATURE STUDY

The literature study was conducted and continued throughout the thesis by a wide range of information searches, using course material and scientific articles discovered from a wide topic searches in digital databases e.g. Google scholar and Chalmers library database. The purpose of the literature study is to build the theoretical foundation for this thesis three research questions and to secure that the thesis holds a high scientific level, which is a precondition for an academic research. Examples of keywords that was used includes, but are not limited to: *Lean Production AND leadership, Lean Production AND MLQ, leanness, transformational leadership AND leanness.* This study was supervised by Professor Mats Winroth, PhD, at Chalmers University of Technology, whom also provided references to relevant articles and directions.

3.3 SELF-COMPLETION QUESTIONNAIRES

The quantitative method of using self-completion questionnaires was chosen since it gives this master thesis a better ability to collect bigger samples of answers and therefore is it also better at projecting the result and the actual opinion of the survey population. A questionnaire also requires less effort per se than individual interviews when processing the results, and is therefore more suitable to use on bigger samples. A potential risk was a low response rate of the survey participants, but a close relationship between the researcher and the companies' participants head leaders has hopefully increased the interest and positively influenced a higher response rate.

After the literature study, two different scientifically proven questionnaires were chosen for this thesis. The main reason for choosing existing questionnaires was that they already have been evaluated on a validity and reliability basis, but also time limitations and the possibility of transferability was factored

in. The first questionnaire is named the Multifactor Leadership Questionnaire (MLQ (Form 5x-short), appendix 1) and measures Leadership styles. The second is called the Leanness Questionnaire (LQ, appendix 1) and measures an organization's degree of Leanness.

3.3.1 Multifactor Leadership Questionnaire

The MLQ is based on research done by Bernard Bass and Bruce Avolio and is a questionnaire that through a 45 item questionnaire measures leadership styles of leaders in organizations. The tool is in its fullest extent designed to be a 360 tool were the evaluated leaders are not only doing a self-evaluation of their leadership styles, but also are evaluated by their managers, peers, and followers. A 360 approach would have been preferable since the "true" leadership lies in the eye of the beholder, but it was considered to produce too much work and being too sensitive to this type of study, therefore was only the self-evaluation questionnaire of leadership styles carried out. Consideration was taken into account that this thesis only evaluates self-perceived leadership styles in order to avoid serious concerns about the validity of the MLQ instrument.

Of the 45 items can three leadership styles and eight leadership skills be divided. Only the three main leadership styles are used in answering the third research question. The three main leadership styles are: transformational-, transactional-, and passive/avoidant leadership style.

The use of the MLQ was licensed and a Swedish translation was provided by Avolio & Bass (2015) but can not unfortunately be redistributed to its fullest extent in this thesis due to confidentiality reasons (but are partially included in appendix 1). The MLQ was answered, measured and scored by the use of a 5-point Likert scale (0-4), which measured the frequency, ranging from: "Not at all" to "Frequently if not always". The questionnaire is designed to take approximately 10-15 minutes to answer, but took this study's respondents an average of 10 minutes to answer.

3.3.2 Leanness questionnaire

The LQ includes both internal and external dimensions of an organization. Shah and Ward (2007) have identified 10 dimensions of Lean Production and subsequently constructed a 41 item questionnaire to measure these dimensions. According to Shah and Ward (2007 p. 801) does the LQ "allow the researchers to assess the state of Lean implementation in firms and to test hypotheses about relationships between Lean Production and other firm characteristics that affects firm performance".

While the MLQ was provided in Swedish from Mindgarden, the LQ needed translation from English to Swedish. The reason for translating the LQ was to avoid "response hesitation" and misunderstandings due to linguistic skills. To ensure that no critical faults of the modification occurred during the translation process did the translation process followed a thorough translation method based Forsyth et al. (2006) article. The questionnaire can be found in appendix 1 and uses the same 5-point Likert scale (0-4) as the MLQ, measuring the frequency ranging from: "Not at all" to "Frequently if not always". The questionnaire was designed to take about 10-15 minutes to complete, but took this study's respondents an average of 10 minutes to answer. The leanness score is calculated by using the mean score of all the dimensions corresponding items. Then calculating the mean of all the dimensions that corresponds to the indexes: Supplier-, Internal-, or Customer related. The leanness score is then finally calculated by using the mean from the three indexes. A thicker description of the calculation method is provided in appendix 2.

In order to further lower the non-response rate of the questionnaires due to employees with not enough information of the production system, only manufacturing managers (or higher) that holds leadership positions answered the questionnaires.

3.4 SAMPLING DESIGN: NATIONAL ASPECT AND INDUSTRY CHARACTERISTICS.

To simplify the extent of this research, only Swedish companies are included in this master thesis study. When benchmarking companies to each other that are not located within the same country, cultural factors, such as, economic and government policies, national competition and the rate of economic development can be a cause of higher or different performances. It is important to take the stated factors into account in order to correctly benchmark companies to each other. Leaving these factors out by only focusing on Swedish companies is therefore increasing the transferability of this master thesis, but also limits in some extent the transferability other Swedish companies. (Davies & Kochhar, 2002)

In order to properly benchmark companies that is located in different industry sectors, different questionnaires that target specific industrial characteristics for each industry sector would be needed. This is due to that lean practices may not be transferable between industries without being practiced differently (James-Moore & Gibbons, 1997). Therefore is an external influence on companies' performance easier to determine if a study is conducted within a specific industry. On the other hand, the downside of only focusing on one industry is that it may reinforce assumptions of the industry rather than challenge them, but unfortunately also lowers the transferability of the study outside of the specific industry.

However, when studying the connection between leanness and leadership style, the focus should be on finding as similar companies as possible, in order to take out as much of the cultural differences between different industries as possible. Even though Bass (1997) adds that the MLQ is applicable even outside the United States and that the comparability of the MLQ results is more sensitive to cultural differences than national boundaries has this master thesis only focused on one specific industry. Another reason for focusing on the chemical producing industry was that the researcher has previous connections to leaders that are working in the industry and who informed the researcher about their problems implementing Lean. (Bass, 1997; Davies & Kochhar, 2002)

3.5 DATA COLLECTION, RESPONSE RATE, AND MISSING DATA

Careful attention has been taken in the sampling design and selection of the companies since these aspects, as said before, strongly can influence the result of this study. Particular attention was given to the contact strategy of approaching attractive companies. The initial contact was made through e-mail to leaders of suitable companies where after an initial presentation was booked if they agreed to participate in the study. The purpose of the initial presentation was to assure that the participating companies gained something from actively participating in the study. A detailed profile of their leadership- and leanness status compared to companies in the same industry was at the initial presentation promised and delivered after the collection of the survey data. Companies that did not accept to participate in the study declined due to facing heavy workloads.

The final responses were obtained from 6 companies, 8 sites, and 54 leaders. In each company, 4-16 respondents were involved from different organizational functions and hierarchical levels, but whom all shared that they had a leadership role.

The participated companies has all agreed to publish their names, but to anonymize their results. The companies and their participating sites are as follows:

- **AkzoNobel** is a multinational company active in more than 80 countries and employees around 47,000 people. Their main fields are decorative paints, performance coatings and specialty chemicals. Three sites from AkzoNobel are participating in the study, all within the specialty chemical division and located in Sweden: Stenungsund, Kvarntorp, and Örnsköldsvik. (Wikipedia, 2016)

- **BIM Kemi** is a Swedish family-owned business, are active in 10 countries and employees around 200 people worldwide. Their main field is working towards the cellulose based industry. The participating site is located at their headquarters in Stenkullen, Sweden. (Bim Kemi, 2016)

- **Borealis** is a multinational company and is the world's eighth largest producer of polyethylene and polypropylene with approximately 6,500 employees. The Swedish operation is located in Stenungsund and the participating site produced polyethylene. Their research center participated in addition to the polyethylene site in this study. (Wikipedia, 2016)

- **Kemira** is a chemical industry group with mainly three segments: Pulp & Paper, Municipal & Industrial, and Oil & Mining with the focus on water-intensive industries. The company is multinational and operates in 40 countries and has around 4,200 employees. The participating site is located in Helsingborg, Sweden. (Wikipedia, 2016)

- **Nynas** is chemical producer focused on specialty naphthenic oils and bitumen products. The company are active in more than 30 countries and has around 850 employees. Their headquarters is located in Stockholm, Sweden, but the participating site is located in Gothenburg, Sweden. (Wikipedia, 2016)

- **Perstorp** is a chemical producer with around 1,500 employees. The company has production sites in 8 countries. The company has its headquarters in Malmö, Sweden, but the participating site is located in Stenungsund, Sweden. (Perstorp, 2014; Wikipedia, 2016)

The two questionnaires were filled in either through a word document delivered through e-mail correspondence, personal presentation of the questionnaires followed by a collection of a printed version of the word document, or a combination of the two. When the questionnaire was delivered only through e-mail correspondence, two reminder e-mail was sent.

The return and response rate of the questionnaires from the 8 sites is 56.3% (54/96) and was collected during a time window of two months. All the data collected through the questionnaires are treated confidentially. No other person, except the author of this master thesis, is able to connect any answers

to any specific person or company. To anonymize the results, a minimum clustering size of three respondents per site or site organization was chosen and is recommended by Bass and Avolio (2009).

Table 6 displays the missing data from the leanness questionnaire in percentiles and is a respondent average from the 6 participating companies, and divided among the 10 dimensions. The missing data from the MLQ is very low where all the dimensions are missing less than 3 % of the data.

Table 6. Missing data table from the LQ

Dimensions	Supplier feedback	Supplier JIT	Supplier development	Customer involvement	Pull	Flow	Setup	SPC	Employee involvement	Production maintenance
Missing data (%)	9	32	32	25	26	37	27	19	10	18

3.6 DATA ANALYSIS

The third research question was formulated as "Is there a relationship between perceived leadership styles and leanness in Swedish chemical companies?". The null hypothesis is that there is not any correlation between leadership styles and the degree of leanness. In this master thesis is the leanness score the dependent variable and measures the degree of leanness, while the leadership styles are divided into three styles ranging from active to inactive leadership styles: transformational leadership, transactional leadership, passive/avoidant leadership. To analyze the correlation, a hierarchical multiple linear regression analysis, using SPSS of the scores from the two questionnaires was used. The calculations of the questionnaire scores were done in Microsoft Office Excel. However, before the hierarchical multiple linear regression was run in SPSS, data analysis of the questionnaires' reliability, possibility of data spuriosity, multicollinearity, and heteroscedasticity, was conducted to ensure valid and reliable results.

3.6.1 Reliability

The purpose of measuring reliability is to make sure that different items in a dimension, consistently, over time, and in different sample groups measure the same thing. Chronbach's alpha is a measurement of the internal consistency which is the correlations between items in a dimension, in order to see if the items relate to each other. (Forza, 1996; Bryman & Bell, 2011)

A presumption was made when calculating the leanness score, which is that all dimensions and their corresponding indexes has the same value effect on leanness. The main reason for choosing the presumption is that the dimensions of the LQ, for example, Pull and Flow have different number of items which would cause them to have different weights on the leanness score if all items should have been grouped together to calculate the leanness score. The same reasoning goes for the indexes and therefore has no weighting of dimensions or indexes been done. The general downside of indexing is that some variation disappears from the data which causes the reliability to go down.

Measuring and calculating the leadership styles from the MLQ is a little bit different than the LQ since all leadership styles has the same number of items. Therefore are the reliability indexes from the transformational-, transactional- and passive/avoidant leadership derived directly from the corresponding items.

When calculating the scores for both the different leadership styles and Leanness score, only answered items were used in the calculations. If a dimension lacked answers from more than 50% of the corresponding items, the dimension was considered blank and not used in further calculations. The same strategy was used when calculating indexes and leanness scores. The reason for this strategy was that a mean from a dimension/index can not be considered reliable if it is response rate is less than 50%. (Kines, 2015)

According to George and Mallery (2003, p.231) is a Chronbach's alpha over 0.7 a good indication of an acceptable internal consistency and they also provided the following rules of thumb: "_>0.9 Excellent, _>0.8 Good, _>0.7 Acceptable, _>0.6 Questionable, _>0.5 Unacceptable".

In Table 7 is the dependent variable, leanness score, just below 0.7, while the Supplier-, Internally-, and Customer related indexes are above. The independent variable Transformational holds a good reliability while Transactional and Passive/Avoidant respectively has a questionable and poor reliability. For further study comparison are all reliability measures displayed in table 7.

Table 7. Chronbach's alpha scores of the dimensions and indexes from the MLQ and the LQ

Lean Measurements	**Chronbach's alpha**	**Leadership Measurements**	**Chronbach's alpha**
Leanness score	0.686	Transformational	0.827
Supplier Related	0.71	Transactional	0.623
Internally related	0.703	Passive/Avoidant	0.56
Customer Related	0.864	Idealized influence (attributed)	0.581
Supplier feedback	0.773	Idealized influence (behavior)	0.438
Supplier JIT	0.495	Inspirational motivation	0.67
Supplier development	0.724	Intellectual stimulation	0.605
Customer involvement	0.864	Individualized consideration	0.649
Pull	0.814	Contingent reward	0.378
Flow	0.829	Management-by-exception (active)	0.74
Low Setup Time	0.582	Management-by-exception (passive)	0.531
SPC	0.804	Laissez-Faire	0.621
Employee involvement	0.675		
Production maintenance	0.694		

3.6.2 Spuriosity

To avoid the possibility of a spurious regression model a control variable was included in the regression model as an additional independent variable. The control variable should have potential to affect both leanness and leadership styles in order to affect the outcome. The number of employees directly working on a site (no outsourced workforce) has been used as a control variable, since it could affect how a site work with leadership (larger site could/should have more hierarchical levels) and leanness (a larger site might have more capital/percent of employees working with for example quality improvement). Figure 7 illustrates the possible relationships between the stated variables. (Sundell, 2015)

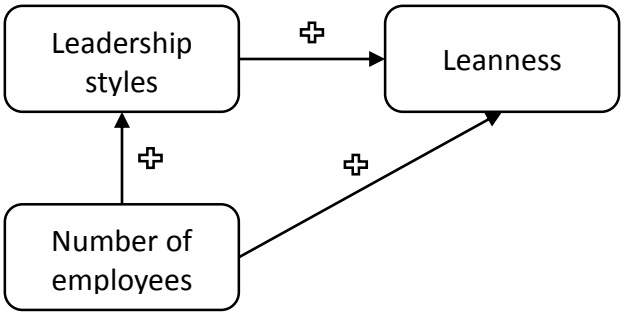

Figure 7. Illustration of possible relationships between the independent, independent control-, and dependent variables

3.6.3 Descriptive data

After the control variable "number of employees" was included in the model, the descriptive data gives a picture of how the data from the independent variables is distributed regarding to the dependent variable leanness score. Table 8 displays the descriptive statistics of the regression model data that have 46 valid leanness score responses, while Transformational-, Transactional-, and Passive/Avoidant leadership has 53, and Number of employees has 54. Figure 8 displays scatter plots of how the leanness score corresponds to Transformational ($R^2\ linear = 0.221$), Transactional ($R^2\ linear = 0.062$), Passive/Avoidant ($R^2\ linear = 0.001$), and Number of Employees ($R^2\ linear = 0.054$).

Table 8 Descriptive statistics of the dependent and the independent variables.

	N	Minimum	Maximum	Mean	Std. Deviation
Leanness score	46	.7741	3.4833	2.495506	.5828243
Transformational	53	1.8000	3.9000	3.083019	.4125371
Transactional	53	1.0000	3.5000	2.355346	.5314372
Passive/Avoidant	53	.0000	1.6250	.670597	.3884057
Nr of Employees	54	40	906	349.94	322.638
Valid N (list wise)	45				

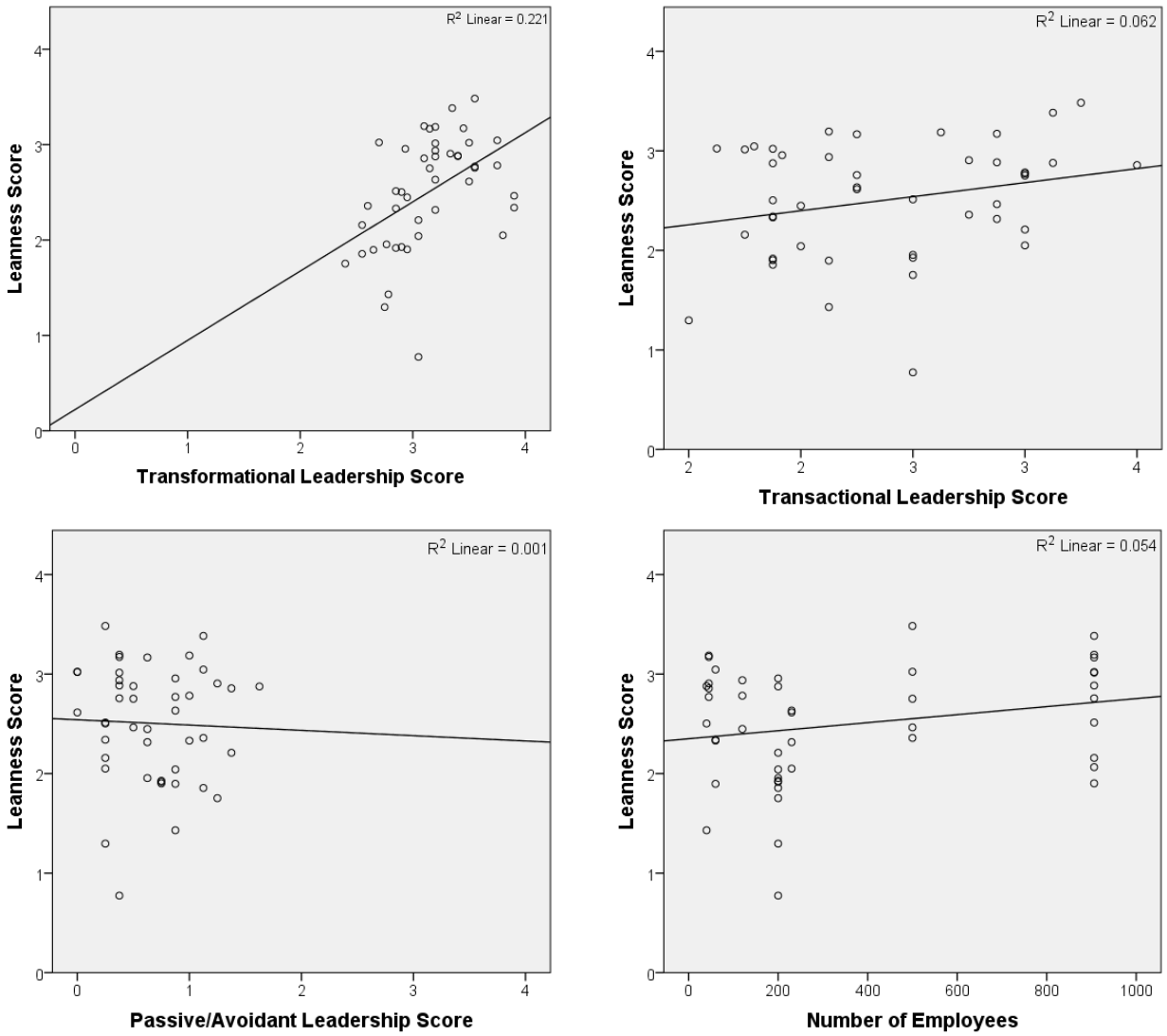

Figure 8. Scatterplots of how the independent variables relates to the dependent variable

3.6.4 Multicollinearity

When two or more of the independent variables are highly correlated to each other it becomes hard to separate the effects of each independent variable on the dependent. Multicollinearity usually leads to variables, that independently are significant by themselves, get insignificant in the multiple regression analysis. A lower variance inflation factor (VIF) than 4-5 indicates that multicollinearity is not an issue (Sundell, 2015). In this study, all independent variables have a VIF below 1.5 which indicates that the data do not have a multicollinearity issue.

3.6.5 Heteroscedasticity

Heteroscedasticity means that the variance are unevenly distributed along the regression line. For example, when the value of the independent variable increases along the x-axis, the unexplained variation in Y increase or decrease along the regression line. A preference for an Ordinary Least Square (OLS) regression in order to reflect the data as good as possible is that the variance along the regression line is as small as possible and that the variance is evenly distributed along the regression line (homoscedasticity). If the variance is not evenly distributed it affect the significance test so that it shows a higher or lower significance depending on where on the x-axis you look.

Looking at the scatter plots of the independent variables in figure 8, it looks like no heteroscedasticity exist, but to rule out the possibility, a Breusch-Pagan test (BP) was calculated. A BP-value of 1.0955 was calculated from the data and from using a Chi^2 table, a 4 degree of freedom was found, which mean that there is a 10 percent significant heteroscedasticity, which in other words means that our data with very high probability is homoscedastic.

4 RESULTS

The previous chapter provided a detailed description of how this thesis was conducted and how the data analysis was performed. This chapter presents the results to the three research questions. The results are presented as a leanness profile, a Leadership profile, and a hierarchical multiple linear regression of the 6 Swedish chemical companies. Only the results and how to interpret the results is included in this chapter. Discussion of the results are saved for the next chapter.

4.1 RESULT RESEARCH QUESTION 1: PROFILE OF SELF-PERCEIVED LEADERSHIP STYLES

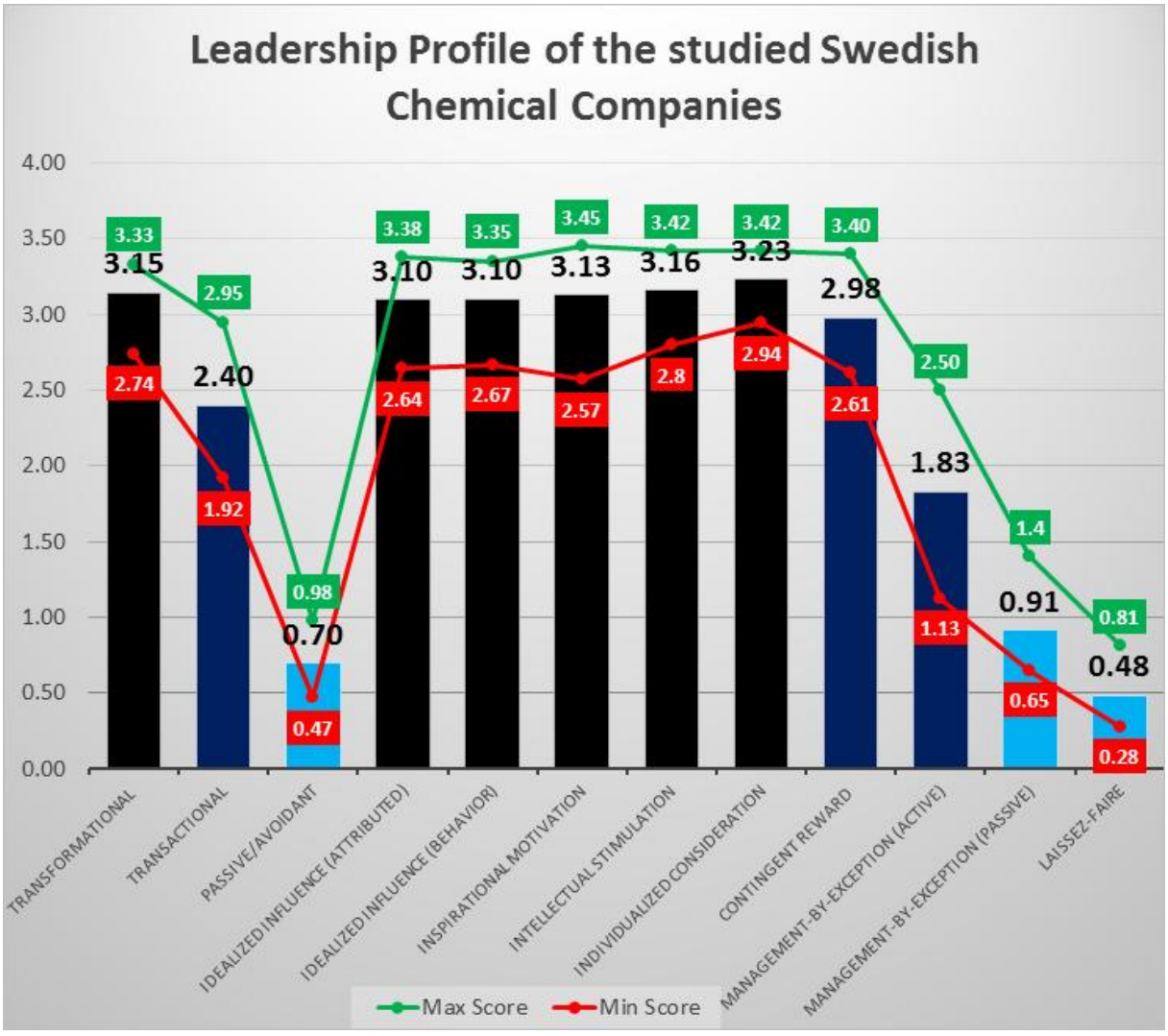

Figure 9. Self-perceived leadership profile of the studied Swedish chemical companies

Figure 9 presents a leadership profile, where each bar is representing the average score of the leadership- style or skill from the 6 participating chemical companies. The green line represents the highest score any company scored for each bar. The red line represents the lowest score any company scored for each bar. Table 9 presents the Likert scale interval which the respondent answered the items through. For example, the transformational leadership style scored 3.15 in figure 9 and therefore on average used “Faily often” at the 6 participating companies.

Table 9. The five Likert scales of the questionnaires describing the frequency of leadership/lean practice.

Frequently, if not always	3.2-4
Fairly often	2.4-3.2
Sometimes	1.6-2.4
Once in a while	0.8-1.6
Not at all	0-0.8

Before interpreting the scores in figure 9, one should have in mind that the self-perceived leadership profile is impacted by factors such as:

- Previous knowledge and experience of leadership styles
- Culture (self-critical or self-confident cultures)
- Work related activities

The less difference it is between these three factors, the higher is the comparability of the leadership profiles between and within organizations. Even though true leadership is in the eyes of the beholder, the leadership profile can be interpreted as “what type of leadership skills does this company/business think they can improve”.

4.2 RESULT RESEARCH QUESTION 2: LEANNESS PROFILE

Figure 10 presents a leanness profile, where each bar represents the average score of the 6 Swedish chemical companies that participated in this study. The green line represents the highest score any company scored for each bar. The red line represents the lowest score any company scored for each bar. Table 9 presents the Likert scale interval which the respondent answered the items through. For example, the leanness score is 2.56 in figure 10, which means using table 9 that the Swedish chemical industry has rated the frequency they use Lean as "Fairly often".

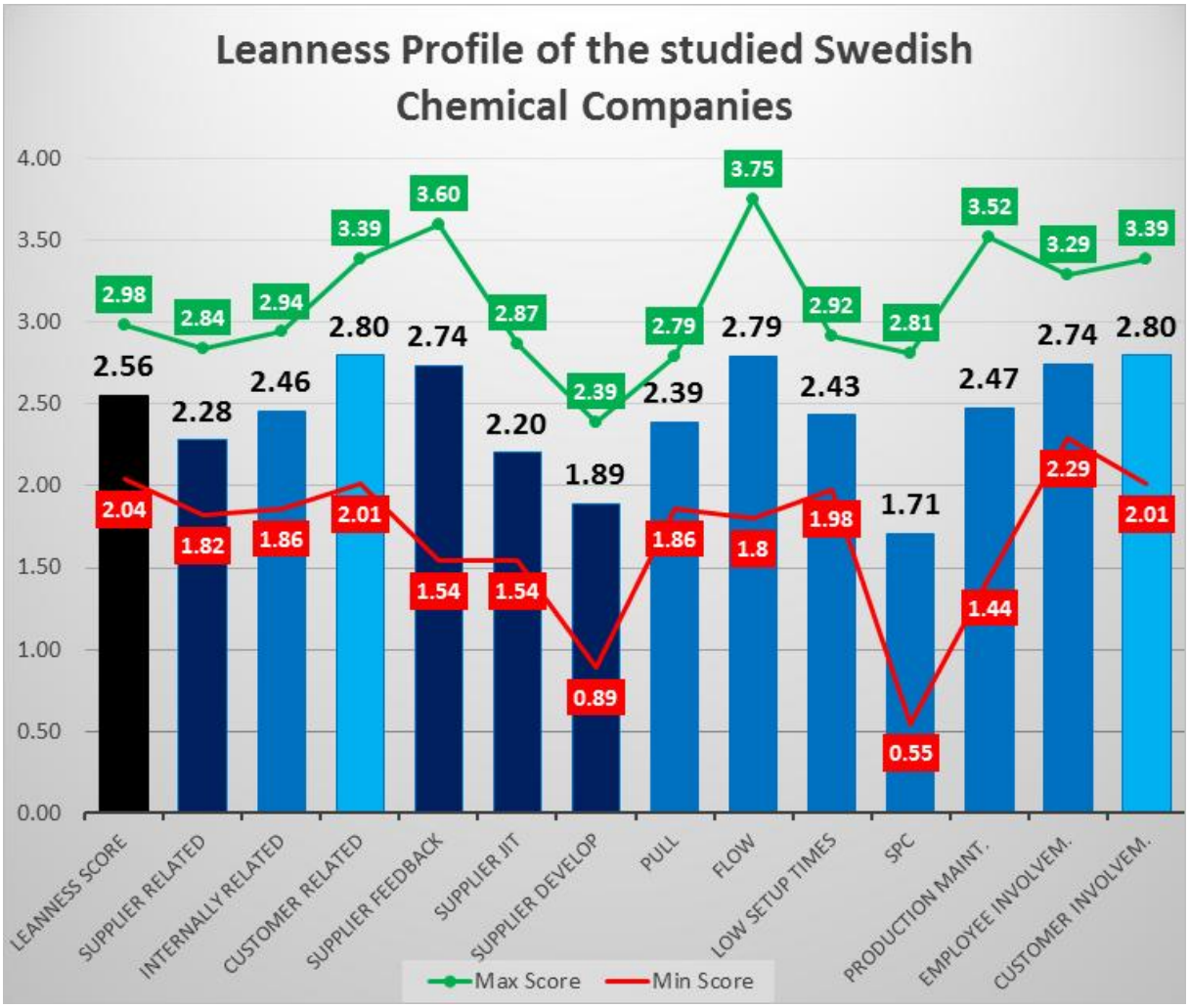

Figure 10. Leanness Profile of the studied Swedish chemical companies.

Before interpreting the score, one should have in mind that the leanness score is impacted by factors such as:

- Previous knowledge and experience of Lean methods
- Business factors/areas
- Culture (self-critical or self-confident cultures)

The less difference it is between these three factors, the higher is the comparability of the leanness scores between and within organizations. The leanness score can therefore be interpreted as "how lean is the company/business area relative to what the company/business area think they could be?".

4.3 RESULT RESEARCH QUESTION 3: CORRELATION BETWEEN LEANNESS AND LEADERSHIP STYLES

Model 1 in table 10 is testing the independent control variable *number of employees*. Furthermore, R^2 in model 1 interprets that 7.3% of the variation in the dependent variable *leanness score* is explained by model 1. The unstandardized B is 0 and is statistical insignificant. So a possibility of spuriosity from the control variable can be disregarded.

Table 10. Presentation of the hierarchical multiple regression analysis. The dependent variable is leanness score and the independent variables are: transformational-, transactional-, passive/avoidant leadership, and number of employees.

Hierarchical multiple regression analysis Dependent variable: Leanness score Unstandardized Beta-Coefficients. Standard error within punctuation marks.		
	Model 1 (control variable)	**Model 2**
Transformational leadership		0.736** (0.227)
Transactional leadership		0.077 (0.166)
Passive/Avoidant leadership		0.235 (0.215)
Number of Employees	0.000 (0.000)	0,001* (0.000)
Intercept	2.2339*** (0.124)	-0.358 (0.710)
N	45	45
R^2	0,073	0,325
R^2 Change	0,073	0,253
Statistical significance: *** = p<0.001, **=p<0.01, *=p<0.05		

In table 10, model 2 presents that the leadership styles are highly contributing to the variance with a R^2 change value of 25.3%. In total, the independent variables in model 2 explains 32.5% (R^2) of the variance of the dependent. Of the independent variables, transformation leadership and number of employees are the only independent variables that have a statistically significant effect on the leanness score. The transformational leadership has a B-coefficient of 0.736 with a standard error of 0.227, which means that when the transformational leadership scores increase with one step, the leanness score increase with 0.736 steps. The number of employees has a B-coefficient of 0.001 with a standard error of 0, which means that when the companies has one more employee the leanness score increases with 0.001.

5 DISCUSSION

The previous chapter presented the results connected to the three research questions. This chapter presents a discussion of the methodology used.

5.1 METHODOLOGY

In order to answer the research questions two questionnaires were used called the *MLQ* and the *LQ.* Comments regarding the questionnaires has been collected informally through e-mail conversations and are based on the researchers contact with the participating leaders from the companies. The initial e-mail did normally come from the respondents since they were allowed to contact the researcher if they had any questions regarding filling out the questionnaire. Most of the contact can be directed towards the LQ and especially how to fill out certain items. The main problem seemed to be the items connection to the leaders operation; consequently did not the question fit into how the company operated. As it can be seen in table 6, *Flow* seemed to be the dimension where the respondents had the most trouble to answer the items (37% missing answers). Through mail conversations, many respondents said that *Flow* was hard to answer since the Chemical industry has many continuous flow processes and it is hard to translate and understand the items in that type of operation.

A problem with dimension-validity can occur when the respondents have a hard time to translate items to their own operation. Are the dimensions measuring the right thing if the respondents do not fully understand item? One must be careful interpreting dimensions that have a higher degree of missing data since the validity of the dimension itself can be lower than the dimensions with less missing data.

Informed consent is needed to process the respondent's answers which led to that only questionnaires with informed consent was included in the data. This did not lead to a lower response rate than return rate since all the returned questionnaires agreed to share their response. The high response rate was probably a result of a close e-mail connection between the researcher and the respondents. As mentioned in the methodology chapter was both the return and response rate 56.3%, which can be seen as more than adequate since Nulty (2008) compiled that paper-based response rate was on average 56% while the online response rate was 33%. This master thesis has a response rate that both surpass face-to-face administration and online questionnaires which is positive for both validity and reliability of the study.

Nulty (2008) argues that to improve online response rates, one could provide rewards for participation. This was taken into consideration before the study was carried out, but was dismissed since it could create an unprofessional relation to the respondents. Instead a strategy of a closer connection to top management was chosen, with the purpose that the top management encouraged and emphasized the importance of participation.

5.2 RESULTS

5.2.1 Research Question 1: What leadership styles do leaders in the Swedish chemical industry practice?

The overall result of the perceived leadership styles in the participating Swedish chemical companies can be concluded from figure 9 as: transformational Leadership are the most prevalent leadership style and is practiced "Fairly often", the transactional leadership style is practiced "Sometimes", and the passive/avoidant leadership style is within "Not at all". The result is in line with 50 % of Bass and Avolio's (2009) benchmark visualized in appendix 4 on self-evaluating leadership styles; the studied

chemical companies have a similar profile as 50% of the general US business companies in the benchmark. Management-by- Exception (active) in figure 9 sticks out with a score of 1.83 compared to the 50 percentile benchmark in appendix 4 with a score of 1.5. Deviations are interesting to notice since they can expose leadership areas where the company deviate from other companies and therefore identify improvement areas or areas where the company exceeds expectations.

The companies that are scoring higher (80 percentile) in appendix 4 are in a higher degree practicing transformational leadership styles than the companies in figure 9, but are also practicing transactional- and passive/avoidant leadership styles in a higher degree than the chemical companies. In other word does the studied chemical companies have a great potential to improve their practice transformational leadership styles when comparing to the benchmark in appendix 4, but the key is to practice the same amount of transactional- and passive/avoidant leadership styles as before. One should have in mind that even though it is useful to compare leadership profiles between different types of businesses, an optimal comparison is within its own business area, since it is a more representative sample.

Bass and Avolio's (2009) benchmark in appendix 4 does not take into account what leadership styles that are preferred when working with Lean. Figure 5 presents that the optimum Lean Leadership practice is 90% transformational leadership, 10% transactional leadership, and 0% passive/avoidant leadership. If that is true and compared to figure 9, the leaders in the chemical companies in this study have to increase their transformational leadership practice, and at the same time lower their practice of transactional and passive/avoidant leadership to improve their work with Lean related activities.

5.2.2 Research Question 2: How Lean is the Swedish chemical industry?

The leanness profile of the six Swedish chemical companies in figure 10 is compiled from calculated data collected through the LQ developed by Shah and Ward (2007). The LQ is an assessment tool for leanness progress and therefore measures both internal and external dimensions of the company's operational operations that relates to Lean. The data extracted from the questionnaire can be used for both internal and external benchmarking as well for companies outside the chemical industry and other businesses. However, one must bear in mind that a higher score do not necessarily means that a company is leaner than a company with a lower score since the score is a self-assessment tool of Lean progress. As mentioned earlier should the score be interpreted as "how Lean is the company/business area relative to what the company/business area think they could be?". Therefore, a leanness score of "3" can be interpreted as "we have reached 75% (3/4) of our leanness potential with today's knowledge and experience".

Figure 10 presents that the participating chemical companies have a leanness score of 64% (Fairly often). The customer related has reached 70% of the potential, while internally- and supplier related has more room for improvement with the scores of 61.5% and 57% respectively. This result is not fully in line with Andersch's (2014) study where it was concluded that customer- and supplier areas of a company are less Lean than internal areas. The theory behind the conclusion is that companies normally focus their Lean efforts on their manufacturing area (internally related) since it is believed that it is in that area Lean implementation and development efforts gives most effect on product quality. (Andersch, 2014).

The dimension with the highest score in figure 10 is Customer Involvement where the chemical companies consider themselves to have reached 70% of their potential. A breakdown of the dimensional scores in figure 10 is done in appendix 3, where it also can be seen that the companies has reached the farthest at giving their *customer feedback on quality and delivery performance* (80%) when it comes to Customer Involvement.

The dimension with the second highest score is Flow (69.8%) in figure 10, and is tricky to interpret since it has a high level of missing answers, as can be seen in Appendix 3 under *Missing Answers*. Missing answers come from respondents that did not understand the question in their work situation, know how to answer, or found the question irrelevant and therefore left the questionnaire item unanswered. A reason for why there are many missing answers within the Flow dimension could be that many of the chemical companies in the study have continuous process productions, while the questionnaire items are formulated from a batch production viewpoint. The changed context may have made many respondents confused and therefore left the item blank. Even so, thinking rational a continuous process should by definition be optimal for a streamlined product flow.

The third and fourth highest scoring dimensions in figure 10 are Supplier feedback and Employee Involvement with both 68.5%. Farthest have the participating companies reached in considering that *shop-floor employees are important to include in problem solving teams* (85%), as can be seen in appendix 3. Interesting though is that it seems that there is some improvement room on how and if the *shop-floor employees are driving suggestion programs* (57.5%). A conclusion could be that the shop-floor employees are included in "fire management teams" but not used as drivers of daily CI.

Production Maintenance is the fifth highest scoring dimension in figure 10 with 61.8%. In appendix 3 are the daily *maintenance of the equipment* (75%) driving the score while the companies have improvement opportunities on how they *display maintenance records of equipment for their employees* (45%).

The sixth highest scoring dimension is Low Setup Times (60.8%) in figure 10. In appendix 3, the company has *Low Setup Times* is the highest scoring question (70%). One hypothesis behind that score could be that many of the sites have continuous processes where the raw material is delivered through pipes in the plants. When switching to a new product, sometimes only cleaning of tanks/silos is required for the new production process to be "tuned-in", and therefore could the setup times be shorter than at plants where equipment needs to be moved or recalibrated.

The seventh highest scoring dimension is Pull Production (59.8%) and can be found in figure 10. In appendix 3 it can be seen that the *production is customer driven and planed by the shipment of finished goods* (77.5%), but at the same time does not barely a *system for production control exist* (27.5%). Therefore, it exists improvement room for the chemical companies exist in the form of creating or improving their pulled production control system.

Supplier Just-In-Time are the eighth highest scoring dimension with a score of (55%), in figure 10. In appendix 3 does the chemical companies usually have *a formal supplier certification program (*70%), but does not *allow their suppliers to be involved in the new product development process* (50%). Interesting is that, as mentioned earlier, the chemical companies strives to establish long term relationships with their suppliers but at the same time hesitate to involve them in their new product development process.

Two dimensions stand out, where the participating companies in figure 10 have scored the lowest. The areas are Supplier Development (47.3%) and Process Control (42.75%). Appendix 3 gives hints on why these two areas have scored the lowest. Within the Supplier Development area, *suppliers manage our inventory* (27.5%) and *suppliers are contractually committed to annual cost reductions* (30%) are dragging the score down. Even though *annual cost reductions* is scoring low, there is also a high level of missing answers, which might be explained by that it is an area often controlled and managed by senior management, and therefore might the site management lack information about that area. When it comes to the dimension Process Control, only the *conduction of process capability studies* (70%) is increasing the average score. When the researcher visited the companies, SPC was something

the chemical companies were keen and willing to improve since they understood the benefits, but the problem was that there is too little information, experience and knowledge available on how to use SPC together continuous processes.

All bars in Figure 10 have a maximum and minimum indication which is what the highest respective lowest scoring company has scored on that bar. These max/min indications can be used as a benchmark for companies participating in this study as well as other companies in the chemical industry on how far companies perceive that they have reached within different lean areas. Even though all companies have different knowledge and experience, which affect the score, it can give an indication of which Lean areas other chemical companies perceive that they are good at. For example, one company perceives that they have reached 70.3% of their potential (max) within SPC, while another think they have reached 13.8% (low). It does not seem unlikely to think that the company that scored the highest also are better at SPC than the company that scored the lowest.

Bear in mind that when a company redo the LQ and if improvement work has been done (within the measured areas) between the measurement occasions, the new score might be lower than the first even though the company has improved themselves. The may sound contradictive, but the reason for it is: relativity. When a company acquires more knowledge or experience in an area, it may also have more experience to discover faults and problems.

5.2.3 Research Question 3: Is there a relationship between leadership styles and leanness in Swedish chemical companies?

A significant correlation between leadership styles and leanness has been found in this study. In table 10, transformational leadership correlates with +0.736 to leanness and holds a significance level of $p<0.01$. Simplified, it means that when transformational leadership increases by one step, from for example 0 to 1, leanness increases from 0 to 0.736. Furthermore, neither transactional- nor passive/avoidant leadership are statistically significant at a 95% level in table 10. The model 2 in table explains that 32.5% of the variation in leanness, which can be interpreted as leadership styles are explaining 32.5% of changes in leanness.

The result of this study is in line with Wochl (2011) article which concluded that there is a +0.540 correlation between leanness and transformational leadership with a significance level of $p<0.01$. Wochl (2011) study had an explanation level of 29.6% and did not neither find any correlation between leanness and transactional- nor passive/avoidant leadership styles.

Despite that no significant correlation between leanness and transactional- and passive/avoidant leadership styles could be found in this study, it can be concluded that transformational leadership has a positive correlation to leanness in the six studied Swedish chemical companies. Testani and Ramakrishnan (2011) explain that transformational leadership, unlike transactional leadership, focuses on the leader's qualities, skills, and abilities to make a change through a vision, rather than a "give and take relationship" between leaders and followers. Transactional leadership will therefore fail to feel at home during a Lean transformation process because of the less active/defensive leadership style fails to empower and inspire followers. The differences between the leadership styles could be a reason why it is possible to find the transformational leadership style statistically significant to leanness, while the result in this study and Wochl (2011) can not find statistical significance between leanness and the transactional- and passive/avoidant leadership styles. Maybe it does not exist a correlation between transactional-, passive/avoidant leadership styles and leanness? Maybe a bigger respondent sample is needed.

6 RECOMMENDATIONS FOR IMPROVING LEANNESS

The interest of participating in this study indicates that there is a will and need to understand the association between leadership and leanness within the Swedish chemical industry. One of the outcomes from this study was that the participating companies has reached 64% of their leanness potential and the improvement room indicates that leadership could be an important key for improving leanness.

The first recommendation the researcher can give chemical companies after completing the study is to assess their leanness development opportunities. That can be done by, for example, using the LQ provided in appendix 1. When the leanness is assessed, the different areas of where the company has the most improvement potential should be focused on first. Testani and Ramakrishnan (2011) recommend that Lean development or iniatives uses a top-down leadership support, but a bottom-up approach when implementing new functions or guidelines. (Testani & Ramakrishnan, 2011)

The second recommendation attends the issue of why many Lean initiatives fail to meet objectives or sustain the transformational gains. Testani and Ramakrishnan (2011) argue that a lack of focus on the organizational culture and commitment from the organization's leadership team may be one of the biggest reasons. Therefore, to realize and sustain transformation initiatives, transformational leadership is needed. To create motivation and lower the resistance to change transformational leadership can add security by creating a vision of how the future should and will look like. When a follower can see where they "fit in" and what role they play in the company during and after the change, the resistance to change decreases and motivation increases. Therefore, plays transformational leadership a big part when an organization transforms itself to a high-performing and adapting culture. Therefore, should the company's leaders be assessed and evaluated on their leadership profile to investigate how and to what degree transformational leadership they practice. A self-evaluating or a 360 degree MLQ evaluation is a good tool to evaluate leaders' leadership profile. Unfortunately can not the MLQ be provided in the appendix in its full form due to confidentiality reasons, but can be licensed on www.mindgarden.com. (Testani & Ramakrishnan, 2011)

The third recommendation is to train or hire transformational leaders. Leaders that in a high degree practice the transformational leadership styles treat their followers as experienced experts whose ideas and contributions are important for the success of the lean initiative. By using the followers' experience and knowledge, continuous improvement opportunities can be found and corrected together with top-down leadership support. In other words, the transformational leadership styles aligns with the core principles of Lean through the possibility of making the leaders the lead facilitators in successful Lean initiatives. Behaviors that the transformational leaders practice can be found in table 2 in the literature chapter. (Testani & Ramakrishnan, 2011)

However, even when applying these recommendations it is important to recognize one of the main causes of why many Lean transformations falter. Lewis (2013) argues that it is usually caused by that the old norm of operating the company returns. A business should consider what type of leader they want. If they want to keep on running the company as they always have, use a manager. But if they want to make a change and take the company to a new and better place, use a leader. In other words, before initiating or developing a Lean initiative make sure that the change start and continuously is enforced through the senior management (Lewis, 2013).

7 CONTRIBUTIONS OF THIS MASTER THESIS

Table 11 is a summary of the research questions, what the finding are, what the conclusions are, and what general recommendations the participating companies can absorb from this master thesis. It is important to understand that to fully comprehend the research questions, findings, conclusion, and recommendations in table 11 it may be necessary to read this thesis from the beginning.

Table 11. Summary of the research questions, research findings, research conclusions, and the recommendations of this master thesis.

Note 1. The leadership styles and the corresponding behaviors are presented in table 2, in the literature chapter.

Research Question 1	Research Question 2	Research Question 3
What leadership styles do leaders in the Swedish chemical industry practice?	How Lean is the Swedish chemical industry?	Is there a relationship between leadership styles and leanness in Swedish chemical companies?
Research Findings		
The six Swedish chemical companies that participated have similar self-evaluated leadership profile as the 50 percentile benchmark conducted in the USA.	The six Swedish chemical companies think they are leaner at customer activities than internal and supplier activities.	Only the transformational leadership style has a statistically significant correlation to Leanness in this study.[1]
Research Conclusion		
The six Swedish chemical companies' leaders should more frequently practice transformational leadership styles.	The six Swedish chemical companies perceive they have reached 64% of their Leanness potential.	Transformational leadership positively correlates (+0.736) to leanness.
Recommendation		
Assess and evaluate leadership profiles of leaders.	Focus on areas where the company has most leanness improvement potential.	Train and/or hire leaders to become more transformational.

8 ASSUMPTIONS AND DELIMITATIONS

The first assumption is that the evaluated manufacturing managers selected their evaluators purposefully, meaning that this research both achieves a purposeful distribution and uses a purposeful sample.

The second assumption is that all participants answer survey items honestly.

The first delimitation is that this study only used a pre-selected group of companies within the Swedish chemical industry and not all companies of the entire industry. This was due to time and scope limitations of the master thesis.

The second delimitation of this study was that the association between different leadership styles and leanness was only evaluated in the manufacturing management level and not in the entire company. Furthermore was the leadership styles only evaluated with the MLQ's self-evaluating questionnaires and not by follower feedback which means that the evaluated leadership styles are self-perceived.

9 FUTURE RESEARCH

As previously mentioned, a need could exist to modify the LQ to fit different industries. Some dimensions and items are not fit for continuous process production evaluation and are therefore hard to understand for the respondents in their context. Despite that some dimensions show an increased number of missing answers, hope is that this master thesis contributes to the body of theory presented in the theory section. Especially, the area that relates to Lean Leadership and how to measure it.

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APPENDIX 1 - SWEDISH VERSION OF THE LQ AND MLQ

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CHALMERS
UNIVERSITY OF TECHNOLOGY

Del 1 av 2

Frågeformulär som mäter vilken ledarskapsstil du använder dig av

Mitt namn är John Svärd och detta frågeformulär är en del av mitt examensarbete för Chalmers Tekniska Högskola i Göteborg. Syftet med arbetet är att undersöka vilken typ av ledarskap som fungerar bäst för att arbeta med Lean Produktion. Målet med arbetet är att dess resultat ska bidra till att öka din arbetsplats förståelse för hur ledarskapet ska användas och fungera när ni arbetar med leanrelaterade moment. Förhoppningen är att arbetet i slutändan kommer att förbättra ditt arbetsklimat. Därför är ditt deltagande viktigt för både dig och din arbetsplats. Men självklart är ditt deltagande frivilligt och du har rätt att avsluta formuläret när du vill.

Alla deltagare kommer att fylla i formuläret anonymt, vilket tar ca 15-20 minuter. Resultatet från ditt frågeformulär kommer att adderas och sammanställas tillsammans med flera andra företag som deltar i studien. Ditt företag kommer att få ta del av det sammanställda resultatet för ditt företag och se hur företaget ligger till jämfört med andra företag, men inga resultat med avseende på enskilda personer eller arbetsgrupper kommer att presenteras i arbetet eller för företaget om det är möjligt att identifiera enskilda personer/grupper.

Om du har några frågor är du välkommen att kontakta mig på telefonnummer: 0704-93 60 53 eller mailadress johnsvard@hotmail.com. **När du fyllt i formuläret, vänligen spara det och skicka tillbaka den sparade versionen till** johnsvard@hotmail.com.När jag tar emot mailet byter jag ut din mailadress till ett formulärsnummer för att anonymisera ditt formulär. Om det inte är möjligt att skicka det via e-mail så kan du skriva ut det och skicka det till följande adress: John Svärd, Doktor Forselius gata 16, 41326, Göteborg, Sverige.

Jag har nu läst igenom framsidan av frågeformuläret och samtycker till att fylla i formuläret enligt de förutsättningar som beskrivits.	☐ Ja

Frågeformuläret bygger på forskning av Bernard Bass och Bruce Avolio där de utvecklat ett formulär för att definiera och mäta Ledarskapsstilar i företag. Formuläret har sedan översatts till svenska med så små modifikationer som möjligt.

Del 1 av 2- Frågeformulär som mäter vilken ledarskapsstil du använder dig av

Vilken anläggning jobbar du vid?:

Anvisningar: Den här enkäten hjälper dig att beskriva din ledarskapsstil.

1) Svarsalternativen har en 5 gradig skala som går från 0 (”inte alls”) till 4a (”Ofta, om inte alltid”). Bedöm *hur ofta* varje påstående passar in på dig.
2) Var så ärlig och noggrann som möjligt när du svara på frågorna. **Men om påståendet är irrelevant, du är osäker eller inte vet svaret lämnar du ett blankt svar.**
3) **För att svara på en fråga så byt ut den siffra som motsvarar det du vill svara mot ett X.** Sätt endast ett X per fråga för det svarsalternativ som bäst representerar din åsikt.

Ordet ”*andra*” kan t.ex. syfta på arbetskollegor, gruppmedlemmar, chefer, underanställda och/eller alla de uppräknade positionerna.

Använd följande skala:

Inte alls	**Någon enstaka gång**	**Ibland**	**Ganska ofta**	**Ofta om inte alltid**
0	1	2	3	4

1.	Jag hjälper andra i utbyte mot att de anstränger sig	0	1	2	3	4
2.	Jag ifrågasätter givna förutsättningar för att avgöra om de är ändamålsenliga	0	1	2	3	4
3.	Jag ingriper först när problem blir allvarliga	0	1	2	3	4
4.	Jag ser till att uppmärksamheten riktas mot misstag, undantag och avvikelser från det normala	0	1	2	3	4
5.	Jag undviker att bli inblandad när viktiga eller svåra frågeställningar ska lösas	0	1	2	3	4
…	…..	..	..	..	..	..
…	…..	..	..	..	..	..

Del 2 av 2

Frågeformulär som mäter hur Lean din arbetsplats är

Mitt namn är John Svärd och detta frågeformulär är en del av mitt examensarbete för Chalmers Tekniska Högskola i Göteborg. Syftet med arbetet är att undersöka vilken typ av ledarskap som fungerar bäst för att arbeta med Lean Produktion. Målet med arbetet är att dess resultat ska bidra till att öka din arbetsplats förståelse för hur ledarskapet ska användas och fungera när ni arbetar med leanrelaterade moment. Förhoppningen är att arbetet i slutändan kommer att förbättra ditt arbetsklimat. Därför är ditt deltagande viktigt för både dig och din arbetsplats. Men självklart är ditt deltagande frivilligt och du har rätt att avsluta formuläret när du vill.

Alla deltagare kommer att fylla i formuläret anonymt, vilket tar ca 15-20 minuter. Resultatet från ditt frågeformulär kommer att adderas och sammanställas tillsammans med flera andra företag som deltar i studien. Ditt företag kommer att få ta del av det sammanställda resultatet för ditt företag och se hur företaget ligger till jämfört med andra företag, men inga resultat med avseende på enskilda personer eller arbetsgrupper kommer att presenteras i arbetet eller för företaget om det är möjligt att identifiera enskilda personer/grupper.

Om du har några frågor är du välkommen att kontakta mig på telefonnummer: 0704-93 60 53 eller mailadress johnsvard@hotmail.com. **När du fyllt i formuläret, vänligen spara det och skicka tillbaka den sparade versionen till** johnsvard@hotmail.com. När jag tar emot mailet byter jag ut din mailadress till ett formulärsnummer för att anonymisera ditt formulär. Om det inte är möjligt att skicka det via e-mail så kan du skriva ut det och skicka det till följande adress: John Svärd, Doktor forselius gata 16, 41326, Göteborg, Sverige.

Jag har nu läst igenom framsidan av frågeformuläret och samtycker till att fylla i formuläret enligt de förutsättningar som beskrivits.	☐ Ja

Frågeformuläret bygger på forskning av Rachma Shah och Peter T Ward där de utvecklat ett formulär för att definiera och mäta Lean Produktion i företag. Formuläret har sedan översatts till svenska med så små modifikationer som möjligt.

Del 2 av 2 -Frågeformulär som mäter hur Lean din arbetsplats är

Anvisningar: Syftet med detta frågeformulär är att få din uppfattning av hur Lean din arbetsplats är, oavsett om ni har arbetat med Lean tidigare eller inte

1) Svarsalternativen har en 5 gradig skala som går från 0 (”inte alls”) till 4a (”Ofta, om inte alltid”). Bedöm *hur ofta* varje påstående passar in på dig.
2) Var så ärlig och noggrann som möjligt när du svara på frågorna. **Men om påståendet är irrelevant, du är osäker eller inte vet svaret lämnar du ett blankt svar.**
3) **För att svara på en fråga så byt ut den siffra som motsvarar det du vill svara mot ett X.** Sätt endast ett X per fråga för det svarsalternativ som bäst representerar din åsikt.

Använd följande skala:

Inte alls	Någon enstaka gång	Ibland	Ganska ofta	Ofta om inte alltid
0	1	2	3	4

1.	Vi har nära kontakt med våra leverantörer	0	1	2	3	4
2.	Vi ger våra leverantörer återkoppling om deras kvalité och leveranssäkerhet	0	1	2	3	4
3.	Vi strävar efter att etablera en långsiktiga relationer med våra leverantörer	0	1	2	3	4
4.	Våra leverantörer är direkt involverade i utvecklingsprocessen av nya produkter	0	1	2	3	4
5.	Våra nyckelleverantörer levererar produkter till våra produktionsanläggningar på Just-In-Time bas	0	1	2	3	4
6.	Vi har ett formellt program för att certifiera våra leverantörer	0	1	2	3	4
7.	Våra leverantörer är genom kontrakt förbundna att årligen minska kostnaderna	0	1	2	3	4
8.	Våra nyckelleverantörer är lokaliserade i närheten av våra produktionsanläggningar	0	1	2	3	4
9.	Vi har på central nivå kontakt med våra nyckelleverantörer om viktiga frågor	0	1	2	3	4
10.	Vi reducerar aktivt antalet leverantörer som levererar samma produktkategori	0	1	2	3	4
11.	Våra nyckelleverantörer hanterar vårt lager	0	1	2	3	4
12.	Vi utvärderar leverantörer baserat på totalkostnad och inte på enhetspris	0	1	2	3	4
13.	Vi är ofta i nära kontakt med våra kunder	0	1	2	3	4
14.	Våra kunder ger oss återkoppling om vår kvalité och leveranssäkerhet	0	1	2	3	4
15.	Våra kunder är aktivt involverade i våra nuvarande och framtida produkterbjudanden	0	1	2	3	4
16.	Våra kunder är direkt involverade i våra nuvarande och framtida produkterbjudanden	0	1	2	3	4

17.	Våra kunder uppdaterar ofta vår marknadsavdelning med deras nuvarande och framtida efterfrågan	0	1	2	3	4
18.	Produktionen är kundorderstyrd och planeras utifrån det verkliga behovet av färdigt gods	0	1	2	3	4
19.	Varje produktionssteg styrs av det verkliga behovet i efterföljande steg	0	1	2	3	4
20.	Vi använder ett kundorderbaserat produktionssystem	0	1	2	3	4
21.	Vi använder Kanban eller ett liknande system för att styra produktionen. (Kanban är ett sätt att signalera eller synliggöra material behov i industriproduktion)	0	1	2	3	4
22.	Våra produkter är klassificerade i grupper med liknande processbehov	0	1	2	3	4
23.	Produkterna är klassade och grupperade efter ingående bearbetningsprocesser (gruppteknologi)	0	1	2	3	4
24.	Produktionsutrustning grupperas så att de kan producera ett kontinuerligt flöde av produktfamiljer	0	1	2	3	4
25.	Produktfamiljer bestämmer vår anläggnings layout	0	1	2	3	4
26.	Vår personal övar på omställningar av produktionsutrustning för att minska ställtiderna.	0	1	2	3	4
27.	Vi arbetar för att minska ställtiderna i vår produktionsanläggning	0	1	2	3	4
28.	Vi har korta ställtider i vår produktionsanläggning	0	1	2	3	4
29.	En stor andel av vår utrustning/processer mäts med hjälp av statistiska verktyg (SPC)	0	1	2	3	4
30.	Det finns ett omfattande användande av statistiska tekniker för att reducera processvariationer	0	1	2	3	4
31.	Ute i produktionen används tavlor eller liknande som visar andelen defekta produkter	0	1	2	3	4
32.	Vi använder t ex fiskbensdiagram för att identifiera orsaker till kvalitetsproblem	0	1	2	3	4
33.	Vi undersöker om vi har tillräcklig processkapabilitet för att möta våra kunders krav innan nya produktlanseringar	0	1	2	3	4
34.	Produktionsnära personal är viktiga att ha med i problemlösningsteam	0	1	2	3	4
35.	Produktionsnära personal driver förslagsprogram	0	1	2	3	4
36.	Produktionsnära personal deltar i genomförandet av förslagsprogram	0	1	2	3	4
37.	Produktionsnära personal tränas i flera olika arbetsuppgifter	0	1	2	3	4
38.	Varje dag har avsatt arbetstid för planerat verktyg-/maskinunderhåll eller liknande aktiviteter.	0	1	2	3	4
39.	Vi underhåller alla våra verktyg/maskiner regelbundet.	0	1	2	3	4
40.	Vi upprätthåller utmärkt dokumentation av våra verktygs-/maskinunderhåll och relaterade aktiviteter	0	1	2	3	4
41.	Vi visar upp vår underhållsdokumentation på verkstadsgolvet för att aktivt informera personal	0	1	2	3	4

APPENDIX 2 - INSTRUCTIONS ON HOW TO CALCULATE THE LEANNESS SCORE.

Table 12 shows how to calculate the mean scores of the dimensions from the LQ for one individual respondent. The letter A symbolize" answer" and the number is the number of the item, hence A2 equals the answer for item 10.

Table 12. How to calculate to mean scores on the LQ dimensions

1. If the number of answered items was less than 50% of the total number of items for that dimension, then all answered answers in that dimension was excluded for the individual respondent (Kines, 2015).

Dimensions	**Mean score calculation**[1]
Supplier feedback	(A1+A2+A3)/Number of answered items
Supplier JIT	(A4+A5+A6)/Number of answered items
Supplier Development	(A7+A8+A9+A10+A11+A12)/Number of answered items
Customer Involvement	(A13+A14+A15+A16+A17)/Number of answered items
Pull	(A18+A19+A20+A21)/Number of answered items
Flow	(A22+A23+A24+A25)/Number of answered items
Setup	(A26+A27+A28)/Number of answered items
Statistical Process Control	(A29+A30+A31+A32+A33)/Number of answered items
Employee Involvement	(A34+A35+A36+A37)/Number of answered items
Production maintenance	(A38+A39+A40+A41)/Number of answered items

When the mean score for each respondent had been calculated, the mean scores for each site and/or companies were calculated with the same 50% rule. The reason for calculating the means of means when calculating the overall leanness score is that each company/sites had different number of respondents. To avoid weighting each company depending on the number of respondent means of means was the chosen calculation method.

No calculation method for the MLQ is included in the appendix due to confidentiality reasons. For more information about how to calculate the score from the MLQ, visit www.mindgarden.com.

APPENDIX 3 – AVERAGE SCORE AND MISSING DATA FROM THE LQ ITEMS

Nr	Dimensions	Items	Average Score of the 6 Chemical companies	Missing answers %
1	Supplier Feedback	Vi har nära kontakt med våra leverantörer.	2.7	8.6
2	Supplier Feedback	Vi ger våra leverantörer återkoppling om deras kvalité och leveranssäkerhet	2.6	8.6
3	Supplier Feedback	Vi strävar efter att etablera en långsiktiga relationer med våra leverantörer	3.0	12.1
4	Supplier JIT	Våra leverantörer är direkt involverade i utvecklingsprocessen av nya produkter.	2.0	25.9
5	Supplier JIT	Våra nyckelleverantörer levererar produkter till våra produktionsanläggningar på Just-In-Time bas.	2.3	34.5
6	Supplier JIT	Vi har ett formellt program för att certifiera våra leverantörer	2.8	31.0
7	Supplier Development	Våra leverantörer är genom kontrakt förbundna att årligen minska kostnaderna.	1.2	48.3
8	Supplier Development	Våra nyckelleverantörer är lokaliserade i närheten av våra produktionsanläggningar.	1.7	17.2
9	Supplier Development	Vi har på central nivå kontakt med våra nyckelleverantörer om viktiga frågor.	2.6	29.3
10	Supplier Development	Vi reducerar aktivt antalet leverantörer som levererar samma produktkategori	2.2	34.5
11	Supplier Development	Våra nyckelleverantörer hanterar vårt lager.	1.1	27.6
12	Supplier Development	Vi utvärderar leverantörer baserat på totalkostnad och inte på enhetspris.	1.9	46.6
13	Customer involvement	Vi är ofta i nära kontakt med våra kunder.	2.8	12.1
14	Customer involvement	Våra kunder ger oss återkoppling om vår kvalité och leveranssäkerhet.	3.2	10.3
15	Customer involvement	Våra kunder är aktivt involverade i våra nuvarande och framtida produkterbjudanden	2.7	37.9
16	Customer involvement	Våra kunder är direkt involverade i våra nuvarande och framtida produkterbjudanden	2.6	34.5
17	Customer involvement	Våra kunder uppdaterar ofta vår marknadsavdelning med deras nuvarande och framtida efterfrågan.	2.9	44.8
18	Pull	Produktionen är kundorderstyrd och planeras utifrån det verkliga behovet av färdigt gods.	3.1	17.2
19	Pull	Varje produktionssteg styrs av det verkliga behovet i efterföljande steg	2.8	22.4
20	Pull	Vi använder ett kundorderbaserat produktionssystem.	2.5	32.8
21	Pull	Vi använder Kanban eller ett liknande system för att styra produktionen.	1.1	31.0
22	Flow	Våra produkter är klassificerade i grupper med liknande processbehov	3.0	36.2
23	Flow	Produkterna är klassade och grupperade efter ingående bearbetningsprocesser (gruppteknologi)	2.7	39.7
24	Flow	Produktionsutrustning grupperas så att de kan producera ett kontinuerligt flöde av produktfamiljer.	2.9	37.9
25	Flow	Produktfamiljer bestämmer vår anläggnings layout.	2.6	29.3
26	Setup	Vår personal övar på omställningar av produktionsutrustning för att minska ställtiderna.	1.9	32.8
27	Setup	Vi arbetar för att minska ställtiderna i vår produktionsanläggning	2.5	20.7

28	Setup	Vi har korta ställtider i vår produktionsanläggning	2.8	22.4
29	Statistical Process Control	En stor andel av vår utrustning/processer mäts med hjälp av statistiska verktyg (SPC).	1.6	31.0
30	Statistical Process Control	Det finns ett omfattande användande av statistiska tekniker för att reducera processvariationer	1.6	29.3
31	Statistical Process Control	Ute i produktionen används tavlor eller liknande som visar andelen defekta produkter	1.6	13.8
32	Statistical Process Control	Vi använder t ex fiskbensdiagram för att identifiera orsaker till kvalitetsproblem	1.8	17.2
33	Statistical Process Control	Vi undersöker om vi har tillräcklig process kapabilitet för att möta våra kunders krav innan nya produktlanseringar	2.8	27.6
34	Employee Involvement	Produktionsnära personal är viktiga att ha med i problemlösningsteam	3.4	6.9
35	Employee Involvement	Produktionsnära personal driver förslagsprogram	2.3	12.1
36	Employee Involvement	Produktionsnära personal deltar i genomförandet av förslagsprogram	2.5	15.5
37	Employee Involvement	Produktionsnära personal tränas i flera olika arbetsuppgifter	2.9	10.3
38	Production Maintenance	Varje dag har avsatt arbetstid för planerat verktyg-/maskinunderhåll eller liknande aktiviteter.	2.0	31.0
39	Production Maintenance	Vi underhåller alla våra verktyg/maskiner regelbundet.	3.0	6.9
40	Production Maintenance	Vi upprätthåller utmärkt dokumentation av våra verktygs-/maskinunderhåll och relaterade aktiviteter	2.6	13.8
41	Production Maintenance	Vi visar upp vår underhållsdokumentation på verkstadsgolvet för att aktivt informera personal.	1.8	25.9

APPENDIX 4 – BENCHMARK OF SELF-EVALUATED LEADERSHIP STYLES

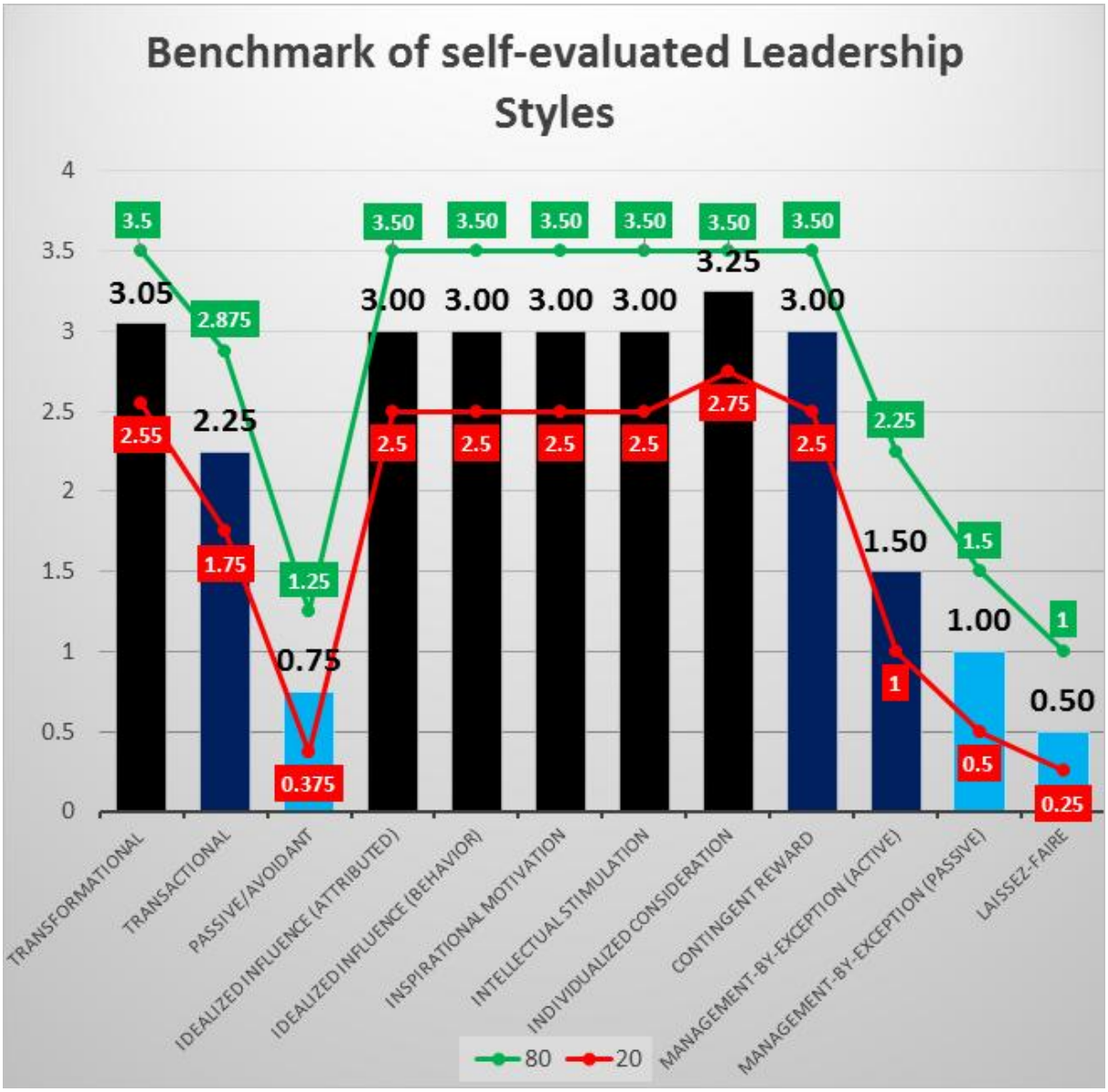

Figure 11. Benchmark of self-evaluated leadership styles.

The bars in figure 11 represents median leadership style score of individual scores based on self-ratings in companies based in the US (Bass & Avolio, 2009). In other words are the bars representing that 50% of the respondents has scored themselves the same or higher than the bars in the USA, which also implicates that 50% has scored themselves lower.

The green line represents the 80 percentile line; 20% of the respondents has scored higher than the green line. The red line represent the 20 percentile; 80% of the respondents has scored higher than the red line. (Bass & Avolio, 2009)

APPENDIX 5 – THE ENGLISH VERSION OF THE LQ

Nr	Dimensions	Items
1	Supplier feedback	We frequently are in close contact with our suppliers
2	Supplier feedback	We give our suppliers feedback on quality and delivery performance
3	Supplier feedback	We strive to establish log-term relationship with our suppliers
4	Supplier JIT	Suppliers are directly involved in the new product development process
5	Supplier JIT	Our key suppliers deliver to plant on JIT basis
6	Supplier JIT	We have a formal supplier certification program
7	Supplier development	Our suppliers are contractually committed to annual cost reductions
8	Supplier development	Our key suppliers are located in close proximity to our plats
9	Supplier development	We have on a corporate level communication on important issues with key suppliers
10	Supplier development	We take active steps to reduce the number of suppliers in each category
11	Supplier development	Our key suppliers manage our inventory
12	Supplier development	We evaluate suppliers on the basis of total cost and not per unit price
13	Customer involvement	We frequently are in close contact with our customers
14	Customer involvement	Our customers gives us feedback on quality and delivery performance
15	Customer involvement	Our customers are actively involved in current and future product offerings
16	Customer involvement	Our customers are directly involved in current and future product offerings
17	Customer involvement	Our customers frequently share current and future demand information with marketing department
18	Pull	Production is "pulled" by the shipment of finished goods
19	Pull	Production at stations is "pulled" by the current demand of the next station
20	Pull	We use a ”pull” production system
21	Pull	We use Kanban, squares, or containers of signals for production control
22	Flow	Products are classified into groups of similar processing requirements
23	Flow	Products are classified into groups of with similar routing requirements
24	Flow	Equipment is grouped to produce a continuous flow of families of products
25	Flow	Families of products determine our factory layout.
26	Setup	Our employees practice setups to reduce the time required
27	Setup	We are working to lower setup times in our plant
28	Setup	We have low set up times of equipment in our plant
29	Statistical Process Control	Large number of equipment/processes on shop floor are currently under Statistical Process Control
30	Statistical Process Control	Extensive use of statistical techniques to reduce process variance

31	Statistical Process Control	Charts showing defect rates are used as tools on the shop-floor
32	Statistical Process Control	We use fishbone type diagrams to identify causes of quality problems
33	Statistical Process Control	We conduct process capability studies before product launch
34	Employee involvement	Shop-floor employees are key to problem solving teams
35	Employee involvement	Shop-floor employees drive suggestion programs
36	Employee involvement	Shop-floor employees lead product/process improvement efforts
37	Employee involvement	Shop-floor employees undergo cross-functional training
38	Production maintenance	We dedicate a portion of everyday to planned equipment maintenance related activities.
39	Production maintenance	We maintain all of our equipment regularly
40	Production maintenance	We maintain excellent records of all equipment maintenance related activities
41	Production maintenance	We post equipment maintenance records on shop floor for active sharing with employees