A SUPPORTIVE FRAMEWORK FOR SUCCESSFUL IMPLEMENTATION OF IMPROVEMENT WORK

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Abstract

Lean Production is one of the most generally accepted concepts for increasing operational effectiveness. However, its implementation is still challenging for many companies as it implies not only changes of technical systems and management systems but also changes in attitudes and culture. Generalizable implementation steps have still not yet emerged and there are many ways to implement Lean Production. A Lean Production implementation is a never ending process since it is always possible to become leaner. Thus, the implementation of Lean Production is a long-term commitment for a company in order to reach success.

There is a need for research on how to develop and integrate improvement work in order to establish a successful implementation of Lean Production. Accordingly, the overall purpose of the research presented in this thesis is to contribute to an increased understanding of how to successfully implement Lean Production. Moreover, the objective is to develop a supportive framework for a successful Lean Production implementation and to describe this in a general process for the implementation of improvement work.

Through literature reviews and three research studies, a supportive framework for the successful implementation of improvement work has been developed. The first study is an explanatory literature and interview study to build a concept model of improvement work. The second study is an exploratory embedded single case study that was conducted to validate the model. Finally, the third study is an exploratory multiple holistic case study that investigated enablers for continuous improvement after a radical implementation of Lean Production.

The resulting supportive framework consists of important actions to consider during the different stages of a process for the implementation of improvement work. In the first stage after a radical implementation phase, actions important to sustain change and enable continuous improvement include for example a focus on good leadership on shop floor and efforts in the area of control and follow-up of results in production teams.

To develop continuous improvement several actions are defined, like the importance of understanding the context of improvement work including important relations to operations and to develop the production strategy with objectives to align the improvement work.

To reach long term success it is important to integrate continuous improvement into operations and important actions for this stage are for example to update the Operational Management System on the company-specific-production-system framework’s processes continuously, which includes visualisation of the overall improvement work process.
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Lina
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Publications

Appended Papers

Paper I

*Stålberg was the main and corresponding author of the paper and von Axelson was the presenter of the paper. The literature review and the concept modelling were made by all authors as a team.*

Paper II

*Stålberg initiated the paper and made the literature review, the data collection, the analysis and was the main and corresponding author of the paper. Fundin reviewed and quality assured the paper.*

Paper III

*Stålberg initiated the paper and made the literature review, the data collection, the analysis and was the main and corresponding author of the paper. Fundin reviewed and quality assured the paper.*

Additional Publications

Early definitions

Lean Production (LP) – is an approach to manage operations, which operates to increase the production efficiency by continuously eliminating waste in the production processes by applying the main principles Just-In-Time and Jidoka and by striving for perfection through continuous improvement. The purpose of the principle Just-In-Time is to produce and deliver goods in the exact amount and at the exact time as they are needed. The principle Jidoka concerns building quality into the product by ensuring that everything is done right from the start and stopping immediately if something does go wrong.

Continuous improvement – is an improvement process that is constant, endless and on-going and includes various types of improvements ranging from incremental improvements to improvements of more radical nature.

Radical implementation of Lean Production – includes a major change in the physical layout of a production plant in a move towards flow production, including an introduction of the basic methods and tools according to LP.

Mini-transformation – the introduction of basic methods and tools according to LP during the radical implementation of LP.

Company-specific-production-system (XPS) – is a corporate improvement program inspired by Toyota Production System (TPS). An XPS’s principles resemble the principles of the TPS and LP and an XPS represents the strategic choice of operating principles most important to a company. An XPS can also be an example of a holistic approach to improvement, where the “best of” Just-in-Time, Six Sigma, Total Quality Management, LP and so on can be strategically selected by the organisation.

Operational Development (OD) – OD is an improvement program that is primarily based on behavioural science and psychology. The basic thought in the OD model is that the success of operational development is to reach consensus in the whole operation in relation to what is important. Building on this consensus and involving all co-workers in systematic improvement work, good results can be achieved.

Holistic improvement work – is a continuous improvement approach, in which programs, methods and tools from several improvement approaches are incorporated, taking a holistic perspective on production system improvement.
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1. Introduction

This chapter introduces and describes the background to this research area and intends to give the reader an understanding of why this thesis has been written. The problem statement is described leading to the objective of the thesis and the research questions. Further, the scope and delimitations are discussed and the expected contributions presented. The chapter ends with a presentation of the outline of the thesis.

1.1 Background

Since the manufacturing industry and industry-related services have contributed greatly to the high GDP growth that Sweden has had the last 20 years (Ersson & Sagström, 2013), a sustained well-functioning welfare society which offers a sufficient number of job opportunities will continue to require a prosperous manufacturing industry.

However, to stay competitive, it is vital for the manufacturing industry to continuously improve and increase its production efficiency since the competition has increased and been globalized (Petersson et al., 2009; Teknikföretagen et al., 2011; SQMA, 2012; Ersson & Sagström, 2013). One of the most generally accepted concepts for increasing operational excellence used in the industry today is Lean Production (LP) (Sörqvist, 2013). There is no comparative production concept that utilizes and develops production into the strongest competitive mean of a company as radically as LP (Bellgran & Säfsten, 2010). Thus a strong and recent trend for companies is to develop and implement corporate improvement programs as company specific production systems (XPS) based on LP and inspired by Toyota Production System (Netland, 2013).

Despite its popularity, the understanding of what LP actually means varies and there is no clear established definition (Marodin & Saurin, 2013). According to Hines et al. (2004), LP has evolved from a production toolkit into the complexity of an entire lean business system. LP originates from the Toyota Production System and was introduced to the Western World by Womack and Jones in the book The machine that changed the world (Bellgran & Säfsten, 2010). In line with Petersson et al. (2009) LP can be viewed as an approach to or a strategy for managing operations. Thus LP can be viewed as an umbrella term that includes company culture, values, basic principles, methods, leadership and employeeship. Accordingly, LP strives to increase the production efficiency by continuously and tirelessly eliminating waste in the production processes by applying some main principles which are Just-In-Time and Jidoka and by striving for perfection through continuous improvement (Petersson et al., 2009).

Implementing LP is a huge challenge since it includes changes of both the technical systems and the management systems as well as changes in attitudes and culture (McKinsey, 2007; Liker, 2009; Sörqvist, 2013). Consequently, even though LP is a well-known concept used for many years in the industry, its
implementation is still often a challenge to companies and generalizable implementation steps have not yet emerged (Marodin & Saurin, 2013). Also, since LP builds on continuous improvement the implementation of LP is a never ending process, meaning it is always possible to become leaner with no fixed end date (Hines et al., 2004; Liker, 2009). LP can be implemented through a radical implementation (Womack & Jones, 2003; Yamamoto & Bellgran, 2013), which is a transformation and can be like a reengineering phase according to Netland (2012), that is followed by continuous improvement. As is argued by Sörqvist (2013), without an initial transformation there is a large risk of sub-optimizations since the basis which the improvements are based on will be incorrect.

Sustaining improvement approaches is still a major challenge to companies and many efforts fail (Bergman & Klefsjö, 2010; Sörqvist, 2013). According to Snee (2010), one important way to make the improvement work last is to build a sustaining infrastructure and to make improvements into a business process. Other studies show that what distinguishes better companies from less good companies in terms of improvement attempts and resulting performance change is that better companies have a holistic management system which includes one integrated improvement approach, effectively integrating all aspects of the business plan and change initiatives (Samson & Challis, 2002). Accordingly, having a holistic improvement approach aligned with the production strategy including the vision and objectives of the organisation increases the possibility of reaching long-term success (Johnson et al., 2007). Further, having this comprehensive view of the improvement work also gives the approach the ability to prioritize among parts of it (Petersson et al., 2009). In these integrated improvement approaches there is also a need to combine different improvement methodologies, since no methodology alone can contain everything (Hoerl & Gardner, 2010). As proposed by Hines et al. (2004) and Sörqvist (2013), even LP could benefit by being combined with other improvement concepts and methods. According to Netland and Sanchez (2014), an XPS is an example of a holistic approach to improvement, where the “best of” Just-in-Time, Six Sigma, Total Quality Management, LP and so on can be strategically selected by the organisation.

However, even though an XPS is an example of a holistic approach to improvement, implementing it and realizing its potential as a holistic approach to improvement where different methodologies and tools are combined remains a huge challenge. During an LP implementation it is important to adapt the LP concept to the specific particularities of the company (Marodin & Saurin, 2013). This means that it is important to consider legacy structures (Sörqvist, 2013), and if necessary the incorporation of other improvement approaches since many companies tend to implement multiple improvement approaches based on different stakeholders’ beliefs and experiences of improvement programs (Johnson et al., 2007).

In order to continue to develop the organisation towards industrial excellence and continuous improvement after a radical implementation of LP as an XPS approach,
it is important to understand what it takes to build and maintain business excellence, which has been paid limited attention in previous research (Brown, 2013). This will be further elaborated in the next section.

1.2 Problem statement and research objective

As stated in the background section, improving operations and increasing performance is crucial for a manufacturing industry to stay competitive globally. Further, LP is one of the most generally accepted concepts for increasing operational excellence used in the industry today. However, since there are different understandings of LP as a whole and since there is a constant evolution of LP, it is not easy to grasp how an LP implementation affects and relates to operations. Further, to develop successful improvement work there must also be an adaption of the LP concept, even though it is presented as a corporate improvement program, in other words as an XPS, towards the specific settings of the company including considerations of legacy structures. Also, an implementation of LP is a never ending process including continuous improvement and constant learning. This implies that gradually the organisation will become leaner and leaner and increase its understanding concerning when and how to apply methods and tools to improve performance further. But before the company has achieved an LP culture where LP has been institutionalized into the settings of the company there is a big risk that the implementation of LP fails which is common for many improvement attempts. Moreover, as also manufacturing companies tend to implement several improvement approaches based on what is believed to be important by different stakeholders within the company the picture of improvement work tends to become even more complex. Also in previous research it has been argued that the LP concept could benefit by combining or integrating methods and tools from other improvement programs, like XPS approaches do.

Designing and developing successful improvement work based on the conditions described above is not an easy task and yet it is necessary for many manufacturing companies, since the development of successful improvement work contributes to establish a successful implementation of LP. By understanding how an LP implementation can be described in relation to operations, as the context of improvement work, the task of designing and developing successful improvement work for companies can be facilitated. Even though there is a great deal of research concerning improvement work, previous research is lacking with regard to the facilitation of the development of successful improvement work in the later stages of an LP implementation where legacy structures and other approaches are regarded.

Accordingly, to better support the manufacturing industry in the area of LP implementation there is a need for research concerning the sustaining change and enabling, developing and integration stages during the implementation of improvement approaches to reach long-term success.
Considering the background and problems described above, the overall purpose of this research project is to contribute to an increased understanding of how to successfully implement LP. Further, the objective is to develop a supportive framework for a successful LP implementation and to describe this in a general process for the implementation of improvement work.

1.3 Research questions
To meet the purpose and objective two research questions are formulated:

RQ 1) How can an improvement approach within a manufacturing company, as an implementation of Lean Production be described?

The first research question responds to the need to understand the context of improvement work and its relation to operations in order to understand how a successful improvement work can be designed within a production system.

RQ 2) What are the most important success factors when implementing an improvement approach, such as Lean Production, within a manufacturing industry?

This research question is formulated to be able to understand what factors affect the ability to sustain and further develop the results in an LP implementation.

1.4 Scope and delimitations
The scope of this thesis is improvement work, more specifically LP within the manufacturing industry, and the unit of analysis is the improvement work and implementation process of LP within the production system. Accordingly, it is a longitudinal study, consisting of three studies, of a transition from a radical implementation of LP to continuous improvement within a manufacturing company in which the researcher is an industrial PhD student. Therefore the case studies are delimited to this manufacturing company. In other words, the results will be specific to this context but can be used as a starting point for more general studies of the same type of phenomenon at other manufacturing companies but also further studies within the corporate multinational group to which the production company in question in the present study belongs.

1.5 Contribution
This research project aims at describing a general process for the implementation of improvement work. Specifically, the research project intends to increase the understanding of a transition from a radical implementation of LP to continuous improvement and how to support the transition which has been the topic of the performed research studies. Accordingly it will generate both a scientific contribution to the research community and a practical contribution to the industry.

The expected contribution to the research community will be an enhanced understanding of important success factors involved when making a transition
from a radical implementation of LP to continuous improvement. It will all be summarised in a supportive framework for the successful implementation of improvement work.

The summarized supportive framework also aims to be a practical contribution since it highlights actions which are urgent in such a transition. These actions could be important to companies implementing LP in a similar approach and possibly in other implementation approaches. Moreover, this research project will also provide the case company with recommendations regarding effective improvement work and important actions which will promote a holistic perspective on production system improvement.

1.6 Outline of the thesis
Chapter 2 presents the research methodology employed in this research. Chapter 3 presents the theoretical frame of reference used in this thesis. Chapter 4 provides a summary of published papers. Chapter 5 contains the overall discussion leading to a proposed supportive framework for the successful implementation of improvement work. Finally in Chapter 6, the conclusions of the conducted research are presented and future research suggested.
2. Research methodology

This chapter presents the research methodology for the research project presented in this thesis. It starts with presenting the scientific approach, explaining the scientific view of the researcher. Thereafter the research strategy is described including chosen data collection method(s) and ways of analysing the data. Then the research process is discussed including a presentation of the performed studies. The chapter ends with a discussion concerning the quality of the research.

2.1 Scientific approach

Research can be performed using different methodological approaches (Gummesson, 1985; Arbnor & Bjerke, 1994; Fagerström, 2004). The choice of method depends to a large extent on the researcher’s view of knowledge, also called paradigm (Gummesson, 1985), but also the nature of the research questions (Lantz, 1993; Yin, 2009).

When discussing different research paradigms the two most common to compare are the positivistic (scientific) and the hermeneutic (interpretive and humanistic) paradigms (Gummesson, 1985). Accordingly, in relation to these paradigms, Arbnor and Bjerke (1994) have classified three research approaches: the analytical, the systems and the actors approach.

- The analytical approach strives to explain an objective reality as far as possible and it implies that reality is built by summative parts. The aim is to explain the causal relations of isolated phenomena.
- The systems approach also presumes that reality is objective. However, it assumes reality to be structured of parts depending on each other. Therefore it cannot be summarized and the whole is more than the sum of the parts. The aim is to find final relations in complex systems in which a part cannot be treated as isolated.
- The actors approach regards reality as a social construction, which means that reality is not independent of us. The actors approach suggests that it is difficult to avoid influencing the phenomena being studied and the aim is to understand the relations between different actors’ interpretations of the studied phenomena.

The scope of this research is improvement work within a production system and the primary aim of the research project is to understand the relation of improvement work to operations and identify the support required to implement successful improvement work. Since improvement work is a complex phenomenon embracing and interacting with multiple areas within operations, a suitable approach is the systems approach assuming that the totality is larger than the sum of ingoing parts. Accordingly, Bellgran and Säfsten (2010), also suggest a systems approach when studying production systems and subsystems within them. However, in this case the systems approach is combined with the actors approach since the research also focuses on interactions between people and processes and
since the researcher is an industrial PhD student who periodically has had the task to improve and develop the improvement work at the case study company, implying that the studied phenomena might have been influenced occasionally. Figure 1 adapted from Arbnor and Bjerke (1994) shows the research approaches in relation to the paradigms and also the researcher’s position among these.

2.2 Research strategy

A suitable research strategy to collect empirical data has been to perform mainly case studies, since a case study has a distinct advantage when a how or why question is being asked about a contemporary set of events over which the investigator has little or no control and it is also an investigation of a specific phenomenon (Yin, 1994). The specific phenomenon can be a program, an occurrence, a person, a process, an institution or a social group (Yin, 1994). Another important advantage of case study research is the possibility to get a holistic view of a process and the research phenomenon (Gummesson, 2000). One of the research questions formulated is a how question and the studied phenomenon is the improvement work within the case company of which the researcher wishes to get a holistic view, therefore case studies seemed to be an appropriate research strategy.

As suggested by Yin (1994) empirical data can be collected through documents, archival records, interviews, direct observations, participant-observations and physical artefacts. In the case studies presented in this thesis the empirical data were collected through interviews, observations, participating observations and documents. The collected data were mainly qualitative data but some were also quantitative.

The qualitative data has been analysed using pattern matching logic according to Yin (1994) and category construction according to Merriam (2009).
2.3 Research process

The research process has been an iterative process between theory and ontology in line with Fagerström (2004), see Figure 2.

![Figure 2. The research process adapted from Fagerström (2004).](image)

The starting point has been the transition from the radical implementation of LP to continuous improvement within one case company. The case company is a production plant with approximately 800 employees, belonging to a global corporate organisation within the Construction Equipment Industry, and the researcher has been an industrial PhD student within the case company. Thus, the problem statement has been based on identified industrial problems in the case study company during their LP implementation and also gaps found in previous research. The books and articles used were found mainly by using the Mälardalen University library directory and databases: Scopus and Emerald. As a basis for the present thesis, three studies have been performed in order to be able to answer the research questions using the research design explained in Table 1. In Figure 3 the time for the studies is visualised in relation to the LP implementation process at the case company.

<table>
<thead>
<tr>
<th>RQ</th>
<th>Study</th>
<th>Research design</th>
<th>Data collection</th>
<th>Paper</th>
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<tbody>
<tr>
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<td>Explanatory literature and interview study</td>
<td>Literature review, interviews</td>
<td>Paper I</td>
</tr>
<tr>
<td>1, 2</td>
<td>Study II</td>
<td>Exploratory embedded single case study</td>
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<td>Paper II</td>
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<tr>
<td>2</td>
<td>Study III</td>
<td>Exploratory multiple holistic case study</td>
<td>Interviews, observations, documents</td>
<td>Paper III</td>
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Figure 3. LP implementation at the case company and the time for the studies.

**Study I**

Study I which is an explanatory study was partly based on an industrial problem statement, at the time, concerning how to combine all on-going and upcoming improvement attempts into one continuous improvement approach. Partly it was based on findings from Study III regarding the need of the organisation to develop the continuous improvement approach as such. Further, there was also an interest in the Kaikaku project in which the researcher was involved at the time for Study I, to find a common base concerning what a holistic improvement approach consists of and how it is linked to operations. The Kaikaku project focused on innovative production development as a way to realize the production strategy and execute strategic initiatives to concrete results in the production.

Accordingly, Study I is an explanatory study since it aims to obtain a better understanding of the current situation and explain the patterns related to the phenomenon holistic improvement work and also identify plausible relationships shaping that phenomenon (Marshall & Rossman, 2006). Further, there is a how question in focus dealing with operational links that need to be traced over time (Blessing & Chakrabarti, 2009). There is also a kind of assumption present that a holistic approach towards improvement work would provide a solution to the identified problems.

Thus, Study I started with an overall literature review in order to investigate the terms holistic improvement system, holistic improvement work, holistic improvement and also find gaps in previous research. To sort things out found in previous research the Kaikaku project group used a method inspired by concept
modelling according to Astrakan (2003) and SIS (2008). The method concept modelling was used to clarify the relationship between terms (approx. ‘words’) and concepts (approx. ‘meanings’) in order to define the specific terms. Concept modelling is an interactive method where the modelling is based on interactive work which combines theory and practice (Gåsvaer & Axelson, 2011). The concept modelling method consists of a work process and notation standard, and the fundamental steps in the work process are:

1) Definition of project
2) Term inventory and prioritizing
3) Modelling and definition of selected terms
4) Decision and use

In the first step the purpose of the project was defined and the concept of holistic improvement work was further investigated through an in-depth literature review. In the second step a preliminary list of terms and words connected to “holistic improvement system” was compiled based on the literature review. The third step was to group and prioritize the terms into “headings” and model the terms into a first version. The model was then revised according to comments and feedback from industry representatives, throughout the interactive process.

Study II
Study II which is an exploratory embedded single case study started when the radical implementation of LP had been completed three years ago at the case company and the organisation had continued to work with continuous improvement, see Figure 3. The study was conducted to gain further understanding about the context of improvement work and how improvement work can be designed in order to validate and improve the concept model. The study also had a descriptive approach since the purpose of Study II also was to identify challenges present in the process of reaching a holistic perspective on production system improvement, in order to be able to develop a supportive framework for the successful implementation of improvement work. However, even though Study II can be defined as both exploratory and descriptive it was primarily an explorative study in line with Marshall and Rossman (2006), since the overall purpose of Study II was to contribute to the ability to answer RQ1 and generate assumptions for future research.

Data were collected through interviews, documents and a participating observation in terms of a workshop with the informants. The interview guide was based on the concept model developed in Study I. There were 10 interviewees from different parts of the production organisation, and they were chosen because they would, due to their roles in the organisation, have knowledge about the current status of the improvement work and thoughts about how it can be improved. To analyse the data from the interviews, category or theme construction inspired by Merriam (2009) was used. In the workshop with the informants, the results from the case study were presented in order to be sure the conclusions make sense and validate
the results and also to give feedback to the case company concerning how to
develop the improvement work and to get an overall understanding.

Study III
Study III which is an exploratory multiple holistic case study started when the
radical implementation of LP in the case company was almost completed, see
Figure 3. The starting position in study III was based on the problems of the case
company concerning the transition between the radical implementation of LP and
continuous improvement. What were the success factors for improvement work
and how would these enable continuous improvement and further development of
the organisation after this radical implementation of LP? As the term exploratory
study suggests, such a study is often conducted because a problem has not been
clearly defined, or its real scope is unclear, and it will help identify a research
focus when the understanding is still insufficient or lacking. It may also help
researchers discover important categories of meaning and generate hypotheses for
further research (Marshall & Rossman, 2006; Blessing & Chakrabarti, 2009).

Study III started with a literature review concerning success factors for
improvement work. Then a multiple holistic case study was performed. It
consisted of six pilot teams; four were machining cells/teams and two were
assembly teams. The empirical data were collected through interviews,
observations and documents. The interview guide used for the study was based on
the eight success factors for improvement work that were derived from the
literature review. 18 interviews were performed where the interviewees were six
production supervisors, six team leaders and six operators. Regarding the
observations the improvement meetings of the teams (9 meetings) were observed.
The documents gathered consisted of business ratios: scrap, 5S audits and
transformation audits. To analyse the qualitative data, pattern matching according
to Yin (1994) was used and then the qualitative questions in the interview guide
were quantified in order to be able to perform a better and more visual comparison
of the groups. To be able to find two pilot teams to compare in terms of success
factors, a successful and a non-successful pilot team needed to be distinguished.
This was done by evaluating the trends in the business ratios on the basis of the
assumption that a positive trend in business ratios implies continuous improvement.
Further, the differences in the performance of the radical implementation of LP
and the success factors for these two selected teams could be analysed in order to
understand how to enable continuous improvement after a radical implementation.
The last stage in the analytical process was to compare all pilot teams in terms of
success factors and also to try to derive strengths and weaknesses found in the
success factors to be able to understand how to further enable continuous
improvement. Concerning the internal validity the results and conclusions have
been discussed with the informants in the case study to validate that the
conclusions make sense.
2.4 Quality of research

A common approach to evaluate the quality of a research project is to regard validity and reliability. Validity concerns whether a study investigates what was intended to be investigated and reliability concerns the level of agreement between different researchers’ measurement of the same phenomenon, the repeatability of an investigation (Fagerström, 2004). According to Patton (1990), the validity and reliability of qualitative data depend on a great extent on the methodological skill, sensitivity, and integrity of the researcher. Generating useful and credible qualitative findings through observation, interviewing and content analysis requires discipline, knowledge, training, practice and hard work. Also, according to Arbnor and Bjerke (1994), for a systems approach validity requires for definitions and results to be perceived as substantial and correct by the researcher as well as other participants in the real system. Further, Mattsson (2004) states that concerning qualitative research an alternative to validity and reliability is transparency, which means that it must be possible for the reader to follow how the research has been performed and on what basis the researcher presents results. When it comes to case studies, Yin (2009) argues that the criteria for judging the quality of research designs are construct validity, internal validity, external validity and reliability.

Construct validity

Construct validity refers to the degree to which a test measures what it claims to be measuring and it involves identifying correct operational measures for the concepts being studied. Tactics that according to Yin (2009) can be used are for instance, using multiple sources of evidence, establishing chain of evidence, having key informants review draft case study report. The phases of research in which tactic occurs are the data collection phase and the composition phase.

- Concerning construct validity in Study II, the case study design and the interview questions were based on the developed concept model, also 10 interviewees answered all the questions in the interview guide. Later on the results and conclusions were presented to and discussed with the informants.

- Regarding construct validity in Study III the assumption was made that a positive trend in business ratios implies continuous improvement. Therefore some business ratios were chosen and these were compared for all pilot teams and a successful and less successful pilot team was distinguished. The success factors derived from theory could be compared between the chosen pilot teams and conclusions could be made concerning abilities to enable and develop continuous improvement. Further, the informants in the case study also reviewed the results and conclusions.

Internal validity

Internal validity seeks to establish a causal relationship, whereby certain conditions are believed to lead to other conditions, as distinguished from superior relationships. Tactics that can be used are pattern matching, explanation building,
addressing rival explanations, and using logic models. These tactics can be performed in the data analysis phase (Yin, 2009).

- To strengthen the internal validity in Study II, the tactics was to use pattern matching logic according to Yin (2009), since the concept model was used as a base for the analysis and the empirical pattern was compared to the predicted concept model. Further, category construction in line with Merriam (2009) was also used to analyse the data within the concept model, where Merriam (2009) sees a category as the same as a theme, a pattern, a finding or an answer to a research question.

- In Study III pattern matching logic was also used to strengthen the internal validity. The success factors derived from previous research were used as a predicted pattern to which the empirical based pattern was compared.

- The concept model in Study I (which not is a case study) was based on findings in previous research and designed in co-operation with other researchers. Feedback from industrial representatives helped to strengthen the overall validity of Study I.

**External validity**
External validity concerns the extent to which the findings of a study can be generalized. Case study tactics that can be used here are using theory in single-case studies, and using replication logic in multiple-case studies. These tactics occur in the research design phase (Yin, 2009).

- Concerning the external validity in Study II, it can be argued that its generalizability is connected to the developed concept model which is derived from theory in Study I.

- To increase the external validity in Study III replication logic could be used since it was a multiple case study. The multiple case study involved six pilot teams, where each team was regarded as a case. Each case was analysed individually based on the theoretical framework. The results of all cases were then compared and a similar pattern for all cases could be seen. Therefore the findings can be argued to be generalizable in relation to a domain or context similar to the case in Study III.

**Reliability**
Finally, reliability demonstrates, according to Yin (2009), that the operations of a study, such as the data collection procedures, can be repeated with the same results. Tactics which can be used are case study protocol and the development of a case study database. These tactics are used in the data collection phase.

- In Study II a document called “Case Study Design” was developed, containing information regarding the questions asked in the study: its
propositions: its unit(s) of analysis: the logic linking the data to the proposition: and the criteria for interpreting the findings; which according to Yin (2009) is similar to a case study protocol, which increases reliability. The protocol in Study III was not as highly developed as the protocol used in Study II. The protocol in Study III contained the theoretical framework, including eight success factors, and an interview guide which was developed based on the theoretical framework, as well as a plan for making the observations and also an idea concerning how to analyse the collected data. Further, in both Study II and III, case study databases were used to store all collected data; notes, transcribed interviews, documents. In Study I, concept modelling inspired by Astrakhan (2003) and SIS (2008) was used which increases the reliability of the study.

**Role of the researcher**
The role of the researcher can also affect the quality of the research (Gummesson, 2000). The researcher is an industrial PhD student at the case company and when this research project started the researcher worked as a change agent in the radical implementation of LP in the case company. During the transition to continuous improvement, the researcher’s role at the case company turned into a more coaching role. Later on, by the time for Study II, the researcher’s role at the case company had turned into the role of a researcher (a PhD student). Moreover, in the beginning of the research process the researcher experienced it as more difficult to stay objective and avoid preconceptions about for example the findings. Also it was difficult to leave the role as a change agent and not be tempted to deliver results on a daily basis to the company and instead focus on the research process and long-term results. However, even though it took some time, it gradually became easier to focus on the role as a researcher and the demands of objectivity connected to that role.

Hence, it can be discussed to what degree the preunderstanding and the researcher’s role at the case company have affected the results and influenced the quality of the research. The researcher has sought to conduct research of good quality. Besides designing for research quality according to (Yin, 2009), where construct validity, internal validity, external validity and reliability have been considered, during the whole research process regular discussions with the supervisors have been conducted with the purpose to improve the quality of the research. Further, on an overall level, since transparency is also an issue which can be regarded concerning quality in qualitative research (Mattsson, 2004), the researcher has aimed to achieve transparency by clearly describing the research processes and methods used and also attempted to be thorough when discussing the basis on which the conclusions are drawn.
3. Frame of reference

This chapter presents the theoretical frame of reference which is used in this thesis. It is founded on literature studies performed during the research process and is based on relevant books and scientific articles. The literature is mainly related to Production Systems, Continuous Improvement, Lean Production, and Change Management.

Production Systems is an important area for this thesis since the case studies are delimited to that context. The areas Continuous Improvement and Lean Production need to be considered since the objective of the thesis is to develop a supportive framework for implementing successful improvement work within a Lean Production context and therefore it is essential to understand what successful improvement work entails in such a context. Further, Change Management is an area important to consider in order to understand how to implement and develop successful improvement work.

The literature has been organised in five chapters: Chapter 3.1 Definition of Production Systems, defines and describes production systems in order to understand the context for the thesis. Chapter 3.2 Production system improvement, generally summarizes what improvement work is, and in Chapter 3.3 Lean Production as a concept for production system improvement, LP is explained. In Chapter 3.4 Implement Lean Production, different approaches to the implementation of LP are discussed. Finally, Chapter 3.5 Factors influencing Lean Production implementation, argues for important factors which affect the LP implementation.

In Figure 4 these areas are visualised where the overlap, called successful improvement work, is the research area in focus and the objective to which this thesis aims to contribute by means of suggestions for a supportive framework for the successful implementation of improvement work.

![Figure 4. Visualisation of the research areas of interest. In this visualisation Lean Production as a concept for production system improvement, is included in Production system improvement, and Factors influencing Lean Production, is included in Implement Lean Production.](image-url)
3.1 Definition of production systems

According to Bellgran and Säfsten (2010) and in line with Rösiö (2012, p. 14) “the production system is seen as a delimited part of the manufacturing system and denotes activities and facilities needed to transform raw material into products or parts of products”.

As Yamamoto (2010) states when performing research on improvements in production, it is necessary to understand production from a holistic perspective, which means taking all elements of the production into consideration. This is necessary because changes can be made in any part of the production, like production processes, production equipment, employees, information processes, management structures, organisation structures and organisation culture (Yamamoto, 2010).

Hubka and Eder (1988) present a systemic approach to understanding and explaining production systems as a transformation system, where the relations between the subsystems are also of importance. In this sense, and due to their division of suitable subsystems, this understanding and definition of a production system is appropriate in this research.

According to Hubka and Eder (1988) the sum of all elements and influences that participate in a transformation is collectively termed transformation system and each transformation system has a fairly well-defined purpose. The transformation system consists of a transformation process or a technical process, an operand that is being transformed and operators that individually exert effects to drive and guide the process. The technical process has inputs and outputs, both of which contain desired and unwanted elements. Its characteristics include the purpose of carrying out a transformation of an operand. The operand can consist of materials, both biological and non-biological, energy and information. The operators consist of human beings, technical systems, information systems, management systems and the immediate environment.

The technical system includes for example machines and equipment. The human system includes operative staff, supervisors and higher management. The human system and the technical system are the two main elements of the execution system that causes the effects to drive the process. The management and goal system constitutes the executive system, with the purpose of providing coordinated directions to the execution system to achieve a desired end, so it indirectly drives the transformation process, and it includes for example instructions and data information. The information system is used as a storage medium and source of necessary information, including elements such as notebooks, information files, and computers and it is used by both the execution and the executive systems (Hubka & Eder, 1988).

A feedback loop is also involved in this system, and it involves measuring the output of a system or process, comparing this to a desired standard or goal, and
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A feedback loop is also involved in this system, and it involves measuring the output of a system or process, comparing this to a desired standard or goal, and dynamically altering the input to attempt to correct any error or deficiency. Feedback is one of the relationships between the elements of a transformation system (Hubka & Eder, 1988). The transformation system is visualised in Figure 5.

![Transformation system](image)

**Figure 5. Transformation system, adapted from Hubka and Eder (1988).**

If a transformation system is used as a model of a production system, the function of the system can be to transform raw material into components or components into complete products (Bellgran & Säfsten, 2010). Improvement work as stated by Yamamoto (2010), can be made in any element in the transformation system, hence in any element in the production system. When making changes in the production system it is argued that it is important to consider the feedback loop to the management system, since the management system constitutes the executive system with the purpose to provide coordinated directions to the execution system in which the human system is a part.

### 3.2 Production system improvement

In order to improve the production system, according to the definition of Hubka and Eder (1988) in the previous chapter, it is important to have a holistic perspective since improvements can be made in any part of the production. Also a holistic point of view can prevent sub-optimizations in the production system (Peterssson et al., 2009).

There are several approaches to improving operations available, such as for instance Total Quality Management (TQM), Lean Production (LP), Six Sigma, Just-in-Time, Operational Development (OD), Continuous Improvement, Kaizen, and Business Process Reengineering (BPR). It is not easy to distinguish them completely, since they tend to overlap and some of them do not have clear definitions.

Briefly, TQM is one of the approaches lacking a clear definition. According to Bergman and Klefsjö (2010), TQM can be seen as a holistic approach where values, methodologies and tools are combined to attain higher customer satisfaction with less resource consumption and the whole approach can be interpreted as a management system. LP is also an approach lacking clear
definition (Hines et al., 2004; Marodin & Saurin, 2013), however it can be viewed as a strategy to eliminate all waste in operations by applying certain principles (Petersson et al., 2009). LP will be further discussed in Chapter 3.3. Six Sigma focuses on the reduction of unwanted variation. By eliminating, or at least reducing, variation in the parameters affecting those characteristics that are important to the customer, the results can be greatly improved. Six Sigma provides a systematic methodology to achieve the necessary improvements and there is a strong emphasis on the role of the top management (Bergman & Klefsjö, 2010). Just-in-Time is an inventory strategy that aims to improve return on investment by reducing in-process inventory and associated costs. To meet Just-in-Time objectives, the process relies on signals, or Kanban, between different points in the process (Bergman & Klefsjö, 2010). The difference of OD compared to other improvement models is that it is primarily based on behavioural science and psychology. The basic thought in the OD model is that the success of operational development is to reach consensus in the whole operation in relation to what is important. Building on this consensus and involving all co-workers in systematic improvement work, good results can be achieved (Sörqvist, 2004). The concept of Continuous Improvement has usually been denoted to embrace incremental improvement in daily operations, however, the concept has also evolved into embracing improvements of more radical nature (Elg et al., 2007), which will be further discussed below. Kaizen is a Japanese term for the process of making incremental improvements and achieving the lean goal to eliminate all waste that increases the cost without adding value (Liker, 2009). Kaizen applied at work means constant on-going improvement that includes everyone – managers as well as employees (Imai, 1993). Accordingly, if the term Kaizen is interpreted as continuous improvement, it includes different ways to conduct and organise the improvement work (Bergman & Klefsjö, 2010; Sörqvist, 2013), as will be described further in Chapter 3.3. BPR includes changes of a more radical and innovative character since it aims to replace the existing settings with something completely new. It is a top-down strategy. However it has shown difficult to apply BPR and as many as 70 % of the companies have failed (Sörqvist, 2004). It is instead argued that BPR should be seen as a complement to more traditional improvement work (Sörqvist, 2004).

According to Elg et al. (2007) improvements are often described by means of one out of two terms: continual improvement and continuous improvement. Usually the terms continual and continuous are used randomly. However, the meaning of continuous improvement is delimited to a small, linear and increasing improvement of an existing process and refers to the nature of the improvement, while continual refers to the improvement process as constant, endless and on-going. Continual implies that an improvement activity is clearly designed and organised for continuity. Hence, the term continual improvement has a greater span and also includes space for innovative or radical improvements which could be a part in an on-going process. Therefore continuous improvement is more limited than continual improvement. However, for some reason the term continuous improvement is more widespread both in theory and in practice and therefore the term continuous improvement will be used in this thesis, as follows:
Continuous improvement is an improvement process that is constant, endless and on-going and includes various types of improvements ranging from incremental improvements to improvements of a more radical nature.

Further, according to Elg et al. (2007), it is difficult to define a continuous improvement approach since there are different understandings of the concept. However, they argue that there are some statements that are shared by all approaches:

- Continuous improvement is a living activity, it is an on-going process that never ends and it requires commitment to continuous learning.
- Continuous improvement should not only lead to improved quality, but also to better results in the areas of profits, costs, productivity, and customer and employee satisfaction.
- Everybody in the organisation is expected to participate in and is embraced by the shared project of continuous improvement, including top management. Looking for ways to improve performance is a normal part of everyday work for all employees.
- Continuous improvement must be organised in a systematic way.
- Improvements must be based on statistics and/or a quantitative evaluation of the performance of processes.

Moreover, it is argued that organisations should develop holistic improvement approaches that are not based on one methodology, since no methodology can contain everything. Hoerl and Gardner (2010) argue that organisations that are seeking long-term success will need a balanced approach to business improvement that includes methods for basic problem-solving, approaches to continuous process improvement, and also systems to identify opportunities for disruptive innovation (Hoerl & Gardner, 2010).

Another aspect which is argued to be important for competitive improvement work is to combine radical and incremental improvements. With radical improvement it is possible to achieve results quickly and jump-start critical initiatives and with incremental improvements an organisation can sustain results and gradually improve (Imai, 1993; Harrington, 1995; Terziovski, 2002). The bottom-up incremental improvement strategy is the preferred strategy to improve customer satisfaction and productivity and the top-down radical improvement strategy is considered appropriate for increasing relative technological competitiveness (Terziovski, 2002).

Deploying and sustaining improvements are still major challenges that can be overcome, by building a sustaining infrastructure and making improvement a business process (Snee, 2007). It is important to adapt new improvement approaches, consider legacy structures and if there are several improvement approaches figure out how these can benefit of incorporation (Sörvqvist, 2013). According to a study made by Samson and Challis (2002), what distinguishes better companies from less good companies in terms of improvement attempts and
resulting performance changes is that better companies have a holistic management system which includes one integrated improvement approach that effectively integrates all aspects of business plans and change initiatives. This single strategic improvement approach may have many parts but it has been thoroughly thought through and comprehensively planned (Samson & Challis, 2002).

3.3 Lean Production as a concept for production system improvement

It is argued that today there is no comparative production concept that in such a radical way utilizes and develops production into the strongest competitive mean of a company as LP (Bellgran & Säfsten, 2010). According to Hines et al. (2004), LP as a concept has evolved over time, and will continue to do. Due to this evolution there has been a significant confusion about what LP is, and what it is not, and no clear definition exists. In the last decade the understanding of LP has evolved from a production toolkit to the complexity of an entire lean business system (Marodin & Saurin, 2013).

However, LP originates from Toyota Production System and LP was introduced to and spread to the Western World through the book *The machine that changed the world* by Womack and Jones in the early 1990’s (Bellgran & Säfsten, 2010). Womack and Jones (2003) have also written the bestselling book *Lean Thinking: banish waste and create wealth in your corporation*, and explain LP as five lean principles. These are: Value, The value stream, Flow, Pull and Perfection. Value means to specify value based on the customer’s perspective. The value stream is the set of all specific actions required to bring a specific product to the market, and by identifying The value stream obvious waste can be eliminated. Flow can be defined as the qualities that make the value-creating process flow. Pull means basically that no one upstream should produce a product or service until the customer downstream asks for it. The last principle is Perfection which involves eliminating waste by continuous radical and incremental improvement (Womack & Jones, 2003).

Liker (2009) specified 14 LP principles and practices based on interviews with Toyota managers as well as visiting Toyota plants during 20 years. The 14 principles are summarized into The Toyota Way and are believed to be the principles defining the culture of Toyota. Toyota Production System (TPS) represents a systematic and well developed example of what can be achieved when applying The Toyota Way. The well-known house of TPS is an example of how simply the systemic nature of LP may be portrayed and discussed. The illustrative TPS house was developed by Fuji Cho, a student of Taiichi Ohno, due to the need to train Toyota’s suppliers (Liker, 2009).

According to Petersson et al. (2009), LP can be viewed as an approach or a strategy for managing operations. Thus, LP can be viewed as an umbrella term that includes company culture, values, basic principles, methods, leadership and
employeeship. Accordingly, LP operates to increase production efficiency by continuously and tirelessly eliminating waste in the production processes, by applying some main principles which are Just-In-Time and Jidoka and by striving for perfection through continuous improvement (Petersson et al., 2009).

The purpose of the main principle Just-In-Time is to produce and deliver goods in the exact amount and at the exact time as they are needed. Applying Just-In-Time assumes that one can work with very short setup times and throughput times, that the scrap is negligible and that the availability of machines and plants is high. The main principle Jidoka concerns building quality into the product by ensuring that everything is done right from the start and stopping immediately if something goes wrong. It is about creating predictability with respect to product quality (Petersson et al., 2009).

To be successful in terms of LP in the long term, a well-established improvement work process where the employees are involved is of central importance, since otherwise there is a risk that short term results will not be sustained in the long term. Those involved in improvement work strive for perfection by eliminating the well-known seven types of waste: overproduction, waiting, unnecessary transportation, over-processing or incorrect processing, excess inventory, unnecessary movement, defects and unused employee creativity (Bergman & Klefsjö, 2010).

Common forms of improvements within the LP concept are various forms of Kaizen. Kaizen is a Japanese word meaning continuous improvement (Petersson et al., 2009; Bergman & Klefsjö, 2010; Sörqvist, 2013). Sometimes Kaizen is interpreted as only focusing on small incremental improvements, but according to Bergman and Klefsjö (2010) and Sörqvist (2013) the term Kaizen if interpreted as continuous improvement includes different ways to conduct and organise the improvement work. Accordingly, there can be daily Kaizen work focusing on improving the daily operations by smaller improvements. Process Kaizen or Flow Kaizen can be made where Process Kaizen focuses on improving a specific process and Flow Kaizen focuses on improving the flow that ties together processes. Other forms of improvement work can be Kaizen event and Kaikaku which are usually used to solve larger and more complicated problems, and they are also conducted at specific times. A Kaizen event is an intense workshop focusing on solving a specific problem at Gemba. Gemba is a Japanee term and stands for the real place and it refers to the shop floor or rather the place of value-adding (Dombrowski & Mielke, 2013). A Kaizen event involves a cross-functional team with different stakeholders and usually there is a workshop leader who manages the Kaizen event. Kaikaku means radical improvement and is a type of improvement work conducted in project form with clear and quantified targets. A Kaikaku involves not only the production employees but usually also product development and support functions to production. An example of a Kaikaku can be to create a new production setup with shorter lead time (Petersson et al., 2009).
In order for companies to be successful in LP it is important that they have a clear position on what they understand as LP and to what extent they want to be lean (Marodin & Saurin, 2013). A recent and strong trend across many manufacturing industries is according to Netland (2013) to develop company-specific-production-systems (XPS) which are corporate improvement programs inspired by Toyota Production System (TPS). XPS development has become common because trial and error have led to the realization that the sustained success of improvement efforts demands a higher degree of systematization and adaption of the best practice to the unique characteristics and environment of each company (Netland, 2013). Inspired by the persistent success of Toyota and its Toyota Production System, many companies firmly believe that having a similar but tailored approach in place will strengthen their own competitiveness, if their XPS principles resemble the principles of the TPS and LP. Hence, an XPS represents the strategic choice of operating principles most important to a company, so an XPS represents “an own-best-way approach to the one-best-way paradigm” (Netland, 2013, p. 1093). Also, according to Netland and Sanchez (2014), an XPS is an example of a holistic approach to improvement, where the “best of” Just-in-Time, Six Sigma, TQM, LP and so on can be strategically selected by the organisation.

3.4 Implement Lean Production

Even though LP is a well-known concept, the implementation of LP is still challenging for many companies and generalizable implementation steps have not yet emerged (Marodin & Saurin, 2013). Implementing LP is a large scale change since it involves changes of the technical systems, and the management systems as well as changes in attitudes and values (Liker, 2009; Sörqvist, 2013). Since LP is to a large extent based on continuous improvement (Womack & Jones, 2003; Shah & Ward, 2007), the implementation process will never end and it is always possible to become leaner (Hines et al., 2004; Liker, 2009; Sörqvist, 2013).

Marodin and Saurin (2013), have performed a literature review of 102 studies where they among other issues investigated methods for implementing LP systems. They found out that value stream mapping (VSM) seems to be a fairly generalizable element of LP implementation. Besides being an implementation method itself, the use of VSM is cited a step in the LP implementation. However, many other methods are strongly concerned with prescribing the use and sequencing of specific LP practices (mapping the current state, identifying customer needs, training employees etc.). Sörqvist (2013) describes it as an iterative process between Flow Kaizen and Process Kaizen. An LP implementation should start with a Flow Kaizen aiming to transform the old flow into an effective flow. Without this change of the flow there is a large risk that many improvements will not have any effect since the base on which the improvement is based is still incorrect and sub-optimisations will occur. The Flow Kaizen will then be followed by Process Kaizen, sustaining and further improving the Flow Kaizen. Later on there will be an interaction between Flow Kaizen and Process Kaizen, and since the transformation of a flow will never be a final state, there will always be a better way (Sörqvist, 2013). Further on, the LP implementation process involves
evolution and refinement of the principles and practices (Marodin & Saurin, 2013), through the Plan-Do-Check-Act cycles of Deming (1986).

Womack and Jones (2003) have developed an implementation process for LP based on four steps that they learned are important from examining successful transformations at manufacturing companies. The process takes a time perspective on the LP implementation, see Table 2. Even though this process and similar processes have been criticized, for instance for being too rigid to deal with the need for adapting LP implementation to the unique context of each company (Yamamoto, 2010), this process or similar processes have been used when implementing LP during a radical change of the production system, also called Kaikaku (Hines et al., 2004).

Table 2. Implementation process of LP based on Womack and Jones (2003).

<table>
<thead>
<tr>
<th>Phase</th>
<th>Specific steps</th>
<th>Time frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get started</td>
<td>Find a change agent</td>
<td>First six months</td>
</tr>
<tr>
<td></td>
<td>Get lean knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Find a leaver</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Map value streams</td>
<td></td>
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<tr>
<td></td>
<td>Begin Kaikaku</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expand your scope</td>
<td></td>
</tr>
<tr>
<td>Create a new organisation</td>
<td>Reorganise by product family</td>
<td>Six months through year two</td>
</tr>
<tr>
<td></td>
<td>Create a lean function</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Devise a policy for excess people</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Devise a growth strategy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remove anchor-draggers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instill a “perfection” mind-set</td>
<td></td>
</tr>
<tr>
<td>Install business systems</td>
<td>Introduce lean accounting</td>
<td>Years three and four</td>
</tr>
<tr>
<td></td>
<td>Relate pay to firm performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implement transparency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Initiate policy deployment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduce lean learning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Find right-sized tools</td>
<td></td>
</tr>
<tr>
<td>Complete the transformation</td>
<td>Apply these steps to your suppliers/customers</td>
<td>By the end of year five</td>
</tr>
<tr>
<td></td>
<td>Develop global strategy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transition from top-down to bottom-up improvement</td>
<td></td>
</tr>
</tbody>
</table>
Implementing corporate improvement programs like XPSs, which are multi-plant improvement programs that are coordinated from the corporate headquarters and implemented in all subsidiaries of the company, is a challenging task (Netland, 2012). Netland (2012) suggests an XPS lifecycle that illustrates a typical path of four implementation phases in relation to five maturity levels (the maturity levels are states described in the XPS implementation), see Figure 6.

In Phase 1, called Establishment, the XPS program necessarily takes the form of a project. The XPS starts with a top-management decision to develop an XPS for the corporate company. Traditional project management techniques are needed to effectively and efficiently plan and design the content, structure and process of the XPS program. The aim is to develop the XPS as far as possible before deployment to reduce confusion in the organisation. Also, each subsidiary must use some time in Phase 1, to understand what the local XPS is, if different from the global XPS.

Phase 2, called Reengineering, is a necessary phase for many subsidiaries that still operate in accordance with mass production logic or with a functional layout. It often includes a major change in the physical layout of the production plant in a move towards flow production. Since Just-In-Time production is much more vulnerable to unplanned variability, the need for standards is consequently much higher. Therefore it is argued that subsidiaries should take advantage of reengineering to establish a completely new and updated factory standard. Further, due to the transition to a leaner production system, the effect on productivity is often of an exponential nature. The physical layout change is a threshold for change that to some extent hinders reengineered companies from falling back to the old factory standard.
In Phase 3, Continuous Improvement, incremental improvements are introduced to the subsidiaries. According to Netland (2012) this phase is difficult to sustain since it relies on the participation of all employees, and the organisational culture must foster improvement suggestions. The XPS process and structure must be able to accommodate these suggestions, also the commitment from managers must be constant and uncompromised and the system must allow for a high degree of ambiguity and uncertainty, because the XPS is a program that is shared between sites. The XPS process refers to how the XPS is implemented in the organisation, and the form of the implementation might vary between subsidiaries within the same organisation. The XPS structure refers to the structure to support the implementation, which is a superstructure at the corporate level and each subsidiary establish an own support structure.

The last phase, Phase 4, Process innovation, is a hard-won phase to reach and sustain. In this phase the company is word class and improves by pushing the performance frontier and in order to do so, the company must succeed with process innovation, because imitating others only brings a company to the frontier and not beyond. The benefits in this phase are typically realized in a step-by-step movement where each innovation brings subsidiaries one step forward. The ability to innovate, as well as spread and absorb the process innovation in the organisation relies on a widespread capacity for learning (Netland, 2012).

Netland (2012) has suggested a framework for successful XPS program management. When entering the later phases in the XPS implementation the XPS must become part of the everyday operations. Accordingly, Phase 2 and 3 and especially 4 in Figure 6 require the participation of all employees in the organisation and each phase requires a specific focus on the particularities of each subsidiary and the adaption to certain settings in the subsidiary, meaning that these phases need to be managed by each subsidiary.

It is well known that the success and greatest difficulties of implementing LP are related to the use of principles (Bhasin & Burcher, 2006; Yamamoto, 2010). Also, in practice it has proven extremely difficult for companies to move beyond the reengineering phase, which might be due to the lack of clear guidelines for program management (Netland, 2012). However, to sustain the results from a radical implementation of LP, like a reengineering phase according to Netland (2012), it is important to continue to work with continuous improvement (Imai, 1993; Womack & Jones, 2003; Sörqvist, 2013).

3.5 Factors influencing Lean Production implementation

Since one focus in this thesis is the transition from a radical implementation of LP like a reengineering phase according to Netland (2012), to continuous improvement, the emphasis is on factors contributing to sustaining and enabling further development of LP as continuous improvement. As already stated, sustaining results and continuing the development of change or improvement initiative are challenges for companies (Kotter, 2002; Bateman, 2005; Liker, 2009).
Understanding the factors that contribute to sustaining change and further development of the organisation may help a company reach long-term success. Based on an analysis of the literature review concerning success factors for improvement work, the factors are summarized as: Production strategy, vision and objectives, Training and learning, Leadership, Control and follow-up, Process, Organisation and support, Participation and Culture, values and behaviours.

**Production strategy, vision and objectives**
According to Porter (1996), operational effectiveness means performing certain activities better than rivals perform similar activities and in contrast strategic positioning means performing different activities or performing similar activities in different ways compared to the competition. Operational effectiveness is necessary but not sufficient, as Porter (1996, p. 62) expresses it “a company can outperform rivals only if it can establish a difference that it can preserve”. Hence to create a sustainable manufacturing environment the strategy is an important element (Porter, 1996; Pham & Thomas, 2012). Having a production strategy is to have a long-range vision for the production function, aligned with a business strategy that sets an overall direction for consistent decision-making in the production, in order to gain competitive advantage. It sets the objectives for production and mobilizes all the resources towards achieving those objectives (Ahmad et al., 2003). The production strategy can be a plan containing activities that are needed to achieve objectives (Bellgran & Säfsten, 2010). For the change initiative or the improvement work the vision of the future state and the production strategy create the ground for and the direction of the change (McKinsey, 2007). Moreover, a well communicated vision creates an understanding of the purpose of the efforts and, thereby, promotes “a corporate quality culture” (Fryer et al., 2007). Further on, having objectives for operations that are communicated to and understood by everyone makes it possible to have the correct focus on the improvements (McKinsey, 2007). The objectives also help to prioritise among improvement activities (Fryer et al., 2007), and create challenges for the employees (Ramström & Stridh, 2008).

**Control and follow-up**
To sustain achieved results, an important factor is control and follow-up of results, since results need to be assessed in order to be sustained and if there are deviations from the objectives, corrections need to be made (McKinsey, 2007). Another important issue is to show the progress of the results in relation to the objectives, since this will increase motivation (Ramström & Stridh, 2008). Negative circles in terms of sustaining results can be avoided by having an on-going evaluation, like audits or assessments (Fryer et al., 2007).

**Training and learning**
To be able to perform excellent work and continuously improve it is important that the employees have the right competence. Also their competence must be continuously developed and improved, and therefore training and learning are of great importance in LP (Sörqvist, 2013). According to Bessant and Caffyn (1997)
and Fryer et al. (2007) training and learning involve the ability of employees to gain the knowledge and tools required to perform the improvement work. This factor includes educating leaders and teams in understanding the lean guidelines, grasping the philosophy behind them, and learning certain skills, for example recognising waste and using appropriate tools. Ramström and Stridh (2008) also include sharing good examples with each other, co-operating with other departments and showing successful examples of improvement projects within training and learning.

**Leadership**

To successfully implement changes like LP and sustain and further develop operations, engaged leadership on all levels is a crucial success factor (Kotter, 2002; Sörgqvist, 2004; Liker, 2009; Sörgqvist, 2013), and nothing can replace the direct involvement of leaders (Koenigsaecker, 2007; Dombrowski & Mielke, 2013). To promote a better improvement culture the lean leader needs to be a role model for his/her employees (Dombrowski & Mielke, 2013). To be a role model and to display engaged leadership on the shop floor include Gemba management, which entails leaders spending time on the shop floor in order to understand the problems, find the root cause and standardise (Dombrowski & Mielke, 2013). Other important aspects are to drive the actions and create the foundation for a learning organisation by learning and sharing knowledge, creating a common understanding of improvement work and explaining why it is important, providing discipline, motivation and incentives, matching interest with improvement areas, asking for ideas and spreading engagement (McKinsey, 2007; Ramström & Stridh, 2008; Dombrowski & Mielke, 2013). Sörgqvist (2013) especially emphasises the great importance of top management commitment and involvement as a vital success factor since the behaviour of top management affects leaders on all levels. On a top level, management commitment and involvement mean that the managers should stay focused on process improvement activities, keep communication channels open, continue visible management and proceed strategic planning (Bateman, 2001; Alukal, 2006; Fryer et al., 2007). Alänge and Steiber (2009) also point out the importance of a commitment to sustainability at the board level in connection with major organisational change. Since a committed top management does not last forever the issue of sustaining change falls back on long-term governance structures. So if the board does not understand the essence of an major organisational change like LP, there is a risk that top management is replaced with new leaders, who are given new directions by the board (Alänge & Steiber, 2009).

**Process**

Successful improvement work contains several methodologies which can be used to accomplish improvement since no methodology alone can contain everything. For instance Hoerl and Gardner (2010) argue that companies need a balanced approach to business improvement that includes methods for basic problem-solving, approaches to continuous process improvement, and also systems to identify opportunities for disruptive innovation. Accordingly, there should be a bottom-up as well as a top-down approach (Sörgqvist, 2004). Hines et al. (2004)
encourage the use of tools drawn from diverse management approaches such as Six Sigma, Marketing, Agile Manufacturing, and System Dynamic to create a unique approach supporting the lean system. For companies that try to achieve an overall systematic approach to improvements containing several methodologies, Sörqvist (2013) points out the importance of developing and visualizing a common improvement work process containing common procedures and work methods.

**Organisation and support**
The improvement work also needs to be organised and supported by implementing an infrastructure with clear roles, well-defined responsibilities and authorities and required skills, that can drive and support the organisation through the change (McKinsey, 2007; Snee, 2007; Ramström & Stridh, 2008; Sörqvist, 2013). Sörqvist (2013) points out levels of improvement that need to be organised and supported in the infrastructure for improvements: local improvement teams, cross-functional improvement projects (like an improvement event) and cross-organisational improvement work (improvement initiatives in cooperation with customers and suppliers). Important roles in this infrastructure are: steering role, supporting role and embodiment role, see Sörqvist (2013).

**Participation**
Participation or involvement is also an important success factor in continuous improvement. In line with Bessant and Caffyn (1997), continuous improvement builds upon the idea of high involvement innovation. They define continuous improvement as an “organisational-wide process of focused and sustained incremental innovation” (Bessant & Caffyn, 1997, p. 10), and state that it, therefore, is important to mobilise high levels of participation in the process. Letting the employees make their own decisions within their teams regarding the way of working can increase involvement. Other crucial motivators are quick responses to ideas, permission to accomplish one's own ideas, avoidance of criticism, leaders participate in improvement work, celebration of successes, offering rewards for successes (collective rewards), focus on small improvement steps, focus on teamwork and employee empowerment, and have fun (Alukal, 2006; Fryer et al., 2007; Ramström & Stridh, 2008).

**Culture, values and behaviours**
Having a supportive culture is also crucial to sustain and develop change initiatives such as LP and continuous improvement according to Kotter (2002) and (Jabnoun, 2001) and once a company/organisation has built a culture that believes in continuous improvement, sustaining LP will be second nature (Koenigsaecker, 2007). Hence, culture change or at least culture awareness is a necessary prerequisite for “excellence”. Kotter (2002) states that the anchoring of new settings in a culture takes time, and further implies that a culture truly changes only when a new way of operating has been shown to succeed over some minimum period of time. Jabnoun (2001) points out values that are important in a supportive culture for continuous improvement. Values that drive continuous improvement are respect, responsibility and empathy. Values that enable
continuous improvement are humbleness, trust, openness and cooperation. Behaviours that support these values can be the following: to see improvement work as a part of the regular work description, to have good attitudes about problems, meaning to see problems as possibilities to improve, to help each other in the improvement teams, to allow everybody to submit ideas about anything, to see continuous improvement as helpful to communication and training, to remember that it is a never ending process, to insist on always following the lean standard work, and to show honesty within the organisation (Ramström & Stridh, 2008).

3.6 Literature essentials

The essential findings of previous research can be summarised as follows:

- To achieve successful improvement work in a production system a holistic perspective on the production system is preferred, since improvements can be made in any part of the production system. Also a holistic point of view helps prevent sub-optimisations of the production system.

- Continuous improvement is the common term to denote improvements which take place over time. It can be understood as an improvement process that is constant, endless and on-going and it includes various types of improvements from incremental improvements to improvements of more radical nature.

- It is also argued that organisations should develop holistic improvement approaches that are based on several methodologies, since no methodology can contain everything.

- Deploying and sustaining improvements are still challenges that can be overcome, by building a sustaining infrastructure and making improvement a business process. For instance a new improvement approach needs to be adapted to operations, legacy structures need to be regarded and if there are several improvement approaches these need to be incorporated into one single strategic improvement approach.

- Today LP is the most generally accepted concept for operational excellence. LP can be understood as an approach or a strategy for how to manage operations, by applying the principles Just-in-Time and Jidoka and striving for perfection through continuous improvement.

- To be successful in LP in the long term a well-established improvement work process is of central importance. Common forms of improvements within the LP concept are various forms of Kaizen, which can be interpreted as continuous improvement.
• A strong and recent trend among companies is to implement corporate improvement programs as company-specific-production-systems (XPS), where XPS principles resemble the principles of the TPS and LP. It can also be an example of a holistic approach to improvement where the best of Just-in-Time, Six Sigma, TQM, LP etc. can be strategically selected by the organisation.

• The implementation of LP is still challenging for companies since it is a large scale change and involves changes of the technical systems, the management systems, as well as changes in attitudes and values. Generalizable implementation steps have not yet emerged. Also, since LP to a large extent is based on continuous improvement, the implementation process will never end.

• The LP implementation can start with a radical implementation phase like reengineering which is followed by a continuous improvement phase introducing continuous improvement. However, in practice it has proven difficult for companies to move beyond the reengineering phase.

• Factors important in the LP implementation are Production strategy, vision and objectives, Control and follow-up, Training and learning, Leadership, Process, Organisation and support, Participation, Culture, values and behaviours.

Understanding these essential aspects seems important in an LP implementation aiming to develop successful improvement work based on continuous improvement that takes a holistic perspective on production system improvement.
4. Paper summary

This chapter summarises the papers written as part within the scope of this research project.

4.1 Paper I: Towards a holistic perspective on production system improvement

Paper I is based on an overall literature review in order to investigate the term holistic/integrated improvement work followed by the development of a concept model describing the context of improvement work. The method concept modelling was used which includes interactive feedback on the model from some production companies.

The purpose of Paper I was to gain further understanding concerning the different components in operations and especially their interaction with improvement work, in order to better and more easily understand the improvement work context and also to visualise the context of improvement work. The concept model can be used to develop support for the process of reaching a holistic perspective on production system improvement, which is essential when working with improvements in a production system.

A concept model of how the components are integrated and related in operations was developed and the concept model is understood as the context of improvement work. The concept model consists of the following components: Strategy, Management system, Production system, Performance measurement system, Improvement system, Program/methods/tools and Perspectives of improvements, see Figure 7. A definition of the improvement work as an improvement system was also formulated based on the concept model.

The definition of an Improvement system, presented in Paper I, is: An Improvement system consists of Programs, methods and tools, supporting different Perspectives of improvement, thus optimizing the performance of the Production system. The Production system, of which the Improvement system is a part, is measured by the Performance measurement system and controlled by the Management system in coordination with the Strategy.
4.2 Paper II: Exploring a holistic perspective on production system improvement

The second paper is based on an exploratory embedded single case study performed at the case company in 2012. The purpose of the study was to understand how holistic improvement work can be organised and what challenges can be observed in the process of reaching a holistic perspective on production system improvement, based on the previously developed concept model in Paper I. The aim was to answer the research questions: How can holistic improvement work be organised? and What challenges can be observed in the process of reaching a holistic perspective on production system improvement?

The findings were that improvement work was organised in three approaches: 1) continuous improvement within the company-specific-production-system (XPS) including LP methods and tools, 2) the Operational Development (OD) program and 3) the process for managing objectives and Key Performance Indicators (KPIs). Thus, the OD program and the process for managing objectives and KPIs are incorporated in continuous improvement in XPS as approaches to manage improvement work in alignment with the production strategy. So if LP is understood as an XPS framework, it seems natural to incorporate more approaches into that framework. However there is a need to update the Operational Management System (OMS) with an overall process for holistic improvement work which shows how it all fits together.

Even if a company is able to organise holistic production system improvement work, there are several challenges to handle. Challenges identified in this study are the following: There is a lack of holistic perspectives on improvement opportunities since the main improvement opportunities are not evident; There is a need to discuss and update the production strategy on a regularly basis to keep it up to date and relevant; Updating the OMS on the XPS processes in the Production system is lacking and a conflict has therefore emerged between XPS and OMS.
regarding the need of an OMS and what is what; XPS is occasionally interpreted as the Production System as such and it is difficult to understand what XPS really is, and this creates confusion for instance when discussing relations; No specific performance measure addresses the improvement work; No awareness of different perspectives on improvements so maybe these are not important at this stage in the incorporation work aimed at the improvement approaches.

4.3 Paper III: Transitioning radical improvement to continuous improvement

Paper III is based on a literature study and then a case study based on the literature review. The case study was performed in 2009 at the case company and is an explorative multiple holistic case study.

The purpose was to map general success factors important for improvement work, and it concerned the factors that enable continuous improvement after radical improvement and the factors that are important to further develop continuous improvement in the organisation, in order to reach a deeper understanding of the transition from a radical implementation of LP to continuous improvement.

From the literature review eight comprehensive success factors were derived: Vision and goals, Control and follow-up, Training and learning, Leadership, Way of working, Participation, Organisation and support, Values. The case study shows that success factors important for enabling continuous improvement after a radical implementation of LP are Participation, Control and follow-up, Leadership and Values. In order for the organisation to enable further development of continuous improvement, it is important that the success factors Vision and goals, Training and learning, Way of working, Organisation and support continue to develop. Figure 8 visualises the findings.

Figure 8. Visualisation of the findings.
4.4 Paper essentials
To summarise the most important findings from the papers some bullet points are made:

• In Paper I, a concept model was developed which represents the context of improvement work, including a definition of the improvement system.

• Paper II describes how holistic improvement work can be organised and identifies challenges in the process of reaching a holistic perspective on production system improvement.

• In Paper III, success factors enabling continuous improvement after a radical implementation of LP are identified and also success factors important to further develop continuous improvement are described.
5. Discussion

This chapter discusses the research results and their implications connected to the research objective and questions. The understanding of the context of improvement work, including a way to organise improvement work, is discussed, as well as critical factors for transitioning a radical implementation of LP to continuous improvement. Based on these proposals a supportive framework for the successful implementation of improvement work is suggested.

The overall purpose of this licentiate thesis has been to contribute to an increased understanding of how to successfully implement LP. Accordingly, the objective has been to develop a supportive framework for the successful implementation of improvement work. In order to reach the conclusions necessary to build this knowledge, several aspects need to be addressed and discussed. Based on the theoretical review and the empirical results, the following areas have been identified as important and relevant to discuss in relation to the purpose, objective and research questions:

- The context and organisation of improvement work
- Factors supporting LP implementation

Figure 9 shows the relation between papers, research questions and discussion.

![Figure 9. Relation between papers, research questions and discussion.](image)

### 5.1 Context and organisation of improvement work

To be able to answer RQ 1) *How can an improvement approach within a manufacturing company, as an implementation of Lean Production be described?*, it is important to understand the context of improvement work and its relations to operations. Accordingly the study described in Paper I was performed due to the need to gain further understanding about different components in operations, and especially about their interaction with improvement work, and the objective was to visualise the context of improvement work. Later on, the developed concept model, understood as the context of improvement work, was used as basis for the case study design described in Paper II aiming to explore a holistic perspective on production system improvement. Paper II hence provides insights how to improve
and develop the concept model further as well as understand challenges present in the process to reach a holistic perspective on production system improvement.

The definition of a production system used in this thesis is a transformation system according to Hubka and Eder (1988), meaning that all components in the concept model are like subsystems in a production system and the production system is superior to all. Although it is so, the concept model should not be seen as a hierarchy since the concept model describes the relationship of the components to each other. Thus, the ingoing components in the concept model should not be interpreted as if they were detached from each other. The reason for visualising them as different components is because they are essential elements in improvement work and their respective relation to improvement work needs to be further understood. Also, for instance the improvement system is visualised as though it is only related to the production system, see Figure 7, however it is also indirectly related to the other components, but through the production system. Concerning the notion (1:M), if the example Improvement system and Program, methods, tools, in Figure 7, is used, the notion here means that there will be One Improvement system but there can be Many Program, methods, tools. Further, the concept modelling is inspired by the concept-modelling methodology according to Astrakan (2003) and SIS (2008).

The concept model was developed in Paper I, see Figure 7. It contains seven components: Strategy, Management system, Production system, Performance measurement system, Improvement system, Programs, methods, tools, Perspective of improvement. It was suggested that the Strategy mutually interacts with one or many Management systems. The Management systems describe the Production system and hence the Production system is controlled by the Management systems. Accordingly, the Performance measurement system mirrors the Production system. The Improvement system optimizes the performance of the Production system at the same time as it is also a part of the Production system. The Improvement system consists of chosen Programs, methods, tools and these Programs, methods, tools are thus parts in the Improvement system. The Programs, methods, tools support different Perspectives of improvements (improve operations in different ways).

When discussing the constituent components in the concept model from Paper II, it is stated based on identified challenges that the production strategy is an important factor in reaching a holistic perspective on production system improvement. Accordingly, a relation showing the importance of linking the Improvement system to the Strategy needs to be added in the concept model since the improvement work is supposed to be aligned with the production strategy (McKinsey, 2007). It was also found that there were no obvious connections between management system and production strategy. However, it is still believed that the Strategy should interact in a mutual sense with the Management system, since both are included in the executive system according to Hubka and Eder (1988).
Previous research does not include a great deal of information concerning how to handle the Management system during an LP implementation. Only the importance of having one integrated Management system in order to be successful in improvement work has been emphasized (Samson & Challis, 2002). Hence, this leads to a change in the concept model to only one Management system instead of many, hence M turns into 1 in the concept model.

The Performance measurement system measures the performance of the Production system in terms of KPIs (Tangen (2004), Salloum (2011)). However, as Johnson et al. (2007) point out, since companies tend to implement several improvement approaches, the impact of a single improvement approach is not reflected in the KPIs, and usually there are no KPIs which address improvement work. This assumption is also supported by the findings in Paper II since no specific performance measure addresses improvement work in the performance measurement system and it is unclear how the improvement activities have affected the KPIs and hence the production strategy. However, in order to understand how the improvement work is performing, and in order to keep it alive, it is important to link it to performance measures (Johnson et al., 2007). Therefore it is suggested that a specific relation should be added between Performance management system and Improvement system in the concept model and that it should also include the component Measurement system for aggregated measures of improvement work.

When discussing the component Improvement system in the concept model the organisation of improvement work is in focus. Findings presented in Paper II show that the improvement work is organised in three main approaches 1) continuous improvement within XPS including LP methods and tools, 2) the OD program, 3) the process for managing production objectives and KPIs. Continuous improvement within XPS is seen as a framework into which the other two improvement approaches are incorporated, all in alignment with production strategy. So in line with Marodin and Saurin (2013), it is important that companies have a clear position on what they understand as LP, and if LP is understood as a XPS framework, which also can be seen as a holistic approach to improvement (Netland & Sanchez, 2014), it seems natural to incorporate more approaches into that framework. When it comes to the concept model the component Improvement system can be viewed as an LP system, at least in a company implementing an XPS framework. The Improvement system in terms of continuous improvement consists of the following approaches: continuous improvement within XPS, OD program and the process for managing production objectives and KPIs. Methods and tools consist of LP methods and tools achieved from the XPS implementation.

The final aspect of improvement work is the component Perspective of improvement which also is the least developed and least understood component. In Paper I there was a discussion regarding what makes the improvement work holistic. It was suggested that the holistic quality was related to the awareness of
when to choose Programs, methods, tools from different perspectives according to the production strategy and systems of the company. This is also emphasised by Swartling (2013) who argues that it would make more sense to establish the problem first and then choose a suitable tool, regardless of the improvement program. This claim indicates that it is the process before the improvement process begins that determines if the improvement work of a company is holistic or not. Based on the case study in Paper II it can be stated that there was no awareness of different Perspectives on improvements. It was instead perceived as difficult to understand how to gain a holistic perspective on improvement work and understand all contexts since there are so many different types of improvement methods, tools and principles. To summarize, there was no systematic process to address specific perspectives on improvements. However, it is suggested that at this point in the incorporation work aimed at the improvement programs, different perspectives might not be important. Later on it can be interesting to discuss perspectives when the organisation has reached a deeper knowledge in systems thinking. Then the organisation might want to reach a higher level in creating a unique improvement approach, selecting methods and tools in relation to what kind of improvement they want to accomplish, hence thinking in terms of systemic cause and effect, as suggested by Seddon and Caulkin (2007).

This overall discussion leads to changes in the concept model, as follows;

- One Management system instead of many, M turns in to 1
- The relation between Strategy and Improvement system is of great importance; therefore a specific relation between Strategy and Improvement system is added
- Consideration of the relation between Improvement system and Performance measurement system
- Adding the component Measurement system since it is of great importance to have measures for improvement work.

Accordingly, the context of improvement work and its relations to operation are now understood as follows: The Strategy mutually interacts with the Management system. The Management system describes the Production system and hence the Production system is controlled by the Management system. The performance of the Production system is measured and monitored by the Performance measurement system. Consequently, the Performance measurement system mirrors the Production system and indirectly the Improvement system. The Improvement system optimizes the performance of the Production system, and the Improvement system is a part of the Production system. The Strategy sets the direction for the Improvement system and hence the Improvement system is aligned with the Strategy. The performance of the Improvement system is measured and monitored by the Measurement system and hence the Measurement system mirrors the Improvement system. The Improvement system consists of chosen Programs, methods and tools and these Programs, methods, tools are thus parts in the Improvement system. The Programs, methods, tools support different Perspectives of improvements.
Consequently the definition of an Improvement system will be: An Improvement system consists of Programs, methods and tools, supporting different Perspectives of improvement. The Improvement system is measured by the Measurement system and indirectly by the Performance measurement system. The Improvement system is aligned with the Strategy and optimizes the performance of the Production system. The Production system, of which the Improvement system is a part, is measured by the Performance measurement system and is controlled by the Management system in co-ordination with the Strategy.

Figure 10 visualises the improved concept model based on the discussion and definition outlined above.

![Figure 10. Improved concept model.](image)

5.2 Factors supporting different stages in Lean Production implementation

To be able to answer RQ2) *What are the most important success factors when implementing an improvement approach, such as Lean Production, within a manufacturing industry*, several factors need to be considered. If the transition to continuous improvement is regarded as several years and not as a single point, like an implementation process according to Womack and Jones (2003) or Netland (2012) (see Chapter 3.4), then factors important at different stages during the transition can be identified.

From Chapter 3.5, eight major important factors are derived that influence the LP implementation from a sustainability perspective, and they are grouped as: Production strategy, vision and objectives, Training and learning, Leadership, Control and follow-up, Process, Organisation and support, Participation and Culture, values and behaviours. Each of these factors involves many important
aspects that can be discussed and that are important in different stages of the LP implementation.

**The sustaining change and enabling stage of continuous improvement**

Paper III has a shop floor perspective and identifies the most important factors close to the end of a radical implementation of LP. It shows what factors are most important for the production teams to be able to sustain change after the radical implementation of LP and enable continuous improvement. The factors that were most important at this stage were: Values, Control and follow-up, Leadership and Participation.

If summarizing these factors, all except Control and follow-up involve soft values, such as attitudes and norms. As was stated in Paper III, this implies that when a production team has been through a radical implementation of LP and many new initiatives are introduced, a good way to sustain change and develop initiatives further is to use Control and follow-up of results, to direct the group and apply a supportive leadership that is aware of the importance of attitudes and values.

Another topic for discussion is the feeling of the production team that the LP principles have been established in their department, which according to Kotter (2002) only happens when a change initiative has proven to succeed over some minimum period of time. This feeling points to the successful performance of the mini-transformation within that team, which was the case according to Paper III. Accordingly, it is important to notice that a successful mini-transformation is an important factor enabling continuous improvement, since it creates a good base for further improvements.

Looking further into the factor Leadership, the findings related to Leadership was that the supervisor is engaged in the improvement work, spends time with the team on the shop floor and regarding encouragement the supervisor gives both positive and constructive feedback for improvement. These findings are all related to the leadership on the shop floor, and similar to the Gemba management which is claimed to be important by Dombrowski and Mielke (2013).

To summarize this discussion, the following factors are important to sustain change after a radical implementation of LP and to enable continuous improvement: Successful mini-transformation, Participation, Control and follow-up, Leadership – shop floor, Values.

**The developing stage of continuous improvement**

Based on the results from the case study in Paper III, the production teams show the same pattern regarding factors enabling and developing continuous improvement. They have different values, but experience nearly the same strengths and weaknesses. The factors that are strong in most pilot teams and also are argued to enable continuous improvement after a radical implementation of LP in the previous section are: Control and follow-up, Leadership on shop floor,
Participation and Values. Meanwhile, the factors that are weak in most pilot teams are Vision and goals, Training and learning, Process and Organisation and support.

When analysing the weak factors in Paper III: Vision and goals, Training and learning, Process and Organisation and support, it was found that most of the weaknesses derived from the organisation. This leads to the statement that the biggest challenges of developing the organisation towards continuous improvement lay at this time within the organisation and not within the pilot teams.

Accordingly, this result also matches the transition at that time, since when this study was conducted almost all production teams in production, including both assembly and machining, had performed mini-transformations and started their journey towards continuous improvement. The support functions like production technology, maintenance, quality, logistics and human resources had all been involved in the mini-transformations of the production cells but the support functions had not been through a structured mini-transformation themselves. Accordingly their structures, procedures, working processes and so on were not yet completely supportive of LP at that point. Changes in support functions, such as work methods and standards would follow, but through continuous improvement. It can be suggested that this might have been important to consider at the same time as the mini-transformations, or at least a plan could have been made for supportive structures and processes that needed to be changed or improved. However, since this is a little bit out of the scope of this thesis it will not be further discussed.

Also the characteristics of the factors Production strategy, vision, objectives, Training and learning, Process and Organisation and support, described in Chapter 3.5, are of such nature, so that these factors can be addressed the organisation to further improve and thus develop continuous improvement.

When discussing Production strategy, vision, objectives based on Chapter 3.5, it can be seen that having a production strategy is to have a long-range vision for the production function that is aligned with the business strategy (Ahmad et al., 2003). The management is ultimately responsible for establishing a production strategy (Bateman, 2001), thus management commitment is important and is argued to be a significant factor for developing continuous improvement. Moreover, the production strategy can be a plan containing activities that are needed to achieve objectives (Bellgran & Säfsten, 2010), and having objectives for operations that are communicated to and understood by everyone makes it possible to retain the correct focus on the improvements and helps to prioritize among improvement activities (Fryer et al., 2007; McKinsey, 2007). The production strategy and long range vision determine the objectives for operations and hence production which is crucial to be able to align and motivate continuous improvement in the production teams.
In the theoretical framework in Paper III in the factor Vision and Goals the production strategy was not highlighted. In case study II, described in Paper II, the production strategy was shown to be very important for the additional development of continuous improvement. Hence it was added in Chapter 3.5 and the important factor is named Production strategy, vision, objectives instead of only Vision and goals. Goals were substituted with objectives since the concept of objective might be more appropriate to use within this area.

The factor Training and learning can be argued to be improved by both production teams and the organisation. Sharing good examples and cooperating with other departments (Ramström & Stridh, 2008) are activities that might be expected to be initiated by the production teams themselves, but then they must realize the importance of those activities and they might not go about them in a structured way. Accordingly, it is important that the organisation understands the importance of Training and learning, so it can offer opportunities to increase competence continuously (Sörqvist, 2013), regarding LP principles, the recognition of waste, tools etc. (Bessant & Caffyn, 1997; Fryer et al., 2007), in order to develop continuous improvement.

The factor Process is suggested to use programs and tools from diverse management approaches (Hines et al., 2004), in order to achieve good results in holistic improvement work, since no methodology alone can contain everything (Hoerl & Gardner, 2010). It is also suggested that there should be a bottom-up as well as a top-down approach (Sörqvist, 2004). The common approach to holistic improvement work also needs to be described and visualised in terms of procedures and ways of working (Sörqvist, 2013). Further, an important issue is also the ability to prioritise in improvement work and not sub-optimise (Petersson et al., 2009), so the main improvement opportunities need to be known and, improvement work also needs to be aligned with production strategy in order make good prioritisations. Since the production teams in Paper III felt there was a lack of a common process for improvement work, this common process for improvement work needs to be developed by the organisation.

In Chapter 3.5, regarding the factor Organisation and support, an infrastructure for improvement work with clear roles, well defined responsibilities and authorities and required skills needs to be implemented, in order to drive and support the improvement work, see for example Sörqvist (2013). By the time for the case study in paper III, the infrastructure for improvement work was seen as the XPS organisation implementing XPS, but at the same time the pilot groups experienced that no one kept the improvement work together on a comprehensive level, something that has been defined as important by (Bateman, 2001), meaning that there was no infrastructure supporting continuous improvement by that time. Instead there was a need for the organisation to develop and implement this infrastructure.
To summarise this discussion, the following factors are important to develop continuous improvement after a radical implementation of LP: Production strategy, vision, objectives, Process, Training and learning, Organisation and support, Leadership – management commitment.

Based on this discussion factors enabling continuous improvement and developing continuous improvement can be improved and visualised according to Figure 11.

![Figure 11. Factors sustaining change, enabling and developing continuous improvement.](image)

**The integration stage of continuous improvement**

Integrating continuous improvement is here referred to as aiming to integrate the concept into the settings of operations so that later on the important institutionalization can occur and make the LP implementation a long-term success (Johnson et al., 2007).

Study II which is described in Paper II was performed two years after the completion of the radical implementation of LP and important challenges in the process of reaching a holistic perspective on production system improvement were derived.

By the time for the Study II, the case company expressed that there was a challenge in keeping the production strategy up to date and alive, which is seen as important for the alignment and motivation of improvement work (Ahmad et al., 2003; Fryer et al., 2007; McKinsey, 2007). Therefore a process to update the production strategy is argued to be an important factor in the long-term LP implementation so it is possible to direct and align improvement work continuously and thereby further integrate continuous improvement.

When it comes to the Management system, it was found in Paper II that during the LP implementation there had been a lack in the area of updating the Operational
Management System (OMS) on the XPS processes in the production system. This had resulted in a conflict between XPS and OMS, regarding the need of an OMS and how it relates to XPS. However, previous research does not offer many suggestions concerning how to handle the Management system during an LP implementation.

Furthermore, there is also this discussion concerning the evolvement of LP into a Management system affecting an entire value chain (Hines et al., 2004; Marodin & Saurin, 2013; Sörqvist, 2013). In other words, this is something to consider when implementing LP. As Marodin and Saurin (2013) point out, in order to be successful in LP, companies should have a clear understanding of what they mean by LP, but also to what extent they want to be lean, and then it also becomes natural to update the Management system to that extent. Paper II also reveals the challenge that XPS is occasionally interpreted as the Production system as such, which creates confusion when discussing relations etc. Since the Production system in this thesis is defined as a transformation system according to Hubka and Eder (1988), XPS is understood as a large part of the OMS, as an OMS for improvement work, describing how to work in the Production system. Having an LP inspired corporate improvement program as a company-specific-production-system according to Netland (2013) requires a continuous update of the OMS during an XPS implementation to avoid misunderstanding and confusion. So as stated in Paper II, an important factor for integrating continuous improvement is to have an updating process in place for the Management system during an LP implementation.

A Measurement system would also increase motivation for the improvement work (Ramström & Stridh, 2008). In order to sustain change, therefore, both in the short term and in the long term, it is essential to create and handle performance measures for improvement work, and this is also an important factor in the LP implementation. In the short term, this aspect is captured by the factor Control and follow-up, but in the long term it can be argued that to integrate continuous improvement it is important to develop performance measures for improvement work.

Since it was shown difficult in Paper II to understand all contexts and how it all fits together, it is argued that another important factor for reaching a holistic perspective on production system improvement is to update the OMS with an overall process for holistic improvement work which outlines connections and relations.

An additional challenge concerning the Improvement system, stated in Paper II, is the lack of a holistic perspective on improvement opportunities since the main improvement opportunities are not evident. This lack reflects the need of a more systematic use of LP methods such as for example VSM and loss analysis. Further implementation of continuous improvement in XPS would facilitate this systematic use but would also require a focus on the XPS implementation and
management commitment (Bateman, 2005). To gain a holistic perspective on improvement opportunities is to make sure the Process Kaizen has the correct base to further improve from (Sörqvist, 2013). Accordingly, gaining a holistic perspective on improvement opportunities is an important factor in the integration phase of continuous improvement.

It can be argued that having a process which addresses specific perspectives on improvement implies that there is a holistic improvement work, so creating such a process can help to integrate continuous improvement and later on create a unique improvement work process.

In Table 3 important actions in the integration phase of continuous improvement are summarized based on previous discussion.

Table 3 Important factors in the integration phase of continuous improvement.

<table>
<thead>
<tr>
<th>Important factors in the integration phase of continuous improvement</th>
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<tr>
<td>Process to update the production strategy</td>
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<tr>
<td>Updating process for the management system during the LP implementation</td>
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<tr>
<td>Update the OMS with an overall process for holistic improvement work</td>
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<tr>
<td>Gain a holistic perspective on improvement opportunities</td>
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<tr>
<td>Develop performance measures for improvement work</td>
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<tr>
<td>Process to address specific perspective on improvements</td>
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5.3 Supportive framework for successful implementation of improvement work

The LP implementation can be performed in different ways and generalizable implementation steps have not yet emerged (Marodin & Saurin, 2013). However, when a radical implementation of LP has been chosen similar to the process described by Womack and Jones (2003) or the process described by Netland (2012), different stages occur during the LP implementation. Understanding how to transition from a radical implementation of LP towards enabling continuous improvement will help to increase the sustainability of implemented XPS principles, methods and tools and further the development of continuous improvement of operations towards becoming leaner.

Further, increasing the understanding of the context of improvement work can help to develop a successful improvement work. Since understanding the context of improvement work and its relation to operations can help the company see what is lacking in order to develop a successful improvement approach and later reach the important integration of LP into operations, which later on might help the important institutionalization to take place and promote long-term success (Johnson et al., 2007).

Study I – Paper I had a holistic perspective on improvement work and the operations to which it was applied due to the need to understand how all
components were related in order to later on develop support for the development of a successful improvement work process, and understand how an LP implementation can be described. Case study II, described in Paper II, also had a holistic perspective on operations and the case study design was based on the concept model from Paper I. The purpose of case study II included to validate the concept model and to understand how improvement work can be incorporated and organised.

Accordingly, in Paper II the organisation of improvement work was considered and it was found that the improvement work is organised in three main approaches: 1) continuous improvement within XPS including LP methods and tools, 2) the OD program, 3) the process for managing production objectives and KPIs. Continuous improvement within XPS is seen as a framework into which the two other improvement approaches are incorporated, all in alignment with production strategy. So as Marodin and Saurin (2013) point out, it is important that companies have a clear idea of what they understand as LP, and if LP is understood as an XPS framework, which also can be seen as a holistic approach to improvement (Netland & Sanchez, 2014), it is natural to incorporate more improvement approaches into that framework.

Based on the discussion in Chapter 5.1, the concept model was improved and a new definition was derived. Hence, the concept model in Figure 10 describes the context of improvement work and its important relations to operations.

The radical implementation had its focus on implementing LP in the production system with respect to the production cells and implementing cross-functional initiatives like control and follow-up in the whole plant. At the same time training regarding LP and XPS principles, methods and tools were given to all employees in the production system. Further, the case study in Paper III had a shop floor perspective since it was within the production cells in production that the XPS principles, methods and tools had been implemented and the production teams therefore had an LP base to further improve from. Consequently, the question in Paper III of how to enable continuous improvement was important. The factors found in this case study showed from a shop floor perspective the importance of having an engaged leader with a Gemba management, working with control and follow-up and attitudes and values within the production team. However, to be able to take further steps into continuous improvement the organisation as a whole needed to develop continuous improvement and therefore focus on factors such as Production strategy, vision, objectives, Process, Training and learning, Organisation and support, Leadership – management commitment. These findings are visualised in Chapter 5.2, Figure 11.

The development of successful improvement work includes understanding the adaption and integration difficulties in order to reach long term success. The purpose of Paper II was also to understand what challenges are present in the process of reaching a holistic perspective on production system improvement. So,
from Paper II important challenges were derived. These challenges are argued to be important factors to consider in the LP implementation process in order to integrate continuous improvement in operations. The factors are summarized in Table 3.

This discussion aims to clarify the important steps in the process of transitioning a radical implementation of LP to continuous improvement. Accordingly, together with the understanding of the context of improvement work and the factors that are found important during the different stages of the LP implementation, the supportive framework can be created. However the findings are transformed into activities in the framework to make the purpose of them clearer. Figure 12 summarises the discussion and suggests a supportive framework for the successful implementation of improvement work. See Figure 12 on next page.
Figure 12. A supportive framework for the successful implementation of improvement work. The framework contains important actions in the process of reaching a holistic perspective on production system improvement.
6. Conclusions and future research

This chapter starts by presenting the overall conclusions of the research project presented in this licentiate thesis. Further, the fulfilment of research objective, research contribution and quality of presented research are discussed. Finally, the chapter ends with a proposal with regard to future research.

6.1 Conclusions

The overall purpose of this licentiate thesis has been to contribute to an increased understanding of how to successfully implement LP. Accordingly the objective has been to develop a supportive framework for the successful implementation of improvement work. A theoretical frame of reference has been presented in order to provide a theoretical foundation for the research project and three studies have been conducted, embracing both empirical data and theory. This has resulted in further understanding of the implementation of LP and of the transition from a radical implementation of LP to continuous improvement, including an understanding of the context of improvement work and important factors to consider in the implementation process of successful improvement work.

When transitioning from a radical implementation of LP, where LP has been implemented in the production teams, into continuous improvement aiming to embrace the whole organisation, it is important to understand the actions sustaining change, and those enabling, developing and integrating continuous improvement in order to achieve successful improvement work in the long term.

In the first stage after the immediate transition actions supporting the production teams in their work to sustain change and enable continuous improvement are:

- Successful mini-transformations in production teams have been performed
- Ensure good leadership on shop floor, be a role model and perform Gemba management
- Work with control and follow-up of results in production teams
- Ensure supportive attitudes and values in production teams

To be able to develop continuous improvement further within the production teams and also make continuous improvement embrace the whole organisation, the following actions are of importance:

- Understand context of improvement work and important relations to operations
- Develop production strategy with vision and objectives to align improvement work
- Develop and document a common process for improvement work, and incorporate different improvement approaches into XPS framework
- Create an infrastructure for improvement work, including roles, responsibilities etc. so there is an organisation and support for improvement work
- Continue training and learning of employees in the area of LP principles, methods and tools
- Ensure long-term management commitment to XPS implementation

To reach long term success it is important to understand what actions are necessary to integrate continuous improvement into operations to later on reach the important stage of institutionalization. These actions are:

- Gain holistic perspective on improvement opportunities
- Update OMS on XPS processes continuously
- Visualise overall improvement work process in OMS
- Update production strategy continuously
- Develop performance measures for improvement work
- Create systematic process to address specific perspectives on improvements to create unique improvement work

These presented actions are proposed to be the constituents in the supportive framework for a successful implementation of improvement work. The framework is also visualised in Figure 12 in Chapter 5.3.

6.2 Fulfilment of objective

To meet the objective of the present research project, two research questions were formulated and by answering them the objective can be considered fulfilled.

The first research question was:

RQ 1) How can an improvement approach within a manufacturing company, as an implementation of Lean Production be described?

It was formulated due to the need to understand the context of improvement work and its relations to operations in order to understand how successful improvement work can be designed within a production system.

Chapter 3.2 describes production system improvement and important aspects of it. Chapter 3.3 describes LP as a concept in relation to production system improvement. In Paper I, a concept model is developed in order to understand the context of improvement work and its relations to operations. Paper II examines how improvement work can be organised. In Chapter 5.1 the context and organisation of improvement work are discussed. This discussion led to improvements of the concept model and hence a better understanding of the context and organisation of improvement work.
Accordingly, to answer RQ1, an improvement approach such as an LP implementation can be described as an improvement system related to the components in operations according to the concept model, see Figure 10. Further, the improvement system can be viewed as an LP system at least in a company implementing an XPS framework. Thus, the improvement system in terms of continuous improvement consists of continuous improvement within XPS and other improvement approaches incorporated into that framework.

The second research question was:

RQ 2) **What are the most important success factors when implementing an improvement approach, such as Lean Production, within a manufacturing industry?**

To be able to understand what factors affect the ability to sustain change and further develop the results in an LP implementation this research question was formulated.

Chapter 3.5 describes different factors affecting the LP implementation and the chapter ends with a summary of these factors. Paper III, which is based on a literature study concerning important success factors for improvement work, examines what success factors are important to enable continuous improvement after a radical implementation of LP and what factors are important for the further development of continuous improvement in the organisation. Paper II also concerns the area of important factors for the LP implementation since important challenges in the process of reaching a holistic perspective are identified.

In, Chapter 5.2, in the section: The sustaining change and enabling stage of continuous improvement, different factors important in this stage are discussed. This leads to the conclusion that the most important factors enabling continuous improvement during the immediate transition with a shop floor perspective are: Successful mini-transformations, Participation, Control and follow-up, Leadership – shop floor and Values. See Figure 11.

As is argued, the transition can also be regarded in a longer perspective, for instance a couple of years. This means that the transition can also include the development and integration of continuous improvement. Therefore factors important for the development and integration of continuous improvement must be considered as important in an LP implementation.

Factors important for the development stage of continuous improvement are also discussed in Chapter 5.2, in the section: The developing stage of continuous improvement. Hence, this leads to the conclusions that these factors are: Production strategy, vision, objectives, Process, Training and learning, Organisation and Support, Leadership – management commitment.
Further in Chapter 5.2, in the section: The integration stage of continuous improvement, challenges in the process of reaching a holistic perspective on production system improvement, derived from Paper II, are also discussed. The discussion leads to the conclusion that they are important factors to integrate continuous improvement. These are: Process to update the production strategy; Updating process for the management system during the LP implementation; Update the OMS with an overall process for holistic improvement work; Gain a holistic perspective of improvement opportunities; Develop performance measures for improvement work; Process to address specific perspective on improvements.

All these factors that are described as important at different stages in the LP implementation constitute the answer to RQ2.

Finally, the answers to RQ1 and RQ2 are summarised as a supportive framework for the successful implementation of improvement work, see Figure 12 in Chapter 5.3.

6.3 Scientific and industrial contributions
This research is derived from an industrial problem and the thesis presents a longitudinal study of an LP implementation in one company. Hence, it provides academic discourse on the topic with deep insights into the difficulties a manufacturing company faces during an LP implementation. Also, since there is little research regarding the adaption and integration difficulties of improvement work into the settings of operations, this research, including the proposed framework, contributes to increasing knowledge within this area.

The contribution to the industry is the supportive framework for the successful implementation of improvement work, since reaching a holistic perspective on production system improvement is complicated and there are many pitfalls on the way. So from this perspective the framework aims at contributing to the ability to avoid some of the problems and making it possible for more manufacturing companies to be aware of the important integration of change initiatives.

6.4 Quality of presented research
Common criteria to asses and evaluate research in terms of quality is validity and reliability as described in Chapter 2.4. The purpose of this research is to increase the knowledge of a transition process from the radical implementation of LP to continuous improvement and how to support this transition. Therefore a longitudinal study, containing one explanatory literature and interview study, one exploratory embedded single case study and one exploratory multiple holistic case study, are conducted in the case company. Since mainly case studies are performed, the quality of research is assessed based on the following criteria: construct validity, internal validity, external validity and reliability. In Chapter 2.4 the ways in which the researcher has sought to assure the quality of the presented research are described in relation to these criteria. As regards validity, the studies are carefully designed in order to assure that the correct phenomenon and unit of
analysis are investigated. The methods for analysing the data are also predetermined in designing the studies, and the results have been discussed with the informants and respondents in the different studies in order to ensure that the results make sense. Moreover, case study protocol has been used as a means to increase the reliability of the research.

During this research project, the researcher has also aimed to be aware of the role of the researcher as further described in Chapter 2.4 and strived for objectivity on the basis of that awareness. Furthermore, in order to improve the quality of the overall research process, continuous discussions with supervisors have been conducted. Finally, the researcher has continuously aimed for transparency by clearly describing the research process and methods throughout the thesis and sought to describe the basis on which the conclusions are made in detail.

6.5 Future research
During the research process, several potential areas for future research were identified and these are presented below.

Since there is no clear definition of LP and the evolvement of LP from a production toolkit to the complexity of an entire lean business system it is not easy to grasp the whole picture of LP. This creates confusion and difficulties appear during the LP implementation even when the company has a specified framework for what they understand as LP, for instance the way in which the case company has its XPS. Further research is needed regarding the adaption and integration difficulties that appear during an LP implementation. For instance how to handle the management system is such an issue that needs to be considered further.

Also there are difficulties in measuring the performance of the improvement work and many organisations have problems relating the performance of the improvement work to the KPIs. An aggregated measure for improvement work is suggested to be important for the productivity, but the relation between aggregated measures and speed of change needs to be further considered.

Finally, since this research has been conducted within one company it would be interesting to widen the scope and further validate the framework including the concept model and develop it further. For example, within the concept model there is the component Perspective of improvement and it is suggested to be important later on when the organisation has reached a deeper knowledge in systems thinking. This gives the ability to create a unique improvement approach and, selecting methods and tools in relation to what they want to accomplish. On the basis of these considerations, it would be interesting to investigate companies thinking in systemic cause and effect and understand how they develop their improvement work to expand beyond lean.
References


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