Managing Production deviations
- A case study at Scania AB

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Master of Science thesis
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Hantering av produktionsavvikelser
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Abstract

The use of continuous improvement programs is a widespread practice present in many organizations throughout the world. CI-programs are mostly associated with Lean production and substantial focus in literature and research are on the applicable tools and methods. This focus has led to the lack of attention to the softer areas of CI such as implementation. The reason explaining this might be due to the difficulties of measuring success in these areas.

In order to investigate production deviations within a company that uses CI a study was performed at the bus chassis assembly at Scania. The deviation handling process and all activities related to it is highly influenced by Scania’s Production System. The studies were conducted at an assembly area with observations and interviews taking place as well as an internal benchmarking performed at the engine assembly.

The conclusion is that the area studied at Scania has the tools and methods needed (although with the need of adjustments) but the implementation part is lacking. This area will come to play a big part in taking SPS one step further.

As a recommendation to the area studied in Scania a group of suggestions has been presented in this paper in order to improve the implementation of SPS. The managerial contribution of this paper is a group of important suggestions. The theoretical contribution of this paper can be seen as a case study that could create an increase insight in the complexity of this topic but also to increase the attention to the importance of it.

Key-words
Production deviation, continuous improvement, lean, SPS, Scania, standardization, work-groups, implementation, human factor
Sammanfattning

Ständiga förbättringar är ett världsomfattande fenomen som används inom flera organisationer. Oftast associerar man ständiga förbättringar med Lean och litteraturen kring ämnet beskriver för det mesta bara verktygen och metoderna som tillämpas. Detta focus har lett till att väldigt lite uppmärksamhet har riktats mot de mjukare delarna så som implementering. En orsak till detta kan vara svårigheten att mäta framgång inom området.


Slutsatsen är att monteringsområdet där studien ägde rum på Scania har verktygen och metoderna som behövs (med behovet av mindre justeringar) men implementeringen har brister. Just implementeringen kommer spela en stor roll i att ta SPS ett steg längre.


Nyckelord
Avvikelser, ständiga förbättringar, lean, SPS, Scania, standardisering, arbetsgrupper, Implementering, Mänskliga faktorn
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Armin Muftic
Abbreviation list

CI – Continuous improvement
SPS – Scania production system
MO3 – Assembly area 3
PL – Production leader
TL – Team leader
PrT – Product technician
PT – Process technician
LL – Local directorate
DQM – Daily quality meetings
C-deviations – Critical deviations
L-deviations – Legal requirement deviations
M-deviations – Major deviations
S-deviations – Standard deviations
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1 Introduction

This chapter introduces this thesis. A background of the problem area is given as well as a short presentation. This is followed by the objective, research questions, delimitations, limitations and lastly the outline of the report.

Manufacturing has always been a competitive industry and companies have always tried to gain advantages through various improvements. In 1911 Taylor started a revolution within the manufacturing industry by introducing the assembly line. His methods and procedures drastically increased the productivity of Fords’ production and transformed the way we see production. Despite the success Taylor and the assembly line received a lot of criticism due to their great focus on only the technical aspects. While Taylorism does consider humans it focuses on creating a process where an employee’s part should be effective as can without any consideration for the well-being of person.

The quest for competitive advantage has led many companies to adopt the practice of Continuous Improvements (CI) (Bessant & Caffyn, 2004). The act of continuously improving manufacturing is often associated with Lean, Six Sigma or TQM. The idea of lean production has spread beyond its origin in Japan and the Toyota motor company. It has become widespread in west and has moved from just being a manufacturing approach to a philosophy (Slack & Lewis, 2008). The basic idea of it is to focus on customer satisfaction first, everything that is not value adding should be considered a waste (Womack & Jones, 2003; Bergman & Klefsjö, 2007).

Most of the literature present within the field of CI focuses largely on the tools and methods and very little attention is given to the implementation and the human aspect. This has led to critics stating that CI is de-humanizing and explorative (Williams et al., 1992). This statement led to the idea that CI-programs should not only consider the technical tools and method but also the social sides of the human dimension of motivation, empowerment and respect (Hines et al. 2004; Taleghani, 2010). While this new and more modern view is emerging there is a limited amount of information within the theoretical field.

In this thesis the case of Scania and their buss assembly in Södertälje is the point of interest. Scania are using a bundle of CI tools and methods that they call Scania Production System (SPS). The inspiration for SPS comes from Toyota Production System meaning that it is heavily influenced by Lean production.
1.1 Problem Setting

By devoting a lot of time and effort into waste elimination, Scania managed too increase their vehicle volume output while retaining the same amount of personnel in production like figure 1 illustrates. Improvements in safety, quality, delivery and efficiency are all credited to SPS and the continuous work at their assembly plants.

To tackle future threats in the industry Scania need to improve their assembly to make sure it produces less defects. In an interview (Scania Inside, 2012) Anders Nielsen, head of Production and Logistics puts emphasis on how it is not enough to just work with deviations and errors when they have already occurred but instead to understand the root cause and solve them long-term. He sees a great challenge for production and he emphasizes how it is important to work with quality and deviation issues to reach the goal of zero-deviations. Scania has a future vision of 150 000 vehicles (both bus and trucks together) produced per year while retaining the same personnel (figure 1), this according to Nielsen is a hardreached goal that requires commitment.

![Figure 1 Scania's vision](image)

The focus of CI is to constantly improve the processes by eliminating waste. Scania consider production deviations as a very large waste, these deviations, or errors occur everyday and they are categorized differently depending on how serious they are. The categories are: Standard (S), Major (M), Legal (L) and Critical (C). The last two (C and L) are considered equally serious and are put under the same category meaning that in practice there are only S, M and C deviations.
By dividing them into different categories it is easier for Scania to prioritize what deviations should be solved first. Scania’s vision is to have zero deviations.

The chassis assembly in Södertälje is divided into two different areas, one for trucks and one for buses. Currently the bus assembly area is producing approximately 13 vehicles per day and the truck side is producing 41, despite this the bus assembly has more C-deviations. Considering this, the zero deviation goal and the future goal of 150 000 vehicles per year it is necessary to investigate the bus side further to give suggestions as to how Scania can improve to meet future demands and requirements.

With the current pressure on production to eliminate waste and work more with deviations to reach present goals, a discussion of the problem area with the Product Engineering Manager Anna-Karin Nordwall was conducted. With her input as well as the authors an objective was formulated.

1.2 Scania Production System

Scania Production System is Scania’s continuous improvement program which is their interpretation of lean. This production system has been made into a leadership philosophy that reaches far beyond just production and it is the center of Scania’s operations. SPS consists of several different blocks as illustrated by figure 2, together they make up the SPS-house. (Bergman & Klefsjö, 2007)

SPS is used in all of Scanias production sites worldwide and its purpose is to contribute to continuous improvements. Ideas that could lead towards improvements are encouraged and improvements made in one factory are spread to the others to ensure that the global production idea is met. (Scania Sverige)
1.3 Objective
The objective of this thesis was to do an analysis of current methods, processes and assembler attitudes that are related to production deviation handling at the bus chassis assembly in Södertälje. By doing this it was possible to map the deviation route from origin to closure. Work related to deviations is both proactive and reactive so the aim was to evaluate the current state and to identify what areas could be improved to reach the goal of zero-deviations in production. Production and operational work is given a lot of responsibility to handle production deviations so the thesis will look at them from the assembler’s perspective.

1.4 Research Questions
With consideration to Scania’s vision of having zero-deviations it is important to investigate how to lower the amount of production deviations. When a production deviation has occurred it is not supposed to occur again, at least not if the deviation handling process has been conducted in the correct way and it can be closed. While investigating these Scania-specific issues it is important to know that the problems could occur at other companies as well. Producing defect products is considered one of the wastes and it certainly exists within many organizations. Because of this, the questions are formulated more generally in the hope of giving both managerial and theoretical contributions. Therefore the first two Research Questions are:

**RQ1:** How can the amount of production deviations be lowered?

**RQ2:** How can a production deviation be closed for efficiently?

The methods at Scania that are related to the deviation handling process are standardized and documented. It is important that they are performed in the correct way for the deviation handling to work efficiently. This leads us to Research Question 3:

**RQ3:** How are standards viewed from an assembler’s perspective?

1.5 Delimitations
The study was performed at MO3 (assembly area 3) which is one of four areas in Scania’s bus assembly in Södertälje. This delimitation was chosen because of the qualitative nature of this thesis.

This thesis investigates production deviations at the operational level and from assembler’s perspective. This was a requirement put forward by Scania.
Scania divide deviations that occur in production into five different segments as illustrated by figure 3. This thesis only considered deviations that occurred when assembly was not performed according to work order.

Since SPS is heavily influenced by CI and Lean the theoretical areas in this thesis coincided with these two. Because deviations or producing defect products are considered a waste by Scania as well as theory (Womack et al., 1990; Ohno, 1988; Shingo, 1981) using this theoretical focus was thought to help solve the problem.

1.6 Limitations
Since humans and human interaction was a significant part of the system under study, it was not unlikely that the work force have an interest in portraying themselves in a more positive way than perhaps is the truth, something that was not possible to control. This is not a fact, but a risk that was a limitation to the research and more specifically a limitation in interviews and investigations.

Another risk was that the other departments that participated in the internal benchmark were not positive to participate. They may have feared to lose control or to be portrayed in a negative way and there was no real incentive for them to participate in this study.

The solutions were not general but adapted to the unique situation at MO3. Despite this the thesis attempted to be a bit more general in its result with the aim to contribute to the existing knowledge in this particular field. Because the general theoretical area is CI it could potentially be of use at other companies.
1.7 Outline

The outline for this thesis is illustrated in figure 4. The methodology chapter describes how the data was gathered in this report, the findings are presented in the empirical data chapter. The theoretical framework describes a bundle of CI tools and methods that are used at Scania.

In the analysis chapter the empirical findings are analyzed in two parts, the first one is on how the tools and methods work and the second part is on the implementation.

Lastly, the conclusions and recommendations are presented. In this chapter the contributions are divided into managerial and theoretical. As previously stated this thesis tries to generalize the specific findings to contribute to the field of CI implementation. The chapter is concluded with suggestions for future research.

Figure 4 Outline of thesis
2 Methodology

This chapter gives an introduction of the methodology used in this thesis. The methodology used affects the way information is gathered and how information is interpreted. The chapter initiates with the scientific approach used and the considerations taken. The following parts include an explanation on how the literature review was performed. The final part explains how the empirical study was performed.

2.1 Scientific Approach

The research paradigm that shaped this project was an interpretivevistic view on how the research should be conducted. The chosen paradigm has been described as the following by Collis & Hussey (2009, p57):

“Interpretivism is a paradigm that emerged in response to criticisms of positivism. It rests on the assumption that social reality is in our minds, and is subjective and multiple. Therefore, social reality is affected by the act of investigating it. The research involves an inductive process with a view to providing interpretive understanding of social phenomena within a particular context.”

In order to understand why this paradigm was chosen, it is good to explain the not chosen and opposite paradigm, positivism.

“Positivism is paradigm that originated in the natural science. It rests on the assumption that social reality is singular and objective, and is not affected by the act of investigating it. The research involves a deductive process with a view to providing explanatory theories to understand social phenomena (Collis & Hussey, 2009, p56).”

Positivism and interpretivism may be considered as each other opposites, but there is a grey scale between the two, which means that it is possible to be more or less related to each individual paradigm (Collis & Hussey, 2009). However, there is a close link to the interpretivism view in a number of areas, as example;

- Reality is subjective and multiple
- Researcher interacts with that being researched
- Researcher acknowledges that research is value-laden and biases are present
- Process is inductive study of mutual simultaneous shaping of factors with an emerging design (categories are identified during the process). Research is context bound patterns and/ or theories are developed for understanding. Findings are accurate and reliable through verification.
With consideration to the statements above it could be said that this case study was leaning more towards interpretivism.

With a paradigm as a foundation for the research, the second cornerstone was to do a qualitative explanatory case study, which took place at Scania’s bus assembly in Södertälje, Sweden. The purpose of the case study was to investigate and explore a single phenomenon in its natural setting, with a variety of methods to obtain a deeper knowledge. With this being an explanatory study, the existing theory was used to understand and explain a current phenomenon (Collis & Hussey, 2009).

What separates case studies from other studies is the fact that the phenomenon is not isolated from its environment. The main purpose is to understand how its behavior or process is influenced or influences its context (Cassell & Symon, 2004).

2.2 Literature Review
The theoretical framework used for this thesis was taken from academic publications within the field of CI. The purpose of the literature review was to describe the existing literature in a specific subject field (Rowley & Slack, 2004). The current literature was evaluated to see if there is a possibility to identify gaps where further research could be conducted. It was found that most CI literature focuses on tools and methods leaving little room for implementation. Because Scania has already implemented CI through SPS it could be possible to study this gap within the implementation area.

Furthermore, Rowley & Slack (2004) highlight how literature reviews are also important in:

- Identifying literature that will contribute towards the research
- Facilitating the building of a list of sources that have been consulted
- Suggesting research methods of interest
- Analyzing and interpreting results
- Building an understanding of theory
- Supporting the identification of the research at hand

The scientific article gathering was conducted with the help of the following databases: Emerald, Scopus, Google Scholar, SpringerLink and ScienceDirect.
2.3 Method
The empirical data for this thesis was gathered from observations and assembly practice at the assembly area of MO3, interviews with employees at the same area and also from benchmarking.

2.3.1 Production observation and assembly practice
In order to understand the existing procedures and the pronounced methods available, the authors observed the production and took part in the assembly themselves, a data collection approach called participant observations which is suitable for case studies (Yin, 2003). The aim of the observation and assembly practice was to get a good understanding of the current situation by studying the process in its natural environment. The result from the observations and assembly practice are presented in the situational description that in turn acted as an input for the continuous work in this thesis.

The aim was to study the bus assembly area and to understand how this is allocated and divided. The assembly practice also gave the opportunity to create a closer understanding in how the assemblers work with the deviations and to understand how the assembly work affects the origin of deviations. This practice gave a first insight in the opinions that exists in the assembly area and it created a foundation for further work. Furthermore, it gave the authors a good opportunity to interact with assemblers.

During a period of time the authors attended the various meetings held every day where topics related to deviations were being discussed and presented. The aim of this was to understand the organization and how it operates when deviations occur.

The assembly presented an opportunity to study the different standards that exists today in the organization. The standards of most interest were the position standard and the assembly standard. The study of the mentioned standards was performed in order to understand the structure behind them. This was important because these standards are created and updated by assemblers and a central part in deviation handling.

To further understand Scania’s views on standards and deviations internal SPS courses were attended. They gave a basic understanding on the values and the work and the purpose behind many aspects strongly related to deviation handling. These courses also presented the authors with guidelines on how a standard should be constructed in accordance with SPS.
2.3.2 Interviews
The interview was formulated in a semi-structured approach to give the respondent the possibility of answering freely, in other words a qualitative study that supports the case study methodology (Collis & Hussey, 2009).

This allowed for the respondent to give their view on the deviation process without being led on. By having a semi-structure it was also possible ask follow up questions to receive more details, an approach that is supported by Beamon (1999). The interview questions used can be viewed in appendix 1. While having a semi-structured approach to interviews the authors also acknowledge that answers might be biased as stated in the limitations.

The target group was the assemblers at the assembly area MO3. Due to limit in time and resources available not all of them could participate in this study. In total 15 interviews were completed, this is out of 20 personnel in MO3.

The participants were chosen by a semi-random selection process. Four key persons were chosen because of their roles in the deviation process, two Team Leaders and two quality roles. The rest of the interviewed subjects were selected randomly from a list given by the manager of the said area. After being chosen and after accepting they were contacted by their Team Leader who sent them to the private room for the interview. No one refused to be interviewed.

The interviews were conducted in private rooms and the interviewed subject was given a copy of the questionnaire to ensure that they could take their time to read and understand all of the questions. The whole interview was recorded with approval and full anonymity was promised and given.

Each interview lasted between 30 minutes and one hour to complete. The assembly area of MO3 was given feedback in the form of a 20 minutes presentation of the findings and conclusions.

2.3.3 Benchmarking
The purpose of a benchmarking study is to find the best practice for a certain industry, this best practice could through implementation then be used to enhance performance (Camp, 1989). For this thesis the benchmarking was conducted at the engine assembly at Scania and is to be considered an internal benchmark because of this. The engine assembly is influenced by SPS in the same way as the bus assembly but their methods vary. The benchmark had one major and one minor aim. The major aim was to retrieve knowledge from other parts of the organization to help improve the case.
It was also more likely that the departments participating in the internal benchmark may be positive in participating since they may be helped by this research as well as the possibility of them to study the finished report later on. The minor aim on the internal benchmark was to examine if the problems are of general nature, if they exist in more departments of the organization.

If the internal benchmark shows that the problems are more general and of interest for more departments of the organization, it may also be of interest of making the research more general in order to be of higher value for the company.

Benchmarking is divided into three areas and they are classified by Carpinetti & de Melo (2002) as:

- **Process benchmarking** – used to compare work and business practices and operations
- **Product benchmarking** – used to compare products or services
- **Strategic benchmarking** – used to compare management and business practices and organizational structures

The benchmarking study in this paper was a process benchmark. It was conducted through a visit at the engine assembly plant where the production technician that is responsible for deviation work at the plant answered the questions. The questions in the investigation were formulated based on the results from the other studies to ensure that the problem areas found at bus were in focus.
3 Theoretical Framework

This chapter contains a review about continuous improvement programs. The chapter has been divided into two parts each discussing main aspects of CI-programs. The first part discusses the tools and methods used in CI-programs and the second part the implementation of CI-program where human factor, commitment and leadership are in focus.

3.1 Introduction to CI-bundles

This thesis focuses on production deviation that occurs at the operational level, these types of errors lead to defect products and are thus a type of waste (Bergman & Klefsjö, 2007). To eliminate waste a company has to continuously improve the operations within their organization (Womack et al., 1990; Ohno, 1988; Shingo, 1981). Different CI-bundles go under different names with Six Sigma and Lean being the most prominent ones. Most of these bundles have one important thing in common, waste elimination.

Muda, together with mura and muri are the three wastes. Muri is the term for overburden and it is overcome by having a work flow and a repeatable process. By overcoming muri there should be an increase in quality and productivity. Mura is the Japanese word for unevenness. It is overcome by using Just-in-time (JIT) or in some cases Six Sigma.

Muda is also considered to be the most important part of lean, but sometimes companies fail to realize that it is best achieved by changing employee behavior (Slack & Lewis, 2008). As stated in the introduction, the first step of eliminating waste, is to identify it. This suggests that it is important to put an effort into changing an employee’s behavior so that they contribute to the continuous process of waste elimination.

Muda is tackled by adding value to a specific process (Womack & Jones 2003). What a company considers waste can vary. However according to Bergman & Klefsjö (2007) one popular type of waste that is frequently mentioned and that has to be eliminated is producing defect products, or in other words production deviations. Tools and methods that reduce and prevent production deviation are: standardized work, mistake proofing, having a balanced workflow and work groups.

3.2 Lean definition

When thinking of lean the traditional set of tools and methods usually come to mind. Just-in-time, kanban and 5 whys are just a few of these that are applied to the operational level (Shingo, 1981; Ohno, 1988; Womack et al., 1990).
Liker’s (2004) prominent definition of lean is based on 14 principles that are crucial for achieving positive results. They are divided into the following four categories: problem solving, people and partners, process and philosophy (Figure 4). The 4P model he presents takes the people aspect into consideration. He developed this model after his time at Toyota in the US.

The different principles are divided into either social (soft) or technical (hard) dimensions by some authors (MacDuffie, 1995; Shah & Ward, 2007). This is further strengthened by the argument that in order to achieve successful lean there has to be a combination of the two when implementing (Bhasin & Burcher, 2006). This view is also investigated by Angelis & Johnson (2010) and it is suggested that lean is a socio-technical system meaning that it combines the tools with the human aspect. There are many similarities in this view and the modern view of seeing lean as a philosophy.

Dahlgaard & Dahlgaard-Park (2006) define lean as a production philosophy that tries to combine mass production with customer focused craftsmanship. Bhasin & Burcher (2006) define lean as primarily a philosophy while Shah & Ward (2007) on the other hand view lean as a combination of both philosophy and practice. It is also argued that the reason companies fail to implement lean successfully is because they view it as a process instead of a philosophy (Bhasin & Burcher, 2006). An investigation of lean amongst Australian companies concluded that it is unavoidable for companies to not adopt lean manufacturing as a working philosophy within their organization if they wish to succeed (Sohal & Egglestone, 1994).
Furthermore, the requirement of workforce commitment for successful lean (Forza, 1996; Bessant & Francis, 1999; Bhasin & Burcher, 2006) could be considered an application example of how a combination soft and hard aspects is essential. Hines et al. (2004) also emphasize the importance of the human aspect in lean. Humans are a very important variable in the success of CI. Hence it is of great importance to not only consider the tools and methods but also the implementation of these.

3.3 Tools and methods
Based on the theoretical framework of CI and Lean the following tools and methods were chosen. They are all related to production deviations in one way or another.

3.3.1 Standardized work
With standardized work the work performed by employees is simplified and variance is reduced, this leads to fewer errors (Liker, 2004; Bicheno et al., 2010). By having standardized work companies lay a solid foundation that is a main requirement in order for CI-programs to be effective. Standards of operations are written and used by human beings and this is important to keep in mind. While many authors within the field of CI agree that standardized work is essential for improvements few discuss standards in detail, especially the human aspect of it.

When considering a problem or subject where human beings are an important part of the structure, it may be wise to consider the connection and difference between tacit and explicit knowledge in an attempt to increase the understanding why certain decisions are made.

Tacit knowledge can be described as less specific knowledge and skills, which is kept by an individual or organization (Connell et al., 2003). Explicit knowledge on the other hand is easier to spread and the majority of explicit knowledge is technical or academic data written in a formal language (Smith, 2001). Smith also recon that there are moments when the tacit knowledge is not as appreciated as much as it deserves and that may lead to that important tacit knowledge is lost (Smith, 2001). According to Wah (1999) 90% of a corporation’s knowledge stored in the minds of their employees and it is obvious that the tacit knowledge is important but unfortunately handles few corporations the explicit and tacit knowledge efficiently (Bonner, 2000).

With consideration to the information above, it is interesting to study how Scania handles explicit and tacit knowledge. Some individuals might have specific knowledge that stops them from doing errors while others lack this knowledge and have to rely on the explicit knowledge. Explicit knowledge may not be enough to complete the task successfully with low errors.
3.3.2 Mistake proofing

There are a great number of mistake proofing approaches and none of them can be considered to be a single solution that fits all different types of companies. The different approaches will evolve and new approaches and solutions are presented as the industries evolve. The approaches can be categorized in four different perspectives according to what is being in focus (Tsuda, 1993):

- Mistake prevention in work environment
- Mistake detection
- Mistake prevention
- Preventing the influence of mistakes

**Mistake prevention in work environment**

This perspective is about how the process is designed in order to avoid errors and mistakes. This might involve how the tools or methods are used in the work environment to facilitate for the worker in avoidance of mistakes. These methods might involve in which way and in what quantities parts, documents, tools, etc. are presented in the work place.

Other studies in the process design suggest a different approach. A process structure is considered to have two different dimensions; wide process structures and deep process structures. Wide structures are processes where the operator has a lot of alternatives for a given choice and deep structures are processes that have a long series of choices. A human is best capable of handling either a moderately wide or moderately deep process structures but not very good if both are presented at the same time. The design of process structure should consider this dimension in order to avoid errors (Norman, 1989).

The idea of having quality controls, or inspections is something that goes against the teachings of Deming and his 14 principles (the third principle) that are the foundation of Total Quality Management (Bergman & Klefsjö, 2007). But with today’s large focus on customer satisfaction it would be very brave to not have any inspections at all.

**Mistake detection**

Mistake detections are inspections that occur after the process has been performed and they are normally named as quality control areas in the production industry. The data gathered from the inspections can be used in order to prevent further errors. A known technique in this area is the use of statistical process control where the deviations are monitored and followed related to a certain deviation limit.
These results are used in order to get an understanding in the development of deviations and could for example give a hint in a tool being worn out.

The inspections can be divided in two different types depending on who is making the inspection:

- Successive-checks
- Self-checks

Successive-checks are performed after the process and are normally performed by a quality responsible controlling the work of others. Self-checks give faster feedback and information about deviations since it’s performed by the same worker that does the work (Grout, 2007).

**Mistake prevention**

Mistake prevention is possible by using techniques that control the inputs of a process prior to actions being made, this is for instance used in the poka yoke method. This inspection can be performed without the need of human intervention by the use of electrical tools or by physical constrains that forces certain actions to be performed correctly. The aim with these inspections is to control the sources of failure before an error occurs (Shingo, 1986).

**Preventing the influence of mistakes**

Preventing the influence of mistakes the process is designed in a way that the impacts of errors are reduced or eliminated. There are two different ways of achieving this:

- Facilitating correction
- Decoupling processes

Facilitating correction are techniques that allows the user to easily correct a mistake done. The techniques are widely used in for example software with the use of undo and redo buttons. The idea is to create possibilities too easily and without any efforts offer the user the possibility to correct the error made.

Decoupling of processes are techniques used to separate the activities with high risk of errors from a point where an error can’t be corrected. An example where this is used is in e-mail services where deleting an email does not really delete it but instead moves it to a deleted emails folder. These techniques can also be used to prevent actions to be performed before. The user could for example get a warning message or information about current status before the point of regret has passed (Grout, 2007).
3.3.3 Work groups
A way for companies to create commitment is to have smaller groups of people who are responsible for CI within their working area (Kaye & Anderson, 1999). This way of working is often associated with Lean, although its origin is from general quality work. The purpose of the meetings is to develop and educate employees and to make them interested in CI and gain knowledge. However, this way of working requires a lot from top management in terms of time allocated to these meetings as well as to make sure that improvement suggestions are implemented. Work groups require resources to be successful.

3.3.4 5 whys
Analyzing a problem and identifying the root cause is important in CI because of the obvious effect on waste elimination. The method called 5 whys is a recognized tool used for this purpose. It works by asking the question why five times to follow the chain of causes to the root cause (Bergman & Klefsjö, 2007; Pettersen, 2009).

However, while being acclaimed as an efficient method that is easy to use it is not without its critics. Toyota’s former managing director Teruyuki Minoura stated that a problem with 5 whys is that it requires skill and understanding from the person using it, otherwise it will fall short and not add any value to the waste elimination process (Anderson, 2009). His experience has showed him that on-the-spot observations are the correct way to use the method, not by the commonly used deduction.

3.4 Implementation
The implementation of CI-programs is highly related to human behavior and the cultural part in an organization. Because CI focuses on eliminating waste the implementation must be successful. This specific area has received less attention due to the difficulties of grasping, connecting, finding supporting proof and fully understanding the topics in this area. Including other reasons for the lack of attention might be for the lack of human integration and the limited application outside high volume repetitive manufacturing (Hines et al. 2004).

A large amount of waste is the main reason businesses fail to generate acceptable performance. Studies have identified that waste is highly related to production metrics such as cost and inventory levels and that CI can contribute to the elimination of these (Sohal, 1994). However, according to Emiliani (1998) there is a lack of focus on social aspect wastes. Lack of communication or commitment is a common issue that is more or less accepted by organizations because of the difficulty of measuring their impact.
An issue with the social aspects of CI is the difficulty of measuring success, unlike financial metric these aspects do not have a number attached to them.

Successful implementation of CI is many times hindered by obstacles created by behavior. The root cause of these behaviors is not really understood so the consequence is an overall acceptance (Senge, 1995; Emiliani, 1998).

The aim for an organization should be to change this kind of behavior because of its lack of value adding. In order to gain a further understanding in the processes and root causes behind the development of behaviors there should be an increased understanding of what supports CI and what does not. The types of behaviors that do not support CI-programs are called fat behaviors. On the opposite side of the scale Lean behaviors are found and these together with the fat behaviors are presented in table 1.

<table>
<thead>
<tr>
<th>Fat behaviors</th>
<th>Lean behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ego</td>
<td>Calmness</td>
</tr>
<tr>
<td>Revenge</td>
<td>Reflection</td>
</tr>
<tr>
<td>Negativity</td>
<td>Patience</td>
</tr>
<tr>
<td>Gossip</td>
<td>Understanding</td>
</tr>
<tr>
<td>Selfishness</td>
<td>Rectitude</td>
</tr>
</tbody>
</table>

Table 1 Fat behaviors vs Lean behaviors

While CI is known for the tools and methods many companies fail to acknowledge the importance of good implementation. This usually leads to fat behaviors amongst personnel and the foundation of CI in the company is not stable. The social aspect is related to humans in an organization, therefore this report will explore the human factor, commitment and leadership.

### 3.4.1 Human factor

Since humans are an important part of processes in organizations it is important to consider the human factor and have an understanding of it. Frederick Taylor was early in his study regarding the human factor and the root causes of error created by it. He understood the important relation between production and human behavior and stated that it is important to understand all the areas related to the processes in order to maximize efficiency in all parts of it. While his view focused more on people doing things in the most effective way it is still considered a foundation for the creation of the CI-program lean (Waddell, 2005).
**Human Error**

The topic of human error is mainly studied in the psychologist field cognitive science. Cognitive science views humans as information processor, which attempts to direct actions and make decisions with limited resources. With the use of stored decision rules and action routines the humans can perform different tasks with little conscious intervention and use of resources (the human brain and energy).

Errors can therefore be seen as a natural consequence of using the decision rules or action routines in incorrect ways (Stewart & Grout, 2001).

The studies in the cognitive science have presented different ways of categorizing the human behavior and the different types of knowledge which is related to the errors a human can create. One of these areas is a theory about the process humans perform to take actions or solving tasks as presented in figure 5 (Reason, 1990). This process is considered to be divided into two steps:

1. Determining the intent of the action
2. Executing the action based on that intention

![Figure 6 Human process](image)

A failure can occur in both steps and cause errors. The errors that can occur are divided into two categories. The first category that is connected to the first step is called mistakes. Mistakes arise due to incorrect knowledge about the intention of the action. The second category is connected to the second step and named slips. Slips occur if the first step is correct but the execution is not performed as intended (Reason, 1990).
Knowledge categorization

Regarding knowledge a study categorizes it in three different types. The different types of knowledge available controls in what way actions are performed. The different types are shown in figure 7. (Rasmussen, 1983; Reason, 1990)

![Figure 7 Knowledge categorization](image)

The theory states that the brain adapts itself depending on the situation presented in order to minimize its efforts and use of resources. For activities that are common and performed in a routine basis the brain uses skilled based actions. The skilled based actions can be considered to be performed on autopilot. The rule based actions are using a set of rules that are known to work in different situations. In situations that have not been previously encountered the brain uses a knowledge based approach. In this case the actions performed are using the process of logical deduction to gain an understanding in what to do. Skilled based activities and rule base activities have evolved from knowledge based activity.

Another theory categorizes the type of knowledge two different types; knowledge in the head and knowledge in the world (Norman, 1989).

Knowledge in head is knowledge that is contained in the human memory and often this kind of knowledge requires significant amount of training and studies.

Knowledge in the world is a technique used to facilitate the introduction of knowledge to the head. These techniques can be reminders on what to in a certain situation with the use of embedded details in the process. Recommendations in how to put the knowledge in the world are the following (Norman, 1989):

- Natural mappings - design of the work area making the understanding of a relationship clear for example controls and the part that is controlled.
- Affordances - introduce features in the process which allows a certain action to be performed.
- Visibility - make the important parts easy to inspect
3.4.2 Commitment

Commitment is the relationship a worker has to the organization and their loyalty towards it (Angelis et al., 2011). Meyer & Allen (1991) propose a model where commitment is divided into three different perspectives. Figure 8 illustrates these.

The perspectives interact with each other shaping a specific commitment profile for each employee. Depending on the commitment profile an employee develops the part that is more noticeable will affect the way the employee behaves in the organization.

Affective commitment is the willingness of employees to get involved in tasks that go beyond their regular responsibilities, for instance improvement work. The affective perspective can be considered to be one of the most positive aspects of motivation and a characteristic wanted in every employee. It is the perspective that can be affected in order to increase the commitment of employees in an organization where CI-programs are applied (Angelis et al., 2011). The following characteristics distinguish affective commitment (Mowday et al., 1982):

- Personal characteristics
- Structural characteristics
- Job-related characteristics
- Work experiences

Several studies have been made regarding personal characteristics and how they can have an effect on affective commitment (Meyer & Allen, 1991). It has been discussed that there could exist a relation between job status and the time spent at
a company, which could in turn affect commitment. When work rewards and work values are controlled there are no signs of correlation (Mottaz, 1988; Lok & Crawford, 1999).

A study has found evidence where decentralization of decision making and formalization of policy and procedure have a correlation with affective commitment (Brooke et al., 1988; Morris & Steers, 1980). The issue with the studies are that they have had an individual objective rather that an organizational. It has been suggested that other reasons might affect affective commitment indirectly by work experience such as employee/supervisor relations, role clarity and feeling of personal importance (Meyer & Allen, 1991).

Work experiences perspective is applying the assumption that affective commitment might be developed as a result of satisfaction of employee’s needs and/or the compatibility of organizations values with the individual’s values (Meyer & Allen, 1991). This perspective can be connected to the motivation theory developed by Herzberg about hygiene and motivating factors. The connection to Herzberg’s theory allows for the categorization of work experience variables into two different categories presented in table 2. The first category named comfort are the variables that is about the employee’s need to feel comfortable in the organization and the second category are the variables that are related to the employee’s feelings of competence in the work role (Meyer & Allen, 1991).

<table>
<thead>
<tr>
<th>Comfort</th>
<th>Feelings of competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmation of pre-entry expectations</td>
<td>Accomplishments</td>
</tr>
<tr>
<td>Equity in reward distribution</td>
<td>Autonomy</td>
</tr>
<tr>
<td>Organizational dependability</td>
<td>Fairness of performance based rewards</td>
</tr>
<tr>
<td>Organizational support</td>
<td>Job challenge</td>
</tr>
<tr>
<td>Role clarity</td>
<td>Job scope</td>
</tr>
<tr>
<td>Freedom of conflict</td>
<td>Opportunity of advancement</td>
</tr>
<tr>
<td>Opportunity for self-expression</td>
<td></td>
</tr>
<tr>
<td>Participation in decision making</td>
<td></td>
</tr>
<tr>
<td>Personal importance to the organization</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Categorization of work experience variables
It is important to understand that the use of this categorization only works as a starting point in order to fully understand all the variables involved in commitment related to work experience.

Creating a higher understanding in affective commitment and by measuring it in an appropriate way, organizations might get a view in how well employees’ are acting in accordance to the organizations best interests (Meyer & Allen, 1991). Having a relationship towards an organization and the success of this relationship is highly related to the values shared by both parts. If values are shared between the parties involved the likelihood of increased commitment and success of the organization will increase (Meyer & Allen, 1991).

**Factors influencing commitment**
Commitment is a topic that has been studied for many years exploring different perspectives with the aim of finding the underlying causes that affects human motivation and commitment. A study made in this field has observed a number of companies with the aim of identifying practices that create commitment in an organization (Angelis & Fernandes, 2012). A set of factors that is assumed to affect commitment observed in the study are:

- Unfairness
- Blame feeling
- Design and implementation of processes
- Capture of suggestions
- Job rotation and pace control
- Job autonomy
- Work environment
- Employee empowerment

Unfairness is highlighting a feeling an employee might feel if a process is not designed with consideration to them. For example the stress and the fear of removal from a process as a rationalizing result of improvements (Buchanan, 1994). If an employee feels that the design of the process is not considering the employee this will create the feeling of unfairness and erode worker commitment (Angelis & Fernandes, 2012).

Once deviations or defects occur, workers might feel a sense of blame due to the investigation process. This sense of blame can persist a long time after the deviation which creates higher risks for the occurrence of more deviations.
It is important that the organization creates an environment where an employee does not get this sense of blame in order to increase the commitment and allow for improvements to be suggested and created more effectively. The employees must be given the opportunity and responsibility for improving the organization.

The design and implementation of processes is important due to ergonomic reasons. A study found a correlation between poorly designed processes where ergonomic issues appear and the amount of suggestions created (Adler et al., 1997). The evidence found could be explained to the employees feeling lack of technical support.

A study showed that implemented process suggestions increased with increased job rotation and pace control (Angelis & Fernandes, 2012). This could be due to the increased understanding of the process and lowered stress due to better control of the pace. It is also suggested that increased job autonomy might increase commitment due to the feeling of trust (Danford, 2003).

If improvement suggestions from personnel are to be wished for in an organization, management need to provide an environment where good communication exists. The importance of this is due to the possibilities of exchanging of knowledge and increased employee involvement (Angelis & Fernandes, 2012). This implies that an organization with good management practice is needed where management creates the environment that supports involvement (Millward et al., 2000). One strategy to increase involvement is to empower the employees which mean giving the employees more responsibility and possibilities to affect their work area (Malcolm et. al., 2004). However, it has been argued that empowerment has little effect on increasing employee satisfaction (Vidal, 2007) and not a necessary condition in order to achieve the goals of a CI-program (Vidal, 2007(2)). The study made by Vital shows that empowerment usually is limited in depth and breadth due to the need of changes in organizational routines and authority structure.

Management needs to be aware about observing and recognizing real commitment in improvement work and avoid a culture where only formal commitment is accepted (Angelis & Fernandes, 2012). Attending improvement meetings without actively participating is an example of formal commitment.

3.4.3 Leadership

A standing point of CI-programs is the importance of management commitment and involvement (Taleghani, 2010; Kaye & Anderson, 1999). The leadership’s ability to communicate the desired goals and being able to engage the whole organization towards the same common goal is related to the softer parts of management
commitment (Womack et al., 1990). Another important part of leadership regarding the implementation of CI-programs is related to the leadership’s ability to take care of the knowledge in house and learn from the results (Kaye & Anderson, 1999).

It is important for managers to have self-perception in order to fully understand the management style applied in the organization. The management style is a manifestation of personal characteristics that could affect the organization negatively if not fully recognized and understood. A leader applying fat behaviors will eventually create an organization filled with fat behaviors (Emiliani, 1998).

The way leadership is applied can have effects on other areas by means that could be counted as crucial for success of the strategy being used. One of this areas highly affected by the way leadership is applied is commitment. The strategy used for management is highly related to skills that are essential in order to be successful (Lok & Crawford, 1999; Brewer, 1993). The managers need to create stable basic conditions in order for the employees to become committed. Studies have shown that the inability of leadership of creating organizations where roles are well understood and defined, support is offered, existence of fairness, participation in decision making, trust in workers competence and opportunities to exercise this competence and management receptiveness of employees suggestions are all directly correlated to decreased commitment (Angelis et al., 2010). These areas affect employee commitment in a way that could be summarized in the employees’ decreased belief and trust on the operating management. In order for managers to avoid the negative effects generated by the areas mentioned above managers should strive to consider the following basic conditions (Angelis et al., 2010; Emiliani, 2003);

- Overtime should be voluntary in order to create an organization where support and fairness exist
- Time to perform tasks should be in a normal pace in order to create a work place where the execution of tasks are important and supported by work-standards
- Elimination of ergonomic problematic areas in the work place in order to avoid health issues and flow interruptions
- Creation of a blame-free environment where workers do not feel blame once deviations occur

The use of CI-programs is not automatically connected to increased commitment by workers.
CI-programs provide the tools and methods to be applied, but the creation of commitment is highly dependent to managerial strategy of execution where design and operation of the system is highly important (Hines et al., 2004; Taleghani, 2010; Angelis et al., 2010). Communication between management and subordinates is not to be forgotten. It is important that management keeps a dialog to subordinates in order to gain access to all the sources of feedback and personal performance.

It is highly important that no fear or threats exists in the communication system since the existence of these will create barriers and the creation of unwritten rules and assumptions that eventually leads to decreased commitment and issues not being discovered.

### 3.4.4 Pitfalls of implementation

There are many different pitfalls that could result in the failure of the implementation of a CI-program with financial losses as a result. A study made of European manufacturing firms (Dale & Lightburn, 1992) has identified six different stages of implementation of CI-programs in organizations. The different stages of implementation shows different characteristics positioning companies in different level of success (figure 9). Although this categorization is related to the implementation of TQM general guidelines can be drawn related to other CI-programs since the main problem areas are related to implementation issues like cultural and communication areas.

The companies in Level 1 are organizations that have adopted the CI-program to its fullest and doing exactly what is expected accordingly to the improvement program guidelines. Level 2 companies have also experienced success in the implementation but suffering problems in maintaining the level needed to sustain the gains of implementation. The main issue is to maintain the culture needed in this kind of organizations. Level 3 companies have been practicing the improvement program for some years and the issues regarding this company is lack of commitment from mainly middle managers since they don’t support the improvement program. This leads to poor commitment and performance since their personal belief is contaminating the work being done. Level 4 organizations are organizations that have implemented the tools and methods in the process but many of these are mainly performed only in a superficial manner. In this type of company the senior management is not fully embracing the CI-program which is spread downwards the organization. Staff is likely to be cynical about the commitment of senior and middle management.
Level 5 organizations have recently started to implement the tools and methods of the improvement programs and the development of the program depends on an effective management that can bring new energy to the organization during difficult periods. Level 6 organizations have not started implementing an improvement program and most of the thoughts and opinions in the organization are mainly related to resistance and the low belief that the improvement program can be implemented (Dale & Lightburn, 1992; (Kaye, 1999).

The study states that many of the studied organizations remain in level 3 and 4 due to different obstacles that prevent the development to higher levels of success. The obstacles can be summarized as follows:

- Divergence from routines
- Defective communication and planning
- Defective follow-up of results and quality
- Lack of commitment and attention to quality improvement
- Lack of investment
- Resistance to change

Divergence from routines is one of the first aspects of why implementation of CI-programs fails. This could descend from different reasons as for example pressure
on delivery or differently view of processes and/or people. It is important that the management provide a good planning to be able to reach the desired goals (Dale & Lightburn, 1992).

Defective planning and communication creates issues where stress and errors are created. It is important that the communication between customer and provider is maintained in order to avoid harmful situations and to be able to develop (Kaye, 1999).

The follow-up of results and the effects of quality issues are important to be able to evolve and learn from the process. If data is not collected it is difficult to know in what direction the production is heading. By collecting data the customers can have a sense of comfort by knowing that the process is being controlled and deviations taken care off (Kaye, 1999; Dale & Lightburn, 1992).

Lack of commitment from the management is important when it comes to suggestions from the employees. If the information gathered and the suggestion provided is not being taken care of, the employees will lose incentive to commit to the improvement program and management will lose credibility (Kaye, 1999).

To be able to evolve, the organization and management need to be prepared to invest time, resources and facility in order to develop the organization in the way it is meant. By not doing this problems will never be solved and the improvement program will not be successful (Dale & Lightburn, 1992).

The last problem area is resistance to change working practices and procedures. This is mainly due to the resistance in evolving and might descend from fear. Workers might see a CI-program as a threat to current situation (Dale & Lightburn, 1992).

Figure 10 presents a fishbone diagram created in a study examining the causes of why management might lack influence with followers in an organization (Emiliani, 1998b). It has a clear relationship to the topics discussed previously and the study presents a group of reasons causing the issues; communication, trust, processes and environment.
Summary
The chapter presented an introduction to CI-bundles with a focus on lean production with its tools, methods and implementation. An introduction to the human perspective was also presented with a focus on human error and the process humans use while performing tasks. Other areas that were discussed were knowledge categorization and commitment where areas that might have an effect on commitment where presented. The chapter was finished with a presentation of categorization of companies in 6 different levels where level 1 is the most desirable. The categorization is related to how far the implementation of CI-programs has reached and what the main obstacles that exists, preventing a company to fully succeed with an implementation and reaching level 1.

The theory discussed in this chapter will be helpful in the following analysis of Scania’s tools and methods and to gain a further understanding in how far the implementation has reached. With the theory it will also be possible to understand why issues exist today in the area studied and what can be done to improve these.
4 Empirical Data

This chapter presents the empirical data from production observations, interviews, practice and benchmarking. The chapter is divided into three parts with the first one describing methods and processes based on practice, observations and information found in standards. The second part presents the information gathered from interviews and the third and last part is data gathered from benchmarking.

4.1 Situational description
The following section presents empirical data from the investigations.

4.1.1 Bus chassis assembly MSB
The bus chassis assembly assembles buses for delivery to the entire world together with the sister production site in Brazil. The customers differ widely and therefore the types of busses ordered differ as well. The lead/takt time is 30 minutes per chassis, this is considered quite long.

The bus chassis assembly area is a progressive assembly line where the chassis of the bus is assembled in sequential line assembly areas. The areas are named and placed in the following order;

- MO1 – the chassis is assembled and connected and supports are mounted
- MO2 – PVC-pipes, electrical system, pressure tanks and front axle are mounted
- MO3 – rear axle, engine, fuel tank and temporary driver’s cabin are mounted
- MO4 – radiator, wheels, containers, battery etc are mounted and the area finishes with test driving and preparing the bus for transport

Each of the areas named above is supported by pre-assembly areas in which parts that are mounted on the line assembly areas are assembled and prepared. The pre-assembly areas are the following

- Pre-assembly MO1 – assembly of front and back of chassis
- Pre-assembly MO2 – assembly of front axle, pressure tanks and PVC-pipes
- Pre-assembly MO3 – assembly of rear axle, fuel tank, engine and driver’s cabin
- Pre-assembly MO4 – assembly of radiator
The body work of the bus is not assembled in Scania since this area is usually performed by the customer due to wide differences in design and areas of use.

Each of the line assembly areas is finished with a quality control where a controller checks areas of interest and tries to discover any deviations. *(This topic is further explained in following chapter about deviation handling.)*

**Organization**

Every line assembly area together with the related pre-assembly has a production leader (PL) that is in charge of the specific area. The PL is responsible for the assembly, adjustments and control, quality and improvement work, working environment, development of the area, assuring that the needed resources and competence is in place, etc.

Every area and every pre-assembly area has its own team leader (TL). The TL is responsible for planning, instructing and coordination of the work in the area. The TL is also responsible to introduce new workers in the area, work as a support for the improvement group, make sure the different standards are followed, active work with quality issues and improvement work and rapport deviations.

Product technician (PrT) is responsible for the product related areas in the line assembly area and its related pre-assembly areas. They are also responsible for working with deviation problems that arise during production.

Process technician (PT) is responsible for the process related areas in the line assembly area and its related pre-assembly areas. They are also responsible for working with deviation problems that arise during production.

Every station has its own group of assemblers that are more or less always in the same area. The main idea is that the assemblers should rotate working places within the area they are working in, which is not a stated rule and is usually up to each to decide if they wish to rotate. The assemblers are responsible for the assembly of the buses and working with deviations that arise during production. The assemblers are also responsible for a certain area of control or improvement, this task is called as a specific role (more about this in the following part).

**Work groups within the organization**

Every line assembly area and pre-assembly area has its own improvement group. This group consists of TL and the assemblers of the area. The improvement group is responsible for areas of improvement in their respective area of work and this could be process- and/or product improvements. Every assembler in the area is a member of the improvement group and each has a special area that they are responsible off.
The work with the special area is named role-work since different roles are assigned to different assemblers. The following are the different roles existing today:

- **Quality** - responsible for quality related areas as deviations and improvements
- **Machine and maintenance** - responsible for machines, maintenance of them and assuring that updated information is available
- **Material** - responsible for material and logistic related areas
- **Method** - responsible for standards and assuring that standards are updated
- **Process** - responsible for updating information about process related issues and work with improvements
- **Product** - works as a support for changes in products and to spread information about product related areas
- **Safety and environment** - assuring safety and environment related topics are followed and to spread information

Every line assembly area together with related pre-assembly area has its own local directorate (LL). The local directorate consists of PL, TL, PrT and PT and they are responsible for personal related topics and production related topics where deviations play an important part.

Scania has recently implemented a new method of work groups named 5+1. The idea with 5+1 is to more actively work with quality related deviations. 5+1 work group consists of a TL and five assemblers that will be considered to be experts in problem solving. The goal with 5+1 work groups is to more actively and in real time work with deviations and quality related issues.

**Meeting structure**

There are a number of meetings that are held during the day in the production area. These meetings involve different members of the organization and the level of information differs as well.

The first meeting of the day is the meeting of the improvement group of every area in the production line. This occurs every day which is the first task before the production starts and the agenda for this meeting involves discussing all the deviations from the previous day and workforce planning.

After this meeting has been finished the TL that has been responsible for gathering the information compiles the important parts of it and prepares for the next meeting.
The following meeting is the meeting of the LL shortly after the previous one. The agenda for this meeting involves discussions about production related areas as accidents and injuries, planned reparations, workforce for the day, deviations the previous day, stop time from the previous day and review of planned activities. This meeting is led by the PL who gathers the information and the discussions are considered to be more detailed.

After this meeting the PL compiles the important information and prepares for the next meeting.

The following meeting involves all PL’s, manager for the product technicians, manager for the process technicians and the bus assembly manager. The agenda for this meeting is that each PL presents the information gathered from the previous meetings. The information is then presented in a board that visualizes the current status of the production regarding workforce, deviations, production output, etc.

After this meeting the bus assembly manager has another meeting with the MS management group. In this meeting all the managers from MS together with the manager for MS discuss what’s been discussed in each production area.

At the same time as the MS management group has its meeting the product managers and the process managers have their own meetings with technicians where the agenda is to summarize the previous day and follow up from the managers regarding different issues/tasks and spread information of importance that has been presented in the previous meeting.

The meetings previously mentioned are named daily controlling and the agenda as discussed above is mainly to discuss the deviations from the previous day. A schematic of daily controlling is presented in appendix 2.

Once every day daily quality meetings (DQM) are being held and these meetings are short meetings with PL, PT, PrT and TL. These meetings are held near the improvements boards that are placed near the related assembly area. The agenda of these meetings is to check the status of improvement and deviation tasks and to decide if they are ready to be closed, which means that they are satisfied with the results, or if they need to work further with the task.

4.1.2 Standards
There are several standards in use at Scania currently. This section presents the standards applicable to this thesis, in other words; those that are related to production deviations.
**Position standard and element sheet**

The assembly method and sequences are stated in different standards which can be found in every station and in each side of the stations. In these standards the workers can find information about the following topics:

- Which station and on which side of the line the standard is applicable
- Assembly work
- In which sequence the assembly is supposed to be done
- Quality controls
- Information about the areas where deviations might occur and the effects if they occur
- The time it takes to do a certain task
- Which tool is involved in a certain task
- Material and parts needed for assembly

The idea with the standards is to create a guideline of work that is used as a support to avoid deviations if the standards are followed by the workers. An example of a position standard and an element sheet is presented in appendix 3.1 and 3.2.

**Update of position standard and element sheet**

The standard is updated by the method role in the specific area where the standards are being used. The first step is to decide the steps that are involved in a certain assembly sequence. It is important during this step to identify all the steps that are involved and to identify the risk areas where deviations might occur. The next step is to use a stop watch to measure the time it takes to do a certain step. This step is important to be able to plan the total amount of time it takes to perform a certain assembly sequence and this is linked directly to the cycle time.

The assembly standard is supposed to be updated every time a new change of the product is introduced or if there are new steps that need to be stated in the standard. These steps might be new control points that have been introduced due to previous deviations.

**Deviation-handling LS112**

The standardized way to perform the process of deviation handling at Scania is defined in Deviation-handling standard LS112.
The standard describes the rules that are to be followed, the communication channels, the people involved in the work and the tasks that are involved in the procedure once a deviation has been detected.

**Responsibility distribution**

Role distribution is described to ensure that communication channels function well. For instance, every quality controller is responsible to report discovered deviations directly to the assembler that has created the deviation as well as to write down the deviation in the chassis-protocol and register it in the internal software Process.

The problem owner is the one responsible to follow the deviation and for closing the deviation once a solution has been presented. The production leader is usually the problem owner but in the case of closing C- and L-deviations the PL does not have the authority to do so, in those cases a member of the MS management group performs this task.

The solution owner is the one that is in charge in finding a solution and to correct the deviation. The solution owner is the assembler that created the deviation and must report back to the problem owner.

**Deviation classification standard LS1409**

The deviations are classified according to a standard called LS1409. In this standard the deviations are organized according to the following classification:

- C-deviations – critical deviations
- L-deviations – Legal requirement deviations (treated as C-deviations)
- M-deviations – Major deviations
- S-deviations – Standard deviations

The standard also states the guidelines that are to be followed when deciding how to classify a deviation. The work procedure is presented in a schematic in appendix 4.1.

**Deviation step-by-step guide**

The general steps that are to be followed once a deviation occurs and has been discovered are the following:

**Deviation feedback, adjustment and report**

1. Identify the deviation
2. Call the assembly area responsible for the mounting
3. Write information about the deviation in the chassis-protocol
4. Record the deviation in process (internal software to register production related matters)
5. The area responsible for the assembly controls the deviation and gathers information to be able to find a solution
6. The area responsible for the assembly corrects the deviation
7. Reports back to the responsible assembler and the area of assembly
8. The area of assembly that is responsible for the assembly returns to their workplace to further work on a solution. Before this the assembling area checks all the chassis on line (with a C- or L-deviation ± 10 trucks/ 5 buses)
9. Inspection/short-term solution is introduced without any delay

Problem solving
10. The area of assembly responsible for the assembly follows the step where the deviation occurred. When needed LL is involved (mandatory with C- and L-deviations)
11. The responsible assembler performs an analysis with the help of problem solving formulary (truck)/ Deviation reporting formulary (bus)
12. The responsible assembler informs about the deviation in the daily follow-up meeting the following day
13. When C- or L-deviations occur PL presents the deviation in the MS management group meeting. The deviation rapport is updated and sent to the issuer.
14. Problem-solving work, follow-up with DQM
15. PL approves closing of the deviation except from C- and L-deviations which is closed by a member of the MS management group.

Information about deviation
Once a deviation has been discovered there is a range of information that needs to be registered and available for future use. The information that must be available is the following:
Must have information

- The solution responsible
- Time when the deviation occurred
- Date for the follow-up of the deviation
- Status of the deviation
  - Open – present deviations that is being worked on
  - Pending – deviations that are in a waiting status which could be for example waiting for implementation
  - Closed — deviations that have been approved
  - Null – deviations without a status

Recommended to have information

- The group handling the deviation
  - Improvement group
  - Local directorate
  - Q-team
- The time when the group has been involved and received information
- Chassis-number where the solution has been applied
- The control of chassis on-line ± 10 trucks/ 5 buses

**Deviation rapport**
The deviation rapport (KÅ-form) is a form used to register the deviation and to visualize the work that has been started. The KÅ-form has different fields that need to be filled in order to understand the deviation and to have some kind of plan to solve this task and to see in which direction the improvement work is aimed at. An example of a KÅ-form can be viewed in appendix 4.2.

The different fields of the KÅ-form are the following:

- Information about the problem owner, name and department
• Information about the discoverer of the deviation, name and department
• Information about the customer, internal or external
• Information about the chassis
• Description of the deviation written by the discoverer and a picture of the deviation
• More information about the problem owner, time when the deviation occurred, position, current status on the assembly area
• Feedback from the problem owner, information about what could have been the reason for the deviation and the proposal for solution
• Analysis of deviation which is performed with the Diamond-model
• Follow-up of chassis on line to secure that the deviations are not in other products

Diamond-model
The diamond model is a visual tool used to analyze the deviations that are classed as C- or L-deviation. This model is based on and if the standard has been followed. It is constructed in a way where the solution owner answers questions in a sequenced order that leads to different outcomes depending on the answer. The diamond-model is presented in figure 11.

<table>
<thead>
<tr>
<th>Is there a standard?</th>
<th>Is the standard detailed enough?</th>
<th>Did the worker know about the standard?</th>
<th>Was the standard followed?</th>
<th>Is the deviation repeated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Create standard Improve standard Educate Act 5 why Ω-kaizen

Figure 11 Diamond-model

The top row contains questions to be answered which are based on how well the assembly standard has been followed. The bottom row shows the different actions that ought to be taken when the top row questions are negative.
The first four actions does not need further explanation but the last two are special methods that require knowledge from the person using them.

Q-kaizen is the method that takes the longest time to perform. This can be seen as a small project form where PrT, PT, PS and PL is involved in a half a day long activity where the aim is to find the cause of a deviation and to find a solution that makes sure that the deviation never occurs again. During this activity the participants uses several tools to analyze the issue and to finally form a solution. Q-kaizen documents are outdated and this method has not been used in several years.

Presentation material used in line
To illustrate deviations and their status each assembly area uses visualization boards. These boards present how the work is progressing and gives fast information about status of the different deviations. This board is also in focus when discussing deviations in DQM’s and during the LL meetings. Each separate area is held responsible for updating and using their board. One example of the boards is showed in figure 12.

Short-term solutions and long-term solutions
The solutions to C- and L-deviations should be of two different natures: a quick short-term solution that is followed by a long-term solution.
The short-term solution should be presented before 24 hours have passed since the occurrence of the deviation. It is as mentioned previously developed by the solution owner with support from the quality role of the related area. If a solution is not presented and implemented within 24 hours the management group is contacted. The nature of a short-term solution is that it is a simple and a quick way to assuring that the deviation does not happen again.

The long-term solution takes longer time to develop and implement. A long-term solution can sometimes require investments. These could be new tools or a rework of the production flow.

**Status control**

Once a deviation occur a status control is introduced. The status control is used in order to make sure that no chassis with deviations reaches the end customer or creates a safety risk further down the production line. The control approval is documented and the documentation is kept in the area of assembly for at least a month to be able to perform follow-ups.

**Control-stamp standard LS085**

The control-stamp explanation and requirements are stated in the control-stamp standard LS085. To ensure that assembly has been performed according to specifications Scania apply the use of control-stamps. The control-stamps are used on documents required by law. Control-stamps also allow ensure that it is possible to trace deviations back to a specific assembler.

There are two types of control-stamps applied in Scania with varied level of responsibility:

- Department control-stamp
- Complete truck control-stamp

The department control-stamp is used to verify assembly and adjustments made in the current area of assembly. Complete car control-stamp is used to verify assembly and adjustments made of all the previous assembly areas.

There are requirements that need to be fulfilled for an assembler to obtain a control-stamp. A department control-stamp is acquired when the assembler has performed and passes the following objectives:

- Complete and passed control of the execution of control-stamping in the specific assembly area
- Attended a test drive
• Read education material about control-stamps

The requirements for a complete truck control-stamp are higher. In order to be able to obtain a complete car control-stamp the assembler is required to fulfill these objectives:

• Acquired a department control-stamp
• 2 weeks of practice in areas related to control
• Control-stamp course with passed final exam

Consequences of failure in control-stamping
The main consequence if control-stamps are not used correctly is that the assembler could lose the control-stamp for a month. PL is responsible for confiscating of the control-stamp. If this occurs more than once the loss of the stamp could be lost for three years.

4.1.3 Training of new employees
The training of new employees follows a special routine which is called LS407. This standard explains the guidelines that are to be followed once a new employee is introduced to an assembly position.

The first step is that PL and PS prepare a plan for the training of the new employee. This plan is given to the instructor chosen to perform the training. The instructor is an experienced assembler that understands the position well. The plan should be given to the instructor in a good time in order for the instructor to be able to prepare the training period. The preparations involve controlling the assembly standards and making sure they are up to date and to print a check list. The check list is a document containing a number of points that the instructor is supposed to make sure the new employee is familiar with and understands.

New employees are supposed to follow a few busses from the first assembly are to the last. After this the new employee is supposed to start to assemble at their designated area. The following step requires the instructor and new employee to individually assemble every other cycle time. Information about safety and risks, ergonomics and deviations should also be explained.

The last part of the training requires the new employee to understand and to be able to complete each step within the allocated time.

When this is the case the instructor assembles one and the new employee three until the instructor approves the new employee for the position.
4.1.4 Methods used in production to avoid deviations

There are several solutions and methods used in production to avoid the rise of deviations with the assembly standard being the most prominent. The idea behind the assembly standard is that if it is followed there will be no deviations.

The use of sequence-tools is a custom made tool that is connected to a system of lights and signals which forces assemblers to perform a task in a specific order. The assembler begins a sequence of assembly by reading a bar code that engages the sequence-tool and makes it possible to start using. If the assembler performs the sequence in the wrong order the system will alert the assembler.

The third method is the presentation of the assembly instruction or MONA as it is called. This document is given to the assembler prior the start of a chassis assembly. The document contains information about the chassis and the components that are included to this specific order. To avoid deviations previous errors are highlighted visually to ensure that the specific issue is given extra attention. It is within these documents that the control-stamps are used.

The last method used to avoid deviations in the assembly process studied is the use of quality control zones. These areas functions as a filter that should not let any faulty chassis pass through.

4.2 Situation description from the assemblers perspective

This thesis looks at deviation handling from the assembler’s perspective. The empirical findings from the assembly practice and observations as well as from interviews are presented here. The opinion identified was divided into the following perspectives (see figure 13).

4.2.1 Process, tools and methods

The empirical investigation shows that a negative attitude towards deviation handling exists among the assemblers. A majority of the interviewed feels that there is not enough time and resources to be able to work with deviations in a satisfying
matter. This usually leads to simple explanations and solutions that don’t really solve any problems. Regarding the assembly standards the opinion is that more work is needed before the assembly standards are considered to be perfect in order to be able to follow them at all times. The assembly standards are not actively used today in the assembly work or other areas. The opinion of having the assembly standard today is mainly to satisfy the management. Some assemblers think that the MONA-instructions could need some improvements since mistakes in the instructions could lead to deviations or confusion. An idea shared by a majority of the interviewed was that deviations are supposed to be kept to a minimum in order to show good results in the assembly area. The opinion points out some kind of competition between the PL’s and something connected to status. This led to situations where a lot of stress was created due to these competitions and in the end many deviations where never reported.

The opinion about the training of new employees was also covered. This in order to understand if the assemblers and others involved thought if the training today was sufficient. The main opinion regarding this perspective was that there was a lack of time to really create a work-training that would cover everything at the start. The current work-training method is rather simple and the follow-up could also need an improvement.

A perspective controlled was the cycle time and in what way the number of assembly steps in the cycle time could affect the occurrence of deviations. The study shows a shared opinion in this perspective where the cycle time and amount of steps didn’t had a relation to the number of deviations. The important was that the cycle time was well balanced and planned in a way that no stress was created. It was very important to not let the amount of assembly steps get overwhelming and it was important to plan a moment of rest in every cycle time. The opinion regarded how longer cycle times could affect the learning process of new positions was that it is indeed harder to learn a position that has a longer cycle time. This was therefore something that needed a correct way of educating and therefore the assembly training had an important part.

The opinion regarding the tools and methods used to handle the deviations was also investigated. The present situation shows that the deviation handling standard is not fully followed as it is supposed to.

Several tools are not being used and there is no really an understanding of these tools. The methods to investigate the deviations (KÅ-form) is not being used or fully recognized by everyone. LS112 states that “the assembler that is responsible for the deviation should be involved in the investigation and problem solving”, this is by far
not always the case. The feeling among the assemblers is that solutions presented by the local directorate are expected to be accepted by them. A majority of the assemblers thinks that the solutions presented are only considering the short time perspective and too simple to be able to solve the real issues. Due to the pressure of time and the way the tools and methods are being used, the solutions created are very simple.

The suggestion treatment perspective was studied in order to understand the opinion regarding how the suggestions sent by the assemblers are being treated by the management and the workers responsible for the suggestion evaluation. The study shows that those suggestions that are most likely to be turned down are well known by the assemblers. The kinds of suggestions that are mostly turned down are the ones that involve high investments or the ones that are related to changes in the construction. The effect of this is that assemblers usually avoid making this kind of suggestions since it never leads to something. For other kind of suggestions the interviewed feels that the management and the responsible for the suggestion evaluation are listening and seems to work with the suggestion.

Receiving feedback about a suggestion was also discussed during the interviews. A majority of the interviewed expressed that the feedback was missing many times. It usually takes a lot of time before something happens and many of the interviewed feels that the suggestions disappears and never heard of again.

4.2.2 Deviation control
One important perspective that affects the work with deviations is the emotional perspective. One area controlled was the importance an assembler put to the deviations. A part of the interviewed did not have a serious view of the deviations and this was due to different reasons. One reason was that it was mainly because the management over-dramatized the deviations. In the assemblers perspective some deviations where not that problematic but the management wanted it to be treated as a very serious situation. Others thought that the categorization was a reason to this over-dramatization since Scania places injury-related deviations to quality related deviations in the same category. This opinion can be directly related to the following quotation from the interview:

“I do not really consider a deviation leading to the bus malfunction or the bus breaking in the middle of the road as a c-deviation since it only requires the bus to be repaired. A c-deviation is if the bus explodes or something similar. A deviation leading to that is critical not a broken engine.”
Others take the deviations more calmly and motivates this by stating that it is only human to make mistakes and something that can never be solved. A large part of the interviewed seemed to put great responsibility that deviations are discovered in the quality control zones and this gives a comforting feeling.

Another area controlled was the opinion if managers controlled and worked with the correct areas. The study showed that the general opinion was that many times the management changed and blamed areas that are not the real reason for the deviations. This is also related to the points mentioned in previous findings where the interest seems to be in solutions that are cheap and easy to develop and implement.

“One area the managers changed was the allowance to have radio on the workshop. This was removed since their opinion was that deviations where created due to this distraction. Nothing was really controlled to support this and we never got any explanation why. Deviations still continue to be created.”

Regarding the investigation of why a deviation has occurred the interviewed expressed that it was too much focus and emphasis in the assembly standard and not much in other areas that might be of interest, as for example Mona. A shared opinion was that the management should be controlling the human aspect in a greater length. The present opinion is that it is not accepted to have human errors. An interview of technicians revealed that other areas are indeed controlled during the investigation process that might not be known by the assembler. Another opinion was that due the focus on the assembly standard, the solutions created would also be related to this one. Another issue expressed is that the problem could end up in the wrong hands since the focus was in the wrong area.

Another part of this was that the assemblers felt that maybe it would be a good thing to give them a second chance if they are responsible of a deviation. The feeling was that maybe it would be a good idea to keep track of how often a type of deviation occurred and adapt the amount of resources and investigation accordingly to this.

The next area of interest in this study was to find out if the assemblers thought that the areas controlled where done in the correct way. A majority of the interview expressed the importance of controlling and handling the deviations as a group and not individually. This because it could be stressful for an individual to do this and doing this as a group would create insight in the matters discussed. This is something that was not always performed today. A majority of the assemblers felt that they
personally got all the blame for the deviations they’ve caused and a lot of energy and resources was concentrated in finding out the responsible for a deviation and why the deviation had occurred. At the same time this enthusiasm was lost once a working solution was supposed to be created. A major part of the interviewed expressed that during the investigation part of a deviation the feeling felt was similar to an interrogation. This created a negative view of the investigation part and some of the interviewed even revealed that at some times they avoided to report a deviation in order to avoid this.

“The deviations registered are only the tip of an iceberg.”

The study revealed that routines are not followed every time once a deviation occurs. The assemblers expressed that many of the solutions presented didn’t have any of the opinions from them and they were just supposed to accept the changes. Another routine that was not followed was related to changes in production and the lack of proper introduction to those. One reason that might explain why routines are not being followed is that the assemblers experienced lack of resources and that the PS and/or PL felt stressed since the whole production line is waiting.

4.2.3 Commitment

The management commitment perspective was studied in order to understand how the assemblers felt about the management involvement in the deviation handling process and how much importance is put into the topic. The opinion shared by a majority of the interviewed is that the management is expressing that quality is important. This picture is something that changed a while ago when volume was the most important and the interviewed feels that it has been a change for the better. Although some of the interviewed expressed that the involvement is not as big in the daily work since not enough resources are put aside in order to be able to work with deviation handling. Other expresses that the management might be too involved and should give the assemblers more responsibility and trust in the areas related to deviation handling. A smaller group of the interviewed feels that the management only cares about the product and little importance is given to the human part.

The assemblers’ commitment perspective was studied in order to understand how the assemblers feel about their own involvement and interest in the deviation handling process. Almost all of the interviewed stated that they don’t want to be the reason for a deviation and this is something related to their personality. Although this general opinion is somehow divided when it comes to how the assemblers handle it in the daily work. Some of the interviewed get involved in other assemblers
deviations and tries to find solutions that are applicable and suitable for the rest of the assembly team. Others are mainly focused in themselves assuring of not to doing the same deviation again.

“It doesn’t feel good when I commit a deviation, but at the same time I am only human. Even robots make mistakes. I only make sure to not make the same mistake again and hope for the best.”

Many of the opinions are mainly related to solutions applied and some of the interviewed stated that solutions that assures that no mistakes are made should be used in a greater extend. Another point of view is related to the categorization of deviations where differences of opinion exist in this matter between the assemblers but also between the assemblers and managers. The way this opinion affects the assemblers involvement is that due to the nature of solutions used today and the difference in opinion regarding the categorization of deviations creates negative attitude towards the deviation handling process.

Another part that affects the assemblers’ commitment is related to in what extent they are involved in the deviation handling process. Although LS112 states that the assemblers responsible for the deviation should be involved in the solution finding process this is not the present case. Most of the interviewed states that today they are mostly only involved during the investigation part and their opinion and knowledge is barely used.

The last part studied was intended to gain a further understanding in what could affect the commitment of the assemblers regarding deviation handling. The general opinion in this perspective was that the negative attitude should be lowered and more positive feedback should be used towards the assemblers. This is not a great cost for the management and many of the interviewed feels that it would affect substantially. One opinion that was shared with many of the interviewed is that it is good to celebrate success since this would make the group more united.

Another part of the opinions was that it was important to give the assemblers a greater understanding in the product, deviations and consequences of these.

This would lead to a greater understanding in the production and how an assembler’s work affects the rest of the assembly line.

4.2.4 Organization and goals
The topic in this perspective is how the responsibility distribution is being experienced and the knowledge in the responsibility areas. The study shows that assemblers have knowledge in the responsibility distribution in most of the cases.
The issue observed about this matter is that the opinion about the responsibility distribution is not aligned with the rules in the deviation handling standard. This is the case since the responsibility for finding solutions to the deviations is most of the times removed from the assembler responsible for the deviation. The responsibility is instead given to a co-worker responsible for the quality area which in reality should work as a support according to the deviation handling standard. Another problem regarding the removal of responsibility is blamed at work force resources on the daily basis.

An opinion that was shared by a majority of the assemblers was that some of the involved in the deviation handling process where not adding value. The presence of these unnecessary roles could create stress but also make the deviation handling work take unnecessary routes. The interviewed thought for example that the PL could take a step back and leave this responsibility to the assembly group.

One perspective studied was the definition of goals and how clear they are among assemblers. The study shows that there are no clear goals that the interviewed knows about. The only goal that they are familiar with is the zero deviations goal that the interviewed feels is hard to reach in the near future. Many of the interviewed expressed that it could be useful to have short-time goals or being able to see the progress in some kind of graph.

If goals or improvement charts are to be presented it is important not to compare different assembly areas to each other since this would give a wrong image and also affect the motivation. The reason is that the different assembly areas has different amount of risk areas where deviation might occur.

Other opinion about this was that the goal should be to work on other areas as for example work satisfaction since this would in turn affect the amount of deviations. The goals should therefore instead be connected to this kind of topics.

4.3 Benchmarking engine assembly factory

The engine assembly at Scania is located at a different plant then the assembly of chassis. The guiding rules for all the plants are SPS but local interpretations do exist. At the engine assembly the lead time is two minutes meaning that working procedures are different adapted to their unique situation.

When a deviation has occurred a problem-solving form is used in the solution process. This form is the engine assembly’s version of the KÅ-form and depending on the classification of the deviation the form is of a different color (C-deviations are printed on red paper). However, unlike the KÅ-form, the diamond-model is absent
and instead there are 21 questions that should be answered with a yes or no. These questions are divided into four categories; position, tools, materials and article/product quality. Each question on the form is answered individually and the questions are not dependent on each other. Also present on the form is 5 whys, after every why there is enough space to answer directly on the form.

A control-point is used at the engine assembly after a deviation has occurred. This control-point is a document that is to be filled out by anyone but the person that did the deviation. The purpose of it is to have a person be extra cautious and inspect the deviation area carefully. The control-point does work as long as it is performed correctly.

**Summary**
The chapter started with a situational description presenting the area studied and how the organization works. Later the current tools and methods related to the deviation handling used in Scania where presented. The tools mentioned are different standards as for example position standards, assembly standards, control stamp standard, deviation handling standard, etc. The chapter also presented the current work training model and a short introduction of the current tools and methods used to avoid deviations was given. The chapter is finished with a presentation of the results from the interviews performed where the answers are summarized in four different areas:

- Process, tools and methods
- Deviation control
- Commitment
- Organization and goals
5 Analysis

The following chapter presents an analysis of the studied area in Scania. The analysis will be used as a foundation in order to discuss if the area studied has been successful in the full implementation of SPS. The theory of CI-programs is analyzed together with the findings in the empirical studies. The chapter is divided in two sections; Tools and methods and Implementation.

5.1 Tools and methods

To create a sustainable organization that is capable of continuous improvements Scania is relying on its production system. SPS is visible and widespread throughout the organization communicating the important part it plays in the success of the organization. Scania are putting a lot of resources in educating employees on the importance of SPS and how to use it in the daily work through. SPS greatly influences the tools and methods used in the production. The tools and methods in use today are considering the main aspects in the SPS-house each pointing out the important parts that needs to be considered if continuous improvements are sought for. In this part the tools and methods related to deviation handling analyzed are the following:

- Standardized work
- Work groups

5.1.1 Standardized work

Standardized work is an essential part of CI and a requirement in order to be able to control the output. As Liker (2004) and Bicheno et. al. (2010) state, standardized work is needed in order to lower variation and thus lower the amount of deviations. The main aspect of SPS is the use of standardized work and Scania rely heavily on standards of operations which is used throughout the organization. The standardized way of working can be observed in several areas through existent documents and the visualization of results. The standards analyzed related to deviation handling process are the following:

- Position standards
- KÅ-form
- Work-training
- Deviation handling standard LS112
- Control-stamp standard
**Position standards**

Scania’s vision is that their position standards should be made in such a way that a person with some assembly experience should be able to take position after just reading it. This has led to very descriptive standards that try to specify exactly how to perform certain tasks. Details include how to hold tools for each different step and how much strength/torque is necessary, which is a clear example of tacit knowledge. Theory states that this type of knowledge is difficult to pass on by writing and the assembly practice conducted at MO3 confirmed this. The empirical studies showed that the details in the standards were not enough to fully understand the assembly process. Instead a more physical approach was required to fully understand each step.

Position standards at Scania are updated by an assembler with the method-role at the specific area. This procedure is a clear example of employee empowerment mentioned in previous chapters in which the employees are given the opportunity to affect their surroundings. A negative consequence is that this leaves room for personal interpretation which explains the observed differences of position standards throughout the organization.

Position standards can be considered to be rule based knowledge that the assemblers are obligated to follow. However, when assemblers evolve and master the assembly process this knowledge could consider to become skilled based. This transition might be a negative development since the mistake proofing approach the standards has loses its function.

**KÅ-form**

The use of the KÅ-form can be seen as a way to logically examine and understand the causes of a deviation. This could be seen as evidence of a technique used in order to implement mistake proofing in the processes as presented by Tsuda (1993). The KÅ-form works as a mistake proofing technique. The way the KÅ-form is being used could also be seen as a way to empower employees since it allows them to get involved and create solutions accordingly to LS112. However, this empowerment puts a lot of responsibility on the employees and their capability to deliver a good improvement suggestion.

Analyzing the KÅ-form and the tools used in it, the study reveals a model that puts great emphasis on how well the assembly standards are being followed. This is especially clear when the diamond-model is examined which is entirely focused on the assembly standard. The clear focus of assembly standards excludes other areas that could potentially be the root cause.
The empirical studies reveal that there are parts of the diamond-model that are very rarely chosen because they are perceived as being difficult or time consuming. An example is the opinion about 5 why and Q-kaizen, with the latter being somewhat of a mystery to most personnel with no one understanding the real use of it.

**Work-training**

Having a standardized way of teaching a new employee their work is important in order to control the results of the education. An aspect about the importance of controlling the results of education is the reassurance that new employees have the basic conditions in order to perform their tasks without the experience of issues. As previously stated in the chapter 3.3.1 where the human process was in focus, it is important that an employee has a possibility to determine the intent of action to avoid the creation of errors. In order to be able to determine the intent of action the education plays an important part. A failure in the education might be a contributing factor to deviations created in the process. However, education itself cannot solely be held responsible for assuring that no deviations occur since knowledge will eventually evolve into skilled based knowledge. This would create other types of risks of deviations that can only be avoided with the help of mistake proofing techniques as poka yoke.

The analysis of the current work-training model and the existent standard for training shows that the work training model used today is not detail specific. The consequence of this is that the success of the training of an employee relies heavily on the instructor and how well the instructor presents the position and its components. The assistance given to the instructor as a support is only a simple checklist with general points making the follow-up of development and results hard to accomplish. The checklist used today is not position specific and this has led to many different interpretations and a large variance in training.

A standardized way of working is a systematization of a process in which the process is divided into smaller components with documents clearly explaining the steps involved in it. The current work-training model cannot be considered a standardized way of performing the process of work-training due to its simplicity and lack of systematization. This could also be seen as evidence showing that SPS is not being followed in work-training.

**Deviation handling and control stamps**

The deviation handling standard LS112 is supporting a standardized way of working due to the clear systematization of the process when deviation occurs.
An analysis of the document shows a clear and supporting model to be followed once deviations occur which also supports SPS. The deviation handling standard is also supporting the empowerment of employees due to the involvement of assemblers close to the process.

As stated in chapter 4.5, Scania are using control stamps in order to control that assembly has been performed accordingly to specifications and due to legislative demand. The procedure when an employee is given a stamp is a standardized way of working and can be seen as a method to prevent mistakes and or detect the mistakes more easily. The different types of control stamps (Department- and complete truck) could also be considered to contribute to the empowerment of an employee since each employee’s responsibility is increased. However, the consequences that follows when failing to use of control-stamps correctly could create a culture where fear and blame exists and this could lower the assemblers commitment. The investigation revealed that the buss-assembly area is not applying the use of the control-stamp standard. This is not supported by SPS and the whole purpose of the assemblers having control-stamps falls short.

5.1.2 Work groups
Scania is applying the use of work groups in different areas of their production. The two work groups mentioned in chapter 4.1, improvement groups and 5+1 groups are the ones tied to deviation handling in production.

The use of work groups in Scania receives support from top management by having allocated time for meetings before every shift. The bus assembly is the first to start with 5+1 at Scania, having moved from larger to smaller work groups. The use of work groups creates the opportunity to involve assemblers and to increase the awareness of continuous improvements. This method is also a way of empowering the employees since they are given possibilities to affect their surroundings by the improvement work performed in the area.

An observation considering the implementation of the 5+1 model revealed issues in the primary part of the implementation. One observation was the lack of communication in the introduction of 5+1 which created misunderstanding and confusion about the new work group model. This was observed during meetings where there was a lot of confusion about what to discuss and the allocation of time to actually perform the tasks.

Although the use of work groups is a way of increasing and using the current knowledge of employees, managers need to be involved and follow the results created by work groups.
An analysis of the current situation revealed the existence of an insufficient demand of results by the management causing a lack of commitment amongst the assemblers.

5.2 Implementation
As Dale & Lightburn (1992) findings show, many companies applying a CI usually experience difficulties passing level 3 and 4 due to the occurrence of different obstacles. Analyzing how far the implementation at the bus assembly CI-programs have reached there indications that this is also the case at Scania. The evidences that could position Scania in these levels can be related to a choice of the obstacles presented by Dale & Lightburn which also have been observed during the analysis:

- Divergence from routines
- Defective communication and planning
- Defective follow-up of results and quality
- Lack of commitment and attention to quality improvement

Divergence from routines
One example supporting the positioning of the studied area in Scania on these levels is the clear divergence from routines occurring in the organization today. The studies of the area reveled several occasions where divergence from routines occurs. The interviewed blamed this on the lack of resources. One clear example is the non-existent use of the control-stamp standard.

Another reason that could support the divergence from routines is the lack of knowledge regarding the routines or the importance of following these (Kaye, 1999). The divergence from routines can be the result of poor support from management which is an important part needed for the success of CI. This is supported by findings made by Angelis (2012) where grade of commitment is highly related to the management’s success of creating the required organization which supports a CI-program. During the studies of the area in Scania this issue was observed where the employees’ knowledge in the existence of standards was tested. The test showed a lack of knowledge in some standards that are supposed to be applied at the assembly area studied.

A standardized way of working is a main cornerstone in several CI-programs and it makes it possible to control the processes and to understand if the production is in a normal state (Kaye, 1999). Scania also use standardization as way of working and it is a main criterion in their production system. By diverging from their routines one of the main objectives is not followed.
Every time a task is performed emphasizes the importance in the understanding of the intent of the action (figure 5). By having an understanding in the intent, errors can be avoided. The first step is highly related to how good a worker is trained and how well of an understanding in the product and process they have. The work-training model in use in an organization is therefore a very important tool in the success of this step. The area studied in Scania is using a simple work-training model that functions as a reference when a position is presented to an employee. An analysis of the work training model reveals a model that fails to be considered as a standardized way of working. The current model makes personal interpretation too big of a factor and no work-training is like the other.

**Defective communication and planning**

As Emiliani (1998) states most organizations don not take the concept of waste a step further. The reluctance of doing this creates an organization where fat behaviors rule and this in turn constrains the complete implementation of a CI. As the empirical studies showed there are evidences pointing out the existence of fat behaviors at the bus assembly. This creates difficulties in everyday work and might become an obstacle in the future success of SPS if not tackled in time.

A fat behavior that exists today is the lack of communication. This occurs in several areas of the bus assembly and it affects and supports other fat behaviors. One clear example of this failure in communication is when a deviation has occurred and it is being investigated. The opinion assemblers share is that the only area controlled is the assembly standard. This is discarded by the technicians since they state that other areas are indeed being controlled. It is clear that there exist a lack of communication between these two groups. The lack of communication affects the commitment in this case since the assemblers does not feel an understanding and support from the organization. This relationship is supported by the findings made by Meyer & Allen (1991) where commitment is highly related to the feeling of being supported by the organization. This is also supported by the findings made by Angelis & Fernandes (2012) in which they state that the occurrence of this kind of feelings would erode the employees’ commitment.

**Defective follow-up of results and quality**

The lack of follow-up of results and quality is present in several areas clearly pointing out the use of tools and methods only in a superficial manner like level 4 organizations do. The following are examples of areas with deficient follow-up:

- Success of work-training
- Solutions presented
• Deviation control
• Reasons of deviations
• Results from work groups

One reason that could explain the deficient follow-up is the lack of standardized work methods for follow-up or the lack of demand of results from management. One example where the follow-up can be considered to be deficient is when deviations have occurred and status control is applied. The current way of doing this today is mainly by being extra observant in the area where deviations occurred. There is not a standardized way to perform the follow-up and no results of follow-up available. This is another indication that Scania could be positioned in level 3 or 4. The same issue is present when the success of work-training is to be controlled. The current work training model does not support the possibilities to follow-up the development and/or success of work-training.

Problems with follow-up of quality are present when deviations are investigated. Creating a blame-free organization is highly important in order to remove the stress factor and to lower the probability of deviations occurring again later on in the process (Kaye, 1999). As Angelis & Fernandes (2012) states it is important that management creates an organization that is blame-free in order to create commitment and allow for improvements to be suggested. The analysis of the studied area in Scania revealed an environment with tendencies where the sense of blame exists. The interviews showed the feeling of blame and shame during the deviation handling process. This approach is not supporting the creation of a blame-free environment.

**Lack of commitment and attention to quality improvement**

Commitment is a very complex topic affected by many different areas. Applying a CI-program does not assure that commitment is increased automatically as mentioned by Angelis (2010). The creation of commitment is the management’s responsibility that is created by applying a strategy that helps in the creation of commitment. As Meyer & Allen (1991) stated there are several areas that might affect commitment indirectly as for example employee/supervisor relation, role clarity and feeling of personal importance. This is further supported by the work of Angelis et al. (2010) where the inability of management to create organizations where roles are well defined, support is offered, existence of fairness, participation in decision making, trust in workers competence and opportunities to exercise this competence is directly correlated to decrease commitment. The studies performed at Scania points out several areas that might affect the commitment in a negative way. One of these areas is related to the role clarity perspective.
During the interviews a majority of the interviewed expressed that some of the roles where not needed and the presence of these could prevent an effective process. Performed observations further confirmed the lack of understanding in roles and what they are supposed to achieve.

The way the deviation handling process is performed today can further increase the risks of negative commitment. A majority of the interviewed expressed that assemblers’ opinion and knowledge is shunned once deviations are investigated and when solutions are produced. This could be considered an evidence of the issues that need to be avoided in order to create commitment, a view supported by Angelis (2010) and Meyer & Allen (1991).

Analyzing the use of the assembly standard as a tool to improve quality the analysis showed a negative opinion amongst the assemblers. The main reason behind this opinion might be that the assemblers feel that management does not consider other areas during the deviation handling process. A lot of emphasis is put to the assembly standards solving all the issues. This could be affecting the assemblers’ commitment as mentioned by Angelis (2012) since they feel no support from management.
6 Conclusion and recommendations

The following chapter presents the conclusions and recommendations for this thesis, they are divided into managerial and theoretical contributions. The chapter also answers the research questions asked in the initial parts of the thesis and it ends with suggestions for future research.

6.1 Managerial contribution

The following section of this chapter concludes the findings and offers recommendations to managers at Scania. While the conclusions drawn are from investigations at the bus assembly they could be of use to other parts of Scania as well.

The conclusion drawn from the empirical studies and analysis performed at MO3 reveals a general lack of commitment. The occurrence of lack of commitment can be traced back to several problematic areas and procedures that create fat behaviors and do not support the fully successful implementation of SPS. In order to affect the commitment and improve the implementation of SPS recommendations will be presented in this chapter.

Good leadership is an important part in order to be successful with implementation of a CI. Good leadership practice means creation of basic conditions and a workplace that supports the CI-bundle. The analysis performed in MO3 shows areas that need to be improved, these include the need to create an organization that fully supports the implementation of SPS. This chapter will present a group of conclusions and recommendations related to the leadership area in order to improve it.

6.1.1 Segmented position standard

The empirical study showed that the position standard today is an important tool in SPS. The current use of the position standard is a document that must be present in every assembly position and updated as the process or product changes. The authors believe that the position standard can be used differently in supporting work-training.

The content of the current position standard satisfies the level information necessary to understand the process of assembly at a specific position. This is in line with what the analysis shows. However, the analysis also revealed that the position standards are not utilized in other areas that can gain advantages of the information in them. The suggestion is to implement a segmentation of the position standards in order to illustrate a more logical view of the position standards. A segmentation of the current position standard should fulfill the following objectives:
• A logical layout of position standard creating a changed viewpoint
• Increased effectiveness in deviation handling process
• A better document that can be effectively used in work-training
• Possibility to decouple parts of the position
• Improved communication during deviation handling making the deviation handling process more efficient

Creating a logical layout

To create a logical layout the current position standard should be segmented. By creating segments the position standard is divided in different blocks that will make it easier to use in both the deviation handling process and during work-training. Every segment consists of a small number of assembly steps in the position. The updates performed on the current position standards are presented in figure 14.

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How to segment the position standard

The segmentation must consider different constraints that exist in a general segment procedure. Due to these obstacles the segmentation should be performed locally in order to gain all the possible advantages.

The following list contains what areas to consider when performing the segmentation of a position standard:
• Natural work paths
• Time
• Area of work
• Function
• Tools
• Assembly instruction

An example of the segmentation of a position standard can be viewed in appendix E.

6.1.2 Work-training model for new assemblers
The analysis of the current situation shows a work-training model that does not follow standardization. The current training model is too simple and it does not cover all important parts needed to create acceptable work-training where fewer deviations are the goal. The success of the education of a new employee is based on who the instructor is. It is important to have a homogenous education model to rule out inadequate training and to control the results. A homogeneous work-training model is also supported by SPS where a standardized work procedure is a cornerstone.

As a result from the analysis a new work-training model is presented that covers the missing areas the current work-training model lacks. The aim is that the new work-training model achieves the following:

• Improved understanding of the product and the process
• Understanding the need of control and early put an importance to follow the standards and control points
• Understanding in deviations and the consequences
• Awareness in the importance of quality and responsibility
• A homogeneous work-training model supporting SPS

Work-training guidelines
In order to create a homogeneous work-training model a set of general guidelines are needed. The general guidelines are a number of steps that are the foundation that exists in order to create a standardized work training procedure. The guidelines are presented in figure 15.
Plan

The first step of the work-training is the preparation of the work-training and the material needed in order to perform the training. This step is performed before the new employee arrives in order to be prepared and have all the information needed.

The first step is determining the employee that will function as an instructor. The instructor is a highly important factor that needs to be carefully selected so that the work-training is effective. The instructor should have good knowledge about the following areas:

- The position presented
- The education model
- The organization in the assembly area
- The standards applicable
- The deviations and consequences
- The product and process

A suggestion could be to have a set of employees that always functions as instructors and additionally educate them in the topics involved during work-training.
Once the instructor has been selected the information about the new employee should be presented to the instructor in order for him/her to be able to adjust the work-training accordingly. The relevant information is mainly related to the new employee’s prior experience.

With the information at hand the instructor can now prepare the material needed in order to perform the work-training. The material can for example be printing of position standards, education material and checklists. The material suggested for work training can be viewed in appendix 6.1 and 6.2.

**Structure**

The new employee is present during this step and the aim is to present the general structure during the work-training.

The structure of the work-training model will use the segmented position standard as a base where the splitting in sequences will play an important part of the work-training.

This step involves a general presentation of the position and introduction to the product, process and customers. The idea with this step is to give the new employee a vision of what is to come and what is expected of him/her.

**Education**

The education step is the actual work-training where the employee is presented to the assembly work at the position. The basic idea is that the education-structure (figure 16) is used when presenting the position for the new assembler. The education-structure is used in every sequence until the new assembler has completed the work-training.

![Figure 16 Education structure](image)

The first part of the education-structure (Why) creates an understanding of the product, process and the customers. This part is highly important in the education process as it educates on responsibility and gives insight in the work being done at the position. This step could be seen as a deeper presentation of the parts compared to the structure step.
The second part is the sequence presentation where the new employee is educated in the actual assembly steps. This part is simultaneously performed with the studies of the assembly standard. The execution of this step should be performed as figure 17 illustrates.

When the new employee has been presented and worked with the sequence for a period of time the control points and the importance of following these is presented. This step is important in the introduction of the control-stamp education and to create understanding in the importance of standards and control points.

Last part of the education step is the presentation of the deviations that can occur in the sequence and the consequences of the deviations. The important part of this part is to create an understanding of the risks involved if a deviation occurs and the importance of responsibility connected to this.

**Test**

This step is performed between every sequence in order to control the assembler’s knowledge in product, process and assembly. By doing this it is possible to get a feedback of how well the training is progressing.

**Feedback**

The feedback step involves a dialog between the new employee and the instructor. The aim of this step is to gain understanding of the new employees’ opinion regarding the work and the work-training. This step can be an input regarding improvements areas of the work-training or changes regarding the way the work-training is performed. During this step there is an opportunity to answer questions and further explanations of parts of the sequence.

The feedback step should be performed between every sequence in order to be able to adjust the following parts if needed.
Evaluation
The evaluation step is executed when all the sequences have been presented and tested. This step can be seen as a final test in for a new employee.

The aim of this step is to ensure that the new employee has been given an understanding of the position. It is important to control how the standards are being followed and how the control points are being executed.

This step can be combined with the evaluation of the control-stamp and if the new employee has fulfilled the requirements to obtain a control-stamp.

Act
The last step of the education model is a reaction to the results from the evaluation. Depending on the results the importance of this step is to gain knowledge on what has gone right and what has gone wrong. Afterwards a decision regarding the new employee is taken.

If the evaluation shows a need for improvement it is important to discuss and plan what to do. It is vital to realize that failure in this part might not encourage fat behaviors later on in the process.

6.1.3 Control-point
The deviation handling standard LS112 states that status control is important once a deviation is discovered, in order to create awareness and assurance that the deviation does not occur again. A conclusion made from the analysis is that the status control is not being effectively used. The benchmarking performed at the engine assembly department in Scania presented an effective method to illustrate the status control. A suggestion to the studied area is to incorporate a similar tool in order to improve the follow up in situations when status control prevails. The tool that is suggested to be incorporated is a sheet containing the following information:

- Name of the involved
  - The assembler in the area
  - The controller
- Area of use
- Period when the status control is active
- Control-stamp areas with chassis number
- Picture of the area of control
- Description of the control applied
- Description of the reason
- Approval from responsible
The idea behind the control-point sheet is that once a deviation occurs status control is activated as stated in LS112. When status control is activated a controller is assigned, this person performs an extra control to the area where the deviation occurred. The controller could be a TL or another assembler but not the assembler that is responsible for the deviation.

By using the control-point sheet the aim is to achieve the following:

- Creating awareness of a deviation
- Clear illustration in order to avoid confusion and to spread information
- The possibility to improve the follow up of deviations
- A standardized way to perform status control

An example of the sheet used as control point is presented in figure 18. A more detailed example of control point sheet is illustrated in appendix 7.

![Control-point Sheet](image)

**Figure 18 Control-point**

### 6.1.4 Basic conditions

The analysis showed problems within the deviation handling process. Many of the concerns in this area are tied to shortages in communication and understanding of the deviation handling process.
However, the problems revealed cannot solely be blamed on this. A majority of the opinions gathered from the interviews pointed to the lack of investigation of other areas when a deviation has occurred.

By widening the focus the authors believe that the deviation handling process could become more efficient. The suggestion consists of a model that should be used during the initial part of a deviation handling process. The purpose of the proposed model is to assure that when working with deviation all the basic conditions are investigated. A second purpose is to improve communication to the assemblers so that they understand that other parts besides the assembly standard are investigated. By creating this understanding the project group believes that the following areas are achieved:

- A model to be followed to identify sources of deviations
- Increased understanding of what is considered normal conditions
- Widen focus on deviation handling leading to increase effectiveness in deviation handling process
- The possibility to earlier introduce effective solutions
- Improving communication

**Basic conditions model**

The model presented consists of needs an assembler requires to perform a task without the occurrence of deviations. These areas can be considered as a package an assembler needs in order to be able to execute a task. The basic condition model is presented in figure 19. Together with 5 whys this model should allow for a thorough investigation of why a deviation occurred.

![Basic conditions model](image)

**Figure 19 Basic conditions model**

*Knowledge* – the knowledge condition is important since the understanding is essential for a deviation-free assembly. A failure in this basic condition will create confusion and deviations. The knowledge condition is mainly affected by work-training and communication flow.
Standards – it is important to have a specific set of rules that points out how a specific task is supposed to be executed. This also relates to the importance of knowing what is considered to be the normal work level. The standards used should be appropriate and fully utilized as intended.

Tools and methods – assuring that the assembler has the appropriate tools and methods in order to perform the tasks without any technical difficulties is very important.

Instructions – assembly instructions with a higher level of information is needed to the different type of products produced. The instructions are a complement to standards and should be clear and contain correct information.

Ergonomics – by ensuring that the ergonomic level is good the risks of deviations and lack of work satisfaction is lowered.

Work environment – the assemblers work environment needs to be controlled in order to assure that disturbances are lowered/eliminated.

Use of model
The basic conditions model is used as a work-frame model that the investigator of deviations can follow during the initial steps of the deviation handling process. The idea is not to incorporate the model in current documents but instead use it as a reference. The idea is that the investigator will control every basic condition assuring everyone is fulfilled. An example of how the process might look like is presented in figure 20.
6.1.5 Implementation
This chapter presents recommendations on how to improve the implementation level of SPS.

Communication and feedback
Improvement programs emphasize the importance of communication and openness in an organization, the underlying reason for this is to gain an understanding of the current situation. The analysis showed issues related to lack of communication which could create obstacles in the continuous success of SPS. One example regarding this issue can be summarized by the following statement:

“The deviations registered are only the tip of an iceberg”

The conclusion drawn from the analysis of the current situation is that the studied area has a potential risk that could affect the continuous work with SPS. The potential risk consists of the fat behaviors supported by the lack of communication that would undermine SPS and make further implementation and success difficult to achieve. The present situation shows a distance between assemblers and the local management created by the lack of understanding and communication between them.

The recommendations are that the communication needs to be improved in the area studied in order to increase the understanding of deviations and the deviation handling process. The belief is that the current distance between the assemblers and the local management group can be reduced to create a more efficient relationship. The improvement of communication can be executed by developing of the following areas:

- Improve the communication regarding what basic conditions are being investigated during the deviation handling process
- Better feedback on the investigation process
- Improve the presentation of improvements implemented
- Improve the sharing of information regarding the existing standards
- Improve the communication about the results of improvement work in the area

Team work and Blame free culture
The analysis showed that team work is not being fully utilized and the existence of a blame culture is present. The creation of a blame free culture is highly important in order to be able to bring all the issues to the surface. The occurrence of a blame culture creates fear and stress which in turn becomes an obstacle in CI.
By utilizing teamwork to a greater extent, an organization can gain advantages by using the knowledge from different sources. The authors recommend the following improvements to increase the use of team work:

- Present and work with deviations as a group and not only by interrogating the responsible assembler.
- See deviations as an opportunity to improve the process and not as an assembler’s failure to execute work.
- Involve several members of the assembly line to produce improvements that solves deviations.

**Standard procedure**

It was found that existing standards are either not being applied or followed as they are supposed to. In order to create incentives to follow current standards, it is important to keep to the rules applied and to never step away from the procedures. By stepping away from implemented procedures or by not applying the same procedures on everyone, the implementation is undermined and the respect for these standards will decrease. The recommendation is to consider the following:

- Assure that the existent standards are followed by everyone. This not only involves the assemblers but also TL, PL and others related to the process.
- Emphasize the importance of not stepping away from standards due to a lack of time or other constrains limiting the possibility to follow standardized procedures.
- Implement and use control-stamp standard LS085.

**Improve role-definition and follow-up**

It has been showed that roles are not well defined and understood by everyone. This misunderstanding creates negative opinions and there is little understanding in what is supposed to be achieved with different roles. The recommendation is that the following should be developed in the area studied in order to improve the level of SPS and decrease the negative opinions about different roles:

- Improve the definitions of roles in order to avoid misunderstandings in what is supposed to be achieved by every role.
- Creation of goals and demand of results from role tasks. There is no clear demand of results from the management regarding work with roles.
- Improve the follow-up of results from role tasks.
- Improve the follow-up of status control.
6.2 Theoretical contribution

As mentioned in the initial parts of this paper the focus of CI literature is on tools and methods, little attention is given to the softer parts in which implementation is the main aspect. During the literature study it became obvious that research in this topic is challenging to perform. The challenge lies mainly in two different aspects: difficulties with measuring and time.

The difficulties of measuring are related to the challenge of measuring successful implementation of a CI-program in an organization. Since implementation is related to the softer parts which in turn are related to culture and commitment it is hard to measure the success of it with the use of common financial metrics. Measuring of successful implementation is also difficult due to the inability to collect data in a regular matter. This obstacle makes the analysis (without direct observation on the processes and the involved) hard to perform.

Another difficulty with implementation is related to time. Considering the implementation of a CI-program on a timeline the tools and methods will be the first parts to be implemented. After the CI-program has been operating for a while, probably several years, the softer parts will start to play an important aspect for the further implementation of a CI-program. As Angelis (2011) presents in a study commitment decreases in the first periods of implementations due to the changes workers are being exposed to. The commitment changes over time when workers are getting more adapted to the CI-program implemented. This can be confirmed from our case. On later periods commitment will rise if the softer parts are being considered during previous stages of implementation. The time aspect can therefore be an obstacle in order to understand what needs to be considered during implementation. This obstacle makes further studies in this field challenging to perform due to the need of performing the research for a long period of time. However, in this thesis the investigated company has been using CI for a long time and is already past the first step of implementing tools and methods.

Studies performed within the field all emphasize the importance of implementation and the need to focus on the softer parts in order to be completely successful in the implementation of CI-programs. The results of this paper can be considered to be a proof for this. Our study has shown that while the tools and methods exist and they are supported by the organization there are still problems, due to the difficulties of implementation and lack of commitment.

A company invests a lot of resources in the implementation of a CI-program and it is of great importance to not forget or neglect the softer parts.
6.3 Summary
A segmentation of position standards together with work-training of new employees is a proactive precaution that could lower the amount of deviations. Splitting the standard into smaller segments could be of benefit. With 30 minutes lead times there are a lot of things that can go wrong, this is especially true if the assemblers do not follow a routine. This could also be true at other companies with long lead times, and a segmentation of standards could also benefit them. One of the reasons behind deviations is sometimes a lack of understanding. This is due to poor work-training of a new employee in the case of Scania. The same issues could present themselves at other companies as well. Thus it could be concluded that by standardizing training and employing these standards correctly should lead to fewer deviations. In other words, the answer to RQ1 could be segmentation of standards as well as work-training.

While the previously mentioned recommendations were proactive, the control point and basic conditions are reactive. Meaning they are to be used after a deviation has occurred. The control-point has been confirmed to work at the engine assembly, but it needs to be used correctly if the positive effects are desired. To use it correctly the assembler responsible for filling it out must do so correctly while also doing what it says. If these requirements are not met it will fall short and be useless.

Basic conditions should help with improvements in production. The current KÅ-form and diamond-model are not appreciated and they do not encourage deviation handling. The basic condition model considers many different areas that could be the cause of a deviation and together with 5 whys it should allow assemblers to understand why a deviation occurred.

By using a control-point and by applying basic conditions to problem solving one should be able to close a production deviation faster. Thus RQ2 is also answered. These suggestions are very specific to assembly production and could most likely not be implemented in productions where the human factor plays a smaller role, such as processing manufacturing.

RQ3 has also been answered. Our study clearly shows that methods and processes are not performed in accordance with standards and in some cases assembler’s do not know of them.
6.4 Future research

- Further analysis in the management area specially middle managers exploring their opinion about SPS
- Further analysis in communication paths exploring why these might fail
- Program for generating standards
- Deeper analysis of human error in the cognitive science field connected with a practical analysis of the tools and processes used in Scania and how well they support the human schemata system
7 References

Literature


**Articles**


**Electronic Sources**


Appendix

Appendix A – Interview questions

For how long have you been working at Scania? ____________________

What is your role at MO3? ________________________________

What is your background? _______________________________

Have you worked in any other departments in Scania? ______________

1. What is your opinion in how well the deviation handling process is working?
   - Very good
   - Good
   - Either good or bad
   - Bad
   - Very bad

   Comments _______________________________________________

2. How well are the tools and methods that exists today for deviation handling working?
   - Very good
   - Good
   - Either good or bad
   - Bad
   - Very bad

   a. What works? __________________________________________

   b. What doesn’t work? ____________________________________

3. How well does the statement “The origin of deviations and amount of work are related” relate to the picture today?
   - Very good
   - Good
   - Either good or bad
   - Bad
   - Very bad

   Comments _______________________________________________
4. What is your opinion regarding deviation handling process? How well does the statement “we work with the correct issues” relate to the picture today?

- [ ] Very good
- [ ] Good
- [ ] Either good or bad
- [ ] Bad
- [ ] Very bad

Comments___________________________________________________

5. How well does the statement “we work in the correct way” relate to the picture today?

- [ ] Very good
- [ ] Good
- [ ] Either good or bad
- [ ] Bad
- [ ] Very bad

Comments___________________________________________________

6. How is the responsibility distribution work today?

- [ ] Very good
- [ ] Good
- [ ] Either good or bad
- [ ] Bad
- [ ] Very bad

Comments___________________________________________________

7. How is the managements involvement in the deviation handling process?

- [ ] Very good
- [ ] Good
- [ ] Either good or bad
- [ ] Bad
- [ ] Very bad

Comments___________________________________________________

8. How is your involvement in the deviation handling process?

- [ ] Very good
- [ ] Good
9. How are you treated when a deviation occurs?

- Very good
- Good
- Either good or bad
- Bad
- Very bad

Comments

10. What is your reaction when you have done a deviation? What is the feeling?

Comments

11. How are the suggested solutions treated by the management? Do you feel that it “pays off” to give suggestions?

- Very good
- Good
- Either good or bad
- Bad
- Very bad

Comments

12. How well does the statement “there are clear reachable goals regarding the deviations” relate with the picture today?

- Very good
- Good
- Either good or bad
- Bad
- Very bad

Comments
Appendix B - Schematic of daily controlling

- **Improvement group meeting**
  - **Involved**
    - TL: Team leader
    - Assemblers
  - **Agenda**
    - Discussions about deviations and workforce planning

- **Local directorate meeting**
  - **Involved**
    - TL: Team leader
    - PL, PT, PrT
  - **Agenda**
    - Accidents and injuries
    - Planned reparations
    - Workforce
    - Deviations
    - Stop time
    - Review of planned activities

- **PL, PrT, PT- and buss-assembly-manager meeting**
  - **Involved**
    - Buss assembly-manager
    - PrT manager
    - PT manager
    - PL from all assembly areas
  - **Agenda**
    - Presentation of data from previous LL meeting

- **PT manager and PrT’s**
  - **Involved**
    - PT manager
    - PrT’s
  - **Agenda**
    - Process related topics

- **PrT manager and PrT’s**
  - **Involved**
    - PT manager
    - PrT’s
  - **Agenda**
    - Product related topics

- **MS management group**
  - **Involved**
    - Manager for the buss and truck
    - Truck assembly manager
    - Buss assembly manager etc
  - **Agenda**
    - Presentation of data from all areas
<table>
<thead>
<tr>
<th>Assembly steps</th>
<th>Time to execute assembly steps</th>
<th>Quality and security information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tempo nr.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tempo, benämning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viktigt/att tänka på</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Positionens balans**

<table>
<thead>
<tr>
<th>Variant 1</th>
<th>Variant 2</th>
<th>Variant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.00</td>
<td>2.00</td>
</tr>
<tr>
<td>3.00</td>
<td>4.00</td>
<td>5.00</td>
</tr>
<tr>
<td>6.00</td>
<td>7.00</td>
<td>8.00</td>
</tr>
</tbody>
</table>

**Andel "Väljefaktor tid" (%) / "Istället" tid (%)**

<table>
<thead>
<tr>
<th>Andel &quot;Väljefaktor tid&quot; (%)</th>
<th>&quot;Istället&quot; tid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% 0%</td>
<td>1% 1%</td>
</tr>
<tr>
<td>2% 2%</td>
<td>3% 3%</td>
</tr>
<tr>
<td>4% 4%</td>
<td>5% 5%</td>
</tr>
<tr>
<td>6% 6%</td>
<td>7% 7%</td>
</tr>
</tbody>
</table>

**Andel (hur vanlig är varianten) (%)**

<table>
<thead>
<tr>
<th>Andel (hur vanlig är varianten) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
</tr>
<tr>
<td>1%</td>
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<tr>
<td>2%</td>
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<tr>
<td>3%</td>
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<td>4%</td>
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<td>6%</td>
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<td>8%</td>
</tr>
<tr>
<td>9%</td>
</tr>
<tr>
<td>10%</td>
</tr>
</tbody>
</table>

**Aktuell tid: 22 min 40 sek**

<table>
<thead>
<tr>
<th>PL</th>
<th>PS</th>
<th>namn</th>
<th>namn</th>
<th>namn</th>
<th>namn</th>
<th>namn</th>
<th>namn</th>
<th>namn</th>
<th>namn</th>
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<th>namn</th>
<th>namn</th>
<th>namn</th>
<th>namn</th>
<th>namn</th>
</tr>
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<tbody>
<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix C2 – Element sheet

<table>
<thead>
<tr>
<th>Symboler</th>
<th>Konsekvans</th>
<th>Svart</th>
<th>Vektlig tid</th>
<th>Sy</th>
<th>Nr Operation</th>
<th>Skylt</th>
<th>Bild</th>
<th>Material- og verktøyhantering</th>
<th>Navn</th>
<th>Navn</th>
<th>Navn</th>
<th>Navn</th>
<th>Navn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Important parts to consider

#### Description of operation

- Consequences if failure in consideration of important parts

### Picture

![Diagram of Scania truck front view](image)

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Appendix D1 – Classification of deviation

COD-model (Classification Of Deviation)

A deviation is detected

Risk for personnel injury or vehicle off road?

Yes

More than one deviation found in check + _ 10

No

It is a C-deviation

Yes

Ask PM if it is a delivery stop?

Yes

It is a C-deviation

No

It is an M-deviation

Yes

Write a ROC

No

Function out of order? Obvious damages? Bad finish?

Yes

It is an M-deviation

No

Not fulfilling legal demands

Yes

Insignificant effect for the vehicle?

Yes

It is an S-deviation

No

It is an L-deviation

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Appendix D2 – Deviation rapport KÅ-form

**Begäran om korrigande åtgärd**

<table>
<thead>
<tr>
<th>Ågare</th>
<th>Kund</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Utfärdare</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Klass</td>
</tr>
<tr>
<td>Address</td>
<td>Upptäckt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Beskrivning</th>
<th>Bild</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ägarens information**

- Tillkomst av något? Position
- Användar| Status på avt
- Biltyp
- Övriga

**Ägarens svar**

- Vad önskades avklarer? 

<table>
<thead>
<tr>
<th>Kontrollerade åtgärder</th>
<th>Anmärkning</th>
<th>Klart</th>
<th>F</th>
<th>D</th>
<th>C</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Utredning**

- Försök deviativera standard?
- Är standard standard?
- Följde standard?
- Ar avkläran avklarad?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NEJ</td>
<td>JA</td>
<td>JA</td>
<td>NEJ</td>
<td>NEJ</td>
</tr>
</tbody>
</table>

**Uppföljning**

- Kontroll +/- 10 chassier
- Kontroll Produktionslager
- Räkenskaps
- Första svar skickat
- Långsiktig lösning finns
- Klart för stangning

- Dokumentation Datum
- Dokument implementering Datum
## Appendix E – Segmented position standard

### Diagram Description

The diagram illustrates a segmented position standard with various components such as positions, labels, and indicators. It appears to be a technical specification or guide, possibly related to mechanical or electrical systems.

### Table Description

The table contains data organized in columns and rows. Each column represents different categories or variables, and the rows provide specific values or measurements. The table is likely used to compare or analyze different segments or elements of the system.

### Additional Notes

- **Legend:** There is a legend at the top of the page that explains the symbols and colors used in the diagram.
- **Sections:** The page is divided into sections, possibly indicating different parts of the standard or related documents.
- **References:** The page may reference other standards, technical documents, or related literature.

### Technical Details

- **Units:** The table uses metric units, indicating a technical or engineering context.
- **Variables:** The variables in the table are numerical, suggesting quantitative analysis.

### Conclusion

The page provides a comprehensive view of segmented position standards, including detailed specifications and comparisons. This is essential for engineers and technicians working with similar systems, as it ensures consistency and accuracy in implementation.
# Appendix F1 – Work training material checklist

**Checklista upplärning**

<table>
<thead>
<tr>
<th>Montör:</th>
<th>Anst. Nummer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruktör:</td>
<td></td>
</tr>
<tr>
<td>Position:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1. Genomgång av positionen</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Produkten</td>
<td></td>
</tr>
<tr>
<td>b. Processen</td>
<td></td>
</tr>
<tr>
<td>c. Kunden</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Genomgång av positionsstandarden</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Sekvens 1</td>
<td></td>
</tr>
<tr>
<td>b. Sekvens 2</td>
<td></td>
</tr>
<tr>
<td>c. Sekvens 3</td>
<td></td>
</tr>
<tr>
<td>d. Sekvens 4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Genomgång av kvalité och ergonomi</th>
<th>Q</th>
<th>Klar</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Sekvens 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Sekvens 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Sekvens 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Sekvens 4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 4. Genomgång av tillbud              |               |
| 5. Presentation av andra standarder |               |
| a. Kontrollstämpel LS085            |               |
| b. Avvikelsehantering LS112         |               |

| 6. Genomgång av flaggning på positionen |               |
| 7. Specifika punkter för positionen  |               |

<table>
<thead>
<tr>
<th>8. Klarar av att arbeta på positionen</th>
<th>Med handledning</th>
<th>Självständigt</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Sekvens 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Sekvens 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Sekvens 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Sekvens 4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 9. Feedback                          |               |

<table>
<thead>
<tr>
<th>10. Uppföljning</th>
<th>Montör</th>
<th>Instruktör</th>
<th>PL</th>
</tr>
</thead>
</table>

| Montör: Namnteckning och datum       |               |
| Instruktör: Namnteckning och datum   |               |
| PL: Namnteckning och datum           |               |
# Sekvens 1 - Programmera

Avdelning MSBC MO3 Förarplats  
Position - Elcentral

<table>
<thead>
<tr>
<th>Tempo</th>
<th>Tid</th>
<th>I</th>
<th>Visat</th>
<th>Testad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tempo 1</td>
<td>120</td>
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<td></td>
<td></td>
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<tr>
<td>Tempo 2</td>
<td>30</td>
<td>Q</td>
<td></td>
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<tr>
<td>Tempo 3</td>
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<tr>
<td>Tempo 4</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Tempo 5</td>
<td>40</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Tempo 6</td>
<td>110</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tempo 7</td>
<td>260</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bar chart illustrating the time distribution for each tempo step.

*Appendix F2 – Work training material segment*
Appendix G – Control point

Kontrollpunkt

<table>
<thead>
<tr>
<th>Position:</th>
<th>Klicka här för att ange text.</th>
<th>Sida:</th>
<th>Sekvens:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montör:</td>
<td>Klicka här för att ange text.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kontrollant:</td>
<td>Klicka här för att ange text.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Stämpel**

<table>
<thead>
<tr>
<th>Classifier</th>
<th>Classifier</th>
<th>Classifier</th>
<th>Classifier</th>
<th>Classifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classifier</td>
<td>Classifier</td>
<td>Classifier</td>
<td>Classifier</td>
<td>Classifier</td>
</tr>
</tbody>
</table>

**Bild**

![Image]

Utörande av kontroll: Klicka här för att ange text.

Anledning varför kontrollen utförs: Klicka här för att ange text.

Godkänt av
PL: 
Kontrollant: 

---

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