Reducing lead time during installation projects through Continuous Improvement and Early Management

- A case study at Tetra Pak

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Abstract

Title	Reducing lead time during installation projects through Continuous Improvement and Early Management.
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Supervisors	Dag Näslund, the Faculty of Engineering at Lund University Anne-Christine Strömgren, Installation Service at Tetra Pak.
Problem	Tetra Pak's strategy is to expand World Class Manufacturing (WCM) from manufacturing to installation projects in order to reduce the installation lead time. There is a challenge in the WCM implementation since it requires a cross-functional approach and uncertainties with the installation projects being at customer's site. The question at hand is; how can Tetra Pak use the Early Management methodology within WCM to achieve Continuous Improvement for installation projects and thus reduce the lead time?
Purpose	The purpose of the master thesis is to develop an Early Management model and critical success factors to achieve Continuous Improvement and reduce the lead time for installation projects.
Method	The case study started with building up an understanding of the installation projects by open interviews and analysing archive data. Relevant theory within Continuous Improvement, WCM and Early Management was combined with the empirical findings to construct a holistic Early Management model with supporting critical success factors for achieving and sustaining Continuous Improvement. Their credibility and to what extent the elements are implemented today was thereafter validated with key stakeholders by structured interviews.
Conclusion	The theoretical and cross-functional Early Management model developed in this study captures many of the current issues in the case company that affect the lead time. The Early Management model requires identified critical success factors to be established in order to achieve and sustain Continuous Improvement.
Keywords	Continuous Improvement, World Class Manufacturing, Early Management, Installation process, Service industry.

Sammanfattning

Titel Reducera ledtiden på installationsprojekt genom kontinuerliga förbättringar och Early Management.

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Problem Tetra Paks strategi är att expandera World Class Manufacturing (WCM) från produktionen till att täcka installationsprojekt för att reducera dess ledtid. Det finns dock en stor utmaning för att utföra detta, då flera avdelningar är inblandade samt osäkerheterna kring att installationerna utförs ute hos kund. Frågan är därför; hur kan Tetra Pak använda Early Management metodologi från WCM för att uppnå kontinuerliga förbättringar för installationsprojekten och därav förkorta ledtiden?

Syfte Syftet med den här rapporten är att utveckla en Early Management modell samt tillhörande kritiska framgångsfaktorer för att uppnå kontinuerlig förbättring och reducera ledtid för installationsprojekt.

Metod Fallstudien började med att bygga upp en förståelse för installationsprojekt genom öppna intervjuer och analysera arkivdata. Relevant teori inom kontinuerlig förbättring, WCM och Early Management kombinerades med empiri för att utveckla en holistisk Early Management modell med tillhörande kritiska framgångsfaktorer för att uppnå kontinuerlig förbättring. Strukturerade intervjuer hölls sedan med nyckelintressenter för att analysera trovärdigheten av dessa, samt hur etablerade de är idag.

Slutsats Den teoretiska och tvärfunktionella Early Management modellen utvecklad i denna studie fångar många av det studerade företagets nuvarande problem som påverkar ledtiden. Early Management modellen kräver etablering av vissa identifierade faktorer för att uppnå och bibehålla kontinuerlig förbättring.

Nyckelord Kontinuerlig förbättring, World Class Manufacturing, Early Management, installationsprocess, Tjänsteindustri.

Glossary

KPI: Key Performance Indicator

OPI: Operational Performance Indicator

CI: Continuous Improvement

TPM: Total Productive Maintenance

WCM: World Class Manufacturing

EM: Early Management

VSU: Vertical Start-up

DSO: Development & Service Operations

PMCO: Product Management & Commercial Operations

SCO: Supply Chain Operations

PS: Process Solutions

ItP: Installation to Performance

PM: Project Manager

PE: Project Engineer

FSE: Field Service Engineer

EDCS: Event Driven Customer Satisfaction

ECA: Europe & Central Asia

NCSA: North, Central & South America

SAEAO: South Asia, East Asia and Oceania

GC: Greater China

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1. Introduction

The introduction chapter's purpose is to introduce the reader to the master thesis. The background and the problem formulation is presented as well as the master thesis' purpose and research questions. The delimitations for the research is stated and the last section is an overview of the chapters to facilitate for continuing reading.

1.1 Background

Continuous Improvement is a structured way to measure, analyse and improve business processes to obtain a competitive advantage and increase business results (Scott et al. 2008). By eliminating waste, defects and losses in processes the objective is to increase quality and customer satisfaction (Antony et al, 2007). Continuous Improvement is the "umbrella" concept for quality initiatives in a systematic and planned program leading to organizational change and performance growth (Lindberg and Berger, 1997). A Continuous Improvement program can include several Continuous Improvement methodologies to achieve its purpose. Some of the most common Continuous Improvement methodologies are Lean Manufacturing, Six Sigma and Total Quality Management (TQM) (Scott et al. 2008).

Traditional Continuous Improvement programs have focused on manufacturing systems with the aim to improve product quality and reduce waste and cost during production. The recent development has been to expand the focus to cover entire organisations, leading to large companies developing their own tailor-made systems by combining different Continuous Improvement methodologies (i.e. hybrid methodologies) to fit their specific organizational needs. While the Continuous Improvement programs get more sophisticated and comprehensive, the implementations become more challenging since the programs require vaster changes in the organisations (Bhuiyan and Baghel, 2005).

One area of increasing importance for the manufacturing sector is after-sales services. Services are evolving to have an increasing role during the customer's choice and thus as a competitive advantage. Recently, services have gained a larger share of the revenue income and therefore also a higher focus in the manufacturing sector. The shift changes the customer relationship from a one-time transaction to long-term relationship and requires stronger customer relationship capabilities (Owida et al, 2016).

The global company Tetra Pak is currently investigating how to expand their Continuous Improvement program, World Class Manufacturing (WCM), from manufacturing systems to cover services. The purpose of the expansion of WCM to services is the belief and expectations of implementing it will contribute to desired business results. The first service category to implement WCM is the *Installation Service* with the goal to reduce the installation lead time. Tetra Pak believes that the

key to achieving Continuous Improvement for *Installation Service* lies in one of the WCM pillar called Early Management. Early Management is a methodology to improve the introduction of new equipment and products. Tetra Pak started the expansion of WCM with Early Management at *Installation Service* in 2012, but the implementation was unsuccessful.

1.2 Problem formulation

The purpose for starting the WCM expansion with *Installation Service* is to reduce the installation lead time. By implementing the Early Management pillar, Tetra Pak is hoping to improve the lead time for the KPI called "Vertical Start-up" with a 50% reduction. This part of the installation lead time is measured from the point where commercial production starts until the new equipment performs according to specifications.

The KPI Vertical Start-up is defined as the percentage of installation projects that reach Vertical Start-up within 8 weeks, i.e which have shorter lead time than 8 weeks. Today the KPI Vertical Start-up target is that 90% of the installation projects should reach Vertical Start-up within 8 weeks and the ambition is to decrease the time to 4 weeks by the year 2020. Hence the question at hand is; how can Tetra Pak use the Early Management methodology within WCM to achieve Continuous Improvement for installation projects and thus reduce the lead time?

To expand a Continuous Improvement program from the manufacturing focus to service products may be challenging, since there is a difference between the repetitive production in-house and customised service projects. There are thereby uncertainties with the installation projects being at customer's site. By executing the projects at the customer's site there are external factors that are hard to control e.g. constantly different project environment and requirements, customer collaboration and plant conditions. For example, one customer in Brazil can have a highly sophisticated production plant while another customer in Malaysia is reconstructing the plant and the installation is executed without any roof or proper floor.

An initial pre-study to the research was conducted to capture the problem situation at *Installation Service* together with the main challenges for implementing WCM in services. The main challenges identified are as follows:

- The significance of the terms Early Management and Vertical Start-up varies between departments and people. A common picture for how to use the Early Management methodology and how it will work is yet to be defined and agreed upon.
- The installation project execution is not well standardised and is affected by factors outside of Tetra Pak's control. Every installation project scope is customised.

- There is no structured process in place how to capture problems or improvement opportunities in the installation projects. Due to this the case company lacks a solid foundation of data to support actions and decision-making. If problems are captured a structure for analyse, prioritize and take action on captured problems or improvement opportunities does not exist.
- The decision to use the Early Management methodology to reduce the installation lead time is not fully aligned within the organisation. A cross-functional approach is needed to expand WCM to Installation Service but a clear plan for the implementation or responsibilities departments is yet not in place.

The WCM implementation requires a cross-functional approach and this research will thereby involve several functions within Tetra Pak's core function *Development & Service Operations* (DSO). This is the organisation that develops, produces and delivers services for the filling machines and distribution equipment. The project to implement Early Management in *Installation Service* has been revived and this research aims to support the case study company with an analysis of the identified challenges. The purpose and research questions of this case study have been developed accordingly.

1.3 Purpose

The purpose of the master thesis is to develop an Early Management model and critical success factors to achieve Continuous Improvement and reduce the lead time for installation projects.

1.4 Research Questions

Three research questions have been defined in order to fulfil the purpose:

RQ1: How can an Early Management model be designed to achieve Continuous Improvement for Installation Service?

RQ2: How can Early Management be used to reduce the installation lead time?

RQ3: What are the Critical Success Factors for achieving Continuous Improvement in installation projects?

1.5 Delimitations

In the master thesis the following delimitations have been made:

- Theoretical areas are restricted to Continuous Improvement programs, WCM and Early Management.
- Implementation aspects are excluded.

- The study is limited to investigate the *Installation Service* projects
- The developed Early Management model and critical success factors should result in lead time reduction and other business results are not considered.
- The lead time reduction goal is limited to investigate possibilities to reduce the "Vertical Start-up" lead time and not the full installation lead time.

1.6 Target audience

The target audience for this thesis is the case study company and the Department of Industrial Management and Logistics at Lund University. In the short period of time the research was conducted the authors touched upon the subject of Early Management in the case study company. The authors hope that the report will provide with a valuable and practical analysis for the case study company. Other target groups are students or people with an interest in Continuous Improvement, World Class Manufacturing or Early Management.

1.7 Thesis structure

The structure of the master thesis is described below to give an overview of the content of all the chapters. By having an overview of the report the purpose is to facilitate for continuous reading.

Chapter 1: Introduction

The introduction chapter's purpose is to introduce the reader to the master thesis. The background and the problem formulation is presented as well as the master thesis' purpose and research questions. The delimitations for the research is stated and finally the last section is an overview of the chapters to facilitate for continuing reading.

Chapter 2: Methodology

This chapter describes what methodology has been used in order to conduct the master thesis. It covers the research approach and method as well as the data collection and analysis. As the validity of end result is dependent on the choice of methodology, it is of great importance that it is well embedded with the research purpose.

Chapter 3: Theoretical framework

The theoretical framework chapter presents the theoretical background that supports for answering the research questions. The first section presents the theory regarding Continuous Improvement that is relevant for the thesis. The second section explains the World Class Manufacturing and Total Productive Maintenance program and methodologies. This is followed by a description of Early Management

and in what situations the methodology is used. Finally, a synthesis of the theoretical framework is presented with the most important findings for this study.

Chapter 4: Empirical study

The empirical study describes the research conducted at the case study company. The case study company is presented with a deeper description about *Installation Service* and the installation process. Following, the empirical data regarding WCM and Early Management is presented to support for answering RQ1. The next section contains the findings regarding Vertical Start-up and concerns RQ2, and finally in the fourth section the empirical data connected to RQ3 is described.

Chapter 5: Development of model and critical success factors

This chapter presents the developed proposed Early Management model and identified critical success factors. Both the model and the critical success factors have been developed based on theoretical and empirical findings.

Chapter 6: Analysis

The analysis conducted in this study aims to support answering the three research questions. The first section presents the feedback from the case study company regarding the developed Early Management model and criteria. Following an analysis will be done regarding if the Early Management methodology can be used for Installation Service and what are the challenges connected to the methodology. The third section investigates whether a proposed Early Management model can lead to lead time reduction and aims to answer RQ2. Section four contains the analysis of identifying the criteria needed for an Early Management model to be successful and aims for answering RQ3.

Chapter 7: Conclusion and recommendation

The final chapter contains the conclusion of the thesis and the final recommendation to the case company. The purpose of the master thesis is to develop an Early Management model and criteria to achieve Continuous Improvement and reduce the lead time for installation projects. Three research questions were defined in order to fulfil the purpose and the aim of the chapter is to give the answer to the research questions. To conclude the report, the final section contains recommendations to the case study company as well as for further research.

2. Methodology

This chapter describes what methodology has been used in order to conduct the master thesis. It covers the research approach and method as well as the data collection and analysis. As the validity of end result is dependent on the choice of methodology, it is of great importance that it is well embedded with the research purpose.

2.1 Research approach

To be able to walk through a research with a high level of trustworthiness, the accurate research approach should be chosen stating the logical reasoning and whether to take the qualitative or quantitative way. The approach is in other words dependent on the research purpose and the way it is characterised (Höst et al., 2006). The following chapters will introduce the reader to the different approaches and explain which approach this master thesis will follow and why.

2.1.1 Deductive, inductive or abductive approach

As research can have different start and ending points, referring to theory and facts, they can follow either an inductive or deductive approach. The deductive approach is followed when the starting point is the theory. It is performed by investigating the applicability of theory on specific instances (Kovács and Spens, 2007), or as Arbnor and Bjerke (2011) describes it, that the creator of knowledge infers single cases on general laws.

In contrary to deduction, the starting point for the inductive approach is empirical observations (Kovács and Spens, 2007). The observations are then used for developing a new theory in the area. When following this approach, a foundation of literature is not a prerequisite (Kovács and Spens, 2005).

A third approach is often recalled as abductive. It is used when a single case is compared to a hypothetical pattern. If it implies to be true, the case should be multiplied to be able to verify generalisation (Arbnor and Bjerke, 2011).

2.1.2 Quantitative or qualitative approach

The empirical data gathered during a research can be of two different characteristics; quantitative or qualitative. The quantitative data is data or fact that can be counted or measured and thereby also directly comparable by using statistics. Qualitative data is often not quantifiable. Instead, it has to be described by words to give details and the whole picture. (Höst et al., 2006)

Both types of empirical data come with strengths and weaknesses in different areas. The characteristics of quantitative data make it possible to use it to make statistical comparison measures for different events or groups. The drawback with gathering

quantitative data is that it may not catch all important aspects in the regarded question or issue. (Höst et al., 2006)

While the qualitative data collection is hard to expand, it captures all important parts around the specific event which may otherwise not be caught. Qualitative data is hard to use for statistically assure specific things and is often more time-consuming to analyse. (Höst et al., 2006)

2.1.3 Research approach for this thesis

The research followed an abductive approach since it started with a rigorous empirical study to understand the situation of the case company. This was done simultaneously while reading relevant theory. The chosen approach gave the possibility to use this first step as input on what areas in the theory to do further research in. Furthermore, the chosen approach was preferred by the authors to, in the best way possible, find the real issues and not only their visual symptoms. Based on the theory and the empirical data collected during the study, a model was developed that could cover the aspects of Early Management, Continuous Improvement and associated critical success factors. The credibility of the model and critical success factors was then checked with key stakeholders at the case company. Input from the stakeholders may imply on adjustments on the model.

The qualitative data is often used in case study research where the focus is explaining a situation (Höst et al., 2006). Considering the nature of the research questions, the chosen data collection involved mainly qualitative data. During the study, the current situation of installation projects and their difficulties were captured by collecting qualitative information from interviews and by participating in project meetings. The choice of using the qualitative data approach made it possible to build up an understanding with a width that would have been cumbersome to achieve with quantitative data collection. It also enabled the freedom of digging deeper in areas that came to be of higher importance, while other areas could be left aside. The credibility check in the later part of the study was conducted by gathering both qualitative and quantitative data from structured interviews. The reason for using a more quantitative approach in this part was to be able to quantify the results in order to detect any relations.

2.2 Research method

As mentioned earlier, the nature of the research questions determines what research method to use. The different methods have their own strengths and weaknesses which should match the abilities that are needed in the research (Höst et al., 2006). Table 1 shows the five major methods; experiment, survey, archival analysis, history and case study.

Table 1: The research strategies with their connecting requirements (Source: Yin, 1994)

Strategy	Form of research question	Requirements over behavioural events?	Focuses on contemporary events?
Experiment	How, why	Yes	Yes
Survey	Who, what, where, how many, how much	No	Yes
Archival analysis	Who, what, where, how many, how much	No	Yes/no
History	How, why	No	No
Case study	How, why	No	Yes

What can be added as a strength or weakness for the different methods are their ability to be fixed or flexible in the strategy. If for example, surveys are used to gather quantitative information, it requires that it looks the same when it is sent out to the participants. Same kind of issues often occurs in experimental strategy research. On the contrary, case studies are often flexible in the setup, making it possible to adjust the strategy on the way (Höst et al., 2006). The flexibility of case study research is also discussed by Dubois and Gadde (2002), where they state that researcher is able to expand his understanding of both theory and the empirical world by switching between strategies but also between theory and empirical observations.

2.2.1 Research method for this thesis

In order to answer the research questions, a case study strategy is found as the most suitable research method. It also allows the authors to be flexible and the possibility to use broad data collection. The case company represents the framing of the research questions since the issues have been discovered in that specific company. The company faces the expansion of its WCM methodology from one part of the company to another. This can therefore be seen as a critical case, meaning that the case company is fulfilling the requirements for being studied (Yin, 1994). As the research questions touch the DSO organisation as a whole, the case study is made on one unit of analysis, i.e. the DSO organisation. Therefore, a holistic view has to be the main focus to fully understand the context of the research area and to answer the research questions in the best possible way.

Linking to Table 1, there will be no control of behavioural events for the research since the Early Management model will not be implemented at the case company. The reason for not implementing the model is that it shows the channels of information on a conceptual level and not any specific details. A full-scale implementation would require a high detailed plan and vast changes in the

organisation, which was not possible during this time period. Furthermore, the results from doing organisational change can take many years before showing any effect (Schonberger, 1986; Näslund, 2013; Netland, 2016; Ahuja and Khamba, 2008; Kotter, 1995).

Due to the short time frame for this research, only one case is analysed to check the credibility of the Early Management model and the critical success factors. To expand the generalisability, more case companies can be analysed in the future. In that case, the companies should perform installations of the same characteristics as Tetra Pak.

2.3 Literature Review

A literature review is a big part of a research since it often permeates the starting point for the research. It helps the author generate ideas essential to the subject and to find gaps in the theory. When the research aims to contribute to the existing theory, this part of the research is important (Kotzab et al., 2005). According to Dubois and Gadde (2002), there is a difference in literature review methodology depending on whether the purpose of the research is to generate theory or confirming theory. The previous paragraph is told to be correct for confirming a theory. Furthermore, when generating theory, the researcher should not be constrained by previously developed theory since the theory is something that develops over time (Dubois and Gadde, 2002).

2.3.1 Literature review in this thesis

The starting point for this thesis was to understand the case company's current WCM program, why this was the first area to investigate both internally and in the literature. During this period, the authors found little theoretical research of how to continuously improve installation project at customer sites, which ended up in the three research questions. As for the theoretical foundation to RQ1 and RQ2, WCM was penetrated even further. It mainly involved Early Management concept which is one of eight pillars in WCM. Since WCM is based on Total Productive Maintenance ideas (McKone et al., 2001), the literature search evolved in that direction. Further on, Continuous Improvement literature was studied to bring a broader base of knowledge in Continuous Improvement concepts and also to illuminate the challenges to evolve and/or implement a Continuous Improvement methodology (Scott et al. 2008). This area is very wide, thus only the most relevant parts were studied. Figure 1 visualises the different theoretical subjects and how they are overlapping. By reviewing ten articles regarding critical success factors for Continuous Improvement, the authors have built a foundation of factors. These were then further developed by empirical findings.

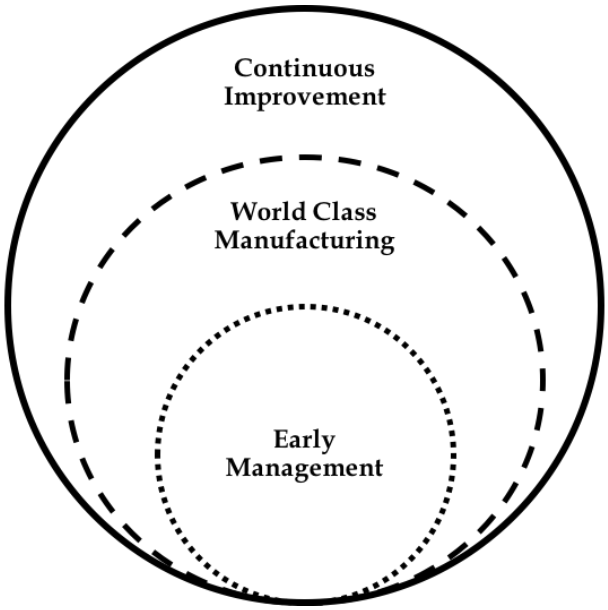

Figure 1. The map for how the theoretical subjects are linked together

The database used for the literature review was LUBsearch, which is Lund University Libraries' internet database. By using the built-in advanced searching function, it was possible to combine keywords in different categories as title, subject terms, abstract etc. When the keywords gave a too wide spectra of articles, focus areas were used to shorten the range. Keywords and the different combination that were used during the study are shown in Table 2. To extend the theoretical framework, keywords that were used in main articles served as a guidance when doing deeper research in those areas. Highlights from the literature search are that there are few articles investigating how Early Management should be designed, connecting difficulties or the result of an implementation. This is why the theoretical spectra has been widened in the range of Continuous Improvement concept to include WCM, TPM and general Continuous Improvement. The articles used as theoretical foundation for the critical success factors have been collected mainly from a combined search of "Continuous Improvement" and "critical success factors".

Table 2. Keywords and focus areas that have been used for theoretical search in this thesis.

Keywords	**Focus areas**
- Wold Class Manufacturing (WCM)	- Installations
- Total Productive Maintenance (TPM)	- Service
- Early Management	- Criteria
- Continuous Improvement	- Critical success factors (CSF)
- Change Management	- Implementation

2.4 Data collection

For case study research, the most common data collection methods are interviews, observations and archival analysis (Höst et al., 2006). They all have strengths and weaknesses which do not make one choice good at all areas, but instead, they should be used to complement each other (Yin, 1994). The following chapters explain the collection methods.

2.4.1 Interviews and observations

Interviewing is a flexible method that can be formed to its specific purpose, having three levels of structure: fully structured, semi-structured or open structured. The fully structured interview is strictly following pre-made questions, giving no or little room for the investigator to steer the conversation. As the questions are followed strictly, this kind of interview can be classified as a questionnaire. The semi-structured interview is guided with prepared questions but gives the investigator room for adjustments. An open interview gives the investigator freedom to ask relevant questions regarding the topic. Since this structure asks for broad discussions, it is important to stick to the topic. (Höst et al., 2006)

2.4.2 Interviews and observations in this thesis

A considerable part of the gathered information for the study has come from open interviews with personnel from different positions in the case company's central organisation. This empirical information has served as support for developing the Early Management model in RQ1. It was also used for answering RQ2 and RQ3. The list of participants for the open interviews is found in Table A.1.1, Appendix A.1. The reason for using a more flexible rather than structured interview approach was to give the authors the possibility to widen the scope during the interview depending on what the participant has knowledge about. Later in the study, the subjects became more and more narrow to get deeper knowledge in relevant areas. The authors also participated in project meetings as a way of collecting data and to get in contact with involved persons. A list of these interviews and meetings with associated discussion subjects can be found in Table A.1.2, Appendix A.1. Both authors were attending the interviews in order to not miss details or leave question marks. By letting one person be responsible for writing down notes, the other had the mission to lead the interview without being distracted in it by thinking. It also gave the opportunity to review the interview and discuss observations of the participant afterward.

As a starting point for the study, both authors are familiar with the case company since they have been working there. Sofie Carlsson has an internship and has worked at Technical Service - Installation Service, please see section 4.1.2 for case company organisation. She has in that way gained knowledge of the central organisation and has been involved in projects for the services provided. Henrik

Larsson Ernefelt has been an assistant for the technical issue resolution department at Capital Equipment. He has thereby insights in how technical issues are logged and handled.

The combination of theory and empirical findings were used for development of the Early Management model and the critical success factors. As the next step, structured interviews were held. It was done to fulfil three purposes which are connected to all three research questions. The list of participants and dates for the structured interviews is found in Table A.2.1, Appendix A.1. The interview guide for the structured interviews is attached in Appendix A.3. Firstly, the participants' opinion about the developed Early Management model was used as input for adjusting or confirming the credibility of the elements, connected to RQ 1. The second purpose was to adjust or confirm the credibility of the critical success factors, that is for RQ 3. Finally, the result of the interviews served as a motive for RQ 2. The interview guide was designed so the participants answered the majority of questions with a grade from a scale of 1 to 5. In order to reduce the risk for misconception when answering, the scale was well-defined and visualised during the whole procedure. With the grading system, a simple way of handling the answers followed. The interviews were held in three different ways, depending on where the participant was situated and the access to different technologies. Face to face, the case company's internal communication system (similar to Skype) or audio contact with shared computer screen.

Due to the short time frame of this thesis, only 15 participants have been interviewed. The structure of the interview guide can, with some adjustments, be translated into a questionnaire and thereby be sent out to a bigger crowd. The risk of doing this is that the possibility to actually describe the components is lost, and thereby the credibility of the results may be jeopardised.

Since the Early Management model is based on both findings from theory and from the empirical findings, the structured interviews were held at the end of the research. In that way, the findings from the open interviews could once more be verified with participants of the structured interviews.

The Early Management model developed in this thesis will involve employees in strategic, tactical and operational level. Since it is rare that one person has deep insights at all levels, it is important to interview persons from different strategic levels so trustworthy conclusions can be drawn. With similar reasoning as for the strategic levels, it is of the authors' interest to find participants within each of the involved functions of the company. The fact that the authors do not have done any observations themselves of real installation projects, the diversity of interviewed persons is highly important. The case company has five clusters around the world and preferably, a number of people from each of the five cluster should participate.

Since the contact with these was lacking, only six persons from the clusters could participate in this study.

2.4.3 Archive data

Archive data is documentation collected for another purpose than for the research. This makes it important to keep in mind what the actual purpose was and what implications it may have had on the result (Höst et al., 2006). Strengths with archives are that they are often covering a long time period, longer than the actual research and that it often comes in big quantities. Weaknesses highlighted are that the information is secondary and may be biased from the original author (Yin, 1994).

2.4.4 Archive data used in this thesis

Archive data conducted by the case company was studied in order to widen the data collection. Reports done from customer satisfaction surveys served as input for developing the Early Management model and for answering RQ 1, RQ 2 and RQ 3. Tetra Pak has also done internal pre-studies and workshops with a focus on the main issues during the Vertical Start-up which was taken into consideration during this study.

2.5 Data analysis

For analysing data as in this thesis, a frequently used tactic is pattern-matching. The idea is to use a predicted pattern as a comparison to the empirical findings. Conclusions can then be drawn from the differences or similarities. When using a pattern designed before knowing the real results, the internal validity will be strengthened. (Yin, 1994)

2.5.1 Data analysis in this thesis

The open interviews that were conducted, started off with the authors having little knowledge. After each interview, the gathered information was used to first build up a broad, but not the complete picture of the subject. The following steps were to provide information and filling the gaps to finally have something of real value. The archive data was used as a complement to this process.

The data gathered from the structured interviews was mainly of quantitative characteristics. The grading system made it possible to categorise and quantify the participants' opinions in order to draw conclusions. To ensure the validity of the conclusions from this data, the pattern-matching method was used. To prove any correlation between different groups, strategic levels, elements or critical success factors, a strict difference was decided beforehand.

2.6 Research validity

When conducting a research, the authors often facing several issues concerning the validity of the research. According to Höst et al. (2006), the research validity can be categorised into three areas; reliability, validity and representability.

Reliability stands for the quality of the data collection with respect to variations in the results. Since it concerns the data collection it is in this phase it can be reinforced. By using case study protocol where the authors are showing how the data collection is made, the level of reliability can be shown to the reader (Höst et al., 2006. Yin, 1994). A good idea can also be to let a colleague check the data collection to give feedback to the author (Höst et al., 2006).

Validity concerns the connection between the actual measurement of data and what is investigated (Höst et al., 2006). It can be that the data is not giving the total picture of what is of interest, and therefore is not enough accurate to draw a conclusion from. Yin (1994) argues that research validity for case studies can be strengthened by several tactics. The use of multiple sources of evidence gives the validity more than one dimension, causing a more reliable situation. When a case study is conducted on a single case, there are often critics addressed at the generalisability. By replication logic, multiple case studies can be made in order to give better strength to the generalisability.

Representability is whether the actual case is considered representative for the research purpose. In case studies, a good and detailed description of the analysed context may strengthen the representability. (Höst et al., 2006)

2.6.1 Managing the research validity in this thesis

Issues regarding the validity of information provided during interviews are sometimes hard to manage. When it was possible during the study, the benefit from multiple sources of evidence, was used. Since much information in this study is personal opinions, this is of great importance. In order to diminish the personal opinions of the participants of the interviews, the same questions were asked to different participants. When possible, the case company's archive data was used to triangulate the information. During interviews, both authors participated to minimise the risk of missing any details. By doing this, one author could always notify whilst the other could concentrate to guide the interview by asking the right questions.

Before conducting the structured interviews, the protocol was sent to the supervisor at the case company for reviewing the reliability of the questions. After minor changes, a pilot interview was done in order to find weaknesses and where clarifications had to be done. No changes were done between the 15 interviewed persons.

Due to the short time frame for this research, only one case is analysed to validate the credibility of the Early Management model. In order to validate the model externally, it should be applied at the case company and the performance should be measured to be able to see if the model has the expected impact. The complexity, and again, the short time frame made this impossible. To expand the generalisability, more case companies can be analysed in the future.

3. Theoretical framework

The theoretical framework chapter presents the theoretical background that supports for answering the research questions. The first section presents the theory regarding Continuous Improvement that is relevant for the thesis. The second section explains the World Class Manufacturing and Total Productive Maintenance program and methodologies. This is followed by a description of Early Management and in what situations the methodology is used. Finally, a synthesis of the theoretical framework is presented with the most important findings for this study.

3.1 Continuous Improvement

Continuous Improvement purpose is to give structured business improvements to achieve higher performance and business results (Scott et al. 2008). A commonly recited definition of Continuous Improvement made by Bhuiyan and Baghel (2005) is "*a culture of sustained improvement targeting elimination of waste in all systems and processes in an organisation. It involves everyone working together to make improvements without necessarily making huge capital investments*". By eliminating waste, defects and losses in processes the objective is to increase quality and customer satisfaction (Antony et al, 2007). Lindberg and Berger (1997) describes Continuous Improvement as a program for organizational change in a structured, planned and organized way, as a contrast to occasional project-based improvements.

In the last decades, numerous of popular approaches and models for Continuous Improvement have emerged. For example, Lean manufacturing, Six Sigma, Total Quality Management (TQM), Total Productive Maintenance (TPM), World Class Manufacturing (WCM), Business process re-engineering and ISO 9000 are some of the buzzwords for achieving business excellence (Kaye and Anderson, 1999). A Continuous Improvement program can include several methodologies to achieve its purpose and fit the specific organization (Scott et al. 2008).

Traditionally, Continuous Improvement programs have focused on manufacturing systems with the aim to improve product quality and reduce waste and cost during production. The recent development has been to expand the improvement focus to cover entire organisations. While the Continuous Improvement programs get more sophisticated and comprehensive, the implementations become more challenging. The greater the organisational coverage is of the Continuous Improvement program, the more demanding changes it requires of the organisations (Bhuiyan and Baghel, 2005).

One area of increasing importance for the manufacturing sector is after-sales services. After-sales services have gained a larger share of the revenues and profit growth and examples of manufacturing-based services are installations, maintenance and spare parts. When services get more attention in the

manufacturing sector it highlights the focus on the customer relationship capabilities, where customer relationships change from a one-time transaction to long-term relationship (Owina et al, 2016). To improve the customer satisfaction, business profitability, market share etc. Continuous Improvement programs is gaining popularity within the service industry (Antony et al, 2007). A fundament of Continuous Improvement is to measure quality and in the service industry the quality of a service delivery can primarily be measured by the receiving customer (Babbar, 1992). Babbar (1992) describes that the service industry requires "*continuous feedback and input from customers*". Feedback from customers is crucial to minimise the difference between the customer and the management perceived quality of the service. Consequently, the customer feedback must be well "*managed for*" to achieve continuous improvement and high service quality, as perceived by the customer (Babbar, 1992).

Even though Continuous Improvement is vastly popular, it is hard to successfully achieve the long term goals when implementing a Continuous Improvement program. Firms usually underestimate the cost of time needed by management and expenditure and fail in sustaining the Continuous Improvement after implementation (Marutschke, 2011).

3.1.1 Critical success factors for achieving and sustaining Continuous improvement

Despite the high popularity of different continuous Improvement programs, many companies are struggling with both achieving and sustaining a long-lasting Continuous Improvement (Kotter, 1995; Netland, 2016). Therefore, many investigations have been done to capture the issues and obstacles in this wide field. Furthermore, there is a lack of theory regarding critical success factors that can be directly connected with the implementation of Early Management. During this study, one of the focus areas has therefore been on finding and categorising issues as a guidance for implementing and sustaining Continuous Improvement for installation projects. The strategy of conducting a list of important critical success factors specific to installation projects has been to first gather and conduct a list of general factors from theory. This list has then been revised by the authors when taking empirical evidence from the case company in consideration. In this study, ten articles regarding critical success factors have been studied in order to give the foundation for further development:

- Wahid and Corner (2009)
- Wahid (2012)
- Weeks et al. (1995)
- Laureani and Antony (2012)

- Sila and Ebrahimpour (2003)
- García et al. (2013)
- Samman and Ouenniche (2016)
- Oprime et al. (2011)
- Näslund (2013)
- Kaye and Anderson (1999)

In a study review done by Näslund (2013), the critical success factors for different change initiatives were studied and compared. The outcome was that they all had very much in common and do not seem to change over time. This is even if the change methods are using different approaches for achieving business results. Instead of having critical success factors connected to the different methods, they tend to be more connected to the efforts with organisational change. This statement reinforces that a general list of critical success factors can be used as a foundation for further development.

During the literature review in this study, the authors found the theoretical criteria model developed by Kaye and Anderson (1999). It clearly shows ten identified critical success factors needed in order to achieve and sustain Continuous Improvement. These are much in line with the rest of the reviewed literature, and therefore, it will serve as the framework in which the content will be discussed.

The ten essential criteria for Continuous Improvement:

1. *Culture for continuous improvement and innovation*
2. *Employee focus*
3. *Focus on critical processes*
4. *Standardise best practices/ Quality Management System*
5. *Integration of continuous improvement activities*
6. *Management*
7. *Stakeholders*
8. *Measurement and feedback*
9. *Learning from continuous improvement result*
10. *Results* *(Kaye and Anderson, 1999)*

From identifying the link between ten critical success factors, Kaye and Anderson (1999) developed a continuous improvement model (Figure 2). By turning the list of criteria into a process model the aim is to make the Continuous Improvement "continuous and self-generating". Two other purposes of the model are to identify what factor needs to be established before a Continuous Improvement attempt, and how to sustain Continuous Improvement over time. The model gives a comprehensive and system view of Continuous Improvement within an organisation.

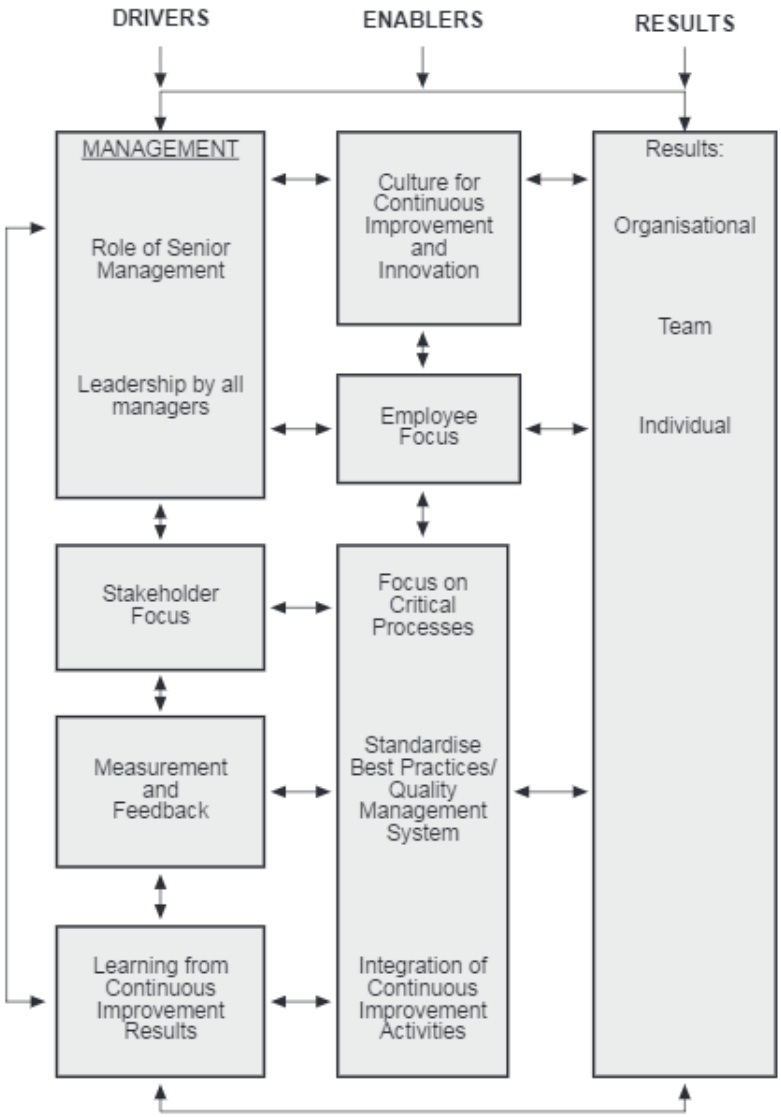

Figure 2: Model for continuous improvement (Source: Kaye and Anderson, 1999)

The model consists of three blocks; drivers, enablers and results. The enablers in the model are the foundation for achieving Continuous Improvement and must be the starting point for implementing continuous improvement. The drivers in the model are ensuring that the continuous improvement is sustainable over time. The results

in the model display the effect on other aspects than financial (Kaye and Anderson, 1999). The following sections describe each of the ten critical success factors in detail.

Culture for continuous improvement and innovation

One way to describe the culture for continuous improvement and innovation, is the perception that the responsibility for quality belongs to everyone in the organisation. The organisational change of the culture has been identified as one of the most important factors for achieving Continuous Improvement since it is very complex and takes long time to implement (Näslund, 2013; Wahid and Corner, 2012; Weeks et al. 1995; Laureani and Antony, 2012; García et al. 2013; Samman and Ouenniche, 2016). An example of main problems in companies reviewed by Wahid (2012) are lack of commitment from people, lack of awareness and understanding of quality and lack of communication. Furthermore, Weeks et al. (1995) highlights the importance of preparedness of the organisation before implementing TQM since a too low prepared organisation is jeopardising the success of an implementation. Elements of best practices to sustain a culture for continuous improvement from the study of Kaye and Anderson (1999) are the following:

- Train all employees in general quality and continuous improvement concepts.
- Have effective communication systems.
- Managers should follow up and strengthen the culture for continuous improvement by assessments and raising awareness.
- Multi-disciplinary teams should be created to focus on improvements.

Employee focus

In the continuous improvement model, Kaye and Anderson (1999) have grouped four areas within the employee focus:

- *Employee involvement:* The staff should actively be encouraged to participate in identifying improvements and make suggestions for changes by for example ideas systems, training, improvement teams and focus groups. The importance of the employee involvement has been found important by many authors (Wahid and Corner, 2009; Weeks et al. 1995; Sila and Ebrahimpour, 2003, Kaye and Anderson, 1999). It has also been statistically proven that employee participation has positive influence on the result (Oprime et al. 2011).
- *Employee empowerment:* Depends on the nature of the business that could give limitations to employee empowerment. (Sila and Ebrahimpour, 2003; Samman and Ouenniche, 2016, Kaye and Anderson, 1999)

- *Teamwork and establishing improvement teams:* Improvement or problem-solving projects by cross-functional teams, focus groups or ad hoc teams and to have cooperation across functions and hierarchy levels. Potential barriers for cooperation should be identified and eliminated. (Wahid and Corner, 2009; Weeks et al. 1995; Sila and Ebrahimpour, 2003; Oprime et al. 2011; Näslund, 2013, Kaye and Anderson, 1999)
- *Training and development:* Identification of training and development of staff (Wahid, 2012; Laureani and Antony, 2012; Sila and Ebrahimpour, 2003; García et al. 2013; Samman and Ouenniche, 2016; Oprime et al. 2011; Näslund, 2013; Kaye and Anderson, 1999)

Focus on critical processes

The critical processes should be identified and documented (e.g. with flow charts). The main business processes should be reviewed regularly to assess if the processes achieve the business objectives and critical success factors. Non-value adding activities should be eliminated and best practices should be captured and implemented. This is the foundation of Continuous Improvement and is therefore seen as an essential success factor (Wahid, 2009; Rummler and Brache, 1991; Sila and Ebrahimpour, 2003; Näslund, 2013). Having a holistic view of the company, highlighting the connections between departments inside the company and the customer, is crucial to counteract sub-optimisation and to ensure cross-functional examination for improvement opportunities (Rummler and Brache, 1995; DeToro and McCabe, 1997).

In the identification process, the following definitions has been found as important from the study of Kaye and Anderson (1999) and should be established:

- Business owner
- Resources and all employees involved
- Process customer and suppliers
- Activities
- Performance indicators
- Measurement mechanism
- Feedback mechanism
- Review points

Standardise best practices/ Quality Management System

The way to continuously improve is based on having a standardised work process and to improve from that point (Oprime et al. 2011). A Quality Management System can be used to standardise best practices in a documented way. The QMS should facilitate the capturing and standardisation of best practices and take away complicated bureaucracy and unnecessary elements. ISO 9001 is a common standard that states the requirement for a QMS (Kaye and Anderson, 1999). The importance of ease for updating standards is urged by Weeks et al. (1995).

Integration of continuous improvement activities

Continuous improvement activities should have a holistic approach across all functions and levels in the organisation. The organisation's strategy and goals should be used to prioritise the continuous improvement projects and activities (Näslund, 2013; Laureani and Antony, 2012). Self-assessment techniques aids to ensure a holistic approach to identifying continuous improvement areas and to have a successful integration of continuous improvement activities (Kaye and Anderson, 1999; Wahid, 2009; García et al. 2013).

Management

The management role is crucial to both achieve and sustain continuous improvement, especially top management (Näslund, 2013; Wahid and Corner, 2009; Weeks et al. 1995; Laureani and Antony, 2012; Sila and Ebrahimpour, 2003; García et al. 2013; Samman and Ouenniche, 2016). This includes that managers at all levels understand the importance of it and also transfer the knowledge to the rest of the involved staff. During a study of hundreds of companies going through organisational change, Kotter (1995) has found that the critical success factors leading to successful change of the organisation is dependent through the planning of management. It goes all the way from the starting point to the point where the change effort is seen as finished.

To be able to understand what Continuous Improvement approach is suitable for a certain organisation, one has to consider the organisation’s business strategy. According to Näslund (2013), the strategic alignment, or link between the change initiative and the business strategy, is most often seen as a critical success factor. This has often an implication for what kind of process improvement program should be used. In the same topic, he also emphasises the importance of long-term perspective since managers frequently are changed and thereby the organisation tends to loose long-term memory. Kaye and Anderson (1999) highlights several best practices for management, namely:

- Senior management should establish a vision and mission statements which clearly identify the long-term aims and purpose of the business/service. This should in turns be directly valuable for the business strategy.
- Establish appropriate business objectives and associated critical success factors linked to the vision, mission and business plans.
- Effective communication systems to transfer the aims of the organisation to the employees.
- All managers should be trained to be fully aware of the long-term strategies and have appropriate measurable objectives for achievements.

Stakeholders

An important driver for Continuous Improvement is the focus on stakeholders. The most obvious stakeholder is the customer (Sila and Ebrahimpour, 2003; García et al. 2013), which often is used to determine both the short and long-term strategy (Kaye and Anderson, 1999). Examples of other stakeholders in an organisation may be employees, suppliers and the community. For stakeholder management the following best practices are identified:

- All major stakeholders have to be identified.
- Mechanisms should be in place to identify the changing needs, expectations and satisfaction of stakeholders (e.g. with meetings, surveys feedback etc.).
- The organisation's long and short-term stakeholder strategies should be regularly reviewed.

What can be said about these best practices is that they are touching the importance of updating the needs and expectations from stakeholders. It is therefore not a one-time activity, but something that needs to be reviewed continuously (Kaye and Anderson, 1999).

Measurement and feedback

Measurement and feedback are the drivers that points out what is well functioning and what is to be improved in the organisation and has been found as critical elements for improving the business (Wahid and Corner, 2009; Oprime et al. 2011; Kaye and Anderson, 1999). Using the investigated companies in Kaye and Anderson's study (1999) as examples, the collection is done by using inputs from customer complaints, management, staff, performance reviews etc. captured as the most relevant best practices regarding measurement and feedback are:

- Appropriate performance indicators relating to all critical success factors and business processes on all levels. They need to be reviewed regularly.
- All involved managers and employees should be aware of the measurement results to urge improvements.
- Avoid measurements with too much focus on financial indicators.

Learning from continuous improvement result

For achieving Continuous Improvement, a well-functioning mechanism should be in place for capture learning from improvement activities that have been done. (Wahid and Corner, 2009; Weeks et al. 1995; García et al. 2013) The best practices according to Kaye and Anderson's study (1999), associated with learning from Continuous Improvement results are:

- By regular meetings, managers and employees can share experiences, progress on projects, successes and failures.
- The effect from training courses for employees should be used as feedback for further improvement.
- Activities in different organisations should be benchmarked to each other to find best practices.

Results

The organisation's results are fed back to both the enablers and the drivers in Figure 2. It is important to highlight that the results should lead to business improvement rather than encouraging number chasing. The results should give feedback not just on organisational level, but also on team and individual level (Kaye and Anderson, 1999).

3.2 World Class Manufacturing & Total Production Maintenance

World Class Manufacturing (WCM) is a mind-set that is not just used at Tetra Pak. It was first named by Richard J. Schonberger in his book *World Class Manufacturing* (1986). The overriding goal can be summarised by the slogan "faster, higher, stronger", or in WCM language; continual and rapid improvement. The strategy is mainly based on the Continuous Improvement methodology TPM that incorporates Just In Time (JIT) and Total Quality Management (TQM) (McKone et al., 2001). The JIT concept is pushing for produce small lot sizes and thereby increase the flexibility within the production sites and decrease the work in process (Schonberger, 1986).

The purpose of TPM is to improve productivity by making processes more reliable while reducing all kind of waste. In 1971, the Japanese Institute of Plant Engineers (JIPM), defined what was called TPM. It was then promoted by JIPM's vice-

chairman, who is seen as the founder of TPM (McKone et al., 2001). It has evolved from previous programs, including JIT and TQM, and focuses on equipment and productive maintenance throughout the entire life-cycle (Wireman, 2004). Furthermore, the ultimate goals with implementing TPM is zero breakdowns, zero defects and zero accidents (Jain et al., 2014).

3.2.1 The 5S

TPM is initiated with 5S as a systematic process of housekeeping (Shamsuddin et al., 2005). The employees have to commit to implement and practice the 5S in order to make it possible to see the problems more clearly in their surroundings. The five steps in 5S are the following (Singh et al., 2013; Sharma, 2012):

- *Sort*: Clear the workshop from unnecessary items, and only letting the needed items be left.
- *Set in order*: Set up dedicated spaces for the items that are left to enable immediate retrieval.
- *Shine*: Keep the workshop clean.
- *Standardise*: Set the current state as the standard. The standardisation also applies for the processes. This is the support for the three first pillars.
- *Sustain*: Follow the standards that are established.

3.2.2 The pillars in TPM

Important to notify is that the eight pillars in TPM should be implemented consecutively to establish TPM successfully (Singh et al., 2013). The eight pillars are described more in detail below:

Pillar 1: Autonomous maintenance

Following the approach of Autonomous maintenance, the personnel is trained to understand, manage and improve their own equipment and processes (Sharma, 2012). This is to go from reactive to proactive maintenance, and thereby reducing defects and minor stops. This is done in three steps. Firstly, the basic equipment conditions should be reached, including establishing standards for cleaning, lubrications etc. Secondly, the personnel are trained to maintain the first step but also to improve it. The third step is to hand over the ownership of the machines to the operating team, letting them continuously improve the standards. (Singh et al., 2013)

Pillar 2: Focused improvement

The driving force behind Focused improvement is zero losses, focusing on improving all activities that can increase the overall effectiveness of the processes,

equipment and plant. To get there, all kind of waste has to be reduced. (Suzuki, 1994; Sharma et al., 2012; Singh et al., 2013)

Pillar 3: Planned maintenance

This pillar is focusing on achieving zero breakdowns through an even better preventive maintenance, by planning the maintenance activities in the best sequence (Sharma et al., 2012). It can be achieved by implementing management systems that can optimise the reliability with a minimum cost. (Singh et al., 2013)

Pillar 4: Quality maintenance

The idea of this pillar is to reduce the defects to zero. By finding the correlations between the defects and manpower, machine, method and material, the root cause can be eliminated. By doing this, the defect is prevented to be produced in the first place and thereby the waste is minimised. (Singh et al., 2013)

Pillar 5: Initial flow control / Early management

The reason for implementing this pillar is to capture learnings from development phase and installation projects so when designing new products, the vertical ramp up and development lead time should benefit from earlier experience. This is divided into two parts; Early equipment management and Early product management. The first is focusing on introducing a machine with a defect free and loss free process. Early product management focuses on the development lead time to minimise loss and defects in the vertical ramp up. Early Management is further described in section 3.3. (Suzuki, 1994; Singh et al., 2013)

Pillar 6: Education and training

Since a big part of the improvements are done by the employees, the aim of this pillar is to educate the employees to be multi-skilled, independent and effective problem solvers. The evolvement in the training goes from "Do not know" to "Can do and also teach others" (Singh et al., 2013). According to Suzuki (1994), this pillar is giving success to the other pillars.

Pillar 7: Office TPM

The Office TPM pillar is focusing on making administrative and support more effective. Thereby, this pillar should be implemented after pillars 1-4. When the internal losses are eliminated and processes are streamlined the scope should be even broader, covering the whole supply chain to make it more efficient. (Singh et al., 2013)

Pillar 8: Safety, health and environment

The direct benefits from implementing this pillar are coming from lost time correlated to accidents and environment system failure. (Shima et al., 2012; Singh et al., 2013)

3.3 Early Management

Early Management, sometimes called Initial flow control, is a method used to introduce new products and processes that are easy to produce and install and where losses in terms of time, defects and quality are minimised. This is done by having processes in place for ensuring that learnings are captured from previously developed products in order to continuously improve to the better (Baines et al. 2006; Suzuki, 1994).

Already mentioned, all of the pillars are supported by the 5S which also includes Early Management. As it is the fifth pillar in TPM, it is preferably implemented after the first four pillars (Singh et al., 2013). The reason is that the Early Management pillar is built upon knowledge from the other pillars (Suzuki, 1994). It also is lower prioritised during the implementation because it includes the engineering of the products (Chiarini and Vagnoni, 2015; Baines et al., 2006). Processes linked to engineering is generally less stressed, compared to production processes. Furthermore, waste in production processes is often easier to measure and more visible in factories why these often are prioritised. This does not strictly need to imply that the losses are small and unimportant. Suzuki (1994) states that Early Management is particularly important for equipment aimed at the process industry, since they often tend to be customised and installed ad-hoc. Therefore, considerably cost reductions can be made. The absence of Early Management during those circumstances may lead to hidden defects that will be found during commissioning. In order to establish a well-functioning Early Management system, not just Research and Development need to be involved, but all departments that can lead to a better product (Suzuki, 1994).

To achieve the wanted goals with Early Management, it has been divided into two approaches, Early Equipment Management and Early Product Management.

3.3.1 Early Equipment Management

For Early Equipment Management, the goal is to introduce a loss and defect free process so that equipment downtime is minimal (zero breakdowns) when it is introduced, and maintenance costs are all considered and optimized from commissioning onwards (Singh et al., 2013; Suzuki, 1994). It is done by addressing the following areas:

- Cost optimisation
- Process design
- Equipment design
- Test operations
- Start-up management

The cost optimisation includes the whole life cycle. Examples included are quality of spare parts, installation cost, assembling cost vs. design disadvantages, production reliability vs. production volume. The process design is tackling how the equipment should be processed, and equipment design aims for achieving easy installations and to provide a reliable equipment. The test operations are done before the start-up of the equipment and its purpose is to eliminate flaws that have gotten through the process. The goal of start-up management/Vertical Start-up is to meet the expectations directly after installation. Issues that can spoil the Vertical Start-up may be bug eliminations, errors occurred during fabrication and installation errors (Gupta et al., 2003). (Suzuki, 1994)

3.3.2 Early Product Management

The focus in Early Product Management is to improve the product development process to make it more efficient. One company mentioned by Suzuki (1994) found that 80% of the product costs are already determined in the design phase, why this is where the most cost improvements can be done. By improving the project planning and perform several activities in parallel, the development lead time can be reduced (Singh et al., 2013). This gives big advantages in "product-to-market-time" that can be very valuable for the company. Therefore, the adoption of lean thinking to more knowledge-based activities as product development, engineering and design should be emphasised (Baines et al., 2006). Apart from the planning process improvement, Early Product Management also focuses on finding equipment flaws before the actual release of the product, and in that way reducing the costs for equipment redesign etc. This is generally called Vertical Ramp-up and enables a faster and more reliable release of new products to the market.

3.4 Synthesis of the theory

By the look of the theoretical content of this chapter, it is clear that the subject for developing an Early Management model and achieving Continuous Improvement is very broad. By reviewing and consolidating the most important findings from the previous chapters, the goal is to make it more comprehensive for the purpose of this study.

The installation project can be seen as a process, why it in some extent should be standardised. This, because it would be required to be able to continuously improve the process (Oprime et al. 2011). For having a successful Continuous Improvement, some critical conditions have to be in place, often referred as critical success factors. The factors seen as most important are related to management, culture and employees, why they tend to be more related to change than the specific application.

The purpose of the WCM methodology is to enable the organisation to achieve continual and rapid improvement (McKone et al., 2001). For improving installation projects, the methodology has emphasised the importance of improving earlier steps in for example Product Development, Production etc. why the Early Management pillar has been integrated (Suzuki, 1994). By using components in this pillar, the case study company can expect results as reduced Vertical Start-up but also other benefits (Singh et al., 2013; Suzuki, 1994; Baines et al., 2006). Regarding the implementation of the Early Management pillar, it has been highlighted that the pillars should be established consecutively since they build upon enablers from previous pillars. Connecting this to critical success factors, Early Management theory does not mention any of the ones that are seen as most important. The conclusion can therefore be drawn that those are established when implementing the first pillars.

The installation projects done by the case company are performed around the world by many different employees. Furthermore, Early Management is highly cross-functional, requiring a lot of structured information sharing. This implies that the Early Management model has to be supported by a feedback system, connecting all involved departments. More exact description than this is hard to reach from the theoretical framework. To develop an Early Management model, the ingoing elements have to be found that should be a part of the model. This requires more specific input from the case company.

For the part of the study aiming for answering RQ3, "*What are the critical success factors for achieving Continuous Improvement in installation projects?*", a list of factors has been developed as most important from the theoretical framework, see Table 3.

Table 3. The list below shows the most important findings for the critical success factors from theory.

Critical success factor	**Description/focus area**
Culture for Continuous Improvement	- Training in general quality concepts - Willingness for improvement and change - Communication systems and follow-ups by managers on culture
Employee focus	- Training and competence - Employee involvement - Employee empowerment
Focus on critical processes	- Identify and document all critical processes - Identify process owners, customers and suppliers - Review and update processes in a structured way - Feedback and measurements
Standardise best practices *Integration of continuous improvement activities*	- Share and standardise best practices - Integrated continuous improvement activities in daily work.
Management	- Effective communication system - Top management role - Involvement of managers on all levels
Stakeholders	- Focus and identify all stakeholders - Update the stakeholder needs
Measurement and feedback	- Measurement of success factors and business processes on all levels - Awareness of measurement results to urge improvement
Learnings of continuous improvement results	- Share experience in regular meetings - Benchmark of organisations to find best practices
Results	- Results should lead to business improvement rather than number chasing

4. Empirical study

The empirical study describes the research conducted at the case study company. In this chapter, the case study company is presented with a deeper description about Installation Service and the installation process. Then, the empirical data regarding their WCM and Early Management is presented to support for answering RQ1. The next section contains the information regarding Vertical Start-up and concerns RQ2, and finally in the fourth section the empirical data connected to RQ3 is described.

4.1 Introduction to the empirical study

The empirical data that this study relies on was gathered in two separate parts. During the first part of the study, open interviews were held in the central organisation to get a holistic view of the case company and how installations are conducted. A list of open interviews and meetings with corresponding discussion subjects is found in Table A.1.2, Appendix A.1. When the authors started to understand installation, the topics evolved to be more problem identification oriented. Important to mention is that the authors were restricted to not conduct open interviews with the clusters in this topics, and was thereby only done in the central organisation. During this first part, archive data from the case company was collected and investigated in order to provide knowledge, but also to confirm, when possible, information from the open interviews. The archive data consisted of information from the case company's internal webpage, extractions from Quality reporting systems, internal studies, workshops, customer surveys and WCM training materials. The empirical data that was gathered during this first part was used for developing the Early Management model and identifying the critical success factors for the model.

The second part of the collection was conducted by 15 structured interviews, with the purpose to verify the developed Early Management model and critical success factors, and if the proposed model would lead to lead time reduction. The interview guide is found in Appendix A.3. Since the result of these interviews concerns the analysis of this study, it will be presented in section 6.

4.2 Tetra Pak and Installation Service

The empirical study starts with reviewing the background of the project scope and the case company. The organisational structure of Tetra Pak and the functions impacting installation projects are mapped and presented in the following sections. The organisational structure is of importance to the Early Management methodology since it is a cross-functional methodology, as described in the theoretical framework. The final sections will contain a description of the installation process. The data in these sections are mainly based on open interviews and material from the company's internal network.

4.2.1 Introduction to Tetra Pak

AB Tetra Pak is a world-leading company within processing, packaging and distribution solutions for the food industry. The global company has 23 600 employees and is present in more than 170 countries. Net sales in 2015 were 11,9 billion Euros. AB Tetra Pak was founded in 1951 by Ruben Rausing and the idea of a tetrahedron-shaped package. The new filling machine, design and material made the process more efficient and reduced waste significantly and became a milestone in the packaging history.

4.2.2 Organisation structure

Tetra Pak's organisation structure is described in the organisation chart in Figure 3. The global company is organised in five geographic clusters and 32 market companies. The central core functions are divided into four categories and are supported by four support functions.

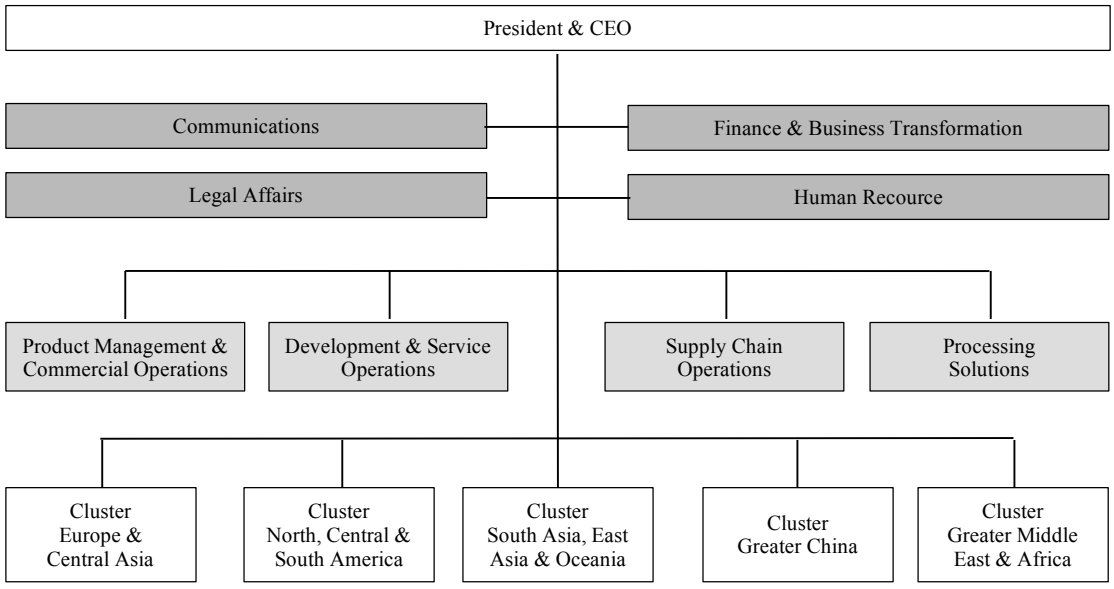

Figure 3: Tetra Pak's organisation

The central four core functions are described below:

- ***Product Management & Commercial Operations*** (PMCO) is the marketing and sales organisation.
- ***Development & Service Operations*** (DSO) is the organisation in Tetra Pak that manages the filling technology business. DSO develops, produces and delivers services for filling machines and distribution equipment.
- ***Supply Chain Operations*** (SCO) source, produce and deliver packaging material and related items e.g. straws.

- ***Processing Solutions*** (PS) is the organisation that manages the food processing business.

The five geographic clusters are responsible of the execution of operations and customer projects in respective core function. The organisations in the clusters mirrors the organisation structure in respective central function or department. The five clusters are *Europe & Central Asia* (ECA), *North, Central & South America* (NCSA), *South Asia*, *East Asia and Oceania* (SAEAO), *Greater China* (GC) and *Greater Middle East & Africa* (GMEA). The 32 market companies are distributed within the clusters.

The case study is conducted within the DSO organisation. DSO contains the functions *Product Development, Capital Equipment, Packaging Material, Packaging Technologies* and *Technical Service*, as presented in the organisation chart (Figure 4).

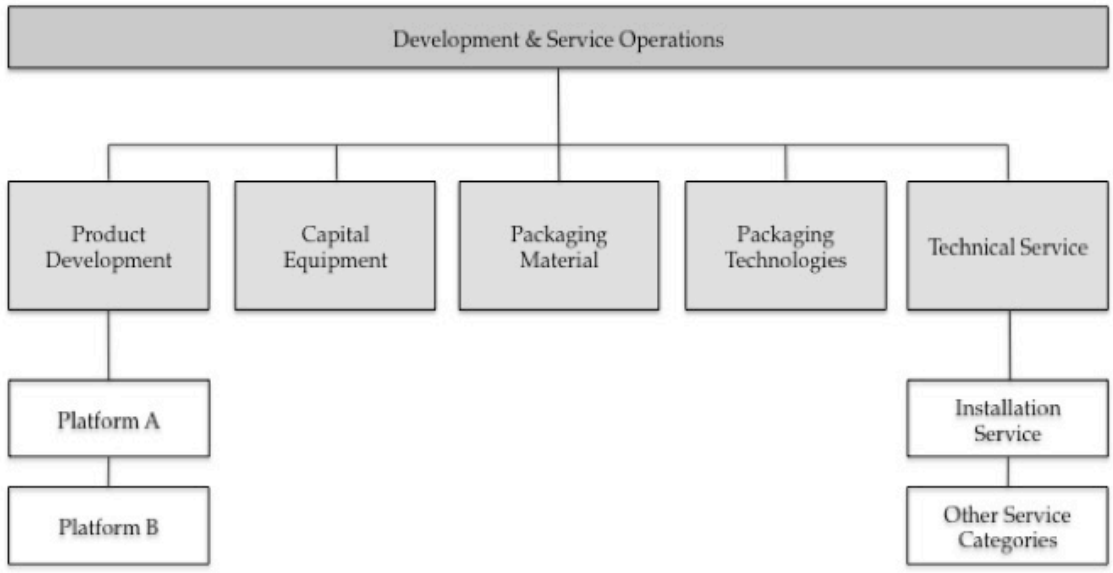

Figure 4: Simplified organisation chart over the Development & Service Operations organisation

The research questions for the case study is affected by *Product Development, Capital Equipment* and *Installation Service* in *Technical Service*. A description about each function follows below.

- ***Product Development*** (PD) is the function that develops the filling machines. *Product Development* is divided into different *Platforms* that contains different type of filling machines. The *Platforms* works independent from each other and are responsible for developing the necessary support material for installing the filling machines e.g. installation manuals.
- ***Capital Equipment*** (CE) is the equivalent to a manufacturing function. Tetra Pak does not manufacture the components to their products, but buy modules from suppliers. *Capital Equipment* assembly the filling machines and test the machines at a facility in Lund, Sweden. After the filling machines pass the tests the machines are de-assembled to modules and shipped to the customer.

The module compositions from the suppliers and from the test facility to the customer are not the same.

- ***Technical Service - Installation Service*** is the Service Category that provide installations of the filling machine and other equipment to the customer after purchase. *Installation Service* is further described in section 4.2.3. Within *Technical Service* there are several other Service Categories that offers Service Products to the customers for example, *Maintenance Service, Expert Service* and *Spare parts.*

4.2.3 Installation Service

Installation Service performs around 2000 installation projects per year. Approximately 500 of the projects are installations of filling machines and 1500 are smaller projects for installing rebuilding kits and distribution equipment. The filling machine installations are the main focus in the installation business and the subject of this study. The empirical study will only consider filling machine installation projects.

The *Installation Service* department consist of a central organisation based in Lund and five de-centralised organisations in each cluster. The central organisation is responsible for the profitability, expert support and business development of *Installation Service* as a whole. Historically, the central organisation focused on expert support and operations, but in the recent years the focus has shifted to a more strategic view of installation as a business. With the new focus the central organisation has driven many improvement projects in terms of profitability, standardisation and development of new services. The cluster organisations are responsible for the execution of the installation projects and their business results. The clusters are working independently, and as a consequence in fairly different ways. Many of the clusters have driven their own improvement projects in different areas. These improvements are local and are not structured mapped or review. However, with the aid of *Installation Service* networks and the internal webpage the improvements can be spread to the other clusters, or to the central organisation for making a global standard.

The installations are sold as an extra service with the machines, but was historically given away to customers for free. The value proposition for buying installation as a service is a guarantee to deliver an equipment performance level within a promised timeframe. The *Installation Service's* commercial agreement with customers is called *Certified Performance*. Depending on equipment type and line configuration, different performance targets are set as the contractual commitment for performance level. The performance target is always the minimum performance level of the line configuration. The Tetra Pak guarantee is that the performance level will be reached within eight weeks from the start of commercial production. This contractual

commitment to guarantee a certain performance level within a specified timeframe is called *Vertical Start-up*. If the performance level is not met within the timeframe, the customers can claim financial compensation or return the equipment. Due to the risk of financial consequences, the *Vertical Start-up* time is of major importance for *Installation Service* and Tetra Pak.

4.2.4 The installation process

To be able to understand the situation and to answer the research questions, the installation process needs to be mapped and analysed. Three months is the standard time for an installation project and the execution is standardised by a global official *installation process*, *installation manuals* and by the *customer contract*. The *installation process*, called *Installation to Performance* (ItP), is general and applies to all types of filling machines and other types of equipment (e.g. distribution equipment) follow the same process. The *installation manual* is specific for each filling machine and is developed by the *Platforms* in *Product Development*. The *customer contracts* are standardised by the *Certified Performance* guarantee, that states what activities needs to be fulfilled in the installation projects. It is only in the contract Vertical Start-up is specified or mentioned.

Any actions for content improvements or changes regarding the *installation process* would be made through projects or by specific requests. Neither the *installation process*, *installation manuals* or the *customer contract* have a structured way for updating, improving or reviewing the content.

Installation to Performance

ItP consists of five phases; *Preparation, Mechanical Completion, Commissioning, Performance Validation* and *Hand Over* (Figure 5). The *Preparation* phase is to prepare the customer for the installation, for example if the customer's plant needs to be rebuilt to accommodate the new equipment. *Mechanical Completion* consists of positioning, assembling and connection of the equipment. The next phase is the *Commissioning* to verify the package quality. This phase validates the food safety, equipment functions and finally the package integrity and appearance. In the *Commissioning's* aseptic test, water is used instead of the commercial product. In the *Performance Validation* the commercial production starts and the equipment is ramped up to reach the committed performance level in the *Certified Performance*. When reaching the performance target this is validated by a performance test. The final phase is the *Hand Over* of the project to the customer, marking that the installation is finalised.

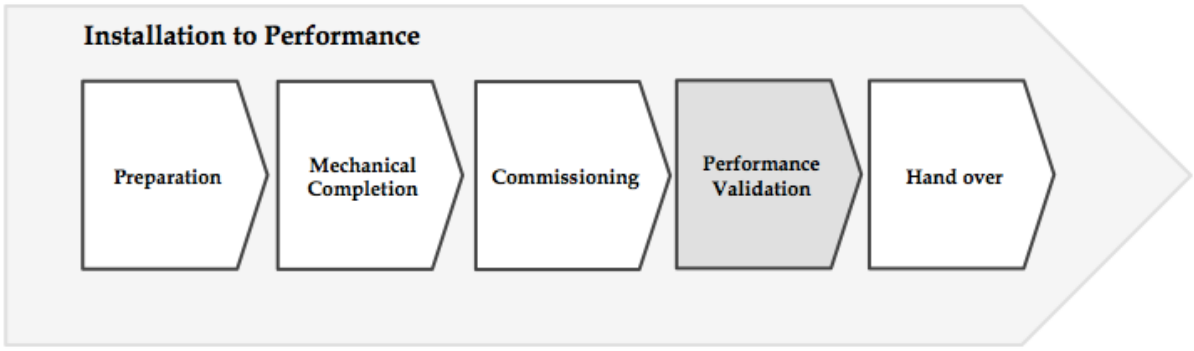

Figure 5: Installation to Performance process

The *Vertical Start-up* is measured within the *Performance Validation* and is presented in Figure 6. *Performance validation* contains four phases; *Verify Performance Preconditions, Execute Performance Ramp-up, Execute Performance Tests* and *Review Performance Validation*. *Vertical Start-up* includes the final three phases except the first step, *Verify Performance Preconditions*. The *Verify Performance Preconditions* phase is the customer's responsibility to fulfil. Preconditions are for example sufficient production volume, material with the right quality and competent operators. The reason why this phase is excluded is that the *Vertical Start-up* time is measured as a KPI, and Tetra Pak only wants to measure the parts they can control. However, the common picture from the open interviews is that the *Vertical Start-up* time often gets disturbed by preconditions that are not fulfilled by the customers in the consecutive phases.

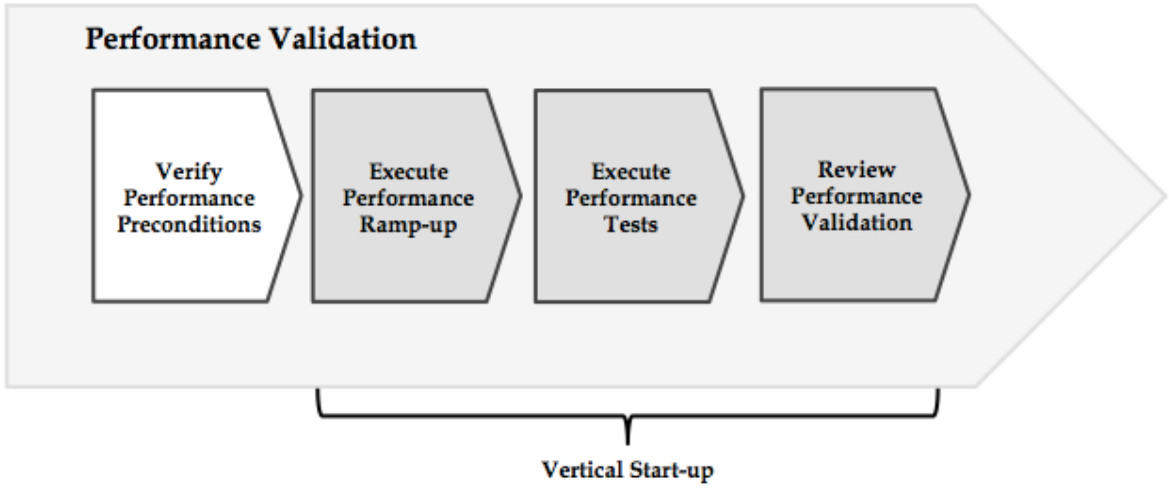

Figure 6: Performance Validation process including Vertical Start-up.

The first phase in the *Vertical Start-up* is *Execute Performance Ramp-up*. As the name describes, this phase is to ramp-up the performance in order to meet the set target. In the ItP process it is not described what are the specific steps or activities in the ramp-up. The description of the activities is of a more general nature e.g. perform root cause analysis on issues. For the second phase *Execute Performance Test* the test method is described in the sales contract with the customer and not fully described

in the ItP. In the final phase of *Vertical Start-up,* the performance tests are validated and approved by both the customer and Tetra Pak.

The installation manual

The installation manual provides information about technical specifications and instructions for the steps in the ItP process. The purpose of the installation manual is to fulfil legal requirements regarding user manuals and to ensure correct installation, operation, maintenance and disposal of equipment. The installation manuals are developed with the guidance of a standard manual that specifies what content should be included in what section. An installation manual is not reviewed or maintained once it has been released unless specific circumstances urge for changes. If a department wishes to improve the installation manuals, the focus usually lies on improving the standard manual. The standard manual is reviewed and updated regularly through a super user network.

The customer contract

Installation Service's commercial offer is called *Certified Performance*, where the guaranteed performance level is binding through the customer contract. The customer contract consists of an agreement, general terms and condition and exhibits. These three types of documents are the most detailed description of how the installation project should be executed. The customer contract contains detailed descriptions about for example, delivery, time plan, Tetra Pak's responsibilities, the customer responsibilities, quality specifications, tests methods etc. It is only in the customer contract that *Vertical Start-up* is described with the start point when commercial production starts. The *Vertical Start-up* is finalised when the filling machine with complementary distribution equipment pass the performance test. The performance test method is that the filling line should perform equal or above the performance target for three times 8 hours of production within 5 consecutive days. The test method is based on the ABMI (Association of the Beverage Machinery Industry) recommendation for Acceptance Tests.

4.3 WCM and Early Management

The purpose of this section is to present the practical examples for how the case company work with Continuous Improvement. The World Class Manufacturing program at Tetra Pak have been reviewed through archive data, open interviews and training. Both the authors participated in Tetra Pak's internal WCM training to fully understand the case company's view on how they work with Continuous Improvement. The main focus of the review lies on the Early Management methodology that is currently implemented in the SCO organisation. The empirical data in this section supports for answering RQ1.

4.3.1 World Class Manufacturing

In 1991 Tetra Pak introduced the Continuous Improvement program, World Class Manufacturing (WCM). WCM has its foundations in Total Productive Maintenance (TPM). TPM is a Continuous Improvement program for maintenance processes developed in Japan for improving productivity by making processes more reliable and less wasteful. WCM was first implemented at Tetra Pak in the SCO organisation, and was later implemented in all producing organisations within the company. The DSO organisation have WCM within the *Capital Equipment* function today. As part of the DSO organisation's strategy the goal is to implement WCM further in the supply chain to cover sourcing and customer deliverance. The starting point of the WCM expansion will be in the *Installation Service*. Hence, Tetra Pak wishes to evolve the Continuous Improvement program from the traditional focus of manufacturing to include service products.

The WCM organisation at Tetra Pak is divided into responsible areas with the pillar structure described in section 3.2.2. The personnel responsible for WCM are not dedicated to only work with WCM, but are often high managers with several other responsibilities. In DSO all pillars except Early Management have been successfully implemented. However, in *Technical Service* and *Installation Service*, no pillars are implemented. Early Management will be the first step to implement WCM in the *Technical Service* function.

4.3.2 Early Management

Early Management is currently used in the SCO organisation in the converting factories. The reason for using Early Management is to strive for Vertical Start-up, which here has a slightly different meaning than the Vertical Start-up KPI at *Installation Service*. In the Early Management methodology at SCO, Vertical Start-up means to strive for the situation when equipment performs according to its specifications when pressing the start button. The concept is also described as "plug and play" and the objective is to "Stop rework and do it right the first time". Early Management at the case study company consists of two blocks; Early Equipment Management and Early Product Management that are described in Table 4. The sum of the two blocks results in Early Management that is summarised as "Development & implementation of new products and production systems".

Table 4: Early Management consists of Early Equipment Management and Early Product Management.

Early Management	**Development and implementation of new products and production systems**
Early Equipment Management	Development, installation and start-up of production systems that are reliable, easy to operate, easy to maintain, safe, produce quality products and are cost effective
Early Product Management	Development of products that are easy to produce and designed for manufacturability

The Early Management system used in the converting factories in SCO is displayed in Figure 7. By having a cross-functional feedback loop from *Manufacturing* to *Product Development*, the aim is to re-design and build away issues or time consuming tasks that impact the installation and start-up of the equipment. The building blocks in the *Early Management* system is the *Work process, WCM toolbox, Project report, Documentation changes* and *Equipment design changes*. A defined standardised work process is followed with tollgates during SCO installation projects. If a problem occurs in the project phases the *WCM toolbox* is used for problem solving within the project. The *WCM toolbox* contains problem solving methodologies and tools from WCM. After each tollgate a project report is created regarding equipment and documentation problems, solutions to problems and suggestions. If a problem occurs that the project team cannot solve themselves, this is captured in the project report and sent to the responsible organisation for root cause analysis. The outcome of the root cause analysis is then sent to *Product Development* to prevent the problem from happening again. The *Product Development* is responsible for taking actions on the problems, and the actions taken are usually improvements on equipment design or documentation. The *Early Management* system is supported by a computer system, C2, for managing the feedback loop and keeping track on actions needed on problems.

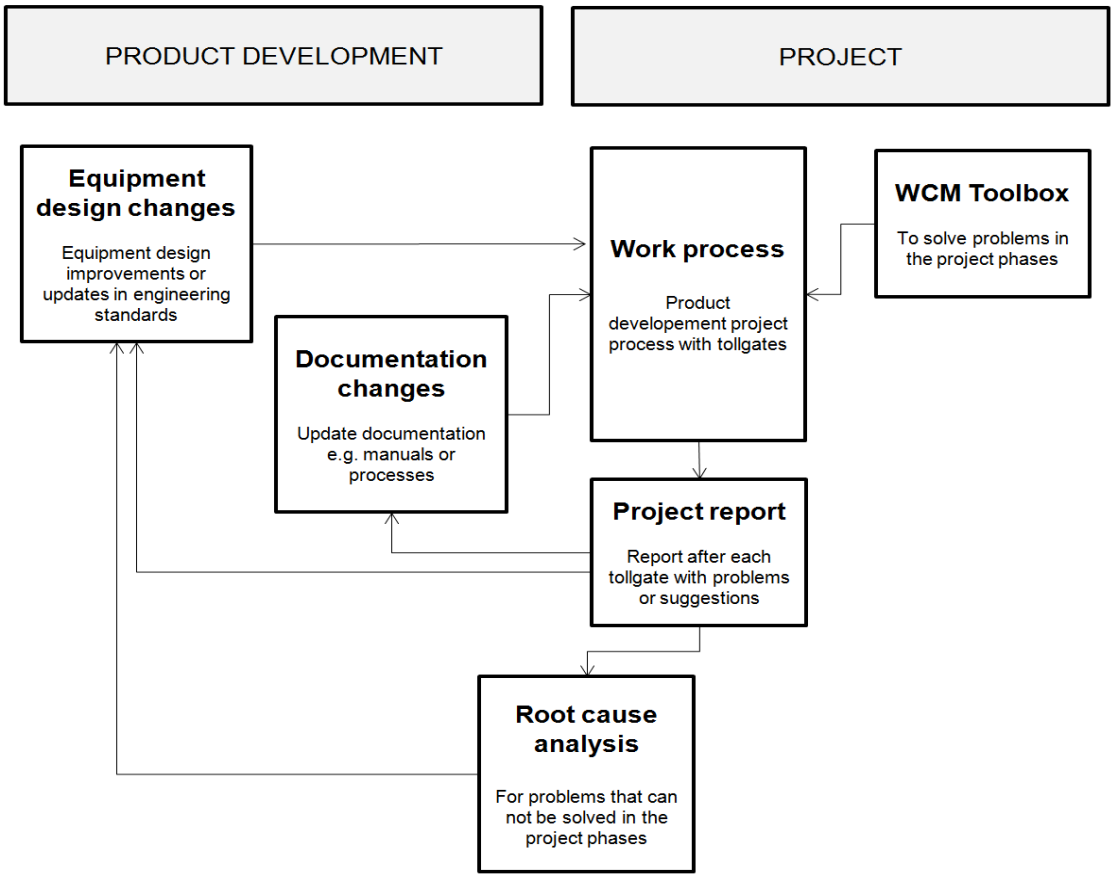

Figure 7: The Early Management system in SCO.

4.4 Reducing the Vertical Start-up time

This section presents information gathered to support answering RQ1 and RQ2. The strategy to answer RQ2 is to identify and map the elements that are affecting the Vertical Start-up lead time. Elements that affects other parameters than the Vertical Start-up, e.g. reduced cost or increased customer satisfaction, have not been the focus of this study. The empirical data in this section is collected by open interviews and archive data.

4.4.1 The Vertical Start-up KPI

Vertical Start-up is both a contractual obligation and a KPI at the *Installation Service* department. Vertical Start-up has been part as a contractual obligation since the start of the *Certified Performance* guarantee in 2004. It was first in 2016 *Installation Service* started measuring the Vertical Start-up as a KPI. The purpose of the KPI is to measure the performance of the execution of the installation projects and to follow up on how well Tetra Pak fulfil the commitment in the customer contracts. The current KPI target is to reach Vertical Start-up within eight weeks in 90% of all installation projects. Tetra Pak's ambition for year 2020 is to reach the target in four weeks in 90% of all installation projects.

Currently 95,3 % of all installations meet the target within eight weeks. Please view Appendix B.1 (restricted to the case study company) for the presentation of the KPI numbers. However, the average Vertical Start-up time is 27,5 days which is already within their target ambition of four weeks. 63 % of the installations are fulfilling the Vertical Start-up within the four weeks' target for year 2020. The numbers provided show that the project time can differ greatly, where 4,7% of the installation projects are over twice as long as the average. One reason for the large time deviation between projects can be a lack of standardisation. From the open interviews, the information varies and can be contractionary regarding whether there is a standardised execution of the installation projects or not. The contractionary opinions, from the personnel that works hands on with installation projects, implies that the problem lies in the variation of execution and scope between projects.

Several projects and activities are ongoing at Tetra Pak to ensure that the current KPI target is met and to find ways to improve the lead time for the 2020 target. One project is driven by the *Capital Equipment* function and is called *Develop an Early Management feedback loop from installation projects*. The purpose is to develop an Early Management system and establish a feedback loop in order to achieve Continuous Improvement and meet the target set for year 2020. Due to the similarities, the master thesis is conducted in close collaboration with this project with the aim to create synergies. The *Capital Equipment* project will for convenience be referred to as the VSU project.

The *Installation Service* are driving several projects and activities under the umbrella name *VSU taskforce*. The *VSU taskforce* drives activities such as competence development, cost reduction and follow up on the KPI results. After the roll-out of

measuring *Vertical Start-up* as a KPI, many clusters showed bad results in terms of reaching the 90% target. Six months after the roll-out of the KPI the *VSU taskforce* drove activities to ensure the KPI was measured and reported in the correct way. After the reported data had been reviewed and corrected, all the clusters met the KPI target. One of the reason for the reporting of incorrect data was confusion for how the KPI is measured. During the roll-out of the KPI, how to measure the KPI was communicated by specific network and by PowerPoint presentations to the clusters.

4.4.2 Reducing the Vertical Start-up time

What is the reason for reducing the Vertical Start-up target with 50%? This is not clearly stated or communicated within Tetra Pak. During the research the authors have identified three possible reasons leading up to the need to reduce the Vertical Start-up time.

The first reason is to strengthen the value proposition of the service since the lead time and performance level is the only commitment that is promised to the customers. The customers express that the value proposition is insufficient with the current commitments. The performance level promised is based on simulation of the equipment and those aspects are harder to influence from the service side. The second reason is, by reducing the lead time the purpose is to increase the customer satisfaction and the customer impression of Tetra Pak. The installation projects are the first interaction the company have with the customer's plants and will give the first impression of quality and service. The customers can challenge why it takes several weeks to ramp-up and reach the performance with completely new equipment. Once the equipment starts running for commercial production the customers expect it to perform according to specifications, not being adjusted and improved for eight weeks in order to function properly. If issues occur during installation projects the customer impression can be affected negatively e.g. low competence or low equipment quality. The third reason is that the Vertical Start-up lead time is the largest phase within installation projects, and by putting focus on this phase it will give most impact to the total project time and reduce internal costs.

4.4.3 Problem investigation for not reaching Vertical Start-up

The Vertical Start-up lead time has an average time of 27,5 days, but only 63 % of the projects can meet the 2020 target of four weeks. The reasons for exceeding four weeks is not clear or captured in a structured way at the case company. Different organisations and people have different opinions about what are the core problems for Vertical Start-up. Since the case company does not have an agreed problem picture, a large part of the thesis work has been an investigation to capture problems and issues. The problem investigation identifies what elements impact the Vertical Start-up time. To analyse the assurance of the identified elements, structured interviews were conducted at different functions to collect feedback. The results

from the identified elements and the structured interviews will be presented in the Analysis chapter.

To investigate what impacts the Vertical Start-up lead time, different type of sources can be combined to identify impacting elements. The sources used in this study are open interviews, review of internal studies and projects, workshop results, quality reporting systems and customer surveys. The information or material from the sources are provided by the case study company. By combining different type of sources the aim is to give a holistic view for what type of problems prevent the installation projects to achieve Vertical Start-up within four weeks. Since the case company does not have a common internal picture regarding what affects the Vertical Start-up, the findings from the problem investigation presented here is mainly from archive data. The sections below describe the collected data from the different types of archive data.

Reviews of internal studies and projects

The authors took part of the results from the Early Management project from 2012 and the results from the current VSU project. The authors also participated in the weekly follow-up meetings for the VSU project. The VSU project team have provided the authors with valuable information, insights and guidance during the research. Two examples of data provided from the VSU project team is the KPI results and data regarding quality issues.

The case study company have made internal studies in different areas that can be utilised to identify the problems in Vertical Start-up. The studies are provided by the case company and some information have been classified. Suitable extractions and compilations regarding Vertical Start-up or the *Performance Validation* phase is presented in this section.

One source of information is a pre-study conducted by one of the authors in 2014. The pre-study researched how to "*Protect and Grow the Installation Business*" in terms of analysing the current service portfolio. Structured interviews with a questionnaire captured feedback from the *Installation Service* departments in the clusters and central team. 25 employees in management positions participated in the interviews. One of the topics in the study is; *"What are the advantages and gaps with installation service current offer"*. Within this topic, open questions were asked about what are the gaps in the *Performance Validation* phase. The interview result from the gaps in the *Performance Validation* phase reveals issues concerning Vertical Start-up. The full transcribed interview results have been reviewed and taken into consideration by the authors, but due to classification the full interviews will not be included in this report. In Appendix B (restricted), table B.2 reveal the percentage of the participants that stated the specific gap.

The information provided from the study shows that there are two main gaps in the *Performance Validation*. The top gap in Performance Validation is *Unsatisfying performance commitment,* which refers to the customers' view of the contractual commitments regarding performance targets and measurements. The second main gap is *Customer production plans,* which highly affects the performance test in *Performance Validation* and accordingly the Vertical Start-up. A common problem is that the customers does not have enough volume for the performance tests and this delays the lead time for Vertical Start-up. The problem with the *Customer production plans* is frequently stated in the open interviews conducted in the master thesis. The *Customer production plan* gap show the impact the customer has on the execution of the installation projects. *Lack of communication* and *Utilities* are other gaps highlighted in the pre-study. *Utilities* are the utilities at the customer's plant, for example power supply or water quality. *Lack of communication* between the customer and the company's staff can lead to delays or conflicts during the installation projects. They are therefore issues that are varying between different customers and where Tetra Pak is not in direct control.

VSU Workshop

During 2016 some clusters had problems reaching the KPI target. The *VSU Taskforce* recommended the installation departments in the clusters to have workshops about the reason for not achieving Vertical Start-up within eight weeks. The authors were provided with the results from one of those workshops held in the cluster Greater Middle East and Asia (GMEA). The full results from the workshop is presented in Appendix B.3 (restricted).

The VSU workshop in GMEA was conducted in June 2016 with 16 project managers participating. In the workshop the problem statement is to identify the "reasons for not reaching Vertical Start-up", which refers to the current VSU target. The result was 20 identified reasons for not reaching Vertical Start-up. The methodology used in the workshop is a fishbone diagram with the categories 4M; Materials, Method, Man and Machine. The result from the workshop is that the reasons (or problems) are evenly divided between the 4M categories, and the workshop material does not reveal the impact or frequency of each problem. The issues described in the fishbone diagram cannot be traced back to one single root cause nor one function/department at Tetra Pak. The functions that can have an impact on the issues are *Product Development, Capital Equipment* and *Installation Service* (both central and in the clusters). The 20 identified reasons for not reaching Vertical Start-up are scattered over many different areas, which contributes to the complexity of the Vertical Start-up problem picture.

Quality reporting system

Equipment quality issues that occur during installations are logged in a quality reporting system called Quality & Technical Issues Platform (QuTI-P). QuTI-P is

used mainly for quality claims and the data is logged manually by Tetra Pak employees. The driving force of the system is the economical compensation for broken parts. The system is made to support the whole life cycle of the equipment, and therefore it is possible to log where in the life cycle the issue occurs. The issues are then consolidated to make it possible to prioritise improvement changes.

The data in Table 5 represents all the technical issues reported in QuTI-P June 2015 - July 2016, and describes how many technical issues are claimed during installation projects during the same period. 6% of all technical issues are logged as a consequence of the 3400 installation projects of both packaging and processing. Unfortunately, it is not possible to sort out the issues that relates to the 500 yearly installations of filling machines (packaging). If assuming that quality issues occur in the same extent in all installation projects <1 quality issues occur per installation project. This is important to keep in mind since equipment quality issues are seen as one reason for not reaching Vertical Start-up in time. Please note that the total sum of 3400 projects do not have a break down in number of equipment lines e.g. one project can have four different equipment lines while another has one equipment line. The other technical issues that are reported in the phase product life cycle are from the 10 000 installed base of equipment lines running globally. It is not possible to track in QuTI-P how many improvement actions have been made on the issues reported from the installation projects.

Table 5: Quality claims connected to installation projects

Phase	**Number of Technical Issues**	**Percentage of Technical Issues**
Installation projects *(3 400 per year*)*	2 584	6%
Product Life Cycle *(10 000 prod. lines**)*	42 438	94%
Total	45 022	100%

** Number of installation projects per year with varying installation time.*
*** Current number of production lines that are in use.*

Customer surveys

Customer satisfaction is of importance and monitored in many functions within the case study company. For *Installation Services* the customer satisfaction are measured by *Event Driven Customer Satisfaction* (EDCS) surveys. An EDCS report from 2015 provide an overview for the customer experience of the installation projects and is presented in Table B.4 in Appendix B (restricted). The table shows that *Performance Validation* is one of the aspects the customers are least satisfied with regarding installation projects. The experience area overview compile survey results with the top-2 scores; excellent or very good. *Performance Validation* gets a score of 83% which is the lowest score on the list. The bottom-score is shared together with *Certified Performance.*

The EDCS report also provide the top three *Areas of Focus for Overall Installation Performance Improvements*, which are shown in Table 6. The top requested improvement *Training,* regards training of the customer's staff during the installation projects. *Issue Resolution* and *Equipment Quality* are strongly connected to the Vertical Start-up lead time. Quality issues and issue resolution impact the whole installation time but the issues are more pressing in the Vertical Start-up. According to the open interviews, it is during Vertical Start-up most equipment quality issues surfaces. The major time consuming tasks during Vertical Start-up is to ramp-up performance and to do issue resolution due to equipment quality issues and wrongful installation.

Table 6: Areas of Focus for Overall Installation Performance Improvements

Improvement areas	**Percentage of the respondents**
Training	40%
Issue Resolution	29%
Equipment Quality	19%

4.5 Identified elements that impact the Vertical Start-up time

In order to develop an Early Management model for Installation Service the authors need to investigate what elements are affecting the Vertical Start-up time. During the analysis 15 elements have been identified that effects the Vertical Start-up time. The 15 elements are mainly based on archive data from the empirical study with additional conclusions drawn from the open interviews. Empirical data from the open interviews can be contradictory and is considered less valuable at the case company. However, contradictory perceptions from the employees indicates there is problems in those areas. To gain credibility for the identified elements and to receive feedback the authors conducted structured interviews to collect feedback on the identified elements. The results from the structured interviews are presented in section 6.1. By collecting feedback in a structured way, the accuracy of the identified elements can be considered to be more reliable. The 15 identified elements that impact the Vertical Start-up time are the following:

1. Equipment quality
2. Design to facilitate installations
3. Processes
4. Manuals
5. Checklists

6. Testing of equipment
7. Packing and shipping
8. Modules
9. Customer management
10. Resource planning
11. Commercial agreements
12. Competence
13. Standardised work process
14. Alignment to process
15. Problem solving methodologies

A detailed description about each identified element are described below. The description contains explanations for each element as well as the background for the identification of the specific element. Throughout the problem investigation it has not been possible to detect the importance, frequency or impact for each element. It is therefore not possible to rank the elements and the list is made without any weight or prioritisation between the elements.

1. ***Quality***

Equipment *Quality* issues is one of the most frequently mentioned reasons for troubles during the Vertical Start-up. *Quality* related topics are mentioned in all of the different types of empirical data. In the review of internal studies, the gaps; *Expectancy of stable performance, Long time to reach target* and *Equipment Issues* are often described as a consequence of quality issues in the full transcribed interviews. In the VSU workshop quality issues can be traced back to *Distribution Equipment (DE) not tested prior to shipping, Factory Acceptance Test (FAT) before shipping and QuTI-P reaction time*. From the customer surveys in the EDCS report the *Equipment quality* is one of top three requested improvement areas.

Quality is already a focus area within the company and a structured approach for handling quality issues exists though QuTI-P. A matter of concern is that from the QuTI-P data it is not possible to track how many quality issues are occurring during the Vertical Start-up nor if any permanent counteractions are taken upon the quality issues. From the open interviews a common view is that insufficient actions are taken to permanent eliminate the issues. It is also stated that the information provided in QuTI-P is incomplete and lacks the foundation for *Product Development* to do design improvements. When *Product Development* take action it requires a separate investigation in order to complete any improvements. However,

consolidated issues from QuTI-P are successfully used to improve the supplier's quality.

The high focus on quality within the company can additionally be demonstrated by the VSU project's scope is to establish a feedback loop in QuTI-P. By collecting feedback from the installation projects at customer site, the aim is that the feedback loop should lead to Early Management and Continuous Improvement.

2. ***Design to facilitate installations***

Design to facilitate installations is an area for *Product Development* that could reduce the installation lead time drastically. From the Early Management theory, *Product Development* plays an important role for reducing waste when introducing new equipment. *Product Development* perform the design improvements in order to eliminate the waste from occurring again. From Early Management in SCO, feedback will be sent to *Product Development* to take actions on. *Product Development* is responsible for making the *Equipment design improvements or updates to engineering standards.*

Findings from the open interviews express concerns that when developing new equipment, the installations have a low priority. *Product Development* receives general requirements from *Installation Service* to take into account for the product design. The requirements are not detailed and therefore it is not possible to evaluate the prioritisation of installation matters during product design. Please note that empirical data from *Product Development* has not been accessible.

3. ***Processes***

The *Product Development* function is responsible for developing and defining the installation process during the development of new filling machines. The improvement of process documentations is not described in the archive data from the empirical study, and the open interviews provide with different opinions and not a cohesive view on the *processes*.

Regarding the theoretical findings, *processes* are described as crucial for Continuous Improvement. The improvement of *processes* is of importance to capture and standardise learnings and improvements (Singh et al., 2013). By having a well-documented standardised process, it is possible to do improvements that reaches all personnel working within those processes. If process changes are made to reduce the installation lead time, the changes need to be captured and documented in order to be implemented throughout all clusters. The importance of having a standardised process is analysed further in section 6.2.2.

4. ***Manuals***

The improvement of the Installation Manual is connected to the improvements of *processes*. The Installation Manual contains the detailed information on how to execute the installation of filling machines. The open interviews give different views on the quality of the content in the *manuals*. Some interviewees use the *manuals* frequently and are satisfied with the content, while other claim that the *manuals* are insufficient and are not used in the clusters. From the empirical data it is not possible to draw any conclusions about the current state of the *manuals*. However, as a sub-part of the installation process it is seen as crucial to have a structured way to make improvements in the *manuals* in order to reduce the lead time.

5. ***Checklists***

Checklists exists both in the installation process and the Installation Manual. With the same argument as stated above, a structured way of improving the documentation for the *checklists* will facilitate the reduction of the installation lead time.

6. ***Testing of equipment***

From the open interviews information was provided regarding the *testing of equipment*. The *testing of equipment* before shipped to the customer is performed by the *Capital Equipment* function. Today the equipment tests are water-tests for two hours with the purpose to evaluate the package quality. The equipment tests do not have any performance target and are only testing the filling machine. In the VSU workshop topics related to *testing of equipment* is expressed in *Distribution Equipment (DE) not tested prior to shipping, Factory Acceptance Test (FAT) before shipping*.

By testing equipment in-house, it can pro-actively capture issues that otherwise would surface at the projects at the customer's site. By improving the tests with for example to include performance parameters, it is believed to result in lead time reductions during the Vertical Start-up.

7. ***Packing and shipping***

The filling machines are advance equipment with sensitive components which can be disturbed during the *packing and shipping*. Some instruments are calibrated at the manufacturing facilities and can be de-stabilised during transportation. The *packaging and shipping* of the equipment can therefore have consequences in the installation process and Vertical Start-up. By capturing eventual issues from the packaging and shipping these can be updated to not happen again. The case study company have driven some improvement projects already for improving the shipping and packing.

8. ***Modules***

The *modules* are the combination of different components that the equipment are shipped in. By analysing the ItP process the authors believe that improvements in the *module* composition could have an effect on the Vertical Start-up. The *modules* are not mentioned in the theory or empirical study.

9. ***Customer management***

Customer management is an area that is impacting the installation time in many aspects. From the open interviews *customer management*, and especially customer production plans, is one of the most pressing issues for the Vertical Start-up. *Customer management* refer to ensuring that all the activities and responsibilities of the customer are fulfilled. A good collaboration and communication can minimise the risk of having delays due to the customer. Other sources that indicates the importance of having *customer management* as an improvement area are the internal studies and the VSU workshop.

Customer production plans, Utilities and *Lack of communication* are all stated as gaps in the performance validation. *Customer production plans* refer to the lack of sufficient volume in order to perform the performance tests. *Customer production plans* is the top-two gap of performance validation in the internal pre-study. *Utilities* and *Lack of communication* are also found as causes for delays. From the VSU workshop 50 % of all the reasons for not achieving Vertical Start-up are related to the customer.

The competence of both Tetra Pak's staff and the customers staff influence the Vertical Start-up time according to the VSU workshop. To ensure the customer's competence it has been categorised under *customer management*. The customer's operators are running the lines during the performance tests and if they are lacking the sufficient competence this impacts the line performance. From the interviews it has surfaced that in many occasions Tetra Pak's staff finds it necessary to interfere during the performance tests in order to pass the committed targets.

Several sources are pointing out the customer's influence on the Vertical Start-up time and the conclusion is that improved *customer management* could lead to lead time reduction. *Customer management* should be highlighted as a focus area to not be renounced as completely out of Tetra Pak's power or responsibility. *Customer management* is categorised as an element under *Service delivery improvements* at *Installation Service.*

10. ***Resource planning***

Resource planning is a parameter that affects the Vertical Start-up in terms of lack of accessible resources. During installation projects Tetra Pak's resources can be pulled away due to urgent issues at other customer's plants. Or it can be that resources with the right competence are not available for the installation project. Resource

availability is expressed as issues in the empirical study in the open interviews, VSU workshop and Gaps in performance validation. With improved *resource planning* the aim is to prevent any issues related to resource availability.

11. ***Commercial agreements***

The *commercial agreements* are the legal documents that dictates the terms and details of the installation projects. It is in the *commercial agreements* the Vertical Start-up is committed to eight weeks, with financial consequences as a guarantee. It is also in the *commercial agreements* the customer requirements and obligations are communicated. The *commercial agreements* are described in section 4.2 and the empirical data are from open interviews and the internal webpage. Additional findings from meetings are the believe that the sales organisation is not clear enough when communicating the terms of the contract, and the customer's obligations are not always fully understood. This further confirmed in the VSU workshop with the issues of *Customer understanding of Performance Validation* and *Customer acceptance criteria not clear*.

By having a structured process to improve the *commercial agreements* this can lead to improved customer relationships as well as a shorter Vertical Start-up. One example of an improvement is a cluster that have developed an additional contract, including the terms of the situation when the customer does not have enough production volume for the performance test. Since the customer production plan is a reoccurring issue, the performance test requirements could be improved to adapt to the customer's situation. One example is irregularities to follow the contract specifications, with the motivation of that it's necessary to complete the projects.

12. ***Competence***

According to the VSU workshop the *competence* of the Project Manager (PM), Project Engineer (PE) and Field Service Engineer (FSE) impacts the Vertical Start-up. Project Managers have the responsibility of executing the project and for example, to coordinate with the customer. The Project Engineers are designing the line layout and configuration. In general, it is the FSE that should perform the steps in the Vertical Start-up, but some clusters have System Specialists resources as a standard. During the Vertical Start-up the ramp-up and issue resolution activities demands a high *competence*. System Specialists are the experts that otherwise handle advanced equipment matters. It is first in the recent years an installation training for the FSE have been developed.

From the EDCS *Issue Resolution* is one of the top-three *Areas of Focus for Overall Installation Performance Improvements.* A fast *Issue Resolution* for upcoming problems during the installations are depending on the *competence* level. If Tetra Pak's staff at site cannot handle the issue it might take days to arrange for a resource with the right *competence* to get involved.

The theoretical findings further emphasise the importance of competence. In the theoretical findings for Continuous Improvement and WCM, *competence* is frequently described as an important component when conducting structured improvement work. In WCM *Pillar 6: Education and training* describes the importance of competent staff (Singh et al., 2013). *Competence* is further described in the critical success factor *Employee focus* and the focus area *Training and development* (Kaye and Anderson, 1999).

13. ***Standardised work process***

From the theoretical framework a *standardised work process* can be seen as a pre-condition for Continuous Improvement. If no standard is in place, there is nowhere to capture and implement new improvements. The importance of having a *standardised work process* is emphasised in Tetra Pak's training for Early Management and in the material provided from the Early Management experiences in SCO.

Installation Service has the latest years driven several projects to standardise the installation scope and offer, and the VSU taskforce is driving activities with the aim to reduce the Vertical Start-up lead time to four weeks. While finding improvements in the work process for lead time reduction, these improvements needs to be standardised and communicated out throughout the clusters in order to give any actual impact on the projects time.

14. ***Alignment to process***

As well as a *standardised work process* is of importance, adherence to the process is of the same importance. The personnel conducting the installation projects need to follow and align to the process in order for improvement changes to have any real impact on the business results. Hence, alignment to the global installation process should be a focus area when striving to reduce the lead time. The perception from the interviews is that the importance of alignment to the defined process is lacking focus or acknowledgement in the case company today. Installation Service have driven activities of standardisation in tools for example, standardising price calculations in *Service Solution Pricing Tool* (SSPT) and implementing the *Certified Performance* to standardising the commercial commitment. However, no data have indicated any activities to follow up on the alignment to standards.

15. ***Problem solving methodologies***

In the Early Management system in SCO a *WCM toolbox* is used with *Problem solving methodologies*. *Problem solving methodologies* can help when performing *Issue Resolutions* or root cause analysis to problems. The purpose of the *Problem solving methodologies* is to reduce the dependency on previous experience to solve problems. It is worthy to take notice on that Tetra Pak have a vast portfolio of equipment types and the filling machines are advanced equipment. By usage of general *Problem*

solving methodologies, advanced problems can be dissected and solved by the FSE with little experience of the specific equipment. Hence, it would be inconvenient to train all the FSE to be experts on all types of filling machines.

4.6 Identified critical success factors for achieving Continuous Improvement

The purpose of this section is to provide the empirical data that will lead to the answer for RQ3 "*What are the critical success factors for achieving Continuous Improvement in installation projects*". The data supporting the answer has to some extent already been brought up in previous sections. The empirical evidence was collected during the first part of data collection, conducted by open interviews, observations in the central organisation and archive data. To make the reasoning through the report more structured, the empirical data in this section is categorised according to *The ten essential criteria for achieving and sustaining continuous improvement* (Kaye and Anderson, 1999), described in section 3.1.2. In order to adapt the critical success factors to installation projects, the approach has been to use the theory as a foundation and strengthen or change it using empirical findings from the case company. It will be done by reflecting on the contemporary difficulties and strengths. By listing the reviewed focus areas for each critical success factor, the intention is to make them more specific to installation projects.

Culture for continuous improvement and innovation

During the WCM training given at Tetra Pak by the WCM champion P6 (2016-09-09), the importance of reporting was brought up in order to have well-functioning Continuous Improvement. To keep the employee motivated to give qualitative feedback, or any feedback at all, there should be a good answer to the question "*What's in it for me?*". A strong motivation is when the feedback leads to a change. It gives the employee a feeling of involvement. If the feedback never leads to any change, the motivation is slowly fading away. When participating at the VSU project meetings, the members shared the feeling that the motivation for providing feedback through QuTI-P, described in section 4.4.2, is to get refunds for broken parts. The main reason should then not be to actually provide information that is leading to change. This was stated by the VSU team (2016-09-27) because the level of details in the feedback through QuTI-P from clusters in many cases is of low quality and thereby hard to investigate centrally. This issue has also been observed by one of the authors while working hands-on with technical quality issues during summer 2016. The statement regarding low employee motivation is also strengthened by the results of the workshop described in section 4.4.2.

The WCM methodology is mainly communicated through the internal web page, providing the organisation with material, success stories and its core concepts. When the authors used the web page to get hold of valuable information for this study,

they found it hard to navigate through the material and to find what could specifically be useful for installation projects. The information is mainly provided in Power Point presentations. WCM basic tools, for example Makigami, Fishbone diagram and 5Why, will be provided as video material, but are not yet finished.

In the category of *Culture for continuous improvement and innovation*, the focus areas are:

- Training in general quality concepts
- Willingness for improvement and change
- Perception of responsibility belongs to everyone
- Communication systems and follow-up by managers on culture
- Learnings from Continuous Improvement results

Employee focus

The case company is providing global trainings in different areas of expertise for their employees in order to improve their skills. However, it is not known if there are local trainings in Continuous Improvement concepts that are aimed at installation teams.

The required competence for the ItP process is not stated in each step, nor in the installation manual. What has been brought up as an idea by P13 (2016-10-19), is the concept of letting employees working with installations get certificates for participating certain equipment trainings. This concept could make it easier to assure the right competence to the right installation projects. Lack of competence during installation projects is a recurrent problem stated in the VSU workshop and from the open interviews. It sometimes occurs when the well-experienced field service engineers often are assigned to other, more prioritised missions than installation projects.

The status in today's Installation Service is that the experience from the employee is not reaching the process owners, nor the Manufacturing or Product Development. It is in other words very valuable information that is lost on the way. By training the employees in Continuous Improvement concepts, involving them in improvement teams and to give suggestions, the outcome should be a higher grade of involvement and empowerment. To drive the continuity, improvement activities should be integrated into all processes concerning installation projects. The important areas for employee focus for this model are thereby:

- Training and competence
- Employee involvement (e.g. suggestions)

- Employee empowerment (e.g. participation)
- Define competences for each activity

Focus on critical processes

Referring to section 4.2.4, the ItP process followed during the installation projects is documented with inputs, tasks and outputs in all steps. The participants in the open interviews were uncertain whether it is followed or not (VSU meeting, 2016-09-16; P1, 2016-09-07). According to P1 (2016-09-07), the way the ItP process is designed leaves room for interpretation which can lead to different ways of executing the installation project. Any further investigations on how well the process is followed globally have not been done by the case company. The business owner for the ItP process is thereby not aware of exactly how good the ItP process is. Measurements on the installation projects are though done to track their performance. Referring to section 4.4.2, the central organisation is reviewing them continuously and is conducting workshops to review their improvement opportunities.

Similar to the ItP process, there is an uncertainty whether or not the installation manual is followed during installations (P13, 2016-10-19; P7, 2016-09-12; P10, 2016-09-28). Any observations from installation projects have not been conducted by the authors due to the long installation project lead time and short timeframe.

Today, QuTI-P is the only structured way in the process for sharing information between departments. This system is though only designed for equipment design and quality improvements and thus, any system for process improvement changes are not established. Areas of importance in this category are thereby:

- Identify and document all critical processes
- Identify process owners, customers and suppliers for the process
- Review and update processes in a structured way
- Ensure alignment to process
- Structured way of information sharing between departments

Standardise best practices / Quality Management System

The theoretical findings regarding critical success factors have shown that an easy way for standardising best practices is preferred without being obstructed by bureaucracy. Today, such way of standardising best practices does not exist on a global level. In connection to standardisation, there were hesitations regarding having a more detailed ItP process. It was based on that the big variations in installation project preconditions have too much influence on the work process which would make a detailed standardisation hard to follow. The variations could

be related to the installation site, equipment line set-up etc. The need of a standardised work process and a way of standardising best practices is essential for Continuous Improvement and thereby, this issue has to be solved in the case company.

Integration of continuous improvement activities

Referring to section 4.2.4, there are no integrated Continuous Improvement activities in the process for improving ItP process, installation manual or customer contracts but is only changed by specific projects or specific requests.

Management

During the open interviews, the importance of top management role, a clearly communicated business objective and alignment of missions were emphasised. Navigating through the internal webpage, it is often reminded that these factors are important. At this webpage, it is clearly stated that the case company is focusing on continuously improving the processes. Having in mind that there is a lack of continuous feedback, review points and updates on ItP process and manuals, this statement can be questioned.

Regarding the more detailed objectives, the authors made the observation that the reason for reducing the KPI VSU was not fully agreed among the interviewed people and the VSU project team. Referring to the theory, the common desired state should be communicated and understood.

As described in section 4.2.5, the roll-out of the KPI VSU was done by sharing PowerPoint presentations through specific networks consisting of managers in the clusters. During the monitoring of the KPI VSU, it became clear that the reported lead times were not measured properly. By reviewing and once more communicating the way it should be measured, the KPI was drastically improved due to wrongly measured KPI. Having in mind that the root cause of many of the stated issues is communication issues, the authors believe that there is a need for a rigid digital strategy for how to communicate in the best possible way. Areas of importance in this category are thereby:

- Digital strategy
- Top management role
- Involvement of management on all levels

Stakeholders

The major stakeholders identified for the installation projects and for achieving Vertical Start-up are the *customer*, *Installation Service, Product Development* and *Manufacturing*. By regularly reviewing the customer satisfaction, the case company

keeps track of the customers' changing needs and expectations. But, the authors perceive that the customer is often the least ranked stakeholder and the feedback from the customer has low priority. Statements have occurred such as "*if the customer cannot fulfil our requirements they shouldn't be allowed to buy our machines*" which indicates an "us vs. them" mentality. Customers express (from the EDCS feedback comments) that the value proposition and the commercial contract has been developed to protect and gain Tetra Pak only.

In regard to the VSU project, among other improvement projects, there is a willingness to connect the *Installation Service* (Central and Clusters) with *Product Development* and *Manufacturing*. In the VSU project, the idea is to bridge this connection with a feedback loop. This is pushed since the case company senses a lack of connection between them. The goal is thereby to strengthen the stakeholder focus in the whole installation process.

The major stakeholders identified at the case company are the *customers*, *IS Central*, *IS Clusters*, *Product Development* and *Manufacturing*. The customers and IS are the stakeholders that directly benefit from the results of the Continuous Improvement at installation projects. Manufacturing is benefitting for ease of installation, since the installation is done in-house in order to test the equipment. Product Development will be contributed with valuable information regarding the quality of the equipment. Since the feedback in the model will be used by the receiver, e.g. the stakeholder, they are the ones that are stating the requirements on the information. Since this has been an issue for Product Development regarding quality issue feedback, it should be included in the description. The reviewed focus areas are:

- *Stakeholder focus* in all steps of the model
- Main stakeholders in the model are: *Product Development*, *Manufacturing*, *IS Central*, *IS Clusters* and *Customers*
- Requirement on information

Measurement and feedback

The performance during installation projects are measured through KPIs and Operational Performance Indicators (OPI) in each cluster, for example the KPI Vertical Start-up. The KPIs are then reviewed in IS Central to monitor the performance of the projects.

Quality issues that are causing downtimes are constantly reviewed through QuTI-P, described in section 4.4.3, and solved by DSO Capital Equipment. The way the issues are automatically prioritised is based on customer impact (severity, size and probability) and does not take into account when during the product life cycle the issues occur. Other prioritisations can only be done manually if it is actively wanted

by the quality analysts. Furthermore, suggestions from the installation projects on equipment designs are uncommon.

Since the feedback is a part of the Early Management model, the focus areas, focusing on measurements, are:

- Measurement of success factors and business processes on all levels
- Awareness of measurement results to urge for improvement

Learning from continuous improvement result

Regular meetings between managers are taking place in the central organisation where improvement projects are discussed and reviewed. It has not been investigated if this is done in the clusters.

Results

The company's results, both central and clusters, are communicated through the internal website and can be reached by all employees. Since measurements on all projects are accessible, it is possible to track the results to project team level.

5. Development of model and critical success factors

This chapter presents the developed proposed Early Management model and identified critical success factors. Both the model and the critical success factors have been developed based on theoretical and empirical findings.

5.1 The development of an Early Management model for Installation service

This section contains information to answer RQ1 *"How can an Early Management model be designed to achieve Continuous Improvement for Installation Service?"* and RQ2 "*How can Early Management be used to reduce the installation lead time?*". An Early Management model is developed from a combination of the theory from Chapter 3 and the empirical study in Chapter 4. The structure of the model has its origin in the Early Management system used in the converting factories in SCO (Figure 7) but has been modified and extended to fit the application in this research. The model's purpose is to continuously improve installation projects to reduce the Vertical Start-up time. From the theory the authors get a basic understanding for Continuous Improvement, WCM and Early Management. By developing a cross-functional model with a holistic approach the aim is to avoid sub-optimisation and to deliver the most value to the customer (Rummler and Brache, 1995; DeToro and McCabe, 1997). From the empirical study the authors gain knowledge from a practical example of the Early Management system in SCO. Further on, from the empirical study the required components for an Early Management model for Installation Service and Vertical Start-up are identified.

The developed Early Management model is presented in Figure 8 below and includes 19 identified elements that impact the Vertical Start-up. The model contains an essential feedback loop from the installation projects at customer site back into the central organisation. The purpose is to counteract and solve problems that affect the Vertical Start-up earlier in the supply chain, and thus reduce the lead time.

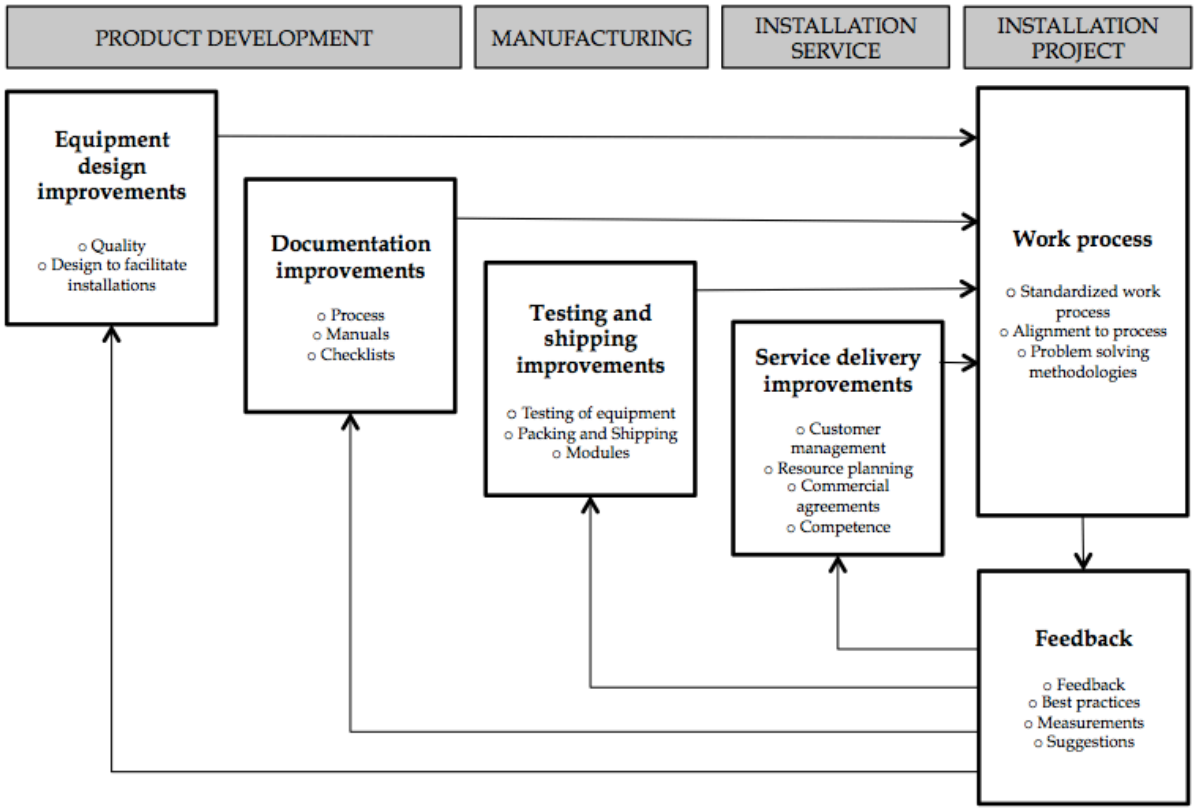

Figure 8. The developed Early Management model

The 15 identified elements from the empirical study that impacts the Vertical Start-up time, are allocated to the responsibility areas of *Product Development, Manufacturing, Installation Service* and *Installation project* at customer site. The identified element can be categorised into five categories; *Equipment design improvements, Documentation improvements, Testing and shipping improvements, Service delivery improvements* and *Work process.* The elements that lie in the responsible field of *Product Development* are under the categories *Equipment design improvements* and *Documentation improvements*. The elements in the category *Testing and shipping improvements* are the responsibility of *Capital Equipment*, or equivalent manufacturing facility in other companies. *Installation Service* has control over the elements in the categories *Service Delivery improvements* and *Work process*. The reason for having *Installation Project* separated from *Installation Service* is to highlight that the Installation Team is the direct link to the execution of the service and they are the ones following the work process. In the model *Feedback* has been added based on the SCO Early Management system. Feedback contains four additional elements *Feedback, Best Practices, Measurements* and *Suggestions,* which aim to include all types of information that can lead to improvements in the model. Furthermore, in the theoretical findings, feedback is defined as a requirement for having continuous improvement (Babbar, 1992; Kaye and Anderson, 1999). The elements in the model are described in Table 7 and the background for including them are described in section 4.5.

Table 7. The identified elements to be included in the Early Management model.

Elements in the model	**Description**
Equipment design improvements	
Quality	• Quality improvements
Design to facilitate installations	• Product Development should consider installation procedure when designing new equipment
Documentation improvements	
Processes	• Improved installation process description • Established definitions of all critical parameters for processes
Manuals	• Improvements to the installation manual
Checklists	• Updates to checklists or integration of checklists into the installation process or manual
Testing and shipping improvements	
Testing of equipment	• Testing to capture performance issues
Shipping and packing	• Securing the equipment condition
Modules	• The composition of the shipped modules from the test facilities
Service delivery improvements	
Customer management	• Customer collaboration and coordination • Ensuring customers responsibility and requirements • Customer competence
Resource planning	• Ensuring available staff with the right competence
Commercial agreements	• Dictates the terms for the installation scope • Requirements and responsibilities • Updates to the commercial contracts to reflect the current business situation • Value proposition and guarantees
Competence	• Competence development • Competence requirements for each activity
Work process	
Standardised work process	• Standardised work process for the installation projects • Updates of process

Alignment to process	• The execution of the projects are aligned to the standardised process
Problem solving methodologies	• Toolbox for supporting the execution of installation projects • Reduce the reliance on previous experience and competence
Feedback	
Feedback	• Feedback captured from the installation projects
Best practice	• Best practices and learnings captured and standardised
Measurements	• Measurements for performance indicators • Other measurements e.g. quality data
Suggestions	• Suggestions from the installation projects

Since it is not possible to implement or test the model during the case study due to time limitations, structured interviews are used to collect feedback on the developed model including each identified element. By collecting feedback, the purpose is to analyse the credibility and accuracy of the model in the case study company. For example, to investigate the accuracy of each element the interviewees can rank the elements in terms of importance for improving the Vertical Start-up. The structured interviews and the results will be presented in Chapter 6.

5.2 The development of critical success factors for achieving Continuous Improvement in installation project

The critical success factors that are provided in this section are aimed for answering RQ3, "*What are the critical success factors for achieving Continuous Improvement in installation projects?*". During the combination of theory and empirical data in the previous section, some additional focus areas have arisen in order to highlight the difficulties in the Early Management model. By taking these focus areas into account, the outcome has given a slightly different categorisation, shown in Table 8. Since the goal of this study is to reduce the Vertical Start-up lead time, the success factor *Result* has been dissolved and merged with *Measurement and feedback*. During the case study, it has been discovered that many issues have been caused by lack in information sharing, often regarding what is shared and how it is shared. Since many focus areas have touched its importance, *Information sharing* has been identified as a separate critical success factor for pinpointing its importance, including *Learnings from Continuous Improvement results*.

The first critical factor to focus on is the *Culture for Continuous Improvement*, which is seen as the most important from theory. It is also the hardest to achieve. This is followed by the process related success factor *Standardise best practices, Focus on critical processes, Information sharing* and *Integrated Continuous Improvement*. To enable the above mentioned factors, there has to be an *Employee focus*. The drivers for the Early Management model are *Management and strategy, Stakeholder focus* and *Measurement and feedback*. They are needed both when implementing the model but also for driving the momentum in the long run in order to continuously change for the better. How these critical success factors should be achieved is individual to every company, but a description of the details found during this study is shown in the right column in Table 8.

Table 8. The reviewed critical success factors with additional descriptions.

Enablers and drivers	**Description**
Enablers	
Culture for Continuous Improvement	• Training in general quality concepts • Willingness for improvement and change • Perception of responsibility belongs to everyone • Communication systems and follow up by management on culture
Standardise best practice	• Capture and standardise best practice
Focus on critical processes	• Identify and document all critical processes • Identify business owner, customers and suppliers for the process • Define competences for each activity • Review and update processes in a structured way • Ensure alignment to process
Employee focus	• Training and competence • Employee involvement (e.g. suggestions) • Employee empowerment (e.g. participation)
Information sharing	• Digital strategy • Structured way of information sharing between departments • Requirements on information • Learnings from Continuous Improvement results
Integration of Continuous Improvement activities	• Improvement activities integrated in all organisations and processes
Drivers	
Management and strategy	• Top management role • Involvement of management on all levels

Stakeholder focus	• Stakeholder focus in all steps in the model • Main stakeholders are: Product Development, Manufacturing, IS Central, IS Clusters and Customers
Measurement and feedback	• Measurement on success factors and business processes on all levels • Awareness of measurement results to urge for improvement

The first critical success factor to focus on is the *Culture for Continuous Improvement*, which is seen as the most important from theory (Näslund, 2013; Wahid and Corner, 2012; Weeks et al. 1995; Laureani and Antony, 2012; García et al. 2013; Samman and Ouenniche, 2016). It is also the hardest to achieve. This is followed by the process related success factor *Standardise best practices, Focus on critical processes, Information sharing* and *Integrated Continuous Improvement*. To enable the above mentioned factors, there has to be an *Employee focus*. The drivers for the Early Management model are *Management and strategy, Stakeholder focus* and *Measurement and feedback*. They are needed both when implementing the model but also for driving the momentum in the long run in order to continuously change for the better. How these critical success factors should be achieved is individual to every company, but a description of the details found during this study is shown in the right column in Table 8.

As for the Early Management model, structured interviews were held to collect feedback on the critical success factors. The feedback served as support for indicating the importance and if they have any weaknesses. This analysis can be found in Chapter 6.

6. Analysis

The analysis conducted in this study aims to support answering the three research questions. The first section presents the feedback from the case study company regarding the developed Early Management model and critical success factors. Following an analysis will be done regarding if the Early Management methodology can be used for Installation Service and what are the challenges connected to the methodology. The third section investigates whether a proposed Early Management model can lead to lead time reduction and aims to answer RQ2. Section four contains the analysis of identifying the critical success factors needed for an Early Management model to be successful and aims answering RQ3.

6.1 Feedback on the developed model and critical success factors

The developed Early Management model and the identified critical success factors for achieving Continuous Improvement could not be verified or tested at the case study company. The research is limited to 20 weeks and during that time an implementation of the model and critical success factors would not be possible. In order to assess the credibility and accuracy the authors asked the case study company for feedback. This section presents and analyses the results from the structured interviews regarding the developed model and critical success factors.

6.1.1 Structured interviews to collect feedback

The assessment of the developed model and critical success factors was performed as described in section 2.4.2. By interviewing 15 employees in different strategic levels and departments the authors aim to capture feedback from all the strategic levels and all the concerned functions. The list of the participants for the structured interviews can be found in Appendix A.2.

The complete interview guide for the collection of feedback can be found in Appendix A.3. The interview guide has two parts; one regarding the model and one part regarding the critical success factors. The two parts have the same structure in terms of first investigating the perceived importance of the elements in the model or the critical success factors. The second part investigated how well the elements or critical success factors are established today at the case study company.

For the first part where the importance of the element/criterion was investigated the participants were asked to grade the importance with a scale from 1 to 5, where the correspondence was;

5 = Essential

4 = High

3 = Medium

2 = Low

1 = No importance

The participants had the opportunity to answer with N/A.

Secondly, the participants graded how well each element/criterion is established in the case company today as an assessment of the case company's current situation.

Since this question about establishment is different from the first, the correspondence of the scale was;

5 = World class standard

4 = Fully established and communicated globally

3 = Established but needs improvement

2 = Exists but not structured

1 = Does not exist

A third question aimed at providing credibility and concluding the view of the model or critical success factors as a whole. For the model the concluding question is *"Is the model applicable on Tetra Pak [in order to continuously improve Vertical Start-up]?"*. And for the critical success factors, the concluding question is *"How much do you think the implementation of the model depends on the Enablers and Drivers?"*. For the concluding questions a grade between 1 to 5 was placed.

As mentioned in section 2.5.1, the pattern matching technique was used in order to prove any variances in the results. When deciding the patterns, factors as the number of persons in each category were taken into consideration. The original intention was to have an even amount of participants in each functional category and strategical level. However, this was not possible to pursue during the case study and the structured interviews are overrepresented by participants from the *Installation Service* department on a tactical level. Due to the risk of low validity of having too few persons in each category, causing big variations, the authors made the decision to not use any categorisations. In order to prove a difference between the different elements and critical success factors, the authors decided that a difference of one (1) had to be shown in the scoring results.

6.1.2 Results of the feedback on the developed model

The structured interviews used a grading scale from 1 to 5 on all the questions. By grading the answers, it facilitates to compare and visualise the results. The results from the feedback on the developed model are presented in Figure 9. The average grade for each element on the question *"Importance for improving Vertical Start-up"* are represented by the grey columns. In the same way the black columns are representing the average grade for each element for *"Established in a structured way"*.

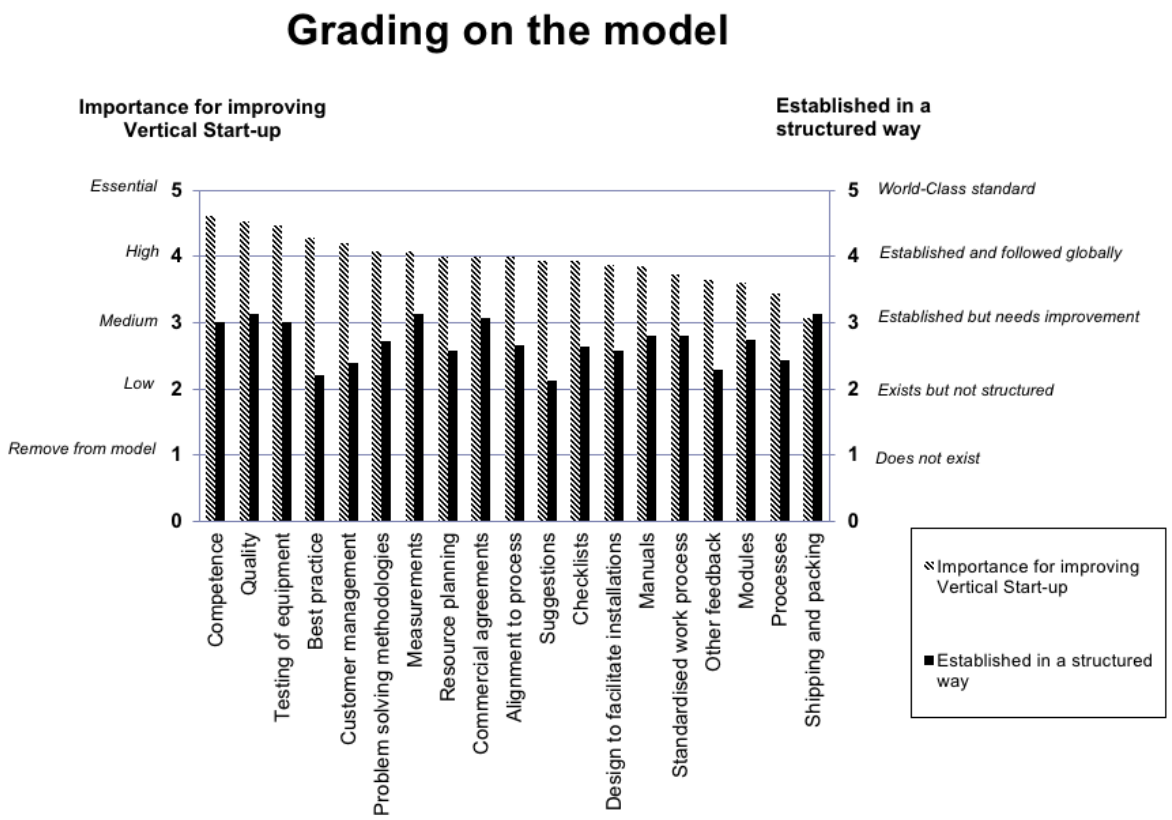

Figure 9: Feedback on the Early Management model from the structured interviews

Based on the interview results, all elements are of importance for the model to reduce the Vertical Start-up time. The importance of the identified elements differs with an average scoring of 1.5 from the lowest to the highest ranked. The highest ranked element, which is perceived to have the highest impact on the Vertical Start-up, is *Competence* (score 4.6). The lowest ranked is *Shipping and Packing* (score 3.1). With the pattern-matching method a difference above 1 is considered to be a difference worth distinguishing. In the result there is two occasions where the scoring differs above 1; *Shipping and Packing* and *Processes* (score 3.4) can be considered to be less important than *Competence, Quality* (score 4.5) and *Testing of equipment* (score 4.5). From the result it can be worth to put extra priority on *Competence, Quality* and *Testing of equipment,* and less priority on *Shipping and Packing* and *Processes.* However, with the low number of 15 participants the authors do not consider the results to be sufficient to put all the elements in a prioritisation list after the scoring in this study. For gaining a deeper understanding on how to prioritise the elements the authors suggest a continuation of the structured interviews.

The results show that all the elements have a *Medium* to *Essential* importance for reducing the Vertical Start-up time. This indicates that the authors have succeeded in capturing the key elements for the model and what is impacting Vertical Start-up. Since no element received the score *1: Remove from model*, none of the elements will be considered removing from the model.

Regarding the results on the establishment, it can be considered to be an initial mapping of what parts of the model are already implemented today. The establishment of the elements have a significant lower grade than the perceived importance. The scores are evenly distributed between *Exists but not structured* or *Established but needs improvement,* which indicates that all the elements do exist today but need improvement for Tetra Pak for successfully reducing the Vertical Start-up time.

For the final concluding question *"Is the model applicable on Tetra Pak [in order to continuously improve Vertical Start-up]?"* the average grade is 4.1. This indicated that the elements in the model have a high importance and the model itself has a high credibility within the case study company.

Due to the lack of an even distribution of the participants in terms of strategic level and functional area it is not possible to draw conclusions regarding the view from different types of participating groups. Any differences in feedback between the groups cannot be analysed, but as a comment it can be worth mentioning that all interviewed groups share similar opinions for the importance of the elements but it can differ in the view of establishment. For a further research the authors propose to investigate difference between the functions in the model, as well as difference between the strategic levels.

6.1.3 Open feedback for the model

During the structured interviews open feedback where collected and are listed in Appendix B.5. The results in Table B.5 *Open questions regarding the developed Early Management model* contain information about the operations at the case study company and have therefore been restricted. A compilation of these interviews is presented in Table 9 below.

Table 9: A compilation of the results from the open questions regarding the developed Early Management model.

Questions	**Answers**
Are there anything that should be included in the model?	• Continuous Improvement tools • Feedback loop between Manufacturing and Product Development • Links to existing processes • People working together (e.g. job rotations) • Sales organisation
Are there any weaknesses in the model?	• Does not show the ownership of actions on the feedback • Discipline to applying it • How to prioritise • How to break the silos between departments?
What are the strengths?	• A feedback loop exists. Follows the essence of CI. • Clear and easy to understand • It is proven that these kind of loops and CI are working • The simplicity • It provides a complete picture with the four main areas
Any general feedback on the model?	• A requirement for this model to work is to have easy access to information. • Important to have good visualisation of relevant information for the employee • The model is too general • The problem seems to be between boxes rather than what's in the boxes. • Put clear definition on what we mean with Vertical Start-up • Important for the employees to see if suggestions have led to any changes • Standardised work process would be ideal but all projects are different (different machine, configuration, customer maturity)

From the open feedback on the model the main findings can be summarised as the model is comprehensive and easy to understand. The majority of the participants gave positive feedback and appreciation for the developed model. A strength is that the model covers the internal supply chain well in the main areas, but for example sales organisation is not included. A reoccurring weakness described is that every installation project is customised which makes it difficult for a standardised work process. Also, the model only includes feedback from the installation projects but there is an opportunity to capture feedback from the test facilities in Capital Equipment where the filling machine is first assembled.

6.1.4 Structured feedback on the identified critical success factors

In this section, the results from the three structured questions regarding the proposed critical success factors are investigated. The overall results from the two first questions are compiled and visualised in Figure 10. The left-hand columns (grey) are showing the average scoring of the first question "*Importance for model to work in practice*", while the right-hand columns (black) represent the average scoring on the second question "*Established in a structured way*".

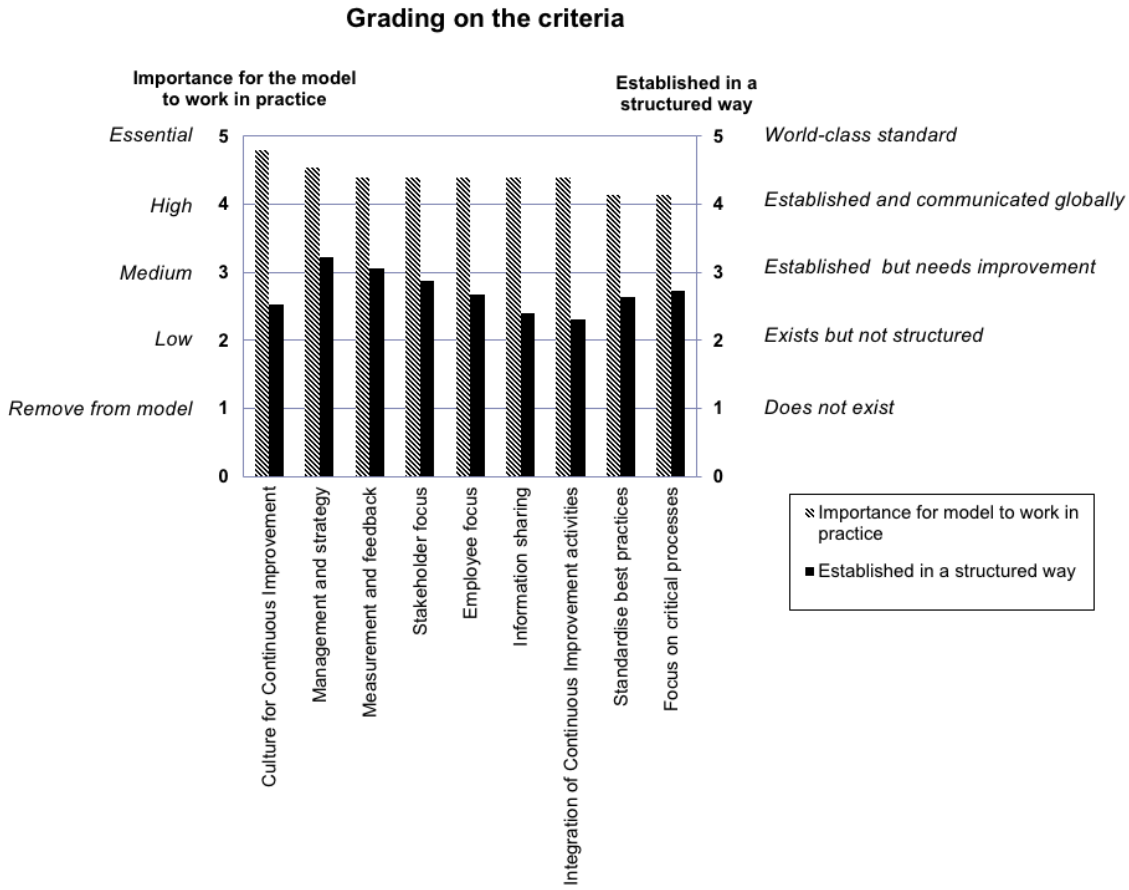

Figure 10: The diagram above shows the average results of the two questions: "How important is the criterion for the model to work in practice?" (right columns) and "Established in a structured way?" (left columns).

Analysing the first question, the total average of all critical success factors is 4.4, which is considered as a *high* to *essential* importance for the model to work in practice. Furthermore, all critical success factors have got a score above 4 (*high*). *Culture for Continuous Improvement* has been ranked as the most important criterion with a score of 4.8, while *Focus on critical processes* has been ranked lowest, with a score of 4.1. In other words, all critical success factors are seen as important. Using the pattern-matching model described earlier, any differences of importance between the factors cannot be proven since the biggest difference in scoring between them is 0.7.

Linking to the second question, the total average of all critical success factors is 2.7 which is considered to be in between *Exists but not structured* and *Established but*

needs improvement. The biggest difference is found between *Management and strategy* with a score of 3.2, and *Integration of Continuous Improvement activities* with a score of 2.3. The greatest difference is thereby 0.9, proving no difference in the establishment. It can though be of interest if the case company will do further investigations.

For the third question, *How much do you think the implementation of the model depends on the Enablers and Drivers*, the result was 4.4 (*high* to *essential*). By comparing it to the total average results for the first question, scoring 4.4, it shows that the critical success factors are, according to the participants, equally important for both implementing and sustaining Continuous Improvement at Installation projects. Finally, the structured questions have shown that all the critical success factors listed in Table 8 are seen as important for achieving Continuous Improvement in installation projects.

6.1.5 Open feedback on the critical success factors

After the three structured questions, the participants were asked open questions regarding the critical success factors. Table 10 is showing a compilation of the most valuable answers collected during the interviews.

Table 10: A compilation of the answers from the open questions regarding the critical success factors.

Questions	Answers
Are there any other critical success factors to include?	• Suppliers are main stakeholders • Joint venture innovation with suppliers • Time and resources • Tools should be integrated into all elements • Feedback from suggestions to urge motivation
Are there any weaknesses with the critical success factors?	• There is room for interpretations (too few details) • Alignment of the KPIs • Shared measurements that the employees can influence • More details regarding Management and Strategy
What are the strengths?	• The critical success factors are on a good level • Capturing the difficulties with achieving Continuous Improvement • Top management commitment is essential and needs involvement on all levels
Any general feedback?	• Standardise best practices should be included in Focus on critical processes • Digital strategy should be removed • The descriptions should be divided into own critical success factors • The list of critical success factors should be reviewed continuously • Culture should be a driver • Too few details and too general critical success factors

As can be understood when reading the motivation for the critical success factors in this thesis, many of the comments stated in Table 10 are indirectly included in the already existing list of factors. In other words, it has been observed that the participants wanted more specific details showing exactly how to establish the critical success factors. Below, some of the comments that are not seen as discussed in the previous sections, are analysed.

Starting from the top of the list, the suppliers can be seen as a stakeholder. However, it is not clear that they are directly contributed by the developed Early Management model. The authors therefore only state the suppliers as a contributor to the results of the installation projects. For stating them as a stakeholder, further investigations should be done. Joint venture innovation is involved in the earlier comment and is seen as something that may be outside the borders of the Early Management model. The model is focusing on the in-company processes and has not taken in consideration involving suppliers in its context. The importance of the involvement should not be neglected though.

Tools are something that has been mentioned several times during the interviews since it is a part of the case company's slogan for improvement; *People, Process and Tools*. The authors find this as integrated into the competence area for the criterion *Employee focus*, but it is mainly involved in the model element *Work process*, where *Problem solving methodologies* is a description.

The comment regarding including *Standardise best practices* with *Focus on critical processes* is something that could be done. The reason why it is a separate criterion is that it should be a general way of working in all processes, rather than just a part of the critical processes. Not all involved processes are seen as critical for the installation projects.

Digital strategy was brought up by S1 (2016-11-29) since S1 believed that the case company already has a strategy for sharing information. The authors state though that the strategy has to be highlighted as very important for the success of the Continuous Improvement for installation projects since it involves people that are spread out globally at the customers' sites.

Overall, the conclusion can be made that the critical success factors were often seen as too general and that each criterion included too many different descriptions. This made it hard for the participants to give each criterion one grade, instead of grading each description. The risk of having such grading system would be that the participants would not focus on the overall contribution of the critical success factor but rather on the small details. The intention of having descriptions was to highlight important examples found in literature and during this study for achieving the specific criterion. In order to establish a plan for how to achieve Continuous Improvement, more specific investigations have to be done for each criterion. Furthermore, the comments are showing that the participants have a high level of understanding for Continuous Improvement. The comments should therefore be seen as more detailed descriptions to focus on for the case company, rather than something that will change the existing list of factors. The conclusion of this analysis is thereby that all the critical success factors listed in Table 8 are seen as important for achieving Continuous Improvement in installation projects. Hence, no changes of the critical success factors should be made.

6.2 Early Management

This section contains an analysis of the Early Management methodology which will assist for answering RQ1: *"How can a theoretical Early Management model be designed to achieve Continuous Improvement for Installation Service?"*. For Early Management, only a limited amount of theoretical sources exists. For this reason the theoretical framework has been complemented with theoretical sources about Continuous Improvement and TPM. The empirical data have contributed with practical examples for the usage of an Early Management system. By combining the findings

from the theory and the empirical study the development of an Early Management model can be done.

6.2.1 The developed Early Management model

Early Management is a method for improving the development and introduction of new products. The approach is to capture learning from the introduction of new equipment or products in order for product development to improve the product design. By continuously improving the product design the purpose is to pro-actively eliminate waste in terms of quality, time and costs (Baines et al., 2006). The Early Management methodology contains two parts; Early Equipment Management and Early Product Management. Early Equipment Management aims for eliminating waste in the introduction of new equipment (Singh et al., 2013). The installation process should be defect free and the equipment should meet its functional specification from the start, the so called Vertical Start-up (Gupta et al., 2003). Early Product Management focuses on improving the product development process and the introduction of new products, with the aim to decrease the "*product-to-market-time*" (Singh et al., 2013).

The case study company's own definition of Early Management is "*Development and implementation of new products and production systems*". The methodology description from the empirical data from Tetra Pak's internal training and the material provided from SCO is well-aligned with the theory. The Early Management model in the SCO organisation is cross-functional between Product Development and the installation projects at customer site. The core capability of the model is to transfer feedback and information between the different areas described in the model. The SCO organisation has gained great results and benefits from using the Early Management methodology, and therefore their model has worked as a foundation when developing the Early Management model for Installation Service.

The developed Early Management model from the case study will focus on Early Equipment Management and exclude Early Product Management. One of the reasons is that the business target for implementing Early Management is to improve Vertical Start-up. Another reason is that the case study was conducted at the Installation Service and Capital Equipment departments, and the authors did not have access to empirical data from Product Development. Without insight in the product development process, Early Product Management was excluded from the development of the model.

6.2.2 Challenges for achieving Continuous Improvement with Early Management

The Early Management pillar in WCM focus on the introduction of new equipment or products, where the Vertical Start-up is synonymous with an efficient and effective installation of equipment. Since one of Early Management goals is to improve the installation of equipment it is natural to consider Early Management

when wanting to introduce Continuous Improvement at *Installation Service*. However, the issue is that Early Management is not a standalone methodology, but depends on the establishment and experience of previous pillars in WCM (Singh et al., 2013; Suzuki, 1994). From analysing the theory, the conclusion is drawn that implementing Early Management single-handed will not be sufficient to achieve Continuous Improvement. For example, 5S is the foundation in WCM and contains to standardise the processes and sustain that the processes are being followed (Singh et al., 2013). The importance of having a standardised process is pressed in Tetra Pak's training for Early Management and in the material provided from the Early Management experiences in SCO. A standardised and fully followed process is a pre-condition for Early Management in order to be able to update and improve the work processes. If no standard is in place, there is nowhere to capture and implement new improvements. The conclusion is that Early Management alone will not achieve Continuous Improvement for Installation Service. For this reason, the development of an Early Management model has been complemented with RQ3: "*What are the Critical Success Factors for achieving Continuous Improvement in installation projects?*". With RQ3 the aim is to ensure that the developed model will achieve the expected results by defining what are the pre-conditions needed. The Critical Success Factors can be compared as Continuous Improvement capabilities, that are needed for any type of Continuous Improvement program or methodology. Without building up the Continuous Improvement capabilities first, there is a risk that a CI program will fail to deliver the expected results.

One of the main challenges the authors have identified for achieving Continuous Improvement in Installation Service is the lack of standardisation. As described above, in order to do structured improvement work there need to be a baseline or documented structure to do the improvements in. One of the reasons for the lack of standardisation is that every project scope is customised. The project scope can contain a single machine or several lines and the customers have different requirements. Another reason is that the actual installation process is not well documented or followed in the clusters. The installation process is described in three main formats, but the description in the formats are not fully aligned with the real process of the projects execution. Furthermore, since there are several sources for how to execute the installation projects, this can contribute to a lack of motivation for the employees to read and follow official processes. For example, one disputed area in the central organisation is whether or not the installation manuals are sufficient enough or used by the clusters during installation projects. There is a similar situation with not accessible information at the official platforms regarding the measurements for Vertical Start-up KPI which could be a reason for the data errors in reporting of the KPI.

Another challenge identified with Early Management is in the theoretical descriptions, the installation projects are considered to be performed in-house and

not at customer site. Due to that the installation projects are at the customer's site, this increases the challenge with implementing Early Management or Continuous Improvement methodology for Installation Service. When installation projects are performed within the company the installation environment is consistent and within the company's control. On the other hand, when being at the customer's site the working environment is never the same and more parameters are out of the company's control and influenced by the customer. Problems that are frequently reoccurring such as the customer's utilities, could be addressed and handled once if the projects would be at the company's own production facilities. The collaboration with the customer is another parameter that influences the projects at the customer's site. Having good customer collaboration is crucial in order to gain access to the necessary means and to keep the time plan. For example, during the performance test the customer must provide with the accurate production volume and operators to run the lines during a specified time frame. The two main challenges identified by being at the customer's site are the installation environment and the dependency of the customer collaboration. The customer relationship is of higher importance for the service industry than the manufacturing industry (Owina et al, 2016). Since the authors have perceived that the customer is often the least ranked stakeholder, it has been identified as very important.

6.3 Reducing the installation lead time

This section analyses the information concerning RQ2 "*How can Early Management be used to reduce the installation lead time?*". First it is analysed if the Early Management methodology is suitable for the purpose of lead time reduction. Following is an analysis if the developed Early Management model can result in lead time reduction at the case study company.

6.3.1 Early Management as a tool for reducing the lead time

The case study company's strategy is to reduce the Vertical Start-up time with 50% and Early Management is the proposed approach for achieving this business result. On behalf of Tetra Pak, the case study has included RQ2 to analyse whether or not Early Management is a suitable method. To answer RQ2, information from the empirical study has been analysed, as well as the theory from Early Management and the findings connected to RQ1.

Based on the theory in section 3.3, Early Management is a suitable method for reducing the installation lead time and improving the Vertical Start-up. Early Management aims for a defect free process and elimination of waste, for example losses in time. By having a structured process in place, Early Management ensures that learnings are captured and that waste is continuously reduced (Baines et al., 2006). Hence, theoretically Early Management should continuously improve the installation projects and reduce the lead time. Other waste reductions, for example in

quality issues, can be expected but is not investigated in this study. The magnitude of the improvements and lead time reduction is not possible to tell from the theory.

The Early Management model in section 5.1 have been developed with the purpose to reduce the installation lead time. Due to the scope of the case study and the 50% business target the lead time is limited to the Vertical Start-up time. The identification of the elements that impact the Vertical Start-up time is based on findings from the problem investigation in section 4.4.3. From the analysis of the empirical data 15 elements have been identified and are presented in the section 5.1. To analyse if the Early Management model will lead to lead time reduction, structured interviews were used as described in section 6.1. The result from the structured interviews show that the model has a high credibility for achieving its purpose within the case study company. However, it has not been possible to measure the results from the developed model since it has not been implemented. Likewise, it is not possible to measure or estimate the magnitude of the lead time reduction as a result from the Early Management model.

To conclude, Early Management is a suitable methodology for achieving the business goals Installation Service at Tetra Pak are aiming for. The methodology is believed to result in lead time reduction and other benefits e.g. improved quality and customer satisfaction. The Early Management methodology is considered to be suitable for more organisations that both manufacture and install their products. After it has been concluded that Early Management is a suitable approach for lead time reduction, the parameters that affect the installation time need to be identified. The identified elements together with the developed Early Management model and the analysis of the Early Management methodology is the answer to RQ2 "*How can Early Management be used to reduce the installation lead time?*".

6.4 Analysis of critical success factors

This section is providing the authors' analysis related to RQ3, "*What are the critical success factors for achieving Continuous Improvement in installation projects?*". The structure of the section is divided into the critical success factors found in chapter 5.2. Each section will start with analysing the connection between theory regarding Early Management and other Continuous Improvement methodologies. A combination of them has to be considered since Early Management is implemented after several other pillars, and thus the associated theory is focusing more on the hard factors than for regular Continuous Improvement critical success factors. This will be followed by the current state of the case company built on the empirical findings. Finally, the possibilities of how improvements should be achieved would be analysed and what they would lead to.

The results from the structured interviews (Ch. 6.1.4) have shown that the critical success factors developed in this study have credibility. Furthermore, the feedback is

indicating that they are important and covers the difficulties with both implementing and sustaining Continuous Improvement. Thereby, the list will be unchanged.

The results show too little variations in order to be able to prioritise them for what is most important to start with. But, from the theoretical findings it has been found that the most important critical success factors are touched by Management, Culture and Employees, why these will be the first factors to focus on. This is true especially during the implementation phase. Following, the critical success factors are listed and analysed:

Culture for Continuous Improvement

According to the theory for TPM, the first pillars, Autonomous Maintenance, Focused Improvements, Planned Maintenance and Quality Maintenance should be implemented in the consecutive order before the company is ready for implementing Early Management pillar (Singh et al., 2013; Suzuki, 1994). The implementations of the first pillars are ensuring that the culture for Continuous Improvement already exists in the rest of the company's departments beforehand. Early Management is a concept that is cross-functional and is therefore dependent on the other departments' contribution to get the wanted effect. For example, improvement suggestions and actions should be handled cross-functionally in the organisation from installation projects to Production and Product Development. Another example is that equipment should continuously be updated with new innovations to gain business results (Suzuki, 1994; Schonberger, 1986).

The perception of low of motivation for reporting issues in QuTI-P is a sign for lack of Continuous Improvement culture at the installation projects. This is also strengthened by the results from the structured interviews. It shows that the willingness of change and to improve equipment quality is on a too low level. There can be many factors why it is low. One factor could be if their effort very seldom leads to any change, the interest will eventually go away. The other departments therefore need to show their gratitude for receiving feedback. By training the employees in Continuous Improvement concepts and making them see that their effort leads to changes, the willingness for improving may be reborn. It also will urge for following the standards.

Employee focus

The importance of the employee focus for achieving Continuous Improvement is mentioned in the majority of CI methodologies (Bhuiyan and Baghel, 2005). Early Management is not an exception. It is also urged in all of the investigated articles regarding critical success factors. The employees executing the installations are the ones that are constantly working with the equipment and the installation process and therefore, those are the ones that can identify the improvement possibilities. By

training them in concepts of Continuous Improvement and Early Management, making them participate in Continuous Improvement teams and give suggestions, it would lead to employee involvement and empowerment.

As stated in the empirical data, the case company is providing trainings for improving installation skills for their employees. However, the level of competence needed is not stated in either the ItP process or installation manual. The authors thereby believe that by stating the competence needed in the processes, it will urge the employees to participate in trainings and thereby increase the competence level. It will also facilitate an easier competence planning, which has been found as an issue for not achieving Vertical Start-up. The results of the structured interviews confirmed that the focus on employees is too low at this point and thereby, this factor should be emphasised by the managers.

Focus on critical processes

As stated in section 3.1.2, all critical processes should be identified and documented in a flow-chart. For establishing Early Management, processes are found in the majority of the case company's departments since it involves that actions are performed in the whole organisation. The critical processes would be the installation execution as well as the Product Development process and they should constantly be reviewed and improved. The product development process is a critical process in the aspect of making the required improvement changes for equipment and product design. The installation process is critical for the execution of the equipment introduction and Vertical Start-up. Since the information flow between the installation project and Product Development is crucial for the existence of Early Management, this should be considered as a part of the critical process.

It is clearly stated that the critical processes involved in the model, especially installation execution and Product Development process, should be identified and documented. In processes, the process owners, customers and suppliers should be identified, which is to some extent done today. The results from structured interviews are though indicating that it is not on the wanted level in order for achieving Continuous Improvement. A reason may be that there have been doubts about the alignment to the processes, and therefore, the importance of this has to be clarified for the employees, thus it is crucial for Continuous Improvement. A reason for why this may be harder to achieve in installation projects than in a production facility is the influences from external factors. The alignment to process enables the possibility to review and update the process in a structured way. As mentioned earlier, this cannot be done today, since there are doubts if the process is followed.

Standardise best practices

One goal with Continuous Improvement is that best practices should be shared and be implemented as the new standard (Kaye and Anderson, 1999; Oprime et al.,

2011). This is also the foundation to TPM, which is the 5S, described in section 3.2.1. One of the core focus areas in Early Management is capturing and sharing of learnings and best practices for both installation executions and development of equipment and products. Hence the standardising of best practices is an essential part in Early Management. The absence of it in the installation projects' global processes conducted by the case company, makes it a critical success factor in order to achieve Continuous Improvement. The results of the interviews indicate that it does exist in some extent, maybe on a local level. If this is the case, the global organisation should take advantage of this and expand it even further.

Information sharing

This critical success factor has been emerged since several other critical success factors have been dependent on the way of sharing information. It plays an important role for communicating the culture, how to involve employees, sharing best practices etc. Furthermore, Early Management is a highly cross-functional model that is demanding an easy and efficient way of sharing information between departments. It becomes even more important since the installation projects are executed by different employees and in different parts of the world.

At the case company, the authors have found several issues pointing at lack in management but could in fact be traced back to communication issues in the organisation. Even if there is a top management support, that everybody agrees with the importance of management involvement and even if information channels exist, it is not sure that it will reach the employees at the lower levels. It does not mean that it is unimportant with the previous factors, but rather that it is very hard to achieve in a good way. The authors therefore urge for having a digital strategy for all information sharing across the company, minimising the risk of misunderstandings while opening up the opportunity to share more information in a better way. The results of the structured interviews show that there is a need for reviewing the way to share information in a structured and efficient way.

Integration of Continuous Improvement activities

In order to have an ongoing cycle of improvements, activities that are actively pushing on finding and achieving improvement opportunities should be integrated into the daily work (Suzuki, 1994; Kaye and Anderson, 1999). The foundation of the Early Management principle is built upon a cross-functional, integrated Continuous Improvement approach, why it is highly relevant for this model. As discussed earlier, the sharing of improvement opportunities found during installation projects to Manufacturing and Product Development is important and should thus be an activity that is a part of the process. In that way, it is an example of an integrated Continuous Improvement activity. By integrating activities of this kind, the company urge for the willingness for improvement which will contribute to a

Continuous Improvement culture. The investigation of the company at the global level shows a lack of these activities, but the results of the interviews is indicating that they exist but not in a structured way. The authors recommend thereby that the case company should do further investigations in this area to map how the current state really looks like.

Management and strategy

Management and strategy are seen as drivers in this model, even though they play an essential role during the implementation of the model since they are needed for establishing the culture and employee focus. It is also repeated through all the articles studied for critical success factors. Since Early Management is not any of the first pillars to implement, top management support should already be established, but how they are pushing the change is still of significant importance. By establishing a long-term strategy and have aligned measurable objectives, top management can urge managers on all levels to drive the change in the right direction. This is especially important for the project managers (Näslund, 2013).

The empirical study has indicated that there is not a clearly communicated desired state of installation projects, which tend to lead to lack of alignment between improvement projects. Furthermore, the managers are not agreed of how the current state looks like. Concerning the results of the structured interviews, the management and strategy are established, but there are room for improvement. The authors believe, with support from the theory, that an increased focus on this critical success factor will lead to better aligned improvement projects that will minimise the risk of sub-optimisation. By finding the real current state, the prioritisation of improvement projects can be more accurate, leading to the desired state in a faster way.

Stakeholder focus

The major stakeholder identified from the theory regarding Early Management is the part of the company that is suffering when there are losses in the installation process or if the installation of equipment is cumbersome. The customers are contributed with less interruptions and faster installations. Taking it one step further, the receiver of feedback also can be seen as a stakeholder since they often want specific information. In this case, it is the Product Development department that is the receiver of feedback.

There is a stakeholder focus on a higher level of the organisation, continuously reviewing customer satisfaction etc. On the lower level, i.e. in the processes, the authors have identified too low focus on the stakeholders. For example, the installation manual has not been reviewed by the field service engineers that are using them. The results from the interviews are further indicating that there is room for improvement. A higher focus on stakeholders in all levels and processes will

most likely lead to better performance of the processes which in return will give a better end result.

Measurement and feedback

In the aspects of Early Management theory, the measurements and feedback are mainly used for detecting losses in terms of time, defects and quality. Since the installation projects will need a combination of Early Management and Continuous Improvement, the measurement and feedback should include other performance indicators related to success factors and business processes on all levels in the involved organisations. By making all involved managers and employees aware of the results, a drive for improvements would be expected.

The wanted results for this study is reducing Vertical Start-up, but since the installation project affects a major part of the company, other results should be collected during the installation projects and fed back to all involved departments. The results should give feedback on every level in the organisation, from the top, down to the FSE in order to drive the improvements.

The case company is using several measurements, amongst them KPI VSU that is one of the key measurements in installation projects is focusing on lead time, which is in line with an Early Management measurement. The measurements are shared within the company so that the employees can take part of them. The results from interviews implies the same, even if there can be improvements. The measurements should thereby be reviewed in order to urge for improvements.

7. Conclusion and recommendation

This chapter contains the conclusion of the thesis and the final recommendation to the case company. The purpose of the master thesis is to develop an Early Management model and critical success factors to achieve Continuous Improvement and reduce the lead time for installation projects. Three research questions was defined in order to fulfil the purpose and the aim of the chapter is to give the answer to the research questions. To conclude the report, the final section contains recommendations to the case study company as well as recommendations for further research.

7.1 Conclusions for the research questions

The following section is divided into three parts where each part is presenting the conclusion and answer for a research question.

7.1.1 Developed Early Management model

This section aims to answer RQ1 *"How can an Early Management model be designed to achieve Continuous Improvement for Installation Service?"* and the result from the developed model is presented in Figure 10. The purpose of this model is to achieve Continuous Improvement and reduce the installation lead time. The developed Early Management model is theoretical since it is not possible to implement the model for tests. The model contains the four main functional areas that drives the performance during installation projects. The four functional areas, *Product Development, Manufacturing, Installation Service* and *Installation Projects,* are responsible for the improvement categories with identified elements. The feedback loop from *Installation Projects* is the essence of the model and is believed to give structured improvements within the case study company. The purpose is to counteract problems earlier in the supply chain, and by doing so reducing the installation lead time at customer site.

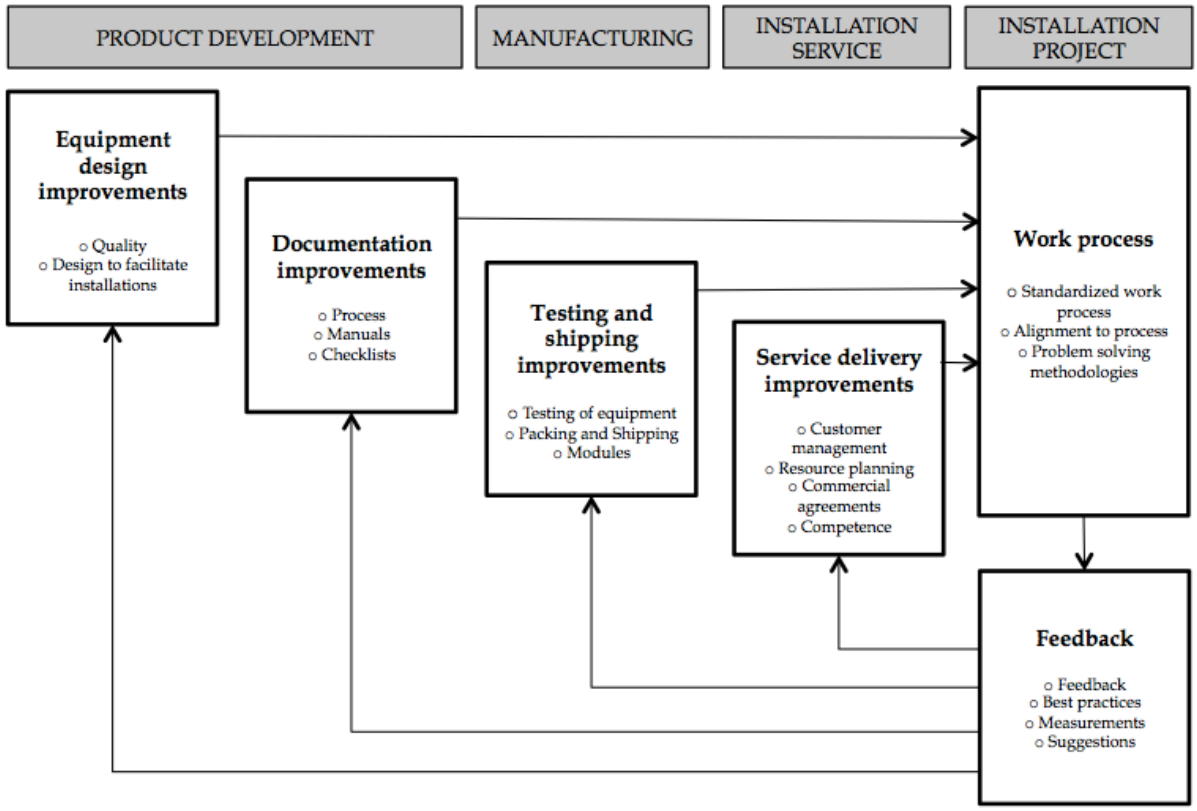

Figure 10: The developed theoretical Early Management model

The conclusion is that the empirical findings and the theoretical are well aligned. The well-functioning Early Management system in the SCO organisation functioned as a foundation for developing the model. The specific elements to be included in the model was further investigated to suit the DSO organisation and *Installation Service*. The identified elements that impact the Vertical Start-up time are described in Table 11.

Table 11. The identified elements that impact the Vertical Start-up time

Elements in the model	**Description**
Equipment design improvements	
Quality	• Quality improvements
Design to facilitate installations	• Installation projects considered during Product Development
Documentation improvements	
Processes	• Improved installation process description • Established definitions of all critical parameters for processes
Manuals	• Improvements to the installation manual

Checklists	• Updates to checklists or integration of checklists into the installation process or manual
Testing and shipping improvements	
Testing of equipment	• Testing to capture performance issues
Shipping and packing	• Securing the equipment condition
Modules	• The composition of the shipped modules from the test facilities
Service delivery improvements	
Customer management	• Customer collaboration and coordination • Ensuring customers responsibility and requirements • Customer competence
Resource planning	• Ensuring available staff with the right competence
Commercial agreements	• Dictates the terms for the installation scope • Requirements and responsibilities • Updates to the commercial contracts to reflect the current business situation • Value proposition and guarantees
Competence	• Competence development • Competence requirements for each activity
Work process	
Standardised work process	• Standardised work process for the installation projects • Updates of process
Alignment to process	• The execution of the projects are aligned to the standardised process
Problem solving methodologies	• Toolbox for supporting the execution of installation projects • Reduce the reliance on previous experience and competence
Feedback	
Feedback	• Feedback captured from the installation projects
Best practice	• Best practices and learnings captured and standardised
Measurements	• Measurements for performance indicators • Other measurements e.g. quality data
Suggestions	• Suggestions from the installation projects

Since the model could not be implemented during the case study it is not possible to measure the performance or results from the model. The chosen way to analyse the credibility and accuracy of the developed model was through structured interviews to collect feedback, as described in section 6.1. From the structured interviews the feedback was positive and indicating that the developed model and identified elements are important. All the identified elements in the model got a high score for "*Importance for improving Vertical Start-up*" and no captured data urged for changes in the model. From the feedback no required changes could be identified and the final proposal for an Early Management model is the same as the original presented model in section 5.

7.1.2 Lead time reduction through Early Management

This section provides with the conclusion to RQ2 *"How can Early Management be used to reduce the installation lead time?"*. Early Management is the proposed approach to reduce the Vertical Start-up time with 50% at the case study company. To answer RQ2, information from the empirical study have been analysed, as well as the theory regarding Early Management and the findings connected to RQ1.

Based on the theoretical findings, Early Management should continuously improve the installation projects and reduce the lead time. Early Management aims for a defect free process and elimination of waste, for example losses in time. By having a structured process in place Early Management ensures that learnings are captured and that waste is continuously reduced (Baines et al., 2006).

From the empirical findings, elements that affect the Vertical Start-up time was identified and incorporated in the developed Early Management model. The identified elements are described in Table 11 and have been confirmed through structured interviews as accurate. In the structured interviews the final question was *"Is the model applicable on Tetra Pak [in order to continuously improve Vertical Start-up]?"*, which received an average grade of 4.1. This indicates that the developed Early Management model has a high credibility within the case study company. To conclude, Early Management is a suitable methodology for improving the results at *Installation Service* and the developed model has high credibility for achieving lead time reduction. The magnitude of the lead time reduction is not possible to tell from the findings in this study. Other benefits in terms of waste reductions can be expected, but this study has been limited to lead time reduction.

7.1.3 Critical success factors for achieving Continuous Improvement in installation projects

The purpose of this section is to answer RQ3 "*What are the Critical Success Factors for achieving Continuous Improvement in installation projects?*". During this study, theory has been used as a guide for finding the critical success factors that can answer RQ3. Empirical findings at the case company has served as indicators for further developing and tailor the factors for this specific application. The outcome was thereby suited to achieve Continuous Improvement in installation projects, please see Table 12. The credibility of these factors has thereafter been tested by structured interviews to identify weaknesses and strengths. The average grade of the critical success factors was 4.4 and is thereby considered as highly important for Continuous Improvement. The feedback received has not urged for changes, and thus, the critical success factors that have been considered as answering RQ3.

Table 12: The critical success factors for answering RQ3.

Enablers and drivers	**Description**
Enablers	
Culture for Continuous Improvement	• Training in general quality concepts • Willingness for improvement and change • Perception of responsibility belongs to everyone • Communication systems and follow up by management on culture
Standardise best practice	• Capture and standardise best practice
Focus on critical processes	• Identify and document all critical processes • Identify business owner, customers and suppliers for the process • Define competences for each activity • Review and update processes in a structured way • Ensure alignment to process
Employee focus	• Training and competence • Employee involvement (e.g. suggestions) • Employee empowerment (e.g. participation)
Information sharing	• Digital strategy • Structured way of information sharing between departments • Requirements on information • Learnings from Continuous Improvement results
Integration of Continuous Improvement activities	• Improvement activities integrated in all organisations and processes

Drivers	
Management and strategy	• Top management role • Involvement of management on all levels
Stakeholder focus	• Stakeholder focus in all steps in the model • Main stakeholders are: Product Development, Manufacturing, IS Central, IS Clusters and Customers
Measurement and feedback	• Measurement on success factors and business processes on all levels • Awareness of measurement results to urge for improvement

The critical success factors are divided into *Enablers* and *Drivers* that are fulfilling different needs. The *Enablers* are seen as the foundation in order for the developed Early Management model to work in practice. The drivers for the Early Management model are needed both when implementing the model but also for driving the momentum in the long run in order to continuously change for the better. How these critical factors should be achieved is individual to every company, but a description of the details found during this study is shown in the right column in Table 12. By analysing the results from the structured interviews, it was not possible to make any prioritisation of the critical success factors. But by investigating the contemporary difficulties of the current state at the case company indicates how to prioritise the improvement efforts, please see next section.

7.2 Recommendations

This section includes recommendations for the case study company to capture the main insights and what value this study has provided. This is followed by a recommendation for future research and how this study has contributed to the academia.

7.2.1 Recommendation to the case study company

Early Management will be the first step to implement WCM in the *Technical Service* function and the approach contravene the principle of implementing the WCM pillars in sequence. The principle of implementing the pillars in sequence is to capture learning and build Continuous Improvement capabilities. As a consequence, the authors believe that the case study company first needs to build the Continuous Improvement capabilities for having a successful implementation of Early Management. The recommendation to the case study company is to get the foundation right by focusing on the critical success factors identified in this study.

Early Management is not implemented in *Capital Equipment* in DSO, even though *Capital Equipment* performs installations in-house and has implemented all other

WCM pillars. The Early Management methodology is recommended to first be implemented in the test facilities to gain learnings and best practices about the methodology. Early Management in *Capital Equipment* would have the benefit to be both physical and organisational closer to the responsible organisations and actions on feedback are therefore facilitated to capture feedback from the installations. The closer relationship between *Capital Equipment* and *Product Development* is also believed to facilitate investigations and analysis of problems or improvement opportunities, since both the functions are located in Lund.

One part of this study has been to investigate what is required in order to implement a well-functioning Early Management model. What has been discovered is that the critical success factors are not enough established and thus, the case company is not ready for implementing a cross-functional feedback system. If such implementation would be done, there is a risk for disappointing results, since it may not be used as intended during installation projects in the future. Therefore, the authors believe that the case company should use the critical success factors that answered RQ3 as guidance to reach the goal. The first area to focus on is to establish a strong Continuous Improvement culture. The idea is to permeate the organisation with the willingness to do better. This is the foundation to the majority of the Continuous Improvement methodologies, and this is not a coincidence. The culture is seen as the hardest area to establish and therefore the authors believe that much focus and resources have to be put into this factor. The following focus areas should be to strengthen the management, strategy and employee focus.

A structured interview guide, similar to the one used in this study, can be used by the case company as an assessment tool in order to map the current situation on a global level. A recommendation is to assess the quantified time influence of each element in the model. In that way, focus areas can be detected and prioritised.

All the processes involved in the installation projects should be mapped and reviewed, focusing on more detailed descriptions and with implemented Continuous Improvement activities. These processes should then be followed globally. One single comprehensive documentation format should be the aim for communicating the standardised processes and for facilitating communication of changes in the process.

7.2.2 Recommendations for future research

First, the authors would like to announce what this study has contributed to the academia. As the theory regarding Early Management mostly covers the internal elements for Product Development, the Early Management model developed in this study can be served as an example of how it can be used for improving installation projects. This model may also be of great value for other companies that are struggling with performance during installations. As the ingoing elements are

specific to the case company, some adjustments are to be expected of applying it to other companies.

Further on, the critical success factors for achieving Continuous Improvement stated in this study has been tailored to installation projects and the difficulties connected to them. In that way, the academia now has been contributed with a list of critical success factors reflecting the issues with complex installation projects at customers' sites.

This study has covered the theoretical part of developing an Early Management model. The ongoing VSU project at the case company involves opportunities for further researches. Since the Early Management model facilitates information flows, the next step would be to investigate how to categorise and prioritise feedback from the installation projects, as this has been requested by the case company.

The theoretical Early Management model developed in this thesis has not yet been implemented at the case company. Therefore, a continuation for this study would be to test the model in order to validate its performance. The development of a Continuous Improvement maturity assessment through the implementation process is another area.

For generalisability, the study conducted at this company can be duplicated onto other case companies that are in the same phase of expansion for Continuous Improvement as Tetra Pak. By finding similarities and differences, a more general model could be developed.

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Appendix A

A.1 List of participants for open interviews

Table A.1.1: List of participants for open interviews

People	Strategic level	Position	Organisation
P1	Tactical	Business Process Coach	DSO CE - Capital Equipment
P2	Tactical	Project Manager B	DSO CE - Capital Equipment
P3	Tactical	Global Expert B	DSO TS - Technical Service
P4	Tactical	Global Expert B	DSO TS - Technical Service
P5	Tactical	Global Process Driver	DSO CE - Capital Equipment
P6	Tactical	WCM Champion	DSO CE - Capital Equipment
P7	Tactical	Quality Manager	DSO CE - Capital Equipment
P8	Tactical	Manager PMO	DSO TS - Technical Service
P9	Strategic	Installation Service Director	DSO TS - Technical Service
P10	Tactical	Project Manager B	DSO TS - Technical Service
P11	Strategic	Quality Manager	Danfysik A/S (Non Tetra Pak)
P12	Tactical	Food Safety & Quality Services BM	DSO TS - Technical Service
P13	Tactical	Global Expert B	DSO TS - Technical Service
P14	Tactical	Senior Project Manager	DSO TS - Technical Service

Table A.1.2: The list of open interviews and meetings conducted at the case company.

People	Date	Topic
VSU team meeting	2016-09-06	Introduction to VSU project
P1	2016-09-07	Introduction to OFCE
P2	2016-09-07	Introduction to VSU
P3	2016-09-08	Certified Performance
P4	2016-09-08	Background information for VSU
P5	2016-09-09	Business Processes connected to VSU
P6	2016-09-09	WCM training part 1. WCM Basics
P7	2016-09-12	Connections between PD and operations regarding VSU
VSU team meeting	2016-09-16	Weekly update for the VSU project
P8	2016-09-19	KPI VSU
P2	2016-09-19	Follow up master thesis
P9	2016-09-20	Supervision master thesis
VSU team meeting	2016-09-20	Weekly update for the VSU project
VSU team meeting	2016-09-27	Weekly update for the VSU project
P2	2016-09-27	Problem identification for VSU
P10	2016-09-28	Problem identification for VSU & Risk management tool
P6	2016-09-30	WCM training part 2. Early Management
P8	2016-10-03	Problem identification for VSU & GMEA Workshop findings
VSU team meeting	2016-10-04	Weekly update for the VSU project
P11	2016-10-07	Continuous Improvement during installation projects
VSU team meeting	2016-10-11	Weekly update for the VSU project
P12	2016-10-12	Vertical Start-up in other companies than Tetra Pak
P13	2016-10-19	PLMS system & Product Development TS streamline
VSU team meeting	2016-10-19	Weekly update for the VSU project
P2	2016-10-27	Follow up master thesis
P3	2016-10-27	PLMS system & Performance tests
VSU team meeting	2016-10-31	Weekly update for the VSU project
P5	2016-11-01	Prioritisation Product Development
P2	2016-11-04	Follow up master thesis
P9	2016-11-04	Supervision master thesis

P4	2016-11-08	KPI VSU historical data & QuTI-P resolution statistics
P9	2016-11-11	Supervision master thesis
P2	2016-11-11	Follow up master thesis
P14	2016-11-15	Early Management findings
P12	2016-11-15	Vertical Start-up in other companies than Tetra Pak
P9	2016-11-18	Supervision master thesis
P11	2016-11-20	Continuous Improvement model and criteria
VSU team meeting	2016-11-22	Weekly update for the VSU project
P2	2016-11-23	Empirical study structure
P9	2016-11-18	Empirical study structure
VSU team meeting	2016-11-29	Weekly update for the VSU project

A.2 List of conducted structured interviews

Table A.2.1: List of participants for structured interviews.

People	Strategic level	Position	Organisation	Central/Cluster	Date interviewed
S1	Strategic	Director IS	DSO TS	Central	2016-11-29
S2	Tactical	WCM Champion	DSO CE	Central	2016-11-30
S3	Tactical	Project Manager B	DSO CE	Central	2016-12-01
S4	Strategic	Director OFCE & BSS	DSO CE	Central	2016-12-02
S5	Operational	Project Manager	DSO TS	Central	2016-12-02
S6	Operational	Project Manager	DSO TS	Cluster	2016-12-05
S7	Tactical	Project Management Office	DSO TS	Cluster	2016-12-06
S8	Tactical	Global Expert IS	DSO TS	Central	2016-12-06
S9	Strategic	Director Operations & WCM CE	DSO CE	Central	2016-12-06
S10	Operational	Project Manager	DSO TS	Cluster	2016-12-06

S11	Tactical	Project Management Office	DSO PD	Central	2016-12-07
S12	Operational	Project Manager	DSO TS	Cluster	2016-12-07
S13	Tactical	Project Management Office	DSO TS	Cluster	2016-12-08
S14	Tactical	PMO Manager TS Central	DSO TS	Central	2016-12-12
S15	Tactical	PMO Manager TS Cluster	DSO TS	Cluster	2016-12-12

A.3 Interview guide - Structured interviews

The interview started with a presentation of the authors, the scope of the project and the goal with the interview. Some questions were asked as introduction:

What is your position at Tetra Pak?

Do you have any practical experience from installation projects?

Do you have any experience of WCM or Continuous Improvement?

The authors described how they have developed the Early Management model with a detailed description of each element. The participant was then asked to grade the elements with a number 1 - 5 accordingly:

Elements in the model	**Importance for improving Vertical Start-up (1-5p)**	**Established in a structured way (1-5p)**
Equipment design improvements for		
Quality		
Design to facilitate installations		
Documentation improvements for		
Processes		
Manuals		
Checklists		
Testing and shipping improvements for		
Testing of equipment		
Shipping and packing		
Modules		
Service delivery improvements for		
Customer management		
Resource planning		
Commercial agreements		
Competence		
Work process		
Standardised work process		
Alignment to process		

Problem solving methodologies		
Feedback for		
Best practice		
Measurements		
Suggestions		
Other feedback		

General question	**(1-5p)**
Is the model applicable on Tetra Pak?	

After the grading, four open questions followed:

Is there anything that should be included in the model?

Are there any weaknesses in the model?

What are the strengths?

Do you have any general feedback on the model?

The authors described how they have developed the criteria. The participant was then asked to grade the criteria with a number 1 - 5 accordingly:

Enablers and drivers	**Description**	**Importance for model to work in practice (1-5p)**	**Established in a structured way (1-5p)**
Enablers			
Culture for Continuous Improvement	• Training in general quality concepts • Willingness for improvement and change • Perception of responsibility belongs to everyone • Communication systems and follow up by management on culture		

Standardise best practice	• Capture and standardise best practice		
Focus on critical processes	• Identify and document all critical processes • Identify business owner, customers and suppliers for the process • Define competences for each activity • Review and update processes in a structured way • Ensure alignment to process		
Employee focus	• Training and competence • Employee involvement (e.g. suggestions) • Employee empowerment (e.g. participation)		
Information sharing	• Digital strategy • Structured way of information sharing between departments • Requirements on information • Learnings from Continuous Improvement results		
Integration of Continuous Improvement activities	• Improvement activities integrated in all organisations and processes		
Drivers			
Management and strategy	• Top management role • Involvement of management on all levels		
Stakeholder focus	• Stakeholder focus in all steps in the model • Main stakeholders are: Product Development, Manufacturing, IS Central, IS Clusters and Customers		
Measurement and feedback	• Measurement on success factors and business processes on all levels • Awareness of measurement results to urge for improvement		

General question	**(1-5p)**

How much do you think the implementation of the model depends on the Enablers and Drivers?	

After the grading, four open questions regarding the criteria followed:

Are there any other Enablers or Drivers to include?

Are there any weaknesses with the Enablers and Drivers?

What are the strengths?

Do you have any general feedback on the Enablers or Drivers?

The authors thanked the participant for the interview. End of interview.