Proactive Quality Management in Production

- A case study at Scania CV AB

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Product and Process Development
Production and Logistics

School of Innovation, Design and Engineering
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Examiner: Antti Salonen
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Rafi Totangy

Stockholm, Sweden 27th May 2016
Abstract

**Title:** Proactive Quality Management in Production

**Subtitle:** *A case study at Scania CV AB*

**Author:** Rafi Totangy

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**Supervisor, MDH:** Anders Fundin

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**Summary:** In order to survive the threatening rivalry, manufacturing organisations are required to constantly improve the quality of their production processes. Earlier research shows that manufacturing industries are today attempting to implement various proactive quality management practices using more structured and systematic working methods in the production processes. However, this attempt is argued to be implemented to a small extent. For that reason, the intention of this thesis is to examine how a multinational company can utilise existing tools and work-methods to proactively improve quality of production processes to better meet or even exceed the needs of customers without financial investments. The intention is to review theoretical research in the field and evaluate its applicability. Further, the aim is to contribute to existing literature and broaden the knowledge in the field of quality management by answering the research questions: 1. How can one proactively improve the quality of the production process without financial investments? 2. How can utilisation and development of existing tools and work-methods at companies establish proactive quality improvement in the production process? 3. What kind of information do one need to apply these methods? The researcher has been conducting a combination of both qualitative and quantitative study to provide an answer for an industrial problem. A generic case study at Scania CV AB was conducted collecting, what is argued to be, extensive amount of primary and secondary data. This thesis has with the findings identified the current state, in terms of output quality, utilised existing tools and work-methods and suggested an automatic solution for the highest failure risk identified. By doing this, the research questions have been answered and the relevance of the theory and its applicability confirmed.

**Keywords:** Quality Management, Proactive Quality Management, Total Quality Management, Quality Improvement
“Quality is free” – Philip Crosby
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## Abbreviations

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<thead>
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ECO</td>
<td>Engineering Change Order</td>
</tr>
<tr>
<td>DE</td>
<td>Scania Engine Production Assembly</td>
</tr>
<tr>
<td>DETP</td>
<td>Product Engineering Engine Assembly</td>
</tr>
<tr>
<td>DTMD</td>
<td>Preparation Axles and IS/IT Coordination</td>
</tr>
<tr>
<td>INAE</td>
<td>Scania Production Logistics IT</td>
</tr>
<tr>
<td>LDETM</td>
<td>Assembly Engineering in Brazil</td>
</tr>
<tr>
<td>MASP</td>
<td>Product Engineering in France</td>
</tr>
<tr>
<td>MONA</td>
<td>Scania’s internal computer system</td>
</tr>
<tr>
<td>MSTC</td>
<td>Product Engineering Truck</td>
</tr>
<tr>
<td>MZEP</td>
<td>Production Engineering in Netherlands</td>
</tr>
<tr>
<td>PtCO</td>
<td>Production Change Order</td>
</tr>
<tr>
<td>P-FMEA</td>
<td>Process Failure Mode and Effects Analysis</td>
</tr>
<tr>
<td>TQM</td>
<td>Total Quality Management</td>
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1. Introduction

This chapter presents the background of the thesis, its purpose and goals. Furthermore, issues that the thesis aims to answer are presented and finally the delimitations and reading instructions.

1.1. Background

The pressure from globalisation has made manufacturing organisations move towards three major competitive arenas: quality, cost and responsiveness (Jimenez et al., 2015; Peris-Ortiz, 2015; Singh, 2014; Judi et al., 2001). Quality, one of those three arenas, is a universal value and has become a global issue. In order to survive and be able to provide customers with good products, manufacturing organisations are required to ensure that their production processes are continuously monitored and their product quality continuously improved (Judi et al., 2001). Earlier research shows that quality management is an important area of practice and research (Peris-Ortiz, 2015). According to Peris-Ortiz (2015), both managers and scholars have become increasingly interested in quality management, and the number of books and articles on the subject has grown exponentially as our knowledge has developed. Further, Peris-Ortiz (2015) claims that today it remains an interesting topic for managers and academics alike, and many organisations use quality practices, techniques, and tools to implement quality management philosophy.

Initially it was thought that quality had a cost and that if quality rose then costs increased correspondingly (Singh, 2014). This vision of quality has been changing and today a commitment to quality enhancement is considered to improve differentiation and also reduce costs (Jimenez et al., 2015). Studies have shown that companies that implement quality management can reduce their costs as a proportion of sales because they control costs successfully, eliminating scrap and rework, and improving their processes (Jimenez et al., 2015). In addition, quality management has positive effects on improving the corporate image and promoting product/service quality, among other outcomes. Consequently, quality can have a positive effect on competitive advantage, through both differentiation and cost leadership (Bindl & Parker, 2010).

The literature on quality has gone through a range of research themes and has principally examined how quality management practices should be adopted, how quality models should be
used, which techniques and tools are most effective in developing quality initiatives and what benefits can be achieved by organizations (Peris-Ortiz, 2015). According to Chiarini (2011) today, in quality management literature, there are a lot of different improvement practices oriented towards improving production processes. They have implementation factors and results in common such as: continuous improvement, customer satisfaction, people and management involvement to mention a few. However, over time, a movement from a “reactive” to a “proactive” approach has been arising (Chiarini, 2011; Osseo-Asare & Longbottom, 2002). The simplest way to classify is thinking in terms of whether you prevent issues or help recover from issues where the literature is highly agreeing on the positive advantage of the proactive approach resulting in preventive highly efficient outcomes (Vasconcellos, 2003; Osseo-Asare & Longbottom, 2002; Chiarini, 2001).

1.2. Problem Formulation

Anderberg et al. (2008), highlights that today, manufacturing industries are attempting to implement proactive quality management practices in the production processes. However, what is also highlighted as a problem is the extent in which this is implemented. This approach is claimed being implemented to a very small extent in relation to its potential theoretically which can result in large loss of long-term quality improvement in manufacturing production processes.

1.3. Aim and Research Question

The above mentioned is a complex situation presenting huge challenges in the production processes. To eliminate problems before they even happen requires proactive quality management practices designed to prevent problems rather than solve them after they have occurred. In addition, without financial investments, this task becomes even more complex than what it actually is.

Following naturally, the aim of the thesis work is to examine how a multinational company can utilise existing tools and work-methods to proactively improve quality of production processes to better meet or even exceed the needs of customers without financial investments.

Thus, this thesis shall answer the following questions:

- How can one proactively improve the quality of the production process without financial investments?
• How can utilisation and development of existing tools and work-methods at companies establish proactive quality improvement in the production process?
• What kind of information do one need to apply these methods?

1.4. Delimitations

The time interval for this thesis is from 2016-01-18 to 2016-06-01. This short time interval results in limitations both in data collection and collection of literature. Furthermore, this thesis is limited to researching one company, Scania CV AB in Södertälje, and is carried out at Product Engineering Engine Assembly, DETP, at Scania Engine Production Assembly in Södertälje. Due to the limited timeframe, the research is limited to be conducted only internally at Scania in Södertälje. Therefore, this thesis does not intend to examine whether the practical approach is applicable to other companies or industries other than the one Scania operates in. Furthermore, the implementation of the proposed results is not planned within the thesis timeframe, basically meaning the scope of this thesis covers only the planning phase.

Since DETP, Scania, will be the client, results will be conducted according to their requirements and preferences. However, there is a high probability that other departments at/or outside Scania may use the results produced, but adjustments to their preferences will not be made.

Further theoretical limitations have been made in terms of using literature conforming to Scania standards. This limitation ensues since the aim of this thesis is to use already existing standards, tools and work-methods at Scania for quality improvement.

1.5. Thesis Structure

For the convenience of the reader, chapters of the thesis are presented below. See figure 1 for the chapters and the main thread of the thesis.
Chapter 1
Background, introduction, problem discussion & aim of the study

Chapter 2
Methodological choices, strategies and context clarification

Chapter 3
Theoretical frame of reference

Chapter 4
Empirical Findings

Chapter 5
Analysis

Chapter 6
Conclusions and Recommendations

References
Appendices

Figure 1 - Thesis Structure - Authors Figure
2. Research Methodology

This chapter presents the methodology used in this thesis work to answer the research questions and draw a conclusion from the empirical and theoretical findings. First, a general description of the research process will be presented to clarify the understanding of the methodology and the approach for the research process. Thereafter, a short presentation of the different methods used for data collection will be given. And finally, the difference of qualitative and quantitative research is explained the concepts validity and reliability clarified, and the context, in which this thesis has been performed, clarified.

2.1. Research Process

The research presented in this thesis purposes to be valid for the academic and industrial communities alike. The starting point of the research has been influenced by problems and challenges evident in both the real world and in theory. Throughout this thesis, literature studies have been iteratively combined with a case study in order to answer the research questions and meet the objective in a desirable fashion. This approach goes in line with Fagerström (2004) whom argues that in order to create dual relevance of the result, the research ought to move in an iterative process combining theory with real world contact. The researcher has been actively conducting interviews, collecting data and analysing it. Further, the researcher has made use of both scientific theories and real world situations throughout the study and continuously been moving between the two borders to provide an answer for an industrial problem. Figure 2, adapted from Fagerström (2004), demonstrates the starting point of the research being both influenced by theory and the real world and with a constant exchange between the two borders, the goal of the research is namely new scientific knowledge and/or new practical knowledge.
2.2. Methodological Approach

When performing a research, according to Arbnor & Bjerke (1997), there are three approaches; Analytical Approach, System Approach and Action Research.

Typical characteristics of the **Analytical approach** in the design of a study;

- An objective measure of a problems significance
- Study a factive reality that is constructed summatively
- The knowledge to be produced must be independent of individuals (observers)
- The goal is to arrive at invariable results, achieving generalizable results

Typical characteristics of the **System Approach** in the design of a study;

- A purpose to explain and/or understand a reality which is consisting of objective and subjective facts
- Consists of components mutually dependent meaning a significant role of each component
- Requires considering a more holistic view of the issue

Typical characteristics of the **Action Research** in the design of a study;

- Reality is not independent of observers.
- Assumes a difficulty in not influencing the phenomenon under study.

---

*Figure 2 - Schematic View of the Research Process (Fagerström, 2004)*
Considering these approaches, when conducting this thesis, the methodology employed has been a combination of both system and actors approach. For instance, a system approach has been used in different stages of this study, when considering internal and external factors that may influence quality assurance in production preparation. On the contrary, the actors approach has been used since the researcher had an active role in collecting, categorising and interpreting data. As a result, the whole process was somehow influenced by the observer.

2.3. Research Strategy

A research can be either quantitative, qualitative or a combination of both. To summarize, this thesis is a combination of both qualitative and quantitative approach.

2.3.1. Quantitative Research

Quantitative research, according to Dawson (2002), should be conducted by collecting statistics through large-scale survey research, using methods such as questionnaires or structured interviews. Further, Dawson (2002) explains that in a quantitative research several respondents should participate, but the contact with these respondents is shorter than in a qualitative research. Quantitative research is basically a research method where statistical and quantifiable results are sought. Patel and Davison (2011) argues that within the quantitative method the research includes measurement from data collections and statistics process, and analyses methods. Saunders et.al. (2007) explain that quantitative data is raw data that not has been processed or analysed. To make the collected data useful, you must analyse it. Graphs, charts and statistics can be useful to analyse, explore, examine, compare, describe and present the collected data.

In this thesis two different items were studied, weekly-meeting records and deviation-reports, to examine historical deviation documents. The historical data were collected to measure and obtain information concerning the amount, and types, of deviations requiring action from DETP. The reason was to illustrate the deviation pattern over time. Thereafter the historical data, in form of statistics, was analysed and examined.

2.3.2. Qualitative Research

Qualitative research is “an umbrella concept covering several forms of inquiry that help us understand and explain the meaning of social phenomena with as little disruption of the natural setting as possible” (Merriam, 1998, p. 5). According to Merriam (1998), the main goal of a
Qualitative research is to understand the nature of a phenomena and reveal how elements work together as a whole.

According to Dawson (2002), qualitative research is, with methods as interviews or focus groups, exploring attitudes, behaviours and experiences. Further arguing that these aspects are seen as most important in qualitative research, resulting in few amount of respondents with longer and more rooted interaction. Patel and Davidson (2011), describes that qualitative research should, through qualitative interviews and interpreted analysis, focus on soft values. Saunders et.al. (2007) explains that qualitative data as quantified non-numeric data being a product of several research strategies.

Finally, to define Qualitative research, (Merriam, 1998) categorized some major characteristics that define the traits of that type of research and separates it from quantitative research, see table 1.

<table>
<thead>
<tr>
<th>Element</th>
<th>Qualitative Research</th>
<th>Quantitative Research</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Focus</strong></td>
<td>Quality (nature, essence)</td>
<td>Quantity (amount, quantity)</td>
</tr>
<tr>
<td><strong>Philosophical roots</strong></td>
<td>Phenomenology, symbolic interactionism</td>
<td>Positivism, logical empiricism</td>
</tr>
<tr>
<td><strong>Associated phrases</strong></td>
<td>Fieldwork, ethnographic, naturalistic, grounded, constructivist</td>
<td>Experimental, empirical, statistical</td>
</tr>
<tr>
<td><strong>Goal of investigation</strong></td>
<td>Understanding, description, discovery, meaning, hypothesis generating</td>
<td>Prediction, control, description, confirmation, hypothesis testing</td>
</tr>
<tr>
<td><strong>Design characteristics</strong></td>
<td>Flexible, evolving, emergent</td>
<td>Predetermined, structured</td>
</tr>
<tr>
<td><strong>Sample</strong></td>
<td>Small, non-random, purposeful, theoretical</td>
<td>Large, random, representative</td>
</tr>
<tr>
<td><strong>Data collection</strong></td>
<td>Researcher as primary instrument, interviews, observations, documents</td>
<td>Inanimate instruments (scales, tests, surveys, questionnaires, computers)</td>
</tr>
<tr>
<td><strong>Mode of analysis</strong></td>
<td>Inductive (by researcher)</td>
<td>Deductive (by statistical methods)</td>
</tr>
<tr>
<td><strong>Findings</strong></td>
<td>Comprehensive, holistic, expansive, richly descriptive</td>
<td>Precise, numerical</td>
</tr>
</tbody>
</table>

*Table 1 - Characteristics of Qualitative and Quantitative research (Merriam, 1998)*

According to (Merriam, 1998), common types of qualitative research are; Basic or Generic, Ethnography, Phenomenology, Grounded Theory and Case Study.

In this work qualitative strategy has been used to study the problem, understand the situation and explain the results. Two qualitative research methods have been applied in this work;
Generic qualitative study and case study. It is worthy to mention that the comprehensive and descriptive findings of this work are the result of the researcher investigating documents, conducting interviews and making observations.

### 2.3.2.1. Generic Qualitative Study

In generic qualitative study, the attempt is simply to “discover and achieve an understanding of a phenomenon, process or the perspectives and worldviews of the people involved” (Merriam, 1998, p. 11). This type of study is an essence of general characteristics of a qualitative study where the goal is understanding, the primary data collection and analysis instrument is the researcher, the use of fieldwork, an inductive orientation to analysis and richly descriptive findings. Merriam (1998) emphasized that the findings of such a study are a combination of description and analysis, in which the analysis is carried out by using the concepts of theoretical framework.

The materials presented in chapter 4 are the results of a generic qualitative study. Furthermore, this chapter provides essential information required to perform and comprehend the case study presented in this thesis work.

### 2.3.2.2. Case Study

An example of definitions of case studies are “An empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.” (Yin, 2003, p. 57) and “intensive descriptions and analyses of a single unit or bounded system such as an individual, event, group, intervention, or community” (Merriam 1998, p. 19). According to Merriam (1998), the most defining characteristic of case study research is limiting the object of the study, the case. Being an explanatory approach, case studies are best fitted to answer how/why questions. Further, case studies provide background information when answering complex questions and does not offer any particular defined data collection methods.

When conducting a qualitative case study, an extensive explanatory insight into the phenomenon is provided with purpose of deriving, through induction, a holistic understanding of a particular bounded system rather than discovering, though deduction, universal, generalizable truths.

Thus, the results of the case study might be limited since its relying on the researchers’ point of view; e.g. observer’s sensitivity, selectiveness and other traits. This is regarded as a drawback
to the case study and therefore the researcher should be cautious about his/her own impact on the findings.

The qualitative case study conducted in chapter 4 has been developed to investigate quality improvement in the production process. Consecutively, the presented findings and results are in the form of explanatory statements.

2.4. Methods of Data Collection

To collect required information and data, this thesis has made use of a literature review, observations, meetings, workshops, internal documents and semi structured interviews.

**Primary Data Collection:** Interviews, Observations and Meetings, Workshops, Documents (Deviation-Reports, Weekly Records)

**Secondary Data Collection:** Literature Review, Internal Material (Educational Documents, Pre-Studies, Thesis Projects)

2.4.1. Literature Review

The literature review in this thesis work is based on books, scientific articles and journals within the chosen topic; Quality Management in Production Preparation. To gather literature of interest, databases, such as Google Scholar, ABI/INFORM Global, Discovery, Emerald and DiVA, and books, from Stockholm, Södertörn and Mälardalen University Library, were used to find relevant scientific literature. Thereafter, a scanning of the literature was conducted in order to gain an adequate level of knowledge of the theoretical subject. Subsequently, a final selection of literature was made to find relevant information, the final selection was based on the relevance of the content in the literature.

Keywords used when searching for scientific papers: quality management, quality assurance, quality tools, total quality management, quality in production preparation, quality in manufacturing, quality in production.

Figure 3 visualises the selection of literature which was performed in the following steps:
2.4.1.1. Source Critical Considerations

In an attempt to strengthen the credibility of the thesis, to the greatest extent possible, relevant sources with distinct academic connections were used. Reading frequently cited and well acknowledged researchers on the subject. The vast majority of the sources consist of scholarly articles published in peer reviewed academic journals, all within the field of study and with relevance to the subject. In order to write an up-to-date and relevant thesis, sources that are as current and contemporary as possible are used, with a majority of them written in the 2000s (with the exception of the original publications on the theory).

2.4.2. Interviews

One method for collecting data, a well-recognised and possibly the most common method, namely interviews was used (O'Gorman & Macintosh, 2014; Dawes Farquhar, 2012). Generally, there are three different interview approaches: unstructured, semi-structured and structured (O'Gorman & Macintosh; 2014; Merriam, 1998). Based on the strengths and weaknesses clarified by O'Gorman & Macintosh (2014) semi-structured interviews are argued to be the most suitable approach in this thesis work. Semi-structured interviews are not as time consuming and doesn’t require as experienced interviewers as unstructured interviews do and also increases the reliability and extent of comparability. In addition, semi-structured interviews allow the researcher to prepare the interview questions in beforehand, which is (once again) beneficial due to the limited experience the student has as an interviewer. At the same time, it enables a wider scope than structured interviews, still allowing for freedom and flexibility in the interviewees answers. This lets them express and clarify their thoughts and views in their own words. Inevitably, the semi-structured interviews have weaknesses as well. They are still quite time consuming and the interview questions can lead to researcher bias (where the
researchers’ opinions and believes influences the interviewees), also no generalisations can be made since they are based on interviews with a limited number of respondents. However, with the limitations mentioned in chapter 1, this approach is argued to be the best approach for this particular study thanks to its wide scope and flexibility, enabling an in-depth understanding and also its suitability for inexperienced interviewers.

2.4.2.1. The Interview Guide

The questions were formulated in a manner so the answers could be somewhat concrete, facilitating the subsequent comparison of the different answers. For more information, the complete interview guide is presented in Appendix II: Interview Guide.

Dawes Farquhar (2012) presents several basic elements for developing a good semi-structured interview guide. When preparing our interview guide we made sure to incorporate as much of these elements as possible.

For instance, a great care was taken in developing questions relating to the aim of the research without being too evident. The questions were also formulated in a language that would be understandable and familiar to the participants, excluding irrelevant theoretical terminology and explaining, in a simplistic manner, the theoretical concepts that needed to be included. The questions where eventually ordered in a sequence that would provide a natural flow and logical order to the interview. Additionally, several ethical research principles were followed in order to create a harmless situation where we as researchers would be perceived as trustworthy to the participants.

2.4.2.2. Sample Design

It’s important to choose relevant respondents since time is consumed and interviewing irrelevant respondents (for the survey’s purpose), is a waste of time. The interviews were conducted with the 10 product engineers working at DETP, Scania Engine Production Assembly in Södertälje. They are the most relevant respondents since the thesis is concerning quality improvement of their work. The interviews were carried out by a visit, meaning verbally through an open dialogue one person at a time, and the interview guide was used to ensure that every interview was carried out in the same manner. Each interview lasted between 40-60 minutes. To remember what the respondents said notes were taken and interviews recorded with the respondents’ agreement. Yet, it’s important to have in mind that recording may be
disincentive to the respondent, however, to ensure that the respondents feels comfortable, they were given the opportunity to elaborate on the answers and approve the draft of the interview.

2.4.3. Benchmarking

“The art of benchmarking is to be sufficiently lowly to recognize that someone is better than you and at the same time be obstinate enough to learn to be equally good or better.” – Andersen and Pettersen, 1997, p. 11

According to Andersen and Pettersen (1997), the goal with benchmarking is to develop and create changes and improvements. Benchmarking is a complement to the continuous improvement since one will:

- Find new resources for improvements outside your own organisation.
- Find new, innovative methods that benefit the development of the company.
- Establish goals in line with the best representatives of the industry.

Benchmarking can be divided into three perspectives:

- Internal
- External
- Best practice

Internal benchmarking is evaluating something (e.g. work process) by studying something (e.g. the same process in different departments) within the company. With benchmarking, one can for example identify and compare different processes between different departments at the company. Comparing two departments in a company to identify strengths and weaknesses and thereby develop adjustments and improvements can constitute internal benchmarking. External benchmarking is when one studies an external party, it can be companies from different industries or from the same industry. It can be an advantage to study a company that produce different products since new things might be learnt by seeing situations from new perspectives. Best practice benchmarking is when one studies the leading company in a certain industry or process. This can be essential to be successful in your business.

In this thesis project, interviews have been conducted in form of a benchmarking process. The benchmarking process was conducted at two different departments at DTMD and MSTC, to compare how the production preparation processes differs between different departments and to identify differences in work-method/environment. Totally, two product engineers were
interviewed at DTND and one product engineer at MSTC. The duration of the interviews lasted for approximately one hour.

The two departments were chosen after recommendation from group managers and product engineers since they have similar production preparation processes, using the same system and similar work-methods, despite preparing production for different products.

Further, benchmarking with national and international units at Scania was executed when developing countermeasures. The benchmarking was in digital form, email conversation due to the long distance, where the researcher has been emailing proposed countermeasures for feedback from all potentially interested Scania units. Totally, apart from for DETP, the proposed countermeasures were sent to internationally located product engineers at MASP in France, MZEP in Netherlands, LDETM in Brazil and to national product engineers at DTMD and MSTC.

2.4.4. Documents and Internal Material

Various documents and internal material was used throughout the thesis. The purpose of collecting these documents is to understand and identify the current state at Scania. Four types of documents where collected, categorised into the following four categories:

**Weekly-meeting records**: data regarding *amount of deviations*, requiring action from DETP, reported from the work-team is stored digitally. This information is available in terms of weekly-meeting records found in Scania’s computer system.

- A total amount of 65 weekly meeting records from the period 2015-2016 were collected.

**Deviation-reports**: Data regarding *types of deviations* is not stored neither digitally nor on paper. However, some production areas take own initiative to store the data on paper in terms of deviation-reports, see Appendix III: Deviation-Report Example.

- A total amount of 101 deviation-reports from the period 2013-2016 were collected.
- 77 deviation-reports from production area 4, 22 deviation-reports from production area 6, and 2 deviation-reports from production area 7.
- The remaining production areas did not store any deviation-reports.

**Internal material and earlier thesis projects** were used to understand the process and to gain deeper and more holistic insight of the issue. Also internal materials were used to describe the background of this thesis, see context clarification in chapter 2.
Earlier and ongoing pre-studies regarding the issue/similar issues were studied. These earlier pre-studies were also used, having contact with the project participants, to set targets with the thesis project. Since it’s not preferable to conduct a thesis project overlapping with earlier/ongoing pre-studies, rather complement.

2.4.5. Observations and Meetings

In direct observation, the researcher observes something without interacting, merely watching and taking in data (Yin, 2003). Observations are, according to Patel and Davidson (2011), the most common method for data collection in our daily lives based on random encounters. Further, Patel and Davidson (2011) argue that as a scientific method, observations cannot be random rather performed and planned in a systematic way.

Observations will be used in as an additional method in this study to further investigate certain parts of the interface between engine production and production preparation, for example meetings with different representatives. According to Andersen et al (1997), observations should be used early in a study to gain a clear view of the problem, thus in this study, observations are used throughout the study and as a follow-up method to the interviews. This approach is supported by Patel and Davidson (2011), stating that observations can be used as an explorative method in the early phase of a study but also to supplement information that have been gathered with other methods. Further, Patel and Davidson (2011) argue that observation as a method is suitable when investigating behaviours and activities in their natural situations, which is corresponding to the purpose of the empirical study.

Furthermore, Genchi Genbutsu, an observation meaning “go and see”, was performed. Genchi Genbutsu is a key principle of the well-acknowledged Toyota Production System, suggesting that in order to truly understand a situation, one needs to go and see the real place, where the work is done. Therefore, a “go and see” was performed at the assembly line for two days, in two different assembly stations, in order to understand the work-process and how deviations might occur.

2.4.5.1. Meetings

During the course of this thesis, the student has worked with DETP and actively been taking part in their daily and weekly meetings. This has enabled the student to sync up the proceeding of the thesis with the project and deliver the required data to the project team simultaneously.
Further meetings with various employees at Scania, e.g. Scania Production and Logistics IT, INAE were constantly occurring to discuss confusions and to brainstorm ideas.

2.4.6. Workshops

To identify failure risks within DETPs work process, a P-FMEA, Process Failure Modes Effects Analysis, workshop was carried out. P-FMEA, is a systematic method by which potential failures of a product or process design are identified, analysed and documented. The group manager and all product engineers from DETP were invited and given the opportunity to attend. Before the workshop, the required material for the workshop was distributed and discussed with the participants. The participants represented the same unit at Scania, DETP, and in total, there were 8 participants out of 11 possible, 7 product engineers and the group manager attended. The participants were divided into 3 smaller groups (3/3/2), with a separate task for each group.

The workshop was conducted in 4 hours, and documented by the researcher afterwards, (e.g. collecting used post-its). By way of introduction, the method P-FMEA together with the purpose and aim of the workshop were presented. The introductory presentation was presented in one hour, to truly make sure that the participants understood the method and their task. The introduction was followed by a case practise where the participants read through and discussed all provided materials and the provided example P-FMEA in order to discuss any uncertainties.

The workshop ended with a full group discussion where every group presented their results from the P-FMEA exercise followed by questions and discussions. The workshop lead to direct response on relevant suggestions for improvements; and there was also a chance to discuss identified uncertainties as the employees had different opinions. After the workshop, the results were documented by the researcher digitally and finally completed together with the group manager.

2.5. Data Analysis

Since this thesis has used both qualitative and quantitative data, different methods for analysing this data has been used. The data collected by quantitative methods is always numerical henceforth analysed using mathematical and statistical methods. There are a wide range of statistical techniques available to analyse this data, techniques used in this thesis are for example graphs and diagrams to find and visualise patterns in collected data.
Data collected by qualitative methods does however not involve numbers or numerical data, often involving words or language resulting in rich data that gives an in-depth picture, requiring therefore different analysis methods. Because qualitative data is drawn from a wide variety of sources, there can be radical difference in scope resulting in a wide variety of methods for analysis. In this thesis, structuring the data into groups and themes, highlighted in the literature, and comparing the data with the literature, has been the analysis method for the collected qualitative data. Furthermore, in order to best work out which method is right for this particular research, discussions with the supervisor has constantly been conducted to clarify the analysis method.

2.6. Validity, Reliability and Objectivity

According to Björklund and Paulsson (2003), there are three measures of the credibility of a study:

- Validity – to what extent you actually measure what you intend to measure
- Reliability – the reliability of the measurements. If you repeat the study, will you get the same results?
- Objectivity – to what extent the values of the author and participants influence the results of the study.

Patel and Davidson (2011), claims that in every study, the effort must be to reach as high validity, reliability and objectivity as possible, thus with regards to resources and time available. Further, Patel and Davidson (2011) suggests one method, namely triangulation, which is commonly used to increase validity and reliability. Triangulation is basically used to indicate that two (or more) methods are used in a study in order to check the results of one and the same subject. This can be done in many different ways during data collection. Several different methods as interviews, observations and documents from different sources can be used to get a comprehensive view of the issue. For instance, if a respondent says a certain thing in an interview but does something contradictive during an observation that can be the basis for a deeper interpretation.

Further, triangulation can also be used by the researcher to validate the study using several data sources. For instance, interviewing different respondents with different perspectives of a certain phenomenon.
According to Björkman and Paulsson (2003), one method for increasing the objectivity of a study is to motivate different choices made during the study. Thus giving the reader a possibility to self-evaluate the objectivity and the results of the study.

The validity of the study has been ensured by having a dialogue with the supervisors, both at MDH and at Scania to confirm that the study is making the necessary progress related to the problem definition.

The study has also been triangulated to increase the validity and reliability by using different methods of collecting data. For instance, the respondent has been interviewing different perspectives on the phenomenon, product engineers, process engineers, group managers, team leaders, assemblers, all which have had their chance to express their perspective on the issue.

2.7. Project Timeline

A basic visualisation of the project timeline is shown in figure 4. For a fully detailed project timeline, see Appendix IV: Time Plan.

2.8. Context Clarification

Scania, with sales and service organisations in more than 100 countries, net sales in 97.8 billion SEK and net income amounted to 6.7 billion SEK, is one of the world’s leading manufacturers of trucks and buses for heavy transport applications. Besides manufacturing customised heavy trucks and buses, Scania also manufactures engines for use in heavy vehicles, marine and industrial applications focusing on efficient, low-carbon solutions enhancing customer
profitability. Scania is aiming to be the leader in sustainable transport striving to build its business by creating value for customers, employees and society.

“With the aim to be the leader in sustainable transport, at Scania we are building our business while creating value for our customers, employees and society. Delivering customised heavy trucks, buses, engines and services, our focus is on efficient, low-carbon solutions that enhance customer profitability.” - Scania Annual Report, 2015, p. 2

2.8.1. Scania Production System (SPS)

Scania Production System (SPS), originating from lean production, was introduced in the company in the mid-1990s. SPS can be seen as a base to meet customer needs, while achieving greater competitiveness, growth and profitability. Scania has visualised how different values, principles and priorities affect each other by means of a house, SPS house, see figure 5.

![Figure 5 - Scania Production System (SPS) (BSEM, 2016)](image)

The foundation of the house, the grey blocks, are representing Scania’s values, also called philosophies. These values are customer first, respect for the individual and elimination of waste (BSEM, 2016) Normal situation – standardised working method, continuous improvement, right from me and consumption controlled production are Scania’s four main principles that form the house’s floor, ceiling and walls. In the middle of the SPS house, one
finds Scania’s four priorities; safety/environment, quality, delivery and cost. All employees, throughout Scania should understand these values, principles and priorities in order to quickly take correct decisions.

2.8.2. Product Engineering Engine Assembly (DETP)

Product Engineering Engine Assembly (DETP), is a supporting function of Scania Engine Production Assembly (DE). DE is a production unit where Scania Engines are produced and DETP acts as product technical support in DE and as a management resource in technical questions.

The aim with DETP:s operation is to contribute to the introduction of new or changed products at the lowest cost with the lowest possible environmental impact and with the right quality. DETP consists of 10 product engineers and one group manager. Performing many different tasks, just to mention a few examples, product engineers are producing work-orders (assembly instructions) to the assembly line, see Appendix V: Work-Order Example, and daily participating at the assembly line to control what deviations and difficulties are arising on or around the product.

2.8.3. Problem Description

With an increased number of introductions (new engine introductions or continuous changes) and a constantly growing number of engine variants (increasing number of customer choices, today 200 customer choices), DETP needs new work-methods to deal with the new demands from the outside world.

Today there is no comprehensive method or tool to be used to proactively assure the quality of the output from product engineers. The output may be checked manually, e.g. by letting a colleague control the work to ensure that everything is correct or by visually controlling a preview.

DETP is today obtaining deviation-reports when deviations are caused at the assembly line, however, since deviations are discovered only when occurred it is a reactive job and does not correspond to Scania’s strategic goal of having zero deviations.

With this thesis project, DETP is requesting a method or a tool to proactively assure the quality of work-orders produced from their internal production system MONA. The following process is suggested:
1. Current-state analysis
2. Develop and utilise existing tools and work-methods
3. Suggest an automated system for improving the quality of the output from product engineers
3. Theoretical Framework

This chapter presents the theoretical framework which is part of the underlying basis supporting the results of the thesis. The chapter begins with basic definitions of quality and describes concepts of quality management.

3.1. Quality Definition and Strategic Issue

According to earlier research, quality is an important aspect in business strategy and provides competitive advantage (Peris-Ortiz, 2015). Since this thesis has a focus on quality and quality management, these areas need to be defined and described as a basis to discuss implications and methods that concern quality.

According to Kehoe (1996), in order to understand the fundamental concepts of quality, the starting point is to understand the meaning of the term “quality” itself. Despite the fact that it might seem elementary, since the word “quality” is a well-recognised word and in general speech used to describe excellence, value, reliability or goodness, it’s important to clarify the definition for this thesis. However, this is not a simple task since up until now, earlier research has been unable to arrive at a single definition of quality.

A definitional example of the term “quality” is The Oxford English dictionary’s definition (Kehoe 1996):

“(Noun) Degree of excellence, relative nature...” – Kehoe, 1996, p. 29

Further examples, Garvin (1984) identified five major approaches to the definition of quality, and disciplines in which they are rooted. Reeves and Bednar (1994) identified similar definitional approaches to quality and concluded that a global definition of quality does not exist. Explaining that different definitions of quality are appropriate under different circumstances.

Further, J.Fox (1993) mentions multiple different definitions of quality thus highlighting The International Standards Organisation’s, ISO, definition of quality. ISO, which has published over 21000 international standards documents (ISO, 2016), presented their definition of quality in its ISO 8402 Quality Vocabulary document as:

“The totality of features and characteristics of a product or service that bear upon its ability to satisfy stated or implied needs.” – ISO, 2016
Moreover, other definitions of quality written by various well-acknowledged writers, so called gurus in quality, are:

“For fitness for purpose or use.” – Juran, 1999, p. 19

Or Feigenbaum’s definition:

“The total composite product and service characteristics of marketing, engineering, manufacture and maintenance through which the product and service in use will meet the expectation by the customer.” – Feigenbaum, 1986, p. 238

And lastly Crosby’s definition of quality:

“For conformance to requirements.” – Crosby, 1989, p. 58

Nevertheless, Kehoe (1996) argues that when it comes to any business, the concept of quality needs to be more precisely understood and clearly interpreted by everyone in the organisation. An important realisation is that quality seems to be a multi-dimensional construct (Garvin, 1984; Hjorth-Anderson, 1984). All these definitions are worth considering together since they can be complementary. Each definition emphasizes on a particular point which is only implicit in the others. Some definitions are brief, e.g. Juran’s definition, while others more expansive, e.g. ISO-definition. ISO-definition is for instance emphasizing on the totality of quality considerations which together satisfy all needs, whether expressed or taken for granted. Feigenbaum’s definition reveals that the customers are those whose criteria of need, fitness and expectation are being addressed. Further highlighting four key divisions, marketing, engineering, manufacturing and maintenance as significant to business. Meaning quality has different function in each one of those divisions. Also, a similarity between both ISO and Feigenbaum is their highlight on the definition being applied equally to a manufactured product and to a delivered service. Finally, despite definitional differences, what is common, in matters of quality, the customer is indeed always right. What the manufacturer feels the customer should want, or what the manufacturer believes they are getting, is irrelevant.

When evaluating quality of a production preparation process, the most important aspect is that specifications are met J.Fox (1993). Therefore, the definition stated by Crosby (1989), conformance to requirements, is used in this thesis since it is considered the most appropriate definition of quality for the study.
3.2. Quality Management (QM)

Kehoe (1996) explains how quality management has become incredibly important as a result of an increasing global competition. Arguing that the international markets for many products are now very mature since products/services offered by different companies from different countries are basically the same. This results in an increasing competition for better quality of the product or service. Also, Kehoe (1996) argues that the conflict between quality and cost does not exist in organisations since they are realising that in the long term, quality actually costs less.

Having expressed different definitions of the term “quality”, and the importance of managing it, naturally the following question is how can quality be managed? According to (Sousa & Voss, 2002), quality management was born with the core ideas of W. Edwards Deming, Joseph Juran, Philip Crosby and Kaoru Ishikawa. Further claiming that it has become an all-pervasive management philosophy in most of today’s business society and is here to stay.

Dean & Bowen (1994) defines quality management as a

“philosophy or an approach to management with a set of mutually reinforcing principles, each of which is supported by a set of practices and techniques” - Dean & Bowen, 1994, p. 2

Watson and Korkukonda (1995) however states that since quality management has become embedded in more and more organisations, it means different things to different people. What’s important is that quality is vital to the prosperity of businesses, J.Fox (1993) argues that the management functions planning, organising, motivating and controlling, must be exercised in pursuit of quality in every department and activity of a company. J.Fox (1993) explains that it is necessary for a company to have conscious and coherent “quality management system” in order to achieve this.

Sousa & Voss (2002) compared five major studies in QM, concluding that there is substantial agreement as to the set of constructs classified under the scope of QM. According to Sousa & Voss (2002), the agreement in the literature on what constitutes QM indicates that QM as a field has indeed matured and is laid down on solid definitional foundations.

3.3. Total Quality Management (TQM)

According to Summers (2010) TQM can be summarised as a management system for customer-focused organisations that involves all employees in continual improvement. It uses strategy,
data, and effective communications to integrate the quality discipline into the culture and activities of the organisation.

Total Quality Management, TQM, is a phenomena expressing companies that consider quality as an integrated strategic function of the overall organisation (Bergman & Klefsjö, 2007; Kiella & Golhar, 1997; Morris, 1989). Summers (2010, p. 12) defines TQM as; “a management approach that places emphasis on continuous process and system improvement as a means of achieving customer satisfaction to ensure long-term company success”.

With a long and complex history, from the industrial revolution to present day, the quality movement has not surprisingly been interpreted in several different ways. Some highlights four relatively distinct phases, some identifies two different movements evolving more or less in parallel, while some highlights a more continuous improvement (Garvin, 1988; Kanji & Ascher, 1993; Dale, 1999 and Dahlgaard et al., 1998).

Yet, the most common description of way which quality and quality improvements have evolved into the present day Total Quality Management (TQM), is that which identifies the four different phases or stages illustrated in figure below: Quality Inspection (after production), Quality Control (during production), Quality Assurance (before production) and Total Quality Management (continuous improvements before, during and after production) (Garvin, 1988; Kanji & Ascher, 1993; Dale, 1999 and Dahlgaard et al., 1998).

The fourth and the current stage as seen in figure 6, Total Quality Management, TQM, involves understanding and implementing quality management principles and concepts in every aspect of an organisation. This development has been described by Bergman & Klefsjö (2003, p. 34) as “a constant endeavour to fulfil, or preferably exceed customer needs and expectations at the lowest cost, by continuous improvements work, to which all involved are committed, focusing on the processes in the organisation”.

Figure 6 – Total Quality Management History (Bergman & Klefsjö, 2003)
According to Dale (1999), visualised in figure 7, values, tools and methodologies are used in TQM in order to improve the organisation continuously. A similar approach is from Shiba et al. (1993, p. 89) arguing that “Total Quality Management (TQM) is an evolving system of practices, tools, and training methods for managing companies to provide customer satisfaction in a rapidly changing world”. In this thesis however, the definition of TQM used is the development of Hellsten & Klefsjö (2000, p. 27) defining TQM as “a management system in continuous change and consisting of values, methodologies and tools, the aim of which is to increase external and internal customer satisfaction with a reduced amount of resources”.

![Figure 7 – Values, Methodologies and Tools in TQM (Dale, 1999)](image)

### 3.3.1. Values

An organisation’s core values are the basis of its culture (Hellsten & Klefsjö, 2000). These core values underpin the basis of succeeding with TQM (Bergman & Klefsjö, 1995). Despite that literature offers a whole variety of suggestions for the values of TQM, roughly, the values presented in earlier literature are the same as those summarized by Bergman & Klefsjö (1995). Also further similar values with considerable agreement with the values presented can be found in (Boaden, 1997; Cameron & Sine, 1999; Dale et al., 2001; Hellsten, 1997 and Sila & Ebrahimpour, 2002).
The values presented by Bergman & Klefsjö (1995), as seen in figure 8, are committed leadership, focus on customers, basing decisions on facts, focusing on processes, continuously improving and letting everybody be committed. These are some of the most recognised core values of TQM (Hellsten & Klefsjö, 2000) and are presented briefly below.

3.3.1.1. Committed Leadership

Working with TQM and keeping up the quality improvements requires total management commitment (Dale et al., 1999; Abraham et al., 1999). According to Dale (1999), the senior management has the responsibility and must initiate planning for implementation and participate in the work including evaluation of processes and results. All senior leaders in the organisation must create a customer orientation and set clear organisational environment and visible quality values in which TQM can achieve its potential. The importance of the role of senior managers as advocates, teachers and leaders cannot be overstated (Tenner & DeToro, 1992). Oakland (1989) explains that TQM must start with these leaders as they must serve as role models throughout the organisation, thus reinforcing the quality values organisation-wide by choosing and applying appropriate techniques and tools.

3.3.1.2. Focus on Customers

Focusing on customers is highlighted by most authors of TQM literature. In fact, it is highlighted as a central core value in TQM, meaning that all products and processes should always have customer focus (Shiba et al., 1993). Earlier research (Oakland, 1989; Tenner & DeToro, 1992; Shiba et al., 1993; Dahlgaard et al., 1994; Bergman & Klefsjö, 2003), explains that quality should be valued by the customers and be put in relation to their needs and expectations. Further, Tenner & DeToro (1992) explains that the organizations need to be dedicated to satisfying customers with continuous and long-term effort since the quality of a product can be experienced as strongly weakened if a competitive product with better characteristics enter the market. Focus on the customer means, therefore, that there is a strive...
for finding out what the customers’ need and what they to fulfil their expectations while systematically developing and manufacturing the product (Dahlgaard et al., 1994).

According to Bergman and Klefsjö (2001), focusing on the customer does not only apply to the external customers. Rather both internal and external customers since every employee has customers within the organization and in order to perform a great job their needs also have to be fulfilled. Further claiming that in order to satisfy external customers, the internal customers also need to be satisfied (Oakland, 1989; Tenner & DeToro, 1992; Shiba et al., 1993; Dahlgaard et al., 1994; Bergman & Klefsjö, 2003).

3.3.1.3. Base Decisions on Facts

An important element in TQM is to make decisions which are based on fact that are well founded and not allow random factors to be a decisive importance (Bergman & Klefsjö, 1994). Deming (1994) argue that speculation or opinion has no place as basis of decision-making highlighting for instance the importance of knowledge regarding variation and ability to handle and control variation. This underlines importance of that the production processes are based on facts related to the customers’ experiences plus customers present and future needs (Bergman & Klefsjö, 2003). Dale (1999) explains that utilising different efficient statistical tools, as the seven quality control tools and the seven management tools, can help obtain, organise and analyse these facts of customer satisfaction.

Bergman & Klefsjö (2003) also highlight the importance of having a clear purpose of the data collection. Before obtaining data it’s important to question what the problem is and what facts are needed. Also stating that the above mentioned statistical tools for processing data can help tackle process variation and reduced it in a good manner. Bergman & Klefsjö (2003) more importantly highlight the importance of an active search for information to be complied and analysed.

To analyse and structure numeric information there are seven quality improvement tools. These are control charts, pareto diagrams, scatter plot, data collection, histograms, stratification and cause-effect diagrams. However, it is not only numerical facts that should be compiled. Verbal information, such as views, descriptions, events and feelings, is of great importance. The seven management tools can be used to structure and analyse this type of information. These are tree diagrams, matrix diagrams, process decisions charts, matrix data analysis, activity network diagrams, interrelation diagraph and affinity diagrams. See Dale (1999) for a more detailed description of these tools.
3.3.1.4. **Focus on Processes**

Nearly every organised activity within an organisation can be looked upon as a process, which means a repetitive sequence of activities (Bergman & Klefsjö, 2003). The goal of the process is to produce products or services, which satisfy its customers (Bergman & Klefsjö, 2003). The consequence of focusing on processes is that the focus is not on results. Instead the result is the dependent variable. The result comes from whatever process is followed, process drives result (Shiba et al., 1993). The process generates data indicating how the process is satisfying its customers. Meaning that we should not look upon every single piece of data, for instance every single customer complaint, as something unique but as part of statistics, which give information about how well the process is working and how it can be improved (Bergmann & Klefsjö, 2003).

3.3.1.5. **Improve Continuously**

It is not enough for an organisation to do better than it did previously. The external demands an organisation faces are continuously increasing and therefore, organisations are required to continually improve the quality of its production processes in order to survive (Bergmann & Klefsjö, 2003). The continuous improvement of the process leads to customer satisfaction, which results in an external quality improvement (Dahlgaard et al., 1994). Moreover, Dahlgaard et al. (1994) explains that the continuous improvement of the production process also leads to fewer defects, which results in an internal quality improvement.

The Deming cycle, or the PDCA-cycle, is a model for process analysis and improvement and serves as a symbol for continuous improvement. The PDCA-cycle is composed of the four stages: plan, do, check and act (Deming, 1994). PDCA-Cycle is below methodologies discussed further in this chapter.

3.3.1.6. **Let Everybody Be Committed**

In order to ensure that the organisations quality strategy is to be successful, all of the organisations employees should be committed in the work of satisfying the customer and to continuous quality improvement (Bergman & Klefsjö, 1994). Moreover, everybody’s commitment means that continuous improvement should be practised everywhere in the processes and that the involvement of all employees at every level should be facilitated (Tenner & DeToro, 1992; Bergman & Klefsjö, 1994). The work is based on the skills and participation of every employee and his or her understanding of what is required. Educating and training all employees provides the knowledge needed on the mission, vision, direction, and strategy of the
organisation as well as the skills they need to secure quality improvement and resolve problems
(Tenner & DeToro, 1992). Keywords for commitment are information, delegation and training

3.3.1. Methodologies

Methodologies are according to Hellsten & Klefsjö (2000, p. 239) “ways to work within the
organisation to reach the values”. A methodology “consists of a number of activities performed
in a certain way” (Hellsten & Klefsjö, 2000). It is important to note that the methodologies
presented in figure 7 are just examples and not a complete list. The main methodology studied
in this thesis is PDCA-Cycle, Plan, Do, Check and Act.

3.3.1.1. Plan, Do, Check, Act (art 23)

Continuous improvements are an essential part of TQM and a way for a company to increase
the satisfaction of customers and employees (Summers, 2010). Berman and Klefsjö (2007)
argue that companies need to continuously improve in order to keep up with competition, and
that even the companies that can be considered good, risk losing their competitive advantage if
they do not continuously improve.

There are different methods for improvements in production processes. (Knowles, Johnson &
described by Bergman and Klefsjö (2007), Petersson et al. (2009), and Summers (2010), is the PDCA
cycle, see figure 9, where PDCA stands for Plan-Do-
Check-Act. The PDCA cycle is illustrated in figure.

The method is described as a cycle where the first
phase is Plan, that includes definition of the problem
(Summers, 2010). The second phase, Do, includes
the implementation of actions that where planned in
the previous phase (Petersson et al. 2009). The third
phase, Check, the actions taken in the Do-phase are
evaluated (Summers, 2010). According to Petersson
et al. (2009), the third phase also includes control
against the Plan-phase. The last phase of the PDCA cycle is Act. Bergman and Klefsjö (2007),
describe the Act-phase to include lessons learned from problems to be able to avoid them in
future projects. Further explaining that if results are unsatisfactory then a new loop of the PDCA cycle should be made to find a solution to the defined problem. The method can help any company to create an organised system for improvement of processes, products and services (ibid).

Using the PDCA cycle means continuously improving a process (BSEM, 2016). The PDCA cycle enables two types of corrective action, temporary and permanent. The temporary is aimed at results by practically tackling and fixing the problem. The permanent consists of investigation and eliminating the root causes and thus targets the sustainability of the improved process. The PDCA-Cycle is divided into 8-steps as seen in figure 10 below covering all parts from problem clarification to standardisations with questions to be answered in each step. At Scania, The 8-Step Model is a Scania standard for continuous improvements.

Figure 10 - The 8 - Step Model (BSEM, 2016)
3.3.2. Tools

Hellsten & Klefsjö (2000, p. 242) define tools as “rather concrete and well-defined tools, which sometimes have a statistical basis, to support decision-making or facilitate analysis of data”. It is important to note that the tools presented in table 2 are just examples and not a complete list. The seven quality improvement tools are the main tools studied in this thesis, since they are identified as being most helpful in troubleshooting issues related to quality (BSEM, 2016).

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause and Effect Diagram</td>
<td>Show causes for a specific event</td>
</tr>
<tr>
<td>Check Sheet/Data Collection</td>
<td>A document/form to collect data in real time at the location where the data is generated</td>
</tr>
<tr>
<td>Control Chart</td>
<td>Used to determine if a process is in a state of statistical control.</td>
</tr>
<tr>
<td>Histogram</td>
<td>A graphical representation of the distribution of numerical data</td>
</tr>
<tr>
<td>Pareto Diagram</td>
<td>A chart containing both bars and a line graph. Bars represents individual values in descending order and the cumulative total is represented by the line.</td>
</tr>
<tr>
<td>Scatter Diagram</td>
<td>A plot using Cartesian coordinates to display values for typically two variables for a set of data</td>
</tr>
<tr>
<td>Stratification (alt. flowchart)</td>
<td>A method of sampling from a population</td>
</tr>
</tbody>
</table>

Table 2 – TQM Tools - Adapted from Hellsten & Klefsjö (2000)

For more detailed information about the quality control tools see Ishikawa (1985)

3.4. Communication and continuous improvements

Communication is an important aspect of all organisations. When it concerns quality management, it has been found to have a major impact on the performance and therefore has potential to improve the quality if handled and used properly.

Communication is said to be “the glue that holds together a channel of distribution” (Mohr & Nevin, 1990, p. 36). In today’s business, communication processes underlie most aspects of organisational functions (Fulk & Boyd, 1991; Mohr & Spekman, 1994). Mohr and Spekman (1994) and Sharma and Patterson (1999) describe how high levels of participation, information sharing and communication quality, including accuracy, timeliness, adequacy and
credibility of information exchange, are associated with a good partnership and a strong relationship between different parts. Furthermore, according to Sharma and Patterson (1999), timely communication fosters trust in order to help in resolving disputes and to align perceptions and expectations between customer and supplier. See figure 11.

### 3.4.1. Parameters of Communication

According to Mohr and Nevin (1990), ineffective communication often leads to misunderstandings, incorrect strategies, and a mutual feeling of frustration that can cause conflicts among the people involved. Therefore, it is said that many of the current problems within firms can be solved by appropriate methods and strategies for communication, within and between firms (ibid.). This is called effective communication by Sharma and Patterson (1999) and can be seen in regular contact between customer and supplier. Mohr and Nevin (1990) describe communication using four different parameters: frequency, direction, modality and content. Communication strategies are presented in the table below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Method</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>&quot;amount of communication&quot;</td>
<td>The amount of contact in relation to amount of contact necessary to conduct activities adequately</td>
<td>Some contact is necessary, too much can overload organizational members.</td>
</tr>
<tr>
<td>Direction</td>
<td>&quot;vertical and horizontal movement of communication within the organizational hierarchy&quot;</td>
<td>&quot;Unidirectionality&quot; (downward or upward) &quot;bidirectionality&quot; (both downward and upward)</td>
<td>Manufacturer is upward communication. Reseller is downward.</td>
</tr>
<tr>
<td>Modality</td>
<td>&quot;method used to transmit information&quot;</td>
<td>Formal and informal distinction</td>
<td>Formal communication through written modes. Informal communication is more personalized (word-of-mouth).</td>
</tr>
<tr>
<td>Content</td>
<td>&quot;the message that is transmitted&quot;</td>
<td>Direct and indirect influence strategies</td>
<td>Direct strategies are designed to change behaviors (requests, recommendations, and promises). Indirect strategies are designed to change beliefs and attitudes.</td>
</tr>
</tbody>
</table>

*Table 3 - Communication Strategies (Mohr & Nevin, 1990)*

The four parameters of communications describe strategies that together with channel conditions work to improve performance of the outcomes (Mohr & Nevin, 1990). Channel conditions consider structure, climate, and power. Channel structure refers to two different structures: relational and market. Relational structure involves joint planning between parties, shared activities, its long term, and interdependence is high (ibid.).
Market structure is more ad-hoc, the relationship is on short-term basis and interdependence is low. Channel climate has implications for communication; in a channel with high trust and supportiveness, more frequent communication will be used, and vice versa within channels with lower trust (Sharma and Patterson, 1999). Further, channel climate is associated with organisational culture, which for example includes leadership, trust, respect, autonomy and responsibilities and reward orientation of management. Channel power can be either symmetrical or asymmetrical. When the power is symmetrical the power is balanced between the different parties, with asymmetrical power there is imbalance. In order to improve the performance of the outcome, the organisation should consider both communication strategy and conditions of the channel, in combination (Mohr & Nevin, 1990).

Communication can however be improved by several methods. One way is to develop smooth, cordial, and ongoing communication between different departments in order to develop the relationship between them (Sharma and Patterson, 1999). The more interaction between the departments, the stronger the relationship will be in relation to knowledge transfer activities, where the goal is to improve the capabilities of the supplier (Wagner and Krause, 2009). According to Carr & Kaynak (2007), communication is more frequent when information technology is used, because it facilitates communication. Managers should assess internal and external communications and take action where communication needs to be increased. They should also be sure to solve problems and increase general awareness of the relationship between communication, service and product quality (Prahinski & Benton, 2004).

3.5. Scope and Use of Theoretical Framework

The theoretical frame of reference presented in figure 12 aims to develop understanding of the literature’s perspective of how communication, and other problem areas, can be improved within the production processes. The starting point of the theoretical framework is the definition of the term quality. In this thesis the term “Quality” is defined as conformance to requirements since the most important aspect when evaluating quality of a production preparation process is that specifications are met (J.Fox, 1993).

In order to understand how to manage quality, it is necessary for a company to have a conscious and coherent “quality management” (J.Fox, 1993). Therefore, managing quality is discussed and the quality management system Total Quality Management, TQM, is presented. TQM is investigated since it is a management system for customer-focused organizations, which Scania certainly claims it is e.g. Customer First is one of Scania’s core values.
In this thesis, since the aim is to utilise existing tools and work-methods to proactively improve quality, when using literature, methods best meeting Scania’s own standards and tools were studied. In order to solve the problem presented practically, the PDCA method was used for this thesis since it is considered feasible with qualitative and quantitative data. Also PDCA is a standardised work-method at Scania for continuous improvements, see Scania’s 8-Step Model in figure 10, therefore, PDCA is argued to be the most feasible method for this particular study. Due to the limitations of this thesis, the thesis covers only step 1 to step 5 in the PDCA-method. Furthermore, different tools were used within the PDCA method as for instance, P-FMEA, Fishbone Diagram, Flowchart and Histogram. They were used once again due to the fact that they are Scania standardised tools for improvement and because they are essential in TQM. Finally, in the analysis, the TQM values were used to analyse the findings. The values where chosen since they are the underpinning the basis of succeeding with TQM where the methodologies and tools are ways to work to reach those values.

Moreover, since communication is one of the most important aspects in continuous improvement it is presented as an important problem area. Communication and continuous improvement is presented as the central point of the theoretical frame of reference where the thesis will use theoretical methods within the topic to realise the aim of this thesis.

![Figure 12 - Scope of Theoretical Framework - Authors Figure](image-url)
4. Empirical Findings

This chapter presents the empirical findings of the thesis based on the conducted research. This thesis has used the PDCA method as a tool for continuous improvement in order to find a solution for today's current situation in regards to identified deviations. The results, from problem clarification to development of countermeasure, are presented.

4.1. Step 1: Problem Clarification

The first step of the PDCA 8-step model is problem clarification. In this section, the purpose is always preventing the risk of triggering a countermeasure, or even standardise a solution without fully understanding what the problem to solve is. Further, all efforts to solve problems must contribute to Scania’s overall goal of the joint mission, otherwise it is a waste of resources and means.

Also, by taking a deeper look at the current situation and deeply consider what the ideal situation is, the aim is to identify previously unrecognised problems. Finally, a clarification of the “ideal situation” is made and in doing so, a visualisation of the “gap” between the current and ideal situation achieved.

The following actions are performed in this section:

1. Identify the overall goal from Scania’s perspective.
2. Identify the ideal solution from DETPs perspective.
3. Visualise the GAP between the current and the ideal situation.

4.1.1. Introductory Interviews

As stated in the previous chapter, the reason why this project has been initiated is DETP’s need of new work-methods to deal with the new demands from the outside world. As the number of product variations increases, resource requirements for product engineers is likely to increase as well.

Introductory interviews were conducted with the 10 product engineers at DETP. These interviews were conducted in the first phase of the project mainly to map the overall picture of the current situation from the perspective of a product engineer and to understand what the ideal situation could look like.
All quotes in this chapter originates from the transcripts. P is short for product engineer, hence, P.1 means product engineer 1 etc.

As mentioned in chapter 2, today, at DETP, there is no comprehensive tool or method to assure the quality of the output from product engineers. The work-methods are reactive and does not correspond to Scania’s overall strategic goal of having zero deviations. Output from product engineers is basically checked manually by using various visual control methods such as printing out a preview of the work-order etc. These control methods are insufficient resulting in deviations at the assembly line.

### 4.1.1.1. Deviations, Work-methods and Work-environment

When asking product engineers what types of deviations they cause, mostly the deviations are problems at the assembly line with the tightening tools or with the barcodes. P1 explains that s/he does not receive many deviation-reports at all, but when s/he receives one, most of the time it considers tightening tools.

“I do not have many at all. But mostly deviations associated with tightening tools. E.g. wrong parameter for the wrong engine resulting in too many or too few attractions.” – P1

This image is shared with the majority of the product engineers at DETP. P2 clarifies that s/he may receive in average one deviation-report per week and mostly it is associated with the tightening tools or with barcodes. However, explaining that most of the deviation-reports she receives are concerning improvements rather than faults, and highlighting that improvements are not as highly prioritised as faults.

“Not much, maybe one deviation-report per week. I also feel like it is improvements most of the time rather than faults.” – P2

Also, there is a large difference between where the deviations are caused. Assembly stations with a high amount of variants e.g. many different tasks to be performed, are more likely to encounter deviations than static assembly stations. P8 clarifies:

“My work-area is quite static, it just consists of the basic assembling of the engines, meaning few variations. Therefore, it’s easier to see potential errors before they occur.” – P8
Further, P8 argues that when having larger introductions of new engines or when implementing something new, deviations occur more frequently. Thus, after some time, fade out resulting in a more stable assembly line. Also P6 explains that communication is also of importance, stating:

“When problems occur it’s mostly when introducing new engines or changes, and the reason is most of the time due to lack of communication between different parts” – P6

When discussing why these deviations might occur. Most of the time, the reason is that product engineers are receiving an enormous variation of problems meaning no pattern is identified in order to solve the root cause. P1 further explains that lack of communication is a central contributor to why deviations occur.

“Problems with communication between product engineers and for example process engineers. Especially when introducing new products or changes.”

– P1

Also product engineers feel that it is impossible to discover a problem before it appears at the assembly line. This is confirmed by all product engineers. P2 states the following:

“It’s impossible to correct oneself before the problem reaches the assembly line. We have over 1000 parameters, and a huge variation of conditions to consider” – P2

Further product engineers explain that it’s difficult to do proactively discover deviations if they believe that they have performed their work correctly. P5 explains that placing task to the right assembly-station might be problematic since there is nothing controlling that the task has actually been placed to the right assembly-station, or placed at all. Especially since one believes that the task is placed before activating for production. P5 expresses:

“Common problems might be when placing new tasks to the right work-stations, that’s a thing we might miss.” – P5

Also a combination of excessive manual work and lack of verification is expressed. Less manual work and more automatic verification is needed in order to really verify the output from product engineers. P1 states the following:
“I believe the problems arise because we do not have enough verification, we do not have the verification methods needed to really verify our work” – P1

P3 confirms that the manual factor is a huge reason to why these problems occur. Despite the fact that guidelines, policies and reminders are existing.

“All the manual work. The human factor becomes the reason for these problems. Despite the fact that we do actually have reminders and guidelines” – P5

Finally, what is commonly expressed throughout the interviews, is the fact that product engineers feel that they do not get the right work conditions to perform their work right. P8 states the following:

“We don’t get the right conditions to perform our work right. We might miss information from process engineers or from global preparation. Basically there are no clear guidelines, but experience and hunches, therefore sometimes faults might occur.” – P8

4.1.1.2. Ideal Situation

When brainstorming how the ideal situation could look like, all product engineers argue that a technical solution is required in order to perform correct work. P8 explains that, a technical solution is necessary to in order to proactively avoid deviations and reach Scania’s overall goal of having 0-deviations.

“Today, we do not have the most user-friend computer systems... To reach Scania’s strategic goal of 0-deviations, you’ll most likely need a technical solution” – P8

Some product engineers believe that it may be possible to improve the current computer systems in order to reach an ideal solution. But once again, according to the product engineers, without a technical solution, either changing the computer system or improving the system, it is impossible to really reach a solution. P4 states:

“Improvement of the current computer system is critical in order to reach an ideal solution.” – P4
Thus, when product engineers are asked to overlook technical solutions and brainstorm other possible solutions, they consider that improvements in work methods and work environment also is of importance and contributes to an ideal solution. P1 explains that, despite it being the entertaining part of the work, the work-environment is disturbing and there is a lack of peace when performing work-tasks requiring a lot of focus and concentration.

"More peaceful and quiet work-environment...Today, I don’t feel that I have the peace and quiet environment I need to perform my work correctly.” – P1

Further, lack of well-defined procedures and work-methods is highlighted. P6 expresses that due to the lack of well-defined standards, experience has major importance. P6 also explains that better communication is needed both internally and externally.

"Use of more well-defined procedures and work-methods. Today, it is very individualistic and the quality of the work you do is mostly depending on experience. Also, better communication is needed with more relevant information.” – P6

Once again, work-methods are also expressed to be reactive since they do not detect faults/deviations in advance. P7 expresses the following:

"The work-methods are not quite developed that we are a step ahead all the time. We must see consequences first to know that there is a problem. Our work-methods do not detect everything and it’s very difficult to discover things in advance.” – P7

Finally, P8 explains that DETP needs to identify more specifically what change is wanted and to identify a current state. Stating the following:

"We need to more clearly map how things are today and identify what we want to change. Simply a current state.” – P8

4.1.2. Summary Problem Clarification

1. The overall goal from Scania’s perspective:

The overall goal from Scania’s perspective is having 0-deviations when introducing new engines or performing changes.
2. The ideal solution from DETPs perspective:

From DETPs perspective, the ideal solution is a technical solution, e.g. more automatic technical support in order to perform unreliable manual work that today is controlled by manual visual control methods. Further, changes in work-methods, e.g. well-defined procedures, and work-environment, e.g. peaceful and quite environment, is needed to progress and to reach the ideal situation.

3. Visualising the GAP between the current and the ideal situation:

The gap between the current state and the ideal situation is the lack of technical support, resulting in unreliable manual work, also lack of communication, issues with work-environment and work-methods are presented. See figure 13.

![Figure 13 - Visualisation Current and Ideal Situation - Authors Figure](image)

4.2. Step 2: Problem Breakdown

The second step of the PDCA 8-step model is problem breakdown. In this section, the aim is to grasp the current situation and fully understand the real problems. The problems to solve are selected, prioritised and their current situations grasped by conducting “Go and See”. With this approach the purpose is to find and confirm the key issues behind the problem.

The following actions are performed in this section:

1. Gather data and facts, break down a large problem into smaller and more specific problems
2. Prioritise and select the problem to solve
3. Go and see – Study the process thoroughly, confirm facts
4.2.1. **Documents**

Data and facts where gathered in order to identify the current state regarding deviations. Documents with information of deviations and deviation-reports were gathered. Also documents regarding the current situation, e.g. educational material and pre-studies were investigated.

4.2.1.1. **Weekly-reports 2015-2016**

Today DETP documents amount of deviations caused by the department on a weekly basis and discussed on the weekly/daily meetings. The diagram below visualises the amount of deviations caused by DETP between the year 2015-2016.

![Amount of deviations per week requiring action from DETP](image)

**Table 4 - Deviations per Week 2015/2016 - Authors Table**

In total, 43 weekly-reports, from year 2015, were collected and totally 182 deviations were found resulting in an average of approximately 4 deviations per week in year 2015. For 2016 however, so far, 19 weekly reports were collected and totally 38 deviations have been recorded resulting in an average of 2 deviations per week. Meaning, as seen in the diagram, that there is a down-going trend-line and if the trend-line continues, DETP is more than halving the amount of deviations resulting in approximately 100 deviations this year. However, when it comes to Scania’s strategic goal of having 0-deviations, there is still a long way to go and a lot of improvements to be made.
4.2.1.2. **Types of deviations**

Since DETP does not document types of deviations rather only amount of deviations, in order to visualise what deviations DETP are causing, a collection of deviation reports was performed. Deviation-reports contain information of deviations caused, e.g. wrong amount of articles, wrong articles, missing articles, missing barcodes, wrong amount of attractions etc.

In total, 101 deviation-reports were collected from 3 assembly stations (3 assembly stations out of 10 are by own initiative archiving deviation-reports for their own use), covering year 2013-2016. Most of the deviation-reports were documented in year 2013 and from station 7. The types of deviations are visualised in the table below.

![Tightening tools & Barcodes](image)

*Table 5 - Types of Deviations - Authors Figure*

In table 5, the result clearly shows that most of the deviation-reports concerns deviations with tightening tools and barcodes. E.g. too many/few attractions, too many barcodes or barcodes missing. The number of deviations concerning barcodes have been reduced significantly. According to product engineers this is probably due to the use of a new preventive function in the computer system MONA, called SCO-warning, and was introduced in late 2015. However, considering wrong amount of attractions, currently it’s the most common deviation according to the collected data.
In order to confirm this information, Go and see was conducted at two assembly areas. D12 – Station 10.64 and D16 – Station 13.2. These assembly stations were chosen in consultation with Product Engineers hence they consider them being stations with varying work-tasks meaning higher risk for deviations. The remarks from the visits are summarised in table 6 below.

### Summary Remarks

<table>
<thead>
<tr>
<th>Summary Remarks</th>
<th>GM: Group Manager</th>
<th>A: Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D12 – Assembly-line</strong></td>
<td>According to TL the most common deviations in work-orders are wrong text/description, wrong number of articles and problems with tightening tools. TL expresses great confusion and uncertainty among work-team when deviations occur. By experience, TL claim that the largest amount of deviations occur when introducing new engines and when engine variants are to be assembled. <strong>GM</strong> claims that better communication between the work-team and product/process engineers is needed to implement work-methods more related to Real Time Management. According to TL when deviations occur, they tend to be inaccuracies with the work-order (e.g. text missing), deviations with tightening tools (too many/few pulls) and missing barcodes. TL also explains that the assemblers might use tightening tools incorrectly and thereby cause deviations as well. TL explains that the assemblers should read the work-order instructions but doesn’t always do so. TL, by experience, claims the work-orders being often accurate. According to TL the most harmful deviation is when barcodes are missing. However, by experience, TL claims most common deviations to be concerning tightening tools, which is harmful too. According to A, most deviations are associated with tightening tools causing stop-time/confusion and expresses the following: “If you get the wrong number of attractions you become unsure if you’ve done the right job and therefore perform a manual check, tightening all the screws again, manually.” According to TL, documentation of deviation-reports is not compulsory since no such policy exists. However, TL believes documentation of deviation-reports to be helpful e.g. historical data.</td>
<td></td>
</tr>
</tbody>
</table>

**Table 6 - Go and See Summary Remarks - Authors Table**

The most common types of deviations are problems with tightening tools and deviations in work-orders e.g. wrong text/wrong articles etc. These deviations occur most frequently while introducing new engines or when engine variants are to be assembled. Results of these deviations are great confusion and uncertainty among the work-team at the assembly line resulting production stops. However, these deviations might be caused by assemblers themselves as well, since they might use the tools incorrectly or avoid reading the work-orders, despite being accurate. Further, deviation-reports are documented at a few assembly-stations
only, since no such policy exists. However, documenting deviation reports is seen as an advantage since helpful historical is used in many ways, e.g. controlling that a change has actually been made.

**Observations D12 – Assembly Line:**

During my 5-hour visit at the D12 assembly line, I have experienced minor deviations resulting in a couple of seconds of production stop. Further what I’ve observed is that the work-team are usually not reading the work-order instructions rather relying on experience, despite having plenty of time doing so. Also, according to TL some deviations might be reported back to DETP as improvements, in the deviation-reports, despite indirectly causing production stops.

**Observations D16 – Assembly Line:**

During my 5-hour visit at the D16 assembly line I have experienced three deviations. These deviations where wrong number of attractions from the tightening tools and appeared when engine variants where to be assembled. Two times, tightening tools provided insufficient amount of attractions and one time the tightening tools provided too many attractions. Whether it’s too many or too few, the frustration at the assembly line is the same. During my visit I’ve also observed that despite deviations occurring at the assembly line, the TL did not write deviation-reports.

4.2.3. **Flowchart – SIPOC**

A flowchart/SIPOC was performed in corporation with product engineers. It was conducted in order to visualise the work process of a product engineer at DETP graphically to more effectively describe the process than with words. The flowchart in figure 14 explains the process clearly through symbols and text. Moreover, providing the gist of the process flow in a single glance.

The flowchart was used as a tool to summarise the inputs and outputs of the work process of a product engineer at DETP. As seen in the figure 14, Suppliers, Inputs, Process, Outputs and Customers form the columns presented in the chart.

SIPOC is presented as the outset of process improvement efforts in TQM and mainly performed to give the project leader, which is unfamiliar with the work process, a high-level overview. Also it was performed to reacquaint people whose familiarity with the work-process has faded or became out-of-date due to process changes.
DETP receives input from various suppliers such as; DEPG, DEPB, DETT, DETM etc. See figure 14. The input DETP receives is handover documents, production change orders (PtCO), assembly sequence and information regarding engineering change orders (ECO). The work-process following after receiving that input varies depending on the input provided. However, just to mention an example, the work-process of a product engineer at DETP might have the following path; understanding the information from the PtCO, placing a task in an assembly station (WPL/TG), updating or changing parameters or compare conditions and finally activate the PtCO for production (PtCO in status 6). This is roughly a description of the work performed. When the work is completed and the PtCO is activated and set to status 6 the output is a work-order containing several types of information such as barcodes, information of articles and information of the assembly order. The customers of this output are firstly the work-team at the assembly line but also logistics and process engineers.

Moreover, the flowchart was also used to identify critical process-steps to progress with and investigate. The process-steps highlighted with a green colour, see figure 14, are critical process-steps, they are; placing tasks in a workplace/task group, updating or changing parameters and verifying in MONA, all of which affect the quality of the output from product
engineers and which are contributing to the amount of deviations occurring at the assembly line. For the flowchart in higher resolution, see Appendix VI: Flowchart.

4.2.4. \textit{P-FMEA}

P-FMEA was chosen as a method to find and list failure causes, failure effects and as a tool for prevention and assessment of failure probability. Moreover, P-FMEA is a Scania standard tool and is an essential part of TQM. The purpose with the P-FMEA was not to solve the problems rather identifying and summarising potential risks with chosen process-steps.

In this thesis, Scania’s internal P-FMEA template was used with the following columns; process-step (describing each step in the process), failure mode (type of flaws the process step can exhibit), failure cause (possible cause to the failure mode), failure effect production (the effect the failure mode can generate in production incl. following process step) and control (every preventive measure and verifying action to prevent the failure mode from occurring). Further the last four columns were used for grading, these are \textbf{occurrence (O), severity (S), detectability (D) and risk priority number (R, which is a multiplication of the three aspects OxSxD)}. See appendix VIII for the P-FMEA template and appendix IX for more information regarding the evaluation criteria used. The results from the P-FMEA are presented in the tables below.
Placing tasks in a workplace/task group was the process with the highest risk priority number (R), as high as 240. As seen in the table above, tasks are today not placed in a workplace/task group due to misinterpretation of the preplist/task-list, wrong filtration in MONA, believing that the job is done (since no control methods are available), disturbance due to urgent errands etc. The effect of the failures can result in missing tasks in work-orders resulting in, for example, no consumption of articles (if assembled by experience), or missing

<table>
<thead>
<tr>
<th>Process Step</th>
<th>Failure Mode</th>
<th>Failure Cause</th>
<th>Failure Effect Production</th>
<th>Control/Preplist</th>
<th>O</th>
<th>S</th>
<th>D</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place tasks in workplace</td>
<td>Not placed tasks in workplace</td>
<td>Misinterpreted PtCO/Preplist</td>
<td>Task missing in work-order/no consumption of article</td>
<td>No control options (exception IM S-Order)</td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No available control options IM S-Order</td>
<td></td>
<td></td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>168</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wrong filtration in &quot;PtCO in structure&quot; / Preplist</td>
<td>Missing assembly</td>
<td>No control options (exception IM S-Order)</td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Available control options IM S-Order</td>
<td></td>
<td></td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>168</td>
</tr>
<tr>
<td></td>
<td>Believe job is done</td>
<td>Parameters not adapted</td>
<td>No control options (exception IM S-Order)</td>
<td></td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>Cancel work due to urgent errands</td>
<td>Parameters not adapted</td>
<td>No control options (exception IM S-Order)</td>
<td></td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>168</td>
</tr>
<tr>
<td></td>
<td>Misinterpreted IC-list/Preplist</td>
<td>Assembly in wrong assembly-station / overcrowded assembly-station</td>
<td>Can be detected by assembly-line / PT using preview (red introductions)</td>
<td></td>
<td>3</td>
<td>4</td>
<td>10</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Available control options IM S-Order</td>
<td></td>
<td></td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Wrong WPL</td>
<td>Not controlled conditions for tasks</td>
<td>Task missing in work-order</td>
<td>No control options (exception IM S-Order)</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Available control options IM S-Order</td>
<td></td>
<td></td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>126</td>
</tr>
<tr>
<td></td>
<td>Missed placing dual tasks (assembly line / pre-assembly line)</td>
<td>Placing tasks only for assembly line</td>
<td>Not pre-assembled to assembly line</td>
<td>Can be detected by assembly-line / PT using preview (red introductions)</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can be detected by assembly-line / PT using preview (green introductions)</td>
<td></td>
<td></td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>126</td>
</tr>
<tr>
<td></td>
<td>Placing tasks only for pre-assembly line</td>
<td>No delivery from logistics</td>
<td>Can be detected by assembly-line / PT using preview (red introductions)</td>
<td></td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can be detected by assembly-line / PT using preview (green introductions)</td>
<td></td>
<td></td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>126</td>
</tr>
<tr>
<td></td>
<td>Wrong local control (TG/WPL)</td>
<td>Wrong conditions for tasks in TG/WPL</td>
<td>Task missing in work-order</td>
<td>Can be detected by assembly-line / PT using preview (red introductions)</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can be detected by assembly-line / PT using preview (green introductions)</td>
<td></td>
<td></td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>126</td>
</tr>
</tbody>
</table>

Table 7 - P-FMEA Results Group 1
assembly etc. Finally, the control methods existing today are almost non-existent. Thereby the following result.

To summarise, the occurrence of the failure “tasks not being placed in a workplace/tasks group” varies from 1 time/every six months to 1 time/month, for each product engineer. The severity of the failure varies from possible production stops to production stops. And finally the detectability of the failure varies from visual control by the product engineer to control possibility non-existent.

Table 8 - P-FMEA Results Group 2

The second highest risk is updating and changing parameters with as high risk priority number as 216. The reason for this failure is forgetting to place FPC-codes/wrong level/wrong conditions etc. The effect of the failure at production is production stops, wrong amount of attractions, wrong torque, confusion and disturbance etcetera. When it comes to control methods it is still manual visual control however, SCO-warnings are used, but do not cover all failure modes. SCO-warnings according to the P-FMEA is the only control method existing today in MONA which is not manual rather automatic.

To summarise, the occurrence of the failure “update and change of parameters” varies from maximum 1 time/every six months to 1 time/month, for each product engineer. The severity of the failure varies from no effect to production stops with partial disruption to customer. And finally the detectability of the failure varies from 100% comprehensive detectability to control possibility non-existent.
Table 9 - P-FMEA Results Group 3

The final process-step investigated is verifying of MONA preview. This process-step holds the lowest risk priority numbers, between 32-120, since there is a low chance of occurrence. The reason for failure might be lack of knowledge, disruption etc. The effect of the failure is for instance verifying the wrong work-order, meaning no verification has actually been made for the intended work-order. Finally, concerning detectability and control options, here as-well there are basically only visual control methods to be used.

To summarise, the occurrence of the failure “verification of MONA preview” varies from fault never occurred to maximum 1 time/every six months, for each product engineer. The severity of the failure varies from possible production stops to production stops with partial disruption to customer. And finally the detectability of the failure varies from 1 visual control to difficulty to discover fault. For a template of the P-FMEA see Appendix VII: P-FMEA Template for the evaluation criteria used see Appendix: VIII: Evaluation Criteria P-FMEA.

4.2.5. Summary Problem Breakdown

1. Gather data and facts, break down a large problem into smaller and more specific problems

When gathering data, results showed that the average amount of deviations caused by DETP are 2 deviations per week. The most common types of deviations are considering tightening tools and barcodes. This perception is shared among product engineers, team leaders, group managers and assemblers. A SIPOC/Flowchart was conducted to break down the problem by
visualising the work process and identify critical process steps. The critical process steps identified are; placing tasks in a workplace/task group, updating or changing parameters in MONA and verification in MONA.

2. Prioritise and select the problem to solve
A P-FMEA was conducted in order to investigate those process steps and to identify potential risks and failures. Once completing the P-FMEA, the risks were prioritised after risk priority number, R, in order to select a problem to solve. The process step with the highest risk priority number is missing to place tasks in a workplace/task group, due to misinterpretation etcetera.

3. Go and see – Study the process thoroughly, confirm facts
Go and see was performed at two assembly stations to confirm the facts. Both assemblers, team leaders and group managers at the assembly line confirm that the most common type of deviation is concerning tightening tools, e.g. too many/too few attractions, resulting in production stops and confusion at the assembly line. Also other thoughts were highlighted such as lack of communication between product/process engineers, that assemblers are usually not reading work-orders and underestimates of deviation amounts.

4.3. Step 3: Target Setting
The third step of the PDCA 8-step model is target setting. In this section, an ambitious goal was set when trying to solve the problem. This was both rewarding and motivating. The purpose with meeting an ambitious goal is to move one step closer realising Scania’s overall goal and at the same time increase personal skills and abilities.

The following actions are performed in this section:

1. Commitment with the organisation – Targets must be met
2. Set a measurable, concrete and ambitious goal

Since we have proceeded with the failure mode with the highest risk priority number, which is tasks not being placed in a workplace/task group. The risk priority number was discussed with the group manager at DETP to confirm that it is the right step to proceed with. Furthermore, this choice was also presented and discussed with both product engineers and with employees conducting pre-studies on similar problems, to confirm that it actually is the most suitable process-step to proceed. Placing tasks in a workplace or task group was considered to be the
most suitable process-step to proceed with and the target set was basically eliminating the problem.

4.3.1. Summary Target Setting

1. Make the commitment with the organisation – Targets must be met
   In order to make the commitment, before setting the target, we convinced ourselves that we are personally going to solve this problem and by doing so, opportunities were created to increase our own skills and abilities which is also the purpose with this action in “target setting”.

2. Set a measurable, concrete and ambitious goal
   The goal set during the “Target Setting” step was not to meet the “Ideal Situation”. The large problem that we have identified and broken down into smaller pieces in earlier steps was now our main concern. What we were setting as our goal in this step was to resolve the key issues with the highest priority.

   The goal is quantitative, detailed and challenging. Basically to eliminate the risk with the highest risk priority number in the P-FMEA. However, when setting the target we have tried to maintain a balance between to be forced to “think outside the box” and to focus on realizing solid and realistic goals.

4.4. Step 4: Cause Analysis

The fourth step of the PDCA 8-step model is Cause Analysis. In this section the original process is thoroughly investigated in order to clarify the root cause. Finding the root cause is the key to make the problem solving successful. If one do not find the root cause, one can hardly prevent the problem to reoccur. In the previous steps we have been focusing on finding the “real problem”. In this step we have been focusing on how to find the “root cause”.

The following actions are performed in this section:

1. Consider as many potential cause factors as possible, avoid all preconceived ideas
2. Continually question “Why?”, prove or disprove any hypotheses
3. Specify the root cause
4.4.1. **Fishbone Diagram**

In order to understand why the problem occurs, a fishbone diagram, see figure 15, was conducted to identify risks and root causes. The “fishbone” was categorised to represent different factors affecting the failure mode. The three major categories of causes to the failure effect are MONA, Work-Methods and Work-Environment.

In MONA there is no warning for tasks not being placed in a workplace at all. So product engineers express a lack of automatic technical support. Since one does not activate the production preparation in status if not believing that the job is completed and is correct.

Further product engineers explain that a disturbing work-environment, e.g. meetings, sudden cancellations and disturbing people are other factors for the effect to occur. Finally, when considering work-methods, the amount of manual work, either working with a printout of an excel spreadsheet or working directly in MONA is a huge contributor to the risk of failure occurring.

For a template of the fishbone diagram, see Appendix IX: Fishbone Diagram Template

### 4.4.2. **Summary Cause Analysis**

1. Consider as many potential cause factors as possible, avoid all preconceived ideas
Potential cause factors have been listed using a fishbone-diagram. Factors have been identified in categories such as work-environment, work-method, MONA (technical factors), people, materials and measurement.

2. Continually question “Why?”, prove or disprove any hypotheses

Due to the limitations, see chapter 1, three categories were proceeded with; work-methods, work-environment and MONA. The technique of 5 why’s, repeating the question “Why?” where each question forms the basis of the next question, was constantly performed in order to determine the root cause of a defect. Found root causes, just to mention an example, is no warning between the link Task/Task Group/Workplace in MONA Assembly structure.

3. Specify the root cause

The root cause in MONA is that a warning between the link Task/Task Group/Workplace in MONA meta structure does not exist. And that the when placing tasks in a workplace/task group the work-methods in MONA are indistinct. Further, multiple root-causes were found in the category work-method and work-environment as for instance forced to discontinue due to urgent errands e.g. production stops, and a lot of manual work e.g. constant manual comparison.

4.5. Step 5: Develop Countermeasures

The fifth step of the PDCA 8-step model is to Develop Countermeasures. In this section countermeasures are presented to the root cause. Further, when developing the countermeasures, the ideal is to develop the most practical and effective countermeasures. This has been performed by involving employees, that will use this solution at their workplace, been in early stages of the solution development. The proposed countermeasures are not restricted by pre-conceptions or boundaries of the current work situation and when deciding upon which actions to take, an evaluation of simplicity, cost and ability to implement quickly were kept in mind. Also most importantly focus is on communication to build consensus with all related people and departments while developing the countermeasures.

The following actions are to performed at this section:

1. Broadly consider all possibilities
2. Narrow down the ideas that are the most practical and effective
3. Develop consensus on the proposed solution
4. Test ideas for effectiveness and select the best solution
When developing countermeasures, the development was divided into two parts. Firstly, Work-Methods and Work-Environment through benchmarking with other units at Scania. Thereafter technical countermeasures with Scania Production Logistics IT, INAE.

4.5.1. Benchmarking Work-Methods and Work-Environment

When developing countermeasures, regarding work-methods and work-environment a benchmarking was conducted with DTMD and MSTC. The topics discussed are deviations occurring today, current work-methods and work-environment. Since Scania is a major company, benchmarking was performed to find information regarding work-methods/tools that are already available in-house, by departments similar to DETP but in different production units, to improve the current situation at DETP.

At MSTC, DTMD and DETP, product engineers are performing similar work-tasks, using the same computer systems and are having the same function in the production process.

When considering deviations occurring today caused by the departments, all are facing similar types of deviations. MSTC explains that the most common types of deviations are something missing in the work-order e.g. missing articles etc. Stating the following:

"We receive deviations regarding missing articles or stuff like that. Basically something missing in the work-order. It is the most common type of deviation." – MSTC

Further MSTC explains that they do not monitor these deviations since they do not cause major damage in production.

"We do not follow minor deviations. Many of the deviations that occur are barely noticeable in production." – MSTC

Thus, explaining that despite a lot of deviations are of minor scale, in the long run they might have caused a lot of damage totally. DTMD also expresses similar deviations e.g. something missing in the work-order, for instance a work-task, which is claimed to occur when product engineers forget to place a task to a work-place.

"Various types of deviations, non-recurrent types. However, one example is placing tasks in a workplace. That you fail to do that." – DTMD
DTMD clarifies that when receiving deviations, they always perform a 5-whys in order to identify the root cause of the deviation and eliminate it. DTMD states:

“We are constantly working with 5 whys on all deviation-reports. In addition, we follow up our deviations all the time in order to improve.” – DTMD

As regards of work-methods, there is a large difference between the three units. For instance, at MSTC, they do not use deviation-reports at all. Deviations are communicated orally and only when communicated often enough, action is taken by product engineers. MSTC states the following:

“We do not have any deviation-reports; it is more of an oral communication. Also, we are not monitoring deviations caused by us. It’s something we should do. We only monitor deviations with serious consequences, it’s not until then that we follow it up.” – MSTC

MSTC explains that today, they do not monitor deviations except for the ones with major consequences. MSTC expresses frustration since they are today only solving problems instead of understanding and preventing these problems from occurring. MSTC argues that it is something they should be doing, at least gathering facts in terms of deviations, arguing it is only when gathering facts and understanding the current situation that they can improve. MSTC states:

“Deviations occur daily, it’s not until we follow up deviations in a more structured way, that we can improve really. Today we are solving deviations, but it’s not like we are analysing how many and so, we are not quite following up that way” – MSTC

Therefore MSTC explains that today control methods are missing completely. They are simply controlling each other’s work. MSTC explains:

“We simply only control each other’s work. Most usually when there is a new or insecure employee.” – MSTC

However, MSTC are optimistically arguing that with more exchange between product engineers at different units, solutions to problems is believed to be easily found. Further
explaining that since they perform similar tasks they can learn a lot from each other. MSTC expresses:

“We have similar work-tasks, are using the same system, but do not have much exchange with each other. Pretty poor understanding of how they work! Basically no communication at all.” – MSTC

Moreover, MSTC explains that a corporation with different production engineering units, especially nationally, would easy to initiate. However, no one is taking the initiative to start this corporation. MSTC states:

“Cooperation with Axles and Engines would have been so easy, it’s just sending an email. The problem is that someone has to do it.” – MSTC

At MSTC, however product engineers are proudly arguing that the work-methods are to a large extent well standardised. MSTC claims that even the colour used does to perform certain tasks matter and that standards are revised at least once a year to remain updated. MSTC expresses:

“We have all of our work-methods pretty well described. And it’s really, at the level, that one is able to follow it when newly employed. Also, we revise the standards at least once a year.”- MSTC

Highlighting the advantages with standardisation, MSTC argues that it simplifies the improvement work and do not see any disadvantages with it at all. Stating:

“As I see it, one must have standardized work methods in order to be able to make an improvement. I see only benefits with standards/routines. And sure, it might take a lot of work, if you do not have the standards that we have had in so many years, but I don’t see any disadvantages with it” – MSTC

DTMD are also sharing this opinion explaining that having standards in everything is something they are always striving for. They also explain that it is especially important when employing new employees. DTMD states:

“We see an advantage in having standards in everything. It’s something that we work on all the time. Because if you have standards, then you have something to lean back on. Especially when you are newly employed.” – DTMD
Also DTMD expresses similar work-methods as MSTC when placing tasks in a workplace. E.g. using the same colours to highlight “placed tasks” when performing the manual transfer. DTMD explains:

“Our work-tasks are very standardised. For instance, when placing tasks in a workplace, we print a PtCO in structure, and use the same colours of the highlighters to mark where we are. Everyone must use the same colour.” – DTMD

Regarding **work-environment** both MSTC and DTMD feel that the work-environment is stressful and disturbing. A way to tackle this environment at MSTC is for instance, when performing work-tasks requiring a lot of concentration and a quiet environment, a colleague takes over the work tasks for a couple of hours. MSTC expresses:

“For example, we have seen that it’s better to do the preparation in MONA and connect the phone to someone else in order to avoid disturbance.” – MSTC

Since DTMD share perception of a disturbing and stressful work-environment they are tackling this problem in a similar way. Explaining that it feels great to have that part of the job done instead of having to do it twice when being interrupted. DTMD states:

“I can say to my colleague that I’m away for a few hours and do the preparation in MONA. It feels great getting that job done. Otherwise, it’s very easy to be disturbed and do twice the work, just to make sure you’re doing it right.” – DTMD

Major differences between the units in terms of deviations, work-methods and work-environment are presented in table 10 below. Further, major advantages and disadvantages are presented between DTMD and MSTC.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Deviations</th>
<th>Work-Methods</th>
<th>Work-Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTMD</td>
<td>Various, non-recurrent types of deviations. E.g., forgetting to place a task in a workplace.</td>
<td>Very standardised work-methods. E.g. same colours when highlighting placed tasks etc.</td>
<td>Disturbing work-environment. Standards not detailed enough. E.g.</td>
</tr>
</tbody>
</table>
Using deviation-reports as a communication form problematic for new employees. Deviations documented and followed up Help by colleagues when preparing in MONA. Using 5 whys on every deviation

**MSTC**

- Missing articles in MONA most common deviation.
- Missing tasks or deviations due to lack of communication
- Relies on oral communication
- Monitors only major deviations.
- No verification methods, depends on product engineers controlling each other’s work.

**DETP**

- Various, non-recurrent types of deviations.
- Problems with parameters concerning tightening tools, placing new tasks to right work stations
- Using deviation-reports as a communication form
- Do not have enough verification methods
- Manual work and lack of communication between different units
- Disturbing work-environment e.g. urgent errands, meetings etc.

<table>
<thead>
<tr>
<th><strong>Table 10 - Benchmarking Results DTMD, MSTC and Engines</strong></th>
</tr>
</thead>
</table>

### 4.5.1.1. Advantages and Disadvantages

<table>
<thead>
<tr>
<th><strong>Advantages</strong></th>
<th><strong>Disadvantages</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DTMD:</strong> Resolving errors to the root cause using 5 whys on each deviation.</td>
<td><strong>MSTC:</strong> Lack of knowledge exchange between different units in product engineering.</td>
</tr>
<tr>
<td></td>
<td>Monitors only major deviations.</td>
</tr>
</tbody>
</table>
Documents deviation-reports digitally, mapping types of deviations occurring.

Working heavily on updating and standardising everything.

**MSTC:**

Using substitutes when performing focus-requiring preparation in MONA.

Striving to work heavily on updating and standardising everything.

| | No documentation considering amount of deviations/types of deviations. |
| | No documented communication form between the assembly line and product engineering. |

Table 11 - Benchmarking Advantages and Disadvantages

### 4.5.2. Technical Countermeasures

In order to develop a technical countermeasure a PowerPoint presentation was created presenting how an ideal improvement in the system would look like to prevent the root cause of the problem investigated. This PowerPoint presentation was developed in corporation with product engineers at DETP and INAE. The solution was presented for product engineers internally at DETP but also externally, via email, to DTMD, MSTC, MASP, MZEP and LDETM. The solution was interesting and wanted by DTMD, MSTC and LDETM however, for MASP and MZEP the solution was unnecessary. The reason is that MASP and MZEP are using an already existing function in MONA to solve this issue today. This function used is called “Unrelated Objects, ASSP033” and was previously an unknown function at DETP, LDETM, DTMD and MSTC. Therefore, testing of the function was performed.

After testing this function, with positive results, the function was presented for product engineers at DETP to catch uncertainties or considerations. The function was welcomed and can thereby be used to improve the quality of the output from product engineers. However, further discussions and testing of different potential scenarios resulted in the fact that Unrelated Objects can only partly be used to eliminate the highest failure risk. The function as is today, can be used for new local tasks, new global tasks and when placing tasks with global/local PtCO. However, the function does not work for DETP when rebalancing and when filtrating the structure from the development assembly line due to the MONA meta structure. See Appendix X: Routine Unrelated Objects. After discussions with a MONA specialist, the recommended action was to create a change request since no other solution in the system was
found. Meaning asking INAE to add/change/improve/automatize some functions in the computer system MONA and thereby enabling us to eliminate this issue completely. See change request in Appendix XI: Change Request.

4.5.3. Summary Develop Countermeasures

1. Broadly consider all possibilities

When developing countermeasures all possibilities were considered. From work-methods to technical countermeasures were brainstormed and documented.

2. Narrow down the ideas that are the most practical and effective

The most practical and effective ideas in all categories (work-methods/work-environment/MONA) where thereafter communicated through benchmarking for further input.

3. Develop consensus on the proposed solution

The proposed technical solutions detected from the benchmarking was proposed and presented to all product engineers at DETP to identify uncertainties or ideas.

4. Test ideas for effectiveness and select the best solution

Thereafter, a routine was created and tested with all possible scenarios, through testing in MONA. The best solution is standardising the use of the new function detected to improve quality of the output from product engineers and broaden the function by suggesting an automated solution. The solution was presented to all potential interests, according to the group manager at DETP, and all production units were interested thereby a higher priority of the change request accomplished.
5. Analysis

This chapter presents an analysis of the findings. In the light of the literature review and the findings, by looking at similarities and differences between the theoretical framework and the findings, an analysis for the how existing tools and work-methods can be used to proactively improve the quality of the production process will be presented.

In the following analysis, fundamental elements of succeeding with proactive quality management, the TQM values, have been compared with the empirical findings. By examining the empirical findings and labelling them, a comparison and a more holistic overview of the patterns in the collected material was achieved. Firstly, focus was on data, relating to the structure of the theoretical framework, then the collected material was analysed and labelled. Finally, to go beyond this, focus was on general themes found throughout all data collected. By doing so, a holistic approach on the current problematic situation is obtained. In this analysis, DETP are, referred to as suppliers and the work-team at the assembly line are referred to as customers.

5.1. Focus on Customers

TQM is a proactive quality management system for customer-focused organisations (Summers 2010), in fact, the central core value in TQM, is focus on customers (Bergman & Klefsjö, 2003). At Scania, “customers first” is actually one of Scania’s three main values, see the SPS house in figure 5, meaning that customers are of an enormous importance for the customer-focused organisation Scania. In terms of DETP, customers are both external and internal. However, to order to satisfy external customers, internal customers also need to be satisfied (Oakland, 1989; Tenner & DeToro, 1992; Shiba et al., 1993; Dahlgaard et al., 1994; Bergman & Klefsjö, 2003). When examining the data collected, findings show that DETP radiates less focus on internal customers, in regards to the work-team at the assembly line. One noticeable example is that DETP receives multiple deviation-reports concerning improvements rather than faults. These improvements are not as highly prioritised as faults and are most of the time postponed. This is understandable since one naturally prioritises solving current urgent problems before working with improvements. However, according to their internal customers many deviations are indirectly, sometimes even directly, resulting in faults in terms of production stops. These
are reported back as improvements when following the template of the deviation-report. According to the literature, (Oakland, 1989; Tenner & DeToro, 1992; Shiba et al., 1993; Dahlgaard et al., 1994; Bergman & Klefşjö, 2003), when focusing on customers, it’s important to find out what their needs and values are in order to try to fulfil their expectations. Therefore, DETP might need to consider how, and if, they actually are finding out their internal customers’ needs since the customers are clearly expressing frustration, uncertainty and lack of trust when “improvements” are postponed.

During Go and See I have literally observed this frustration. Despite that customers faced three deviations in the morning shift they did not report back deviation-reports to the suppliers. Meaning DETP might underestimate the amount of deviations actually occurring at the assembly line. This might be a consequence of the lacking trust, since the customers feel that their feedback, e.g. deviation-reports, might sometimes be taken for granted, e.g. no direct solution or response from the supplier. Subsequently, the results is that some deviations are not reported back to the suppliers, meaning loss of invaluable information. What is even more striking being that this perception is shared by both customers (team leaders, group managers and assemblers at the assembly line) and suppliers (product engineers at DETP). The literature clearly states that every employee has customers and in order to do a good job their needs have to be fulfilled (Oakland, 1989; Tenner & DeToro, 1992; Shiba et al., 1993; Dahlgaard et al., 1994; Bergman & Klefşjö, 2003). This might be one of the examples of why the internal customers are not doing their job 100% correctly.

5.2. Base Decisions on Facts

Basing decisions on well-founded facts and not on random factors is one of the most important core values in TQM (Bergman & Klefşjö, 2003). When examining the data, one of the most shocking observations was the data available from the beginning of this thesis project. The suppliers were basically only documenting amount of deviations occurring, without visualisation for longer-period follow-up. Amount is simply the only fact gathered and is obviously the base decisions are made upon. Some product engineers were arguing that there is an enormous variation of deviations occurring today and further documentation would not help since this deviation variation simply cannot be handled e.g. no pattern would be found. These statements go in line with the literature reviewed, where Deming (1994) explains that in order to be able to control and handle variation, knowledge regarding variation and ability is extremely important. Bergman & Klefşjö (2003), further underlies the importance of that
production processes are based on facts related to customers’ experiences plus customers present and future needs. Explaining that with simple methods one can analyse and structure numeric information e.g. the seven quality improvement tools. By using them for processing data, process variation can be tackled and reduced in a good manner. Therefore, one might criticise the data gathered today since it is considered as an insufficient amount of data to base decisions upon. More data should be gathered regarding the input, work process or output in order to stand on a solid base when taking decisions. Data can be gathered at all different stages in the work-flow. For instance, data can be gathered from input (how accurate is the input?), from work-process (what are the risks and failure modes existing today?) and output (what types of deviations are we causing?).

However, the literature highlights the importance of having a clear purpose when gathering data (Bergman & Klefsjö, 2003). So before obtaining data, it is important to have a current state and question what problems are existing today, and what facts are needed to prevent those problems from occurring. This perception has been also highlighted by product engineers at DETP today expressing the importance of identifying a current state and more specifically identify what change is needed. Furthermore, through go and see, despite most of the assembly stations were not documenting deviation-reports, since such policy does not exist, some assembly stations were doing so with own initiative broaching the advantages of documenting deviation-reports for e.g. historical data and follow-up. Moreover, this initiative was also perceived in the benchmarking process where DTMD are documenting deviation-reports digitally to map the types of deviations occurring and sees only advantages in doing so. This is something DETP might take advantage from. What is most importantly is that DETP continuously has an active search for information regardless of the current state. This is heightened in the literature as Bergman & Klefsjö (2003) explain the importance and highlight the advantages of having an active search for information to comply and analyse.

Nevertheless, DETP should not only focus on gathering numerical information, rather, as the literature highlights, verbal information in terms of views, descriptions, events and feelings are of great importance. Bergman & Klefsjö (2003) explain that in order to structure and analyse this type of information, there are seven management tools.

Product engineers are expressing this type of information in the findings. E.g. the need for a peaceful and quite work-environment when performing work-tasks requiring a lot of focus and concentrations. Disruptions in terms of meetings, urgent errands etc. However, this disturbing work-environment is expressed as the entertaining part of the job. Thus, examples of how these
and similar problems are tackled is found in the benchmarking where DTMD and MSTC, are handing over work-tasks to a colleague when performing focus-heavy work-tasks. This is something DETP might consider. The importance is however to catch these feelings and perceptions in order to take corrective actions.

5.3. Improve Continuously

As earlier literature highlights, organisations cannot expect that doing better than it did previously is enough (Bergman & Klefsjö, 2003; Summers, 2010). Further arguing that it’s essential for organisations to continually improve the quality of its production processes. In this thesis, the PDCA-cycle which serves as a symbol for continuous improvement (Deming, 1994), has been used to tackle the presented industrial problem. Earlier research has been highlighting the importance in defining the problem as the first and most important phase in a continuous improvement project (Summers, 2010). When examining the data collected, product engineers at DETP explain that a current state needs to be identified and should always be updated in order to identify how things are today and what changes are needed in order to reach an ideal situation.

Also today, they are working reactively and are not proactively improving the quality of their production processes, rather solving problems when they occur. Research clearly explains that this is not an effective approach (Garvin, 1988; Kanji & Ascher, 1993; Dale, 1999 and Dahlgaard et al., 1998) and when comparing to the history of quality management one can argue that DETP is today performing quality controls by solving controls during production, e.g. by printing out a preview of the output and perform visual controls after activating for production. Thereby, literature is visually providing guidance and clarification on how DETP is performing when comparing to the history of quality management.

More shockingly is that this situation is not solely unique at DETP, rather when examining the benchmarking results, both DTMD, and MSTC are expressing great frustration with the current work-methods which are claimed to be focusing on solving problems rather than understanding an preventing problems from reoccurring. Further, all units (DETP, MSTC, DTMD) argues that it is only when gathering facts and understanding of the current situation that they can improve really. Maybe it is time use the internal standard, PDCA, in a more structured and organised way for improvement processes with the aim to enable permanent corrective action. In order to succeed with continuous improvements, DETP needs to not only solve problems rather, as the
theory highlights, consistently investigating and eliminating root causes and having sustainability and improved processes as main targets (Dahlgaard et al., 1994).

In this thesis the current-state has been identified and a more holistic description of the problematic situation provided. However, as mentioned in the literature, in order for DETP to reach high customer satisfaction, continuous improvement of the process is constantly needed, which also leads to fewer deviations reported back enabling the suppliers to reach the overall goal of the organisation (Dahlgaard et al., 1994).

5.4. Focus on Processes

Since the production process is a repetitive sequence of activities, aimed to satisfy internal and external customers. According to the literature, the corollary of focusing on processes is that the focus is not on results (Shiba et al., 1993). Meaning results are actually dependent variables and comes from whatever process followed. The process basically drives results (Shiba et al., 1993). The process generates data that indicates how well the process is satisfying its customers (Bergamm & Klefsjö, 2003). By examining the data collected, we are clearly, and visually, receiving information regarding how well the process is working which goes in line with the findings in the literature (Bergamm & Klefsjö, 2003). Today the data collected shows that DETP are receiving approximately two deviations per week. This information can directly be used to evaluate customer satisfaction of the process. With a forecast of, if the deviation trend-line continuous, approximately 100 deviations totally caused by DETP this year. The question is are we fulfilling our customers’ needs and expectations when causing 100 deviations per year? This is a question DETP needs to think about holistically in order to examine why their processes are producing these results.

Further as part of the statistics from the conducted P-FMEA, and as mentioned in the literature, we are also gaining information about how the process can be improved (Bergamn & Klefsjö, 2003). For instance, the detectability of the work-processes producing the presented results are only controlled with unreliable manual visual control methods. Resulting in work-processes with almost non-existing control methods. Once again, this situation is shared among other departments at Scania, e.g. MSTC and DTMD both clarifies that control methods are missing completely. However, it’s important to question, how we can rely and use on such processes in that case? If they are apparent in many different units at Scania.
Moreover, MSTC explains that high levels of standardisation has simplified their improvement work and highlight its provided advantages. DTMD are also sharing this perception and explain that standards of work-processes is something they are always striving for. For DETP however, according to the findings, standardisation of work-methods with well-defined procedures does not exist. Further explaining that today work-processes are consisting of excessive manual work in combination of lack of verification acting as a major obstacle to verify the output of the process despite the existing guidelines and policies. This is invaluable information to consider especially if DETP is about to reach Scania’s strategic goal of having 0-deviations.

5.5. Let Everybody Be Committed

Continuous improvement should, according to the theoretical findings, be practiced everywhere in the production process and the involvement of all employees should be facilitated (Tenner & DeToro, 1992; Bergman & Klefsjö, 1994). High levels of participation, information sharing and communication quality are argued by earlier research to be associated with strong partnership and relationship between different parts (Mohr and Spekman, 1994; Sharma and Patterson, 1999). Demonstrated across all empirical findings, regardless primary or secondary data, and highlighted in the theoretical framework, communication is extremely important. Today one can by certainly say that lack of communication exists both internally and externally. When analysing the empirical data, lack of communication is argued to be a central contributor to why deviations occur. Both customers and suppliers are highlighting the result experienced from lacking communication. This is highly connected to the findings from the theoretical framework were researchers have concluded that ineffective communication leads to misunderstandings, incorrect strategies, and a mutual feeling of frustration that can cause conflicts among the people involved Mohr and Nevin (1990), which is very similar to the data gathered in the empirical findings e.g. by expressing misunderstanding, frustration and lack of trust.

In order to foster trust and help resolving disputes and to align perceptions and expectations between customers and suppliers, timely communication is very important (Sharma and Patterson, 1999). According to the theoretical findings, and to empirical findings, many of the current problems within firms can be solved by appropriate methods and strategies for communication (Mohr and Nevin, 1990).

Internally, when examining the empirical findings, more effective communication between the work-team and product engineers is definitely needed, e.g. the customers are explicitly stating
that more real time communication is needed, therefore DETP might need to consider what communication approaches in terms of methods and strategies are used today and what are the results of having this approach.

Externally, both DTMD and MSTC motivate the potential advantages with more communicative exchange between different product engineers at different units. E.g. solutions are a lot of problems are believed to be easily found with effective communication. The fact that they have similar work-processes, using the same systems and have the same function in production, and most importantly, faces similar types of deviations, indicates that they can learn a lot from each other.

MSTC explains that a corporation with different production engineering units especially nationally would be easy to initiate, thus highlighting that no one is taking the initiative to start this corporation. Findings from the theoretical framework clearly highlights the importance of managers assessing internal and external communications and take actions based on that assessment (Carr & Kaynak, 2007). The findings from the empirical data gathered clearly highlights areas where communication needs to be increased. Therefore, managers should assess those areas presented and consider what might be lost as a cost of lacking communication. Four different parameters are presented in the theoretical findings to improve communication, these are frequency, direction, modality and content which all might be parameters for the managers at the different units to consider assessing in order to succeed in achieving proactive quality management. The more interaction between the departments, the stronger the relationship will be in relation to knowledge transfer activities, where the goal is to improve the capabilities of the supplier (Wagner and Krause, 2009).

5.6. Other Themes

To go beyond the theoretical framework and to gain an even deeper understanding of how utilisation of existing tools and work-methods can proactively improve quality of production processes, a decision of going beyond the theoretical framework was decided. Finding several patterns in transcripts from interviews, workshops, meetings, just to mention a few, where similar attitudes and approaches where detected. Some of the patterns confirm the themes detected in the theoretical framework moreover, some additional themes where found
5.6.1. **System Problems (MONA)**

The problems identified are found in functions technically and in work-methods that have been used for a long time. It can be understood that these are based on assumptions that no longer applies due to an increased product flora. The problem areas can thus be said to have arisen from a changing environment rather than from changes in work-methods, which are described separately below. The handling of the production preparation process in Scania’s internal computer system MONA is generally not user friendly. The information product engineers need to create is available in MONA, given that the engineers in earlier phases has completed their work correctly. The problem is that information is spread over several levels in the system which requires a lot of manual searching. When the information about current tasks is found there is no function to collect or to store them, but the product engineer must write down information on paper to get a complete picture. Despite the extensive manual work, problems still arise with e.g. missing barcodes or wrong amount of attractions, indicating a lack of methodology. Today this is seemingly a system problem, but the background may as well be unthoughtful production preparation process structure from the beginning.

Currently, it is not an obvious resource-related problem that the entire assembly areas tightening information is stored in a basic excel spreadsheet, however, one can directly infer that it is an uncertain format to store all information in. If the document would be lost or accidentally altered, nothing happens in the actual assembly line. However, for product engineers, it would involve total rework for all changes to come. Storing information in the spreadsheet is currently the only way for product engineers to know what the different parameters in MONA contains. There is no ability to store this information in MONA directly linked to the parameter. One might therefore think that the administration in excel is a total non-value-adding work which could be eliminated.

The modular system which allows flexibility for the customer means a growing article flora. This, in turn, means an increasing range of variants to manage and assure the quality of. The production preparation process existing today requires a lot of administration and has such a structure that the complexity increases with the number of variants. This is, just to mention an example, because the barcode to be scanned at every station on the assembly line must contain all information about e.g. tightening needed for each specific engine variant. This means that product engineers must combine all tightening’s applying for each assembly station. Which is performed by complicated manual work methods with unreliable limited controls and verification methods.
5.6.2. Right from the Start

The time pressure that often arise from introductions and the pressure from the top that says the engine must be placed on the market, means operations do not have time to do sufficient work from the beginning. Tests on the development line and consulting with assemblers, is not always performed to the extent desired. This means that product engineers can sometimes produce barcodes for something that is not quite clear, to later perform rework.

In order to do it right from the start, it’s important to know what is right. For product engineers, the education in MONA have been, in most cases, learning by doing. New product engineers are working alongside with other product engineers. There is no established “Best Practice” which would be able to increase the efficiency for each product engineers work and also create a standard way for preparation.

Currently, product engineers are required to have product knowledge and knowledge in each assembly station, in order to work relatively smoothly. Without this knowledge, firstly, it is very difficult to do right from the start but also difficult to know where to troubleshoot incoming deviations. One might think that financially it should be cheaper to avoid deviations than to correct them, why proactive quality management argues to be paying off in the long run.
6. Conclusions and Recommendations

This chapter presents a summary of the study and the results. The conclusions from the findings are presented and proposed countermeasures suggested. Additionally, further research is proposed to increase the knowledge in the field of study.

The main aim of this thesis work is to examine how a multinational company can utilise existing tools and work-methods to proactively improve quality of production processes to better meet or even exceed the needs of customers without financial investments. To accomplish that objective, different study approaches were applied within the production process. As a basis for theoretical reference of this work, theoretical framework from TQM was used, a generic study examined the production process at Scania CV AB.

DETP at Scania CV AB are today missing a comprehensive way to proactively manage the quality of the output from product engineers. Deviations are discovered when occurred at the assembly line resulting in a reactive work-method that does not correspond to Scania’s strategic goal of having 0-deviations. Therefore, the objective of this thesis is to identify the current state, develop and utilise existing tools and work-methods and suggest an automated system for improving the quality of the output from product engineers.

In order to tackle this problem, literature best meeting Scania’s own standards and tools was studied. The PDCA-method was used to solve the problem presented practically. TQM values were used to analyse the findings. The results of this thesis resulted in identification of the current state in terms of deviation-report and identified deviations. Improvement of existing tools and work-methods to proactively manage the quality of the output from product engineers and finally, an automated system for improving the quality of the output from product engineers has been provided.

Scania’s overall goal is having 0-deviations when introducing new engines or performing changes in production. For DETP, today the amount of deviations is forecasted to 100 deviations totally this year. To achieve Scania’s overall goal a technical solution and improvements in work-methods and work-environment are necessary according to the ideal situation identified. Empirical data gathered in terms of documents, interviews, observations, meetings etc. confirms the identified current state. A P-FMEA was later conducted on identified critical steps in the work-process and the process-step with highest risk today is placing work-tasks into an assembly station in the computer system. One of the main root causes for this risk
is a missing link between a task/task group/workplace in the MONA meta structure. After conducting benchmarking with product engineers at national and international production units, a function was found which is used at some production units which identify the missing linkage between a task/task group/workplace and thereby is used to solve this issue. However, after multiple examinations, this function did not eliminate the highest risk completely, therefore, a change request was created to add, improve and automatize this function in order to completely eliminate this issue. This function can instantly be used to improve the quality of the output from product engineers however until the change request is approved and completed, the highest risk is not completely eliminated.

This master thesis answers research questions that are of interest today for all industries that in some way have production processes. The master thesis practically shows how a multinational company can utilise existing tools and work-methods to proactively improve quality of production processes to better meet or even exceed the needs of customers without financial investments and shows connections between existing literature in the field and the real-world. Thereby the research questions can be answered. See following:

1. **How can one proactively improve the quality of the production process without financial investments?**

Quality of the production process can be proactively improved without financial investments by using data already existing in-house. There is an enormous amount of data in-house that can be gathered to solve any type of problem. However, what’s important is identifying the current situation and the future desired state in order to identify what information is needed for the transaction to happen. Thereafter, one has narrowed down the information needed to proactively improve the production process without financial investments.

2. **How can utilisation and development of existing tools and work-methods at companies establish proactive quality improvement in the production processes?**

This thesis has shown that at companies today, there is a huge amount of already existing tools and work-methods to be taken advantage of to establish proactive quality improvement in the production processes. Most importantly is communication, where this thesis has practically used communication to detect a countermeasure, already used today, to the highest risk existing.

3. **What kind of information do one need to apply these methods?**

Information regarding the current state, the future state and what information between is required in order to reach a transaction.
6.1. Proposed Countermeasures

This chapter presents proposed countermeasures as a result from the analysis. There are two types of countermeasures proposed. First a technical countermeasure and second, an analysis of different work-methods/work-environments in-house at Scania provided to identify the “best practice”.

However, most importantly, is implementing the developed countermeasures. With all product engineers at DETP involved, implement the countermeasures with speed and smooth coordination. Further, throughout the implementation of the countermeasures, share the information via reporting, informing or consulting since it is very important that the progress is shared and communicated to other interested parties e.g. MSTC and DTMD. Speed is also important, if run into obstacles or unforeseen problems with the implementation. Never give up and strive forward.

Thereafter, it’s important to continue the improvement work by evaluating both the results achieved and the processes involved in implementing the countermeasures. It is vital to take an in-depth look at whether or not a successful countermeasure implementation makes a solid contribution to internal and external customer satisfaction, and has positive impact on the company as well as the groups personal development.

Further, whether succeeded or failed with the implementation of the developed countermeasures, it’s important to learn from the challenge, and gain knowledge and insight from the overall experience.

Finally, standardise the successful solution in order to repeat the result over and over again. Evaluate the new standards and share best practices with similar parties. Identify the future steps and start the next problem solving immediately.

Basically the suggested solution is to close the PDCA cycle and continuously improve by once again identify the new current state, the ideal situation and start the next problem solving.

6.2. Critical Reflection

There are some critical aspects to be considered when understanding the results of our thesis. It is important to reflect on; what are the actual results obtained? Due to our time limit we have focused on examining only some parts of the theoretical field and the work-processes. This naturally means that our results do not provide a complete picture of the applicability of the
theory. Further, weaknesses might be found in this thesis when considering aspects such as authors interviewing skills and experience in continuous improvement work. For instance, the author might not have adequate skills enough to create well formulated questions which, may have given varying quality of the answers. This can in turn mean that the author might have some overrepresentation of processed data. Further it is also important to consider who the respondents are, since the interviews were conducted voluntarily, we have interviewed respondents that have been interested in participating in our work. Which means that their opinions may not represent the majority and common opinion. Finally, it is important to reflect on the authors understanding of the topic itself. In a very short time the author’s task has been to understand extensive and abstract theory which may limit the quality of the thesis in large.

6.3. Further Research

When writing the thesis several areas in need of further research were recognised. Both more practical and theoretical research is needed in order to get a more comprehensive understanding of the what seems as quite general TQM-theory. Furthermore, more research on the actual implementation of TQM and also on more practical issues is necessary. Finally more quantitative and qualitative research is needed to achieve more generalizable knowledge contribution.

During the process with the thesis the following new interesting research questions has been noticed:

- How can companies today estimate the cost of lacking communication in production processes?
- What KPIs are of most importance in the production processes and how can one determine the most suitable KPIs to use?

Alternative methods in order to achieve a different or better results and conclusions are to:

- Conduct more case studies at different production units
- Perform a P-FMEA with different roles rather than only product engineers.
- Practically work as a product engineer for a couple of months to reach an in-depth understanding of the work-methods and work-environment needed.
7. References


Tano A.S.


Ibrahim, H. (2016, 02 26). Head of Final Assembly Inline Engines, Area 10.


Karlström, J. (2016, 02 26). Team Leader Final Assembly Inline.


Mikael, L. (n.d.). Product Engineer Final Assembly V8 Engines.


Olsson, D. (n.d.). Product Engineer Area 5 and 6 TMS line.


Putrus Hazem, O. (n.d.). Product Engineer Final Assembly Inline Engines.


79 (110)


I. Appendix
II. Interview Guide

**Interview Guide**

1. Can you describe your role and the task you have according to your own opinion?

2. What work-tasks do you have today that are linked to deviations?

3. To what extent do you think that you have time to work with them today?

4. Could you please mention common deviations that can arise when you prepare an engine for assembly?

5. What are the reasons for the deviations arising in your opinion?

6. How do you work today to prevent these deviations from occurring again?

7. Are solutions or deviations documented?

8. How do you use the documented information in such cases?

9. What are the reasons, according to your own opinion, for you not working proactively today?

10. What can your department do or change in order to work proactively with quality improvement?
### III. Deviation-Report Example

**Återföringsrapport för motorkort**  
**LÄMNAS TILL LOKAL PRODUKTEKNIKER PÅ DETP.**

**Fylls i av upptäckare (Montör, VT, Team leader, PL oav):**

<table>
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<tr>
<th>Datum:</th>
<th>Kontaktperson:</th>
<th>POP-id:</th>
<th>Task nr:</th>
<th>PAR:</th>
<th>Omr / Stn:</th>
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**Åtdragning / PAR / Streckkod / Motorkort (Beskriv problem / Avvikelse):**

Till Exempel:  

**Fylls i av åtgärdande person (DETP, DETF, DETT, DETM, ÅT):**

<table>
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<th>Kontaktperson:</th>
<th>Typ av återföring</th>
</tr>
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<tr>
<td>2015-04-20</td>
<td>Jens Wahlberg</td>
<td>Fejltäkten, Försättning X, ECO / EFR</td>
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</table>

**Åtgård / Lösning**

Text: Ny PAR skapad med dragnings för salnatt rör. Ny PAR heter "XOXOXO"  
Andring befintlig PAR: [ ]  
Ny PAR: [ ]

Lägg till testparameter "UTANGIV" på stn 5:19 och "MEDGIVA" på stn 6:27

Skapa rytta Poet 10Nm 10mm på stn 6:27

**Anteckningar dragarprogram/dragarskäp (anteckningar om utfört jobb):**

Text: Ny PAR inläg i iskän med orsakning för saknat rör. Feedback till DETP krävs. Y: [ ] N: [ ] Pto nummer (DETP)

**Ändring utförd av återföringsteknik Signatur / Id u Datum**

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<tr>
<th>Ändring utförd av återföringsteknik</th>
<th>Backup tagen efter rutin?</th>
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<td>[ ]</td>
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**Programmering verifierad av PT:**

Signatur / Id + Datum

Fylls in när Återföringen är klar att lämnas ut till in (DETP, DETF, DETT, DETM):

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<th>Åtgärdsdatum:</th>
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IV. Time Plan
V. Work-order Example

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<th>Pos</th>
<th>Torque</th>
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<tr>
<td>R33063</td>
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<td>Mount damping element for oil pressure pipe between pipe and block.</td>
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<td>15080420203C</td>
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<tr>
<td>R39519</td>
<td>Montera skruvarna till sugroret mellan oljepump och motorblock. OBS! Östra skruvarna på oljepumpen innan skruvarna dras i blocket, för att sedan dra dem på oljepumpen med dragare.</td>
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VI. Flowchart
## VII. P-FMEA Template

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<th>Failure Cause</th>
<th>Failure Effect Production</th>
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</tbody>
</table>
### VIII. Evaluation Criteria P-FMEA

<table>
<thead>
<tr>
<th>Felsannolikhet (Occurrence)</th>
<th>Allvarlighet (Severity)</th>
<th>Upptäckbarhet (Detection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ingen effekt</td>
<td>Hell säkert att felsättet upptäcks. Exempelvis pokka-yoke som till 100% hindrar att felaktiga artiklar kommer till kund eller kommande processsteg.</td>
</tr>
<tr>
<td>2</td>
<td>Liten effekt som kan upptäckas. Påverkar ej leverans till kund (inklusive kommande processsteg)</td>
<td>100% automatisk kontroll som förhindrar/förebygger att felaktig artikel tillverkas.</td>
</tr>
<tr>
<td>3</td>
<td>Kvalitetsstörning, försämrad kapabilitet. Påverkar ej leverans till kund (inklusive kommande processsteg)</td>
<td>100% automatisk kontroll i innevarande processsteg. Processen stoppas direkt om en felaktig artikel upptäcks.</td>
</tr>
<tr>
<td>8</td>
<td>100% måste kasseras. Leveransstopp till kund (inkl kommande processsteg)</td>
<td>Visuell kontroll av operatör efter processen.</td>
</tr>
<tr>
<td>9</td>
<td>Risk för person- eller maskinskada, men med viss förvarning</td>
<td>Svårt att upptäcka feltypen i processen. Tex tidskrävande kontroller såsom försörjande provning eller lab test.</td>
</tr>
<tr>
<td>10</td>
<td>Risk för plötslig person- eller maskinskada, utan förvarning</td>
<td>Kontrolsmöjlighet saknas helt. Felsättet kan omdöjt upptäckas eller förebyggas.</td>
</tr>
</tbody>
</table>

Skala för produktionspåverkan

1. Fel har aldrig påträffats i något identiskt system. | 1. Ingen effekt |
2. Max 1 gång/år | 2. Liten effekt som kan upptäckas. Påverkar ej leverans till kund (inklusive kommande processsteg) |
3. Max 1 gång / 6 månader | 3. Kvalitetsstörning, försämrad kapabilitet. Påverkar ej leverans till kund (inklusive kommande processsteg) |
7. 1 gång/skift | 7. Orsaker produktionsstopp. Behör av 100% måtning. Hälften måste kasseras. Ondtvisligt leveransstörning till kund (inkl kommande processsteg) |
8. >1 gång/skift | 8. 100% måste kasseras. Leveransstopp till kund (inkl kommande processsteg) |
9. >1 gång/timme | 9. Risk för person- eller maskinskada, men med viss förvarning |
IX. Fishbone Diagram Template
X. Routine Unrelated Objects
Routine: Unrelated Objects (Assp033)

When to perform?

- New local tasks
- New global tasks
- Placing tasks with local/global PtCO

Before setting PtCO in status 6
How?

Fill in: T

Fill in: WPL
TG
CA

Filter by PICO
If tasks are showing in unrelated objects after PtCO filtration then they are not placed in a workplace or taskgroup.
XI. Change Request
Change Request:

Extension of function:
Unrelated Objects Assp033

Today

- Highest risk: Tasks not placed in TG/WPL
- No comprehensive control-method or tool
- Manual visual inspection only (e.g. Preview)
- Unrelated Objects Assp033 can partly be used, **however** still manual and not comprehensive
Environment in Europe

Warning, link between T & TG, WPL incl. levels in between

Meta Rules of the Assembly Structure
Unrelated Objects does not work when: Rebalancing and Preplist

Rebalancing - Suggestion

- Disc Task in CATS203 but not in ASSP002.
- PtCO not in status 6.

Show task in Unrelated Objects
Preplist – Development Structure

- Sort by PA
  - Example: Where used.
  - Need: Possibility to chose what PA to control

- AC code?
  - Box development structure = No
  - Question: Does Unrelated Objects use AC logic, or can it do so? For automatic control.
  - 9C 9Z 8A