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Key Performance Indicators for The Product Follow-Up Process at Scania

A Study of KPIs for Process Management and Development within Service at a Research and Development Process

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Abstract

Key Performance Indicators for the Follow-Up Process at Scania – A Study of KPIs for Process Management and Development within Service at a Research and Development Process

Tina Lindewall

The Follow-Up Process at Scania was created in 1997 and has ever since made the deviation handling more efficient. Now, the Process itself is in need of internal efficiency measurements. The objective of this master thesis is to design Key Performance Indicators (KPIs) for the Process. The report sets out to find indicators that: visualizes the process flow, is feasible for the managers and workers to use to evaluate and control the performance of the resources which they are responsible for and also to guide the process owner in the assessment of the functionality of the Process. The Follow-Up Process is a service organization as often is the case in such organizations, the work flow is often hard to physically see and follow. To manage this, this degree project maps the Process as a flow. Then the described flow is analyzed and areas in need of indicators are found. These areas are then compared both to a literature analysis of the Process as a whole and to the KPI related opinions of the people working inside the process. As a result, this study offers a framework describing how the Process should approach the task of designing new indicators in the future, which obstacles to eliminate to be able to design these indicators and also a number of indicators to start to use and visualize in the meantime. The report ends with a summary chapter by chapter, a compilation of the recommendations made and a list of the designed indicators.

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Description in Popular Science

This master thesis has been conducting an investigation on behalf of the truck and bus company Scania CV AB. It was initiated by the part of Scania which has specialized in the receiving and solving reported deviations in Scania’s products. A deviation is oftentimes detected or experienced by a driver or in a workshop and then reported to Scania. The procedure inside of Scania, which then works with, and in the end hopefully eliminates the deviation and reports the solution back to the customer, is referred to as a process – The Follow-Up Process at Scania. This process involves some 500 employees and is cross-functional since it crosses over most of Scanias normal functions in the line organisations used when producing the trucks, buses and industrial and marine engines.

The Follow-Up Process would like to know how well it performs its tasks, i.e. if they get more efficient over time. This is where the question arises: ’How do you measure efficiency in problem-solving?’ To find the answer to this question is also the objective of this degree project. To measure the efficiency of the work inside the Process is a bit tricky though. The Follow-Up Process is a service organization and as a such, the work flow is often hard to physically see and follow. The problem-solving work of the Process can therefore in some ways be seen as invisible, and how do you measure something invisible? The problem-solving work is also hard to measure since it is organized around assignments which vary widely in size, complexity, number of people involved and lead time.

Through a study of how the Process currently performs its work tasks, some work flow mapping and an analysis of what this state and order of work means, have areas which are interesting to design indicators for, revealed themselves. To assure the quality in these areas and their indicators, in terms of representing efficiency and being interesting in reality, the areas have been compared to both literature and the KPI related opinions of the people working inside the Process. This brought out which aspects to consider when creating the process indicators. It also brought out some suggestions of indicators to start with and how to visualize them to everyone working inside the Process. This report then applied some of the designed indicators to the Process, describing how the measurements should be conducted, which consequences this measuring brings to the Process and also how the collected data should be interpreted. This varies from process to process and company to company, so a first consideration of how to reason when implementing those indicators, can be of some value. The report is summarized chapter by chapter in one of the last chapters and all the recommendations made throughout the thesis are compiled in the chapter after that. The Last chapter has a compilation of the designed indicators.

The work to find and adjust indicators for the Follow-Up Process will not be over when this master thesis has ended. It is strongly recommended that further research will be provided, on the basis of the recommendations of this thesis. Also, the Process should remove the obstacles mentioned in the recommendations and develop the recommended indicators, and others, as an iterative process. The method ’Trial and Error and then Correction’ should be guidance in this. At last, but not least, someone should be appointed to continue the work which this project has begun.

Preface

This is a 30 hp master thesis for the Master of Science in Engineering Programme 'Sociotechnical Systems Engineering' at Uppsala University.

My hope is for this report to be used as a foundation for the people of the Follow-Up Process at Scania, when they are continuing their efforts in the developing of the Process and the designing of good Key Performance Indicators. As an additional support, I have put together a separate booklet of introduction of the report, with the objective to facilitate for the reader who has a tight schedule. This booklet will be distributed at Scania.

I would like to express my appreciation for the great effort put in by my sponsor Thomas Almér at Scania Södertälje and my supervisor Peter Gröndahl at the Royal Institute of Technology (KTH). Your sincere interest, commitment and support have been encouraging.

I would also like to take the opportunity to express my gratitude towards all the co-workers at Scania, whose whole-hearted participation has made my work possible.

Last but not least, I would like to thank Rosmarie, Lars, Tobias, Ninnie, Martin, Sara, Cathrin and every other friend of mine, who has followed my work with great interest.

Whenever there is a product for a customer, there is a value stream.
The Challenge lies in seeing it.

– Mike Rother & John Shook

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1 Introduction

This chapter is an introduction to the master thesis and contains a presentation of Scania as a company and the background, objective and delimitations of the thesis.

How do you measure something invisible? ’Invisible’ has a tendency to be considered the same as ’non-existing’. To prevent this phenonemon, and also to be able to discuss internal efficiency, a suggestion is for the invisible work performed in the Follow-Up Process, to be measured. How to perform this is not given though, hence the question of the first sentence. This, because in technical and service organizations, such as the Follow-Up Process, people are sitting at desks, working at computers, sitting around conference tables, walking about and are generally busy moving from task to task. It is very difficult to follow the work flow in the way you can map a physical product as it is being transformed. Once the mouse is clicked and the email has been sent, it is hard to physically see what happens. In service organizations, the work flow is often organized around assignments which vary widely in size, complexity, number of people involved and lead time.

This master thesis therefore decides to map the Process to make it visible, then analyze the current state and then after that, search for performance indicators which visualizes and reflects the needs of both the Process and its customers.

1.1 Presentation of Scania CV AB

Scania operates in about 100 countries and has more than 35,000 employees. Of these, 2,400 work with research and development mainly in Sweden, close to production units. The net income for 2007 was SEK 8 554 000.

Scania has mainly five different larger categories of products: Scania develops, manufactures and sells **trucks** with a gross vehicle weight
of more than 16 tonnes, intended for long-distance, construction and distribution haulage as well as public services.

- Scania concentrates on **buses and coaches** with high passenger capacity for use as tourist coaches and in intercity and urban traffic.
- Scania’s **industrial and marine engines** are used in electric generator sets, construction and agricultural machinery as well as in ships and pleasure boats.
- Scania’s growing range of **service-related products** supports transport and logistics companies on their business operations
- **Financial services** are an important part of Scania’s business. Customers can choose between loan financing, various forms of leasing and insurance solutions.

Scania has a global production network, into which all production units around the world are integrated. This allows great flexibility and cost-effective production. During 2007, Scania produced 78,300 vehicles at very high capacity utilisation. With investements of about SEK 2 billion over three years, by late 2008 Scania can achieve an annual capacity of some 90,000 vehicles and by late 2009 a capacity of 100,000 vehicles.[1]

1.2 Background

The Follow-Up Process is the part of Scania for which this thesis has been conducted. The Process was created 1997 to structurize the work associated with the deviations in Scania's Products. Every company experiences deviations in their products but they all handle them differently. Before 1997, Scania did not have a certain way to collect information about, or solve, those deviations. The work were unstructurized, sporadical and the customer's point of view were many times missed out. One day the Executive Board realized that the company lacked the product quality expected and that Scania had to develop a specific process for the deviations to be handled in and for the employees to understand and to be trained in. And so the Follow-Up Process was born.

The Process has provided Scania with a great progress in handling deviations and asserting product quality world-wide. After the first years of struggle with preaching of how to follow the new process descriptions, the discussion has moved on to be about changes in the existing ones and has currently matured into asking for an efficiency measurement. A first step has been to measure the end result, i.e. the number of solved assignments, but this is not a good enough metric. This master thesis has therefore performed a study which results in recommendations, of indicators and process changes, which can help in the assessement of the internal efficiency.

1.3 Objective

The purpose of this master thesis is to design Key Performance Indicators (KPIs) for the Scania Product Follow-Up Process. The indicators are to be mainly about lead time information but can also be of other character relevant to resource managing and/or mapping of the process performance.

Concerning lead time, the purpose is to figure out whether it is possible to measure, how such measurement should be conducted, consequences that this measuring brings to the process and also how the collected data should be interpretated.

1.4 Fulfillment of the Objective

This master thesis has sat out the following goals to fulfill the objective (section 1.3). It shall:

- Map the Process and analyze it.
- Identify and develop areas of indicators needed and also some specific indicators, witch both fits the Process.
- Develop a method for the Process to use when continuing the search for good indicators.

[1] Scania AB (publ), *Scania in Brief* , 2008.

- Offer suggestions of indicators to start with which also are applied to the Process.

This will be carried out through the following actions:

First, the process will be described (from the customer and upstream) as a flow. Then the described flow will be analyzed to find areas which are in need for indicators. These areas will then be compared both to a literature analysis of the whole process (i.e. not only the areas already detected) and to the KPI related opinions of the people working in the process. This will bring out what aspects to consider when creating the process indicators and also some suggestions of indicators to start with. Finally, some of the KPIs are being applied to the Scania Follow-Up Process. A more detailed description, chapter by chapter, is to be found in the Disposition, section 2.1.

The **indicators** which this report is searching for and designing, mentioned in section 1.3, has the following three main aims:

- To **visualize the process flow** in different ways. The purpose of this is to make them easily available to, and understood by, everyone working in the Process. This is critical to obtain a common view of both the way it flows as well as the current state of the flow.
- To **be feasible to the managers and workers** to use to evaluate and control the performance of the resources which they are responsible for. In the Process this refers to for example the PMs, Assignment Managers, Assignment Leaders, managers of FQ Engineers among others.
- To **guide the process owner YSR** in the assessment of the functionality of the process.

1.5 Delimitations

The following delimitations has been introduced to narrow the scope of this study:

The master thesis is **keeping the overview focus** of the Process, and leaving the details to be worked out by the Process itself, **as opposed to breaking the Process into parts** and studying some of those in more detail. An overview analysis is a necessety in the design of efficiency indicators.

The indicators are to be used for efficiency measurements according to the objective. After a study of the Process, the thesis more specifically chose **work flow efficieny** as the main area of efficiency measurements for the Process. This means, among other things, that financial measurements will not be included.

The study has been carried out under the assumption that the indicators recommended will be **implemented some day soon as a service** to the Process but that **no part** of the Process, or no Product Engineering Area, **will be forced to use the data provided**.

This thesis is a study of the Process within the factory. This means that **the customer in question for the study is the distributor**, not the driver, owner or the workshop. For an illustration, se the framed part of the Process in figure 1.

The Process involves some 500 employees worldwide divided into eleven Product Engineering Areas (see Appendix A). To study them all thoroughly is not possible in five months. Therefore **three Product Engineering Areas have been chosen** in discussions with the sponsor. Those are Bus Chassis, Electrics and Engine and they are presented in section 4.2.

The assignment are divided into three types: the Quick (Q), Medium (M) and Heavy (H). This study presents all three of them but are **only considering the two more advanced types of assignments: The Medium and Heavy.**

Furthermore, the study makes the assumptions that most, if not all, **deviation reports will be connected to an assignment** and that most, if not every, **assignment gets solved**.

The **POL** Meeting (Purchase OnLine) is **excluded** from the study.

The FRAS IT system has a function in the Process but will not be an object of study in this thesis. This study has chosen to **uncritically treat FRAS as a tool of the Process**. The study is recommending **several changes** in FRAS but the objective for this, is to make FRAS support the indicators recommended.

2 Method

This chapter begins with a disposition of the master thesis and then continues with an account for the scientific and working methods used.

2.1 Disposition

The disposition can be motivated as follows:

The flow of the process will be described (from the customer and upstream) in Chapter 4. Chapter 5 analyzes the described flow. Chapter 6 is using the analysis from Chapter 5 to find out what aspects to consider when creating the process KPIs. Finally, some of the KPIs are being applied to the Scania Follow-Up Process in Chapter 7 and 8. A more detailed description follows:

Chapter 3 contains a theoretical background.

Chapter 4 is empirical and describes Scania's organisational structure, where the Follow-Up Process is placed and how the flow of the Follow-Up Process works.

Chaper 5 sets out to determine the areas of indicators needed in the Process today. This is done through an analysis of the current state of the Process, as perceived through the empirical findings presented in this chapter and in chapter 4.

Chapter 6 compares the areas of indicators suggested in Chapter 5 (i.e. developed from the current situation of the Process itself) both with the opinions of KPIs from the people within the Process and with the theoretical methods to detect good indicators. This results in recommendations of indicators for the process and ways to continue the search, recommendations of how to overcome process inconsistencies when measuring and recommendations of how to start to use the indicators suggested.

Chapter 7 applies one of the suggested indicators of Chapter 6: Lead Time. Chapter 7 displays the application of Lead Times by showing how to measure (intervals, metrics and time stamps), what to measure (describing which time that is of interest) and where to measure (offering suggestions of Lead Time intervals). This chapter also gives two examples of how to visualize the True Lead Time and the Current Lead Time. At the end, the First-Pass Yeld is introduced as a good overall indicator.

When looking at Lead Time, as in Chapter 7, questions arises pretty fast as to which time that really counts, i. e. is value-adding. Everything non-value-adding is referred to as Waste and when discussing efficiency, it is important to be able to discuss Waste. KPIs to determine efficiency were an expressed desire in the objective of this thesis, and therefore, **Chapter 8** sums up some of the different kinds of Waste which is measurable in the Process.

Chapter 9 provides an extensive summary of the analysis and appliance of indicators in chapters 5, 6, 7 and 8. To receive information about the objective, methods, theoretical background or the Follow-Up Process, the reader is referred to their respective chapters (1, 2, 3 and 4). For a brief summary, see the Summary of Recommendations in Chapter 10.

Chapter 10 offers a brief summary of the recommendations provided throughout the report, followed by a compilation of every recommendation, section, by section.

Chapter 11 provides a summary of which indicators (PIs, KPIs and KRIs) the Process should use.

Chapter 12 offers the references.

2.2 Working Method to Plan The Order of The Content

The overall outline for the content is based on the method named Value Stream Mapping (VSM). Section 3.3 contains a short review of the theory of the method and a great deal of the order, and content, of the following chapters are connected to the method.

The overall structure of this essay is built in a way familiar to the VSM. This is one way among many to the disposing of the content. It is chosen since the analysis in the essay both has the same denominators as the VMS (the denominator being Toyotas philosophy of Lean Production) and also many times are based on VSM itself. Hopefully this structure makes it easier to follow the analysis along the report.

VSM shows process steps, inputs and outputs.[2] That is, it considers a process and its flow. This kind of thinking does often not exist in non-manufacturing processes but in the Scania Follow-Up Process it does to some degree. Since the flow considering is already present, a more in-depth study concentrated on the flow will be conducted via for example VSM.

In a VSM-like manner the disposition can be motivated as follows:
The flow of the process will be described (from the customer and upstream) in Chapter 4. Chapter 5 analyzes the described flow and Chapter 6 uses the analysis to find out what aspects to consider when creating and choosing the process KPIs. Finally, some of the KPIs are being applied to the Scania Follow-Up Process in Chapters 7 and 8.

Note that the objective of the essay (section 1.3), only leaves room for simplified step 1-5 (in section 3.3) to be carried out throughout the report. The work with the remaining steps is to be continued by the Scania Follow-Up Process after contemplating this essay and its given remarks due to those steps.

2.3 Applied Methodology of the Philosophy of Science

The two most prominent methologies of the Philosophy and Science are the Positivism and the Hermeutics.[3]

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[2] Michael L. George, *Lean Six Sigma: Combining Six Sigma Quality with Lean Speed.* (New York: McGraw-Hill, 2002), p. 186.
[3] Runa Patel & Bo Davidson, *Forskningsmetodikens grunder.* (Lund: studentlitteratur, 2003), p. 26.

2.3.1 This Study is based on Hermeneutics

Hermeneutics may be described as the development and study of theories of the interpretation and understanding of texts.[4] It aims towards understanding of its object of research.[5] This means that the scientist uses hers/his own thoughts, impressions and emotions to create a wider understanding of the studied area. [6]

2.3.2 The Data is Interpretated according to Qualitative Methology

When the information in a study is generated, worked at, analysed and interpreted with the purpose to reach for new knowledge can either Qualitative or Quantitative Methology be used. This master thesis is doing this according to the Qualitative Methology.

Using the Hermenutics almost always means using the Qualitative Methology. [7] Research based on Qualitative Methology places its focus in verbal methods of analysis (for example interviews and interpretations of experiences of people.[8] The Quantitative Methology is used for trials of theory and based on many units of analysis, while the Qualitative Methology is used for development of theory and based on a few cases.[9]

2.3.3 The Interviews were Semi-Structured with a Low Standardization

Interviews means gahtering information through questions.[10] The method is used first and foremost at Qualitative surveys, when the purpose is to create an understanding of the object.[11]

The degree of standardization, as well as the degree of structuration has to be taken into consideration when interviews are used.

A semi-structured form of interview is based on a low degree of standardization. The researcher then has themes which should be covered during the interview. Which question that is to be used to fulfil this varies between the different interviews, but each area should be covered. [12]

2.4 Scientific Work Procedure

The work procedure of this master thesis can be seen as consisting of three parts: The study of literature, the selecting of the interviewees and the performing the interviews and, finally, the analysis of the Process to find the suitable KPIs.

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[4] Patel & Davidson, p. 28.
[5] Lars-Göran Johansson, *Introduktion till vetenskapsteorin.* (Stockholm: Thales, 2000), p. 70f.
[6] Patal & Davidson, p. 30f.
[7] Patel & Davidson, p. 27f, 29.
[8] Johansson, p. 66.
[9] Jan Teorell & Thorsten Svensson, *Att fråga och att svara.* (Lund: Studentlitteratur, 2007), p. 10.
[10] Patel & Davidson, p. 69.
[11] Patel & Davidson, p. 78.
[12] Mark Saunders, Philip Lewis, Adrian Thornhill, *Research Methods for Business Students.* (Harlow: Financial Times/Prentice Hall, 2000), p. 245ff.

2.4.1 Study of Literature

The study of literature is based on a review of literature discussing the development of KPIs. This part provides a theoretical framework and is presented in the Theoretical Background in Chapter Three. The study of literature has furthermore served as a base for the interviews and the analysis of the needs of the Process.

2.4.2 Interviews and Interviewees

The interviews have been conducted throughout the work process of the thesis they have and simultaneously built up knowledge about the Process and its needs. The purpose of the interviews has been to identify, map and analyze the currently used, or wished for, KPIs at the Process or its subprocesses.

The interviewees were strategically selected. The people in key positions with a certain asked-for knowledge, has therein been chosen in a way that has allowed all subprocesses to be represented. The reader is referred to the list of references in Chapter Twelve. The strategic selectioniis built upon the following discussion:

The interviews which aimed to map and contribute to an analysis of the current KPI work, has been with the FQ Engineers and Product Managers of the chosen respective Product Engineering Areas (see section 4.2 for information about the chosen areas). These persons are the ones working in the Process and therefore also the ones possesing the overall knowledge about it and should thereby be able to evaluate the usability of the indicators.

The contact with the FQ Engineers has been continuous and has consisted of, among others, interviews, conversations and group meetings. Additional conversations have been held with the YSR group continuously, whom has provided most of the process knowledge.

All contact, such as interviews and conversations have been personal and in most cases held at the interviewee's work station. The starting base of questions is to be found in Appendix B. All interviews have been recorded and carefully transcribed. Each interview has therefore demanded at least 2 days of processing to enable an as accurate interpretaion as possible.

2.4.3 Analysis of the Process to find Suitable KPIs

The interviews gave the material which enabled a Process analysis. This analysis, combined with a literature analysis, was then used to identify feasible indicators of efficiency for the Process.

The recommended indicators, and the use of those, have been developed during the entire thesis work. The areas of special interest for the designing of the indicators has been found through the interviews and conversations. The Process owner, the YSR group, has been involved through continuous discussions. The indicators have been revised and subjected to further development in cooperation with the interviewees, the sponsor of the master thesis and with the YSR group.

The analyzing part of the thesis work has many times been about understanding the organizational structure and its influence on the indicators. This understanding is important to obtain to be able to discern the parts of the organizational structure which might need to be changed during the development work of finding suitable KPIs. To facilitate this future work, this thesis has analyzed the Process on the basis of the current state. Recommendations for future work is given alongside every indicator recommended.

2.5 Critical Review

The extent to which the presented study can be used, is in some way limited.

The study has been tailor-made for the Scania Follow-Up Process and is therefore, not immediately applicable for other processes or organizations. The theoretical background in Chapter Three, the theoretical framework created through analysis in Chapter Five and Chapter Six, is more usable though. As a first start anyhow.

The indicators and other recommendations were designed from the identified areas of indicators. These areas were found in an analysis of the current state of the Process and this state was obtained through interviews. The degree of feasibility of the indicators will be very low if those interviews and the participating interviewees were wrongfully interpretated (i.e. unsystematical errors) or if the selection of questions or interviewees caused systematical errors. This is always a factor when using Hermenutics and Qualitative Methology (see section 2.3).

Using Qualitative Methology also means that there is a risk that the data collected can not be generalized to the extent to which the researcher has. This study was limited to three of eleven Product Engineering Areas, which might be a problem when introducing the study to the remaining eight areas. Scania describes their organization as one of ’accents’ and there is a possibility that this study did not cover every such.

The delimitations in section 1.5 informed that this study has made some simplifications. These will all affect the use of the indicators and the recommendations in some ways. The main example is that the study does not consider the Q assignments. Although necessary, this simplification has a large impact on a possible direct implementation of the indicators. This, since the number of Q assignments are significantly high although the length of those are only 1/10 or sometimes 1/50 of an Q or M assignment. The Q assignments are very common and the use of those will impact the mesaurments from the indicators in a yet unknown and not yet considered way.

3 Theorethical Backgound

This chapter provides the reader with a summarized theoretical background for the key concepts used in the analysis in chapters 5, 6, 7 and 8.

3.1 Definition of a Process

This thesis is a study conducted at Scania to provide a process of product development with key performance indicators (KPIs). Since the concept 'process' will be used in a coherent way through the thesis, some theory concerning the expression follows in this section. The last paragraph in the section underlines how the expression is used at Scania and also represents the way in which it will be used throughout the thesis.

According to Aronsson et al., a process can be concluded into the following list:[13]

- A process is a chain of activities with a clear beginning and a clear end.
- A process is planned and repeats itself.
- There shall exist clear objectives for the process, as well as a description of the included steps and the expected results.
- A process comprises several activities, often both administrative and operative, and is cross-functional.
- A process is planned and conducted in a standardised manner.
- Within the area of logistics, is it important for the process not to be too short. The point of the processes is their integrating role between different functions. If the process only consists of a small number of activities within a function, it will be short to have the more inter-function-integrating character that is demanded.

For Scania's Product Follow-Up Process every criteria described in the list above is true, although the Product Follow-Up Process describes a process with its own terms:

The Process is a standardised product development working procedure that everyone within the Product Follow-Up follows. The Process is namely just the way that everyone within it perform their work, the order of which work is organized.[14]

3.2 Indicators as Performance Measurements

According to Parmenter, many companies are working with the wrong measurements and many of which are incorrectly termed key performance indicators (KPIs). Parmenter presents three types of performance measurements:[15]

- Key result indicators (KRIs), which tell you how you have done in a certain perspective.

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[13] Håkan Aronsson, Bengt Ekdahl & Björn Oskarsson, *Modern logistik – för ökad lönsamhet*. (Lund: Liber AB, 2008), p.52.
[14] Thomas Almér, *oral conversations*, Feb – Sep 2008.
[15] David Parmenter, *Key performance indicators: developing, implementing, and using winning KPIs*. (New Jersey: John Wiley & Sons Inc., 2007), p.1.

- Performance indicators (PIs), which tell you what to do.
- Key performance indicators (KPIs), which tell you what to do to increase performance drastically.

KRIs and KPIs are easy to mix. This is why the following two sections take a closer look to distinguish them from one another.

3.2.1 KRI – Key Result Indicator

These measures are the result of many actions and give a clear picture of whether you are travelling in the right direction. However, they do not tell you what you need to do to improve these results. KRIs therefore provide information for the board (i.e., those not involved in day-to-day management). KRIs cover a longer period of time than KPIs and are reviewed on monthly or quarterly cycles and not on daily or weekly basis as KPIs are.[16]

Parmenter recommends an organization to have a report of up to ten measures providing high-level KRIs for the board and another report comprising up to 20 measures, a mix of KPIs and PIs, for management.[17]

3.2.2 KPI – Key Performance Indicator

A set of measures focusing on those aspects of organizational performance that are the most critical for the current and future success of the organization, are referred to as KPIs.[18]

Parmenter has found seven characteristics of KPIs:[19]

- They are nonfinancial measures (not expressed in for example dollars, crowns or euros.). The KPI lies deeper down.
- They are measured frequentley (e.g. daily or once every hour). A monthly, quarterly, or annual measure can not be a KPI, since it can not be key to your business if you are monitoring it well after the changes has happened and you are no longer in time to correct them smoothely. KPIs are supposed to be current- or future-oriented measures as opposed to past measures.
- They are acted on by the CEO and senior management team. Management reports, in the same time, need to be management tools but many management reports are merely memorandums of information. To also be a management tool, the management report should encourage timely action in the right direction. This is the role of the KPI.
- The understanding of the measure and the corrective action has to be required by all staff, so that the KPI tells them what action needs to take place.
- They are deep enough in the organisation to tie responsibility to the individual or to the team, making it possible for the CEO to call someone and ask ’why?’.

[16] Parmenter, p. 2f.
[17] Ibid, p. 3.
[18] Ibid, p. 3.
[19] Ibid, p. 5-12.

- They have significant impact (e.g., affects most of the core Critical Success Factors (More about CSFs in the next section)). This means that when the CEO, management, and staff focus on the KPI, the organization scores objectives in all directions.
- They have positive impact (e.g., affect all other performance measures in a positive way).

3.2.3 CSF – Critical Success Factor

CSFs determine the organizations health and vitality and where the organization needs to perform well. Naturally cascading from these CSFs, are the KRIs, PIs, and KPIs, which are actual performance measures. So, if the CSFs are available, the winning KPIs are much easier to find.[20]

This makes it clear that an organization that has spent time defining and conveying its vision, mission and values will be more successfull. Ascertaining an organizations CSFs is a major exercise though, and it is often only obliquely tackled. When first investigating the CSFs, you may come up with 30 or so issues that can be argued to be CSFs. Better practise suggests that you should thin them down to be only between five and eight CFSs. When this is done, the winning KPIs will reside within these CFSs.[21]

3.3 Value Stream Mapping

To be able to create tailor-made indicators, or even the indicator's base, CSFs, for the Process, we need an understanding of the Process itself. This can be received through Value Stream Mapping (VSM) in some level of detail.

Value Stream Mapping is a proven method used in Lean manufacturing. It was adopted by Mike Rother and John Shook from Toyta's material and information flow diagrams.[22]

The VSM is an important aid in the development to become lean[23]. The VSM analysis contains a definition of the whole value flow, measured in all or any one of the metrics time, WIP and use of resources. Not using this tool puts the company at risk to only achieve isolated improvements which will not reach out or affect the value chain and its customer, nor the profitability. This, since the problems might have shifted upwards or downwards in the value chain.[24]

VSM offers oppertunities to, among others, see the whole value flow, identify sources of waste (see section 3.5), concentrate focus on and prioritize actions towards improvement and, finally, the VSM forces a picture of the current state of

[20] Ibid, p. 29.
[21] Ibid, p. 22ff.
[22] Jeffrey K. Liker, *The Toyota Way – 14 Management Principles from theWorld's Greatest Manufacturer*. (New York: McGraw-Hill, 2004), p. 275.
[23] The swedish translation of 'lean' is 'resurssnål'.
[24] Mike Rother & John Shook, *Learning to See. Value-Stream Mapping to Create Value and Eliminate Muda*. (Cambridge: The Lean Enterprise Institute, 2003), passim.

the process to be produced. Such a picture, or map, often serves as a good basis of discussions but is many times missing when the VSM work begins.[25]

Value Stream Mapping is performed step-by-step:

- Start by identifying a family of products to analyze.[26]
- Take a walk on the floor of the office or workshop and study the reality of the work situation.[27]
- Draw a map of the current state of the process, as you walk along the material flow, using paper and a pen. Start at the customers end and walk upstream in the material flow. After the completion of the first outline, it will be possible to zoom in or out for a sufficient level of detail.[28]
- Identify which kind of information that is of interest in the sketch. Some examples could be Lead Time, cassations, uptime or storage in between activities.[29]
- Complete the map with the information flow.[30]
- Start to draw a second map, this time for an ideal future state of the process. Examples of expectancies are for the flow to follow a takt (the takt of the customers order being placed), to have a process with a dynamic distribution of resources and to have equipment available when needed.[31]
- Conclude what improvements that will be needed to transform the current state map into the ideal state map.[32] This is the 'what' to do.
- Decide how carry out, and then implement, these improvements.[33] This is the 'how' to do.
- Perform follow-ups on regular basis.[34]

The extent to which the VMS method is used in this essay is being discussed in Methods in section 2.2.

3.4 Lead Time

Lead Time is a way to measure time in a process. It comprices the whole time it takes to deliver your service or product once an order has been triggered.[35] In other words it means adding every elapsed time, associated with the completing of an

[25] Ibid, passim.
[26] Rother & Shook, p. 4.
[27] Ibid, p. 9f.
[28] Ibid, p. 9ff.
[29] Ibid.
[30] Ibid, p. 23ff.
[31] Ibid, p. 48-73.
[32] Ibid, p. 74-87.
[33] Ibid, p. 88-91.
[34] Ibid.
[35] Mike George, Dave Rowlands & Bill Kastle, *What Is Lean Six Sigma?*. (United States of America: McGraw-Hill, 2002), p. 40.

activity (including the waiting time until the activity is started, i. e. queues), to each other.[36]

Using Lead Time as a measure is important to a company in order to, as soon as possible, gain external visibility and legitimacy.[37]

Little's Formula (for steady state systems)[38] applied to lead time offers the equation:[39]

$$\text{Lead Time} = \frac{\text{Average of Work In Process}}{\text{Average Completion Rate}}$$

Work In Process (WIP) is the amount of work in a process, which is not yet completed. The Completion Rate is, at any given time period (day, week, month), how many items of work that get finished.[40]

Little's Formula comes in handy in many systems since it explains how these three, Lead Time, WIP and Completion Rate, relate to one another.[41] Section 7.6.2 gives a warning though, connected to the use of this equation.

3.5 Waste

If WIP exists, work that is waiting to be worked on exists. This is what constitutes a 'queue' and the time the work spends waiting, is called 'queue time'. A queue is seen as a delay, no matter the underlaying cause.[42]

It all starts with the customer. If a customer saw the queue, she/he would consider it not adding any value to the product. Such work, or time, is called 'non-value-adding' or 'waste'. An activity that on the other hand adds value in the eyes of the customer is called 'value-adding'. A third variant is called 'non-value adding but required'. This refers to activities which do not add any value in the eyes of the customer but is considered a necessity to the serving company. This include, for example, inspections, control systems and documentation. But nontheless this is waste, since people who pay for a service do not think they are buing its internal accounting services too.[43]

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[36] Beau Keyte & Drew Locher, *The Complete Lean Enterprise: Value Stream Mapping for Administrative and Office Processes*. (New York: Productivity Press, 2004), p. 26.
[37] Sten Tellenback, *What Is Lead Time? A Research Note.* (Luleå: Luleå University of Technology, 1992), p 1.
[38] Lennart Råde & Bertil Westergren, *BETA Mathematics Handbook for Science and Engineering*. (Lund: Studentlitteratur, 2001), p.433.
[39] George et al., p. 40.
[40] Ibid.
[41] Ibid, p. 41.
[42] Ibid.
[43] Liker, p. 280.

Non-value-adding, or waste, can be seen in several forms. Here are the seven forms of waste:[44]

- Overprocessing (when trying to add more value to a product or service than what the customer requires).
- Transportation (which is the unnecessary movement of product, materials or information).
- Motion (when people are moving around unnecessary).
- Inventory (WIP that is in excess of what is required to produce the product for the customer).
- Waiting time (every delay between the end of one activity and the beginning of the next).
- Defect (every aspect of the service that does not conform to customer needs).
- Overproduction (when the production of service outputs or products is beyond what is needed for immediate use).

When already acquainted with Lead Time and value-addning time, the Process Cycle Efficiency can be introduced as:[45]

$$\text{Process Cycle Efficiency} = \frac{\text{Value Adding Time}}{\text{Total Lead Time}}$$

This gives a measurement in percentage on how effective the process is.[46]

[44] Michael L. George, *Lean Six Sigma for Service – How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions*. (New York: McGraw-Hill, 2003), p. 259.
[45] George 2002, p. 36.
[46] Ibid.

4 The Company and the Process of Concern

This chapter is empirical and describes Scania's organisational structure, where the Follow-Up Process is placed and how the internal flow of the Follow-Up Process works. This chapter is directed foremost to anyone not too familiar with the Follow-Up Process at Scania.

4.1 Scania and the Follow-Up Process

The following sections present the Follow-Up Process and describe how it is organized in Scania's organisational structure.

4.1.1 Scania's Organisational Structure

As mentioned in section 1.1, Scania has more than 35,000 employees and mainly five different larger categories of products: trucks, buses and coaches, Industrial and marine engines, service-related products and financial services. All these people and products needs to be organized. Scania has chosen a line organisation for this purpose and this means that the employees of different fields of knowledge belongs to their respective line organisation.

A line, or a field of knowledge, could for example be the purchase function. Another example of fields of knowledge is the ten Product Engineering Areas (PAs). Each Product Engineering Area has total responsibility for its product, for example Bus Chassis, Electrics and Engines, which are partly studied in this thesis. These three constitutes three lines within Scania and has their own respective organisations, like all other lines.[47]

4.1.2 Scania's Product Follow-Up Process is 'The Process'

The Scania Product Development process (PD) includes about 2,400 employees[48] and handles the company's research and development.

The Product Follow-Up process is the last of three processes within the Scania Product Development (PD) process. The first two processes are Pre-development and Continuous Introduction. Pre-Development deals with the investigation of business opportunities and technical solutions before Scania begin to develop an actual product. Continuous Introduction implements development assignments relating to new products that will be made available to customers through the Scania product range. After these two processes, the process of interest for this thesis follows: The Product Follow-Up. This process maintains and updates the current product range on the market and improvements are introduced on an ongoing basis during the year.[49]

To simplify one could say that the Pre-development process works with ideas of how a product could be, that the Continuous Introduction process transfers the ideas into products and that the Product Follow-Up corrects deviations in the produced products.

[47] Almér, Feb – Sep 2008.
[48] Scania AB (publ), 2008.
[49] Executive Board, Scania Internal Document *Product Development Process*, 2008

When a product reaches SOP (start of production) and then exists in reality, not only in a drawing or as parts not yet put together, the product belongs to the Product Follow-Up process.

This means that from the point in time, when the first example of a new product is produced, the Product Follow-Up process gets responsibility for that product and every other such for as long as it is produced by Scania. These products exists both inside the factory (until delivery) and delivered to the customer.

When a possible deviation is suspected, either within the factory (for example detected by a production operator) or experienced from a customer, when in worst case standing at the side of the road, a deviation report is sent to Scania. The deviation report is the initiation of the Product Follow-Up process, which then continuous with reviewing of the deviation and later on assigns assignments to correct it. This work is carried out in many steps and these steps are the ones that make up the process.

The types of items that the Product Follow-Up handles are: Field Quality (FQ), Product change request, Design adjustments, Specification adjustments and Cost reduction. In this thesis only FQ items will be considered. FQ means handling the deviations in the field, meaning the already produced products as mentioned. If the deviation is judged to affect customers, the deviation is classified as FQ.

An urgent request for the Follow-Up process is to ‘love deviations’. The objective for the Follow-Up process has to be to abolish itself, although this is not really realistic since every new product might cause deviations not thought of before and since the surrounding environment in which the product is used (i.e. constraints) is constantly in change.[50]

4.1.3 YSR owns The Process

The Department of Product Quality and Technical Information within the R&D sector (referred to as ‘YSR’ internally and in this thesis) is the department that owns the Follow-Up Process. This means that YSR supports and facilitates method improvement found by the people working in the Process. The Process is a standardised product development working procedure that everyone within the Product Follow-Up follows. The Process is namely just the way that everyone within it performs their work, the order of which work is organized. Since the Follow-Up process is cross-functional, most of the personnel within it belongs to, and are located at, their respective line organisation, performing the work of the Product Follow-Up. To be able to do this in the same way in the whole company and all over the world, standardized work methods are needed. The Process has to fit for real work and real situations and are therefore under continuous improvement and has a mission to always challenge the process. The standardization of the work methods on one hand, and the demand for “local accents” to fit the process to the work on the other, is a constant struggle to balance for the company. YSR is the department responsible for development of this process.[51]

[50] Almér, Feb – Sep 2008.
[51] Almér, Feb – Sep 2008.

In its work to support and develop work methods, the department is working for standardization of work methods. This is done through a number of different tasks, for example by the development of work tools, templates and checklists and the result is many times displayed in process maps and in descriptions for the different functions to follow. YSR also leads improvement groups, conducts process training and works for knowledge transfer within the Process and also to other processes.[52]

YSR has a supervising position of the process and another task is therefore to support the resources within it, to achieve flow balance. The department is also supposed to keep KPIs and use them as tools for improvements. This thesis aims to find KPIs that can do just that, but that also helps in the supervising role to keep and create flow balance. [53]

Today YSR has no KPIs supporting the department with information about the process flow itself. The only official measurement that the department is using is the amount of output and in some senses the amount of input. Of those two, only output is used for anything (annual reports etc) and the period of measurement is one year at the time.[54] This does not describe a flow, it describes a black box with something coming out of it, and the work inside is not visible. You can see people working in front of computers, of course, but without indicators you can not see or talk about the flow of the work itself.

4.2 Product Engineering Areas Participating in the Study

As mentioned in section 4.1.1 above, the ten Product Engineering Areas each constitutes a line within the line organisation of Scania and has total responsibility for their product. This means that Engines has responsibility to correct every deviation and communicate this to every step within the factory, such as the drawing board for future engine products, the on-going production and all the already produced engines running in trucks all over the world. For the Product Engineering Network, see Appendix A.

The Product Follow-Up process is cross-functional and is used by the different line organisations within Scania to solve Field Quality (FQ) deviations. These deviations are each Product Engineering Area's responsibility as described above, and those are the ones that solve the FQ deviations, following the Product Follow-Up process.

In this thesis, the following Product Engineering Areas has participated in interviews:

4.2.1 Bus Chassis

The bus chassis are produced separately from the truck chassis and has its own line in the line organisation of Scania.[55]

[52] Almér, Feb – Sep 2008.
[53] Almér, Thomas, Scania Internal Document *Product Follow-Up Presentation*, 2008.
[54] Almér, Feb – Sep 2008.
[55] Magnus MacKaldener, *oral interview* 2008-03-11.

The Product Manager for Bus Chassis (the Product Manager) is the head of the Follow-Up Process in Product Engineering Area) and a Q Team leader, were respondents in this study.

4.2.2 Electrics

Electrics has the overall responsibility for the electricity in Scania's products. This means that "everything with a cord and/or some software" belongs to Electrics. [56]

Respondents from Electrics were the Product Manager and an Assignment Manager.

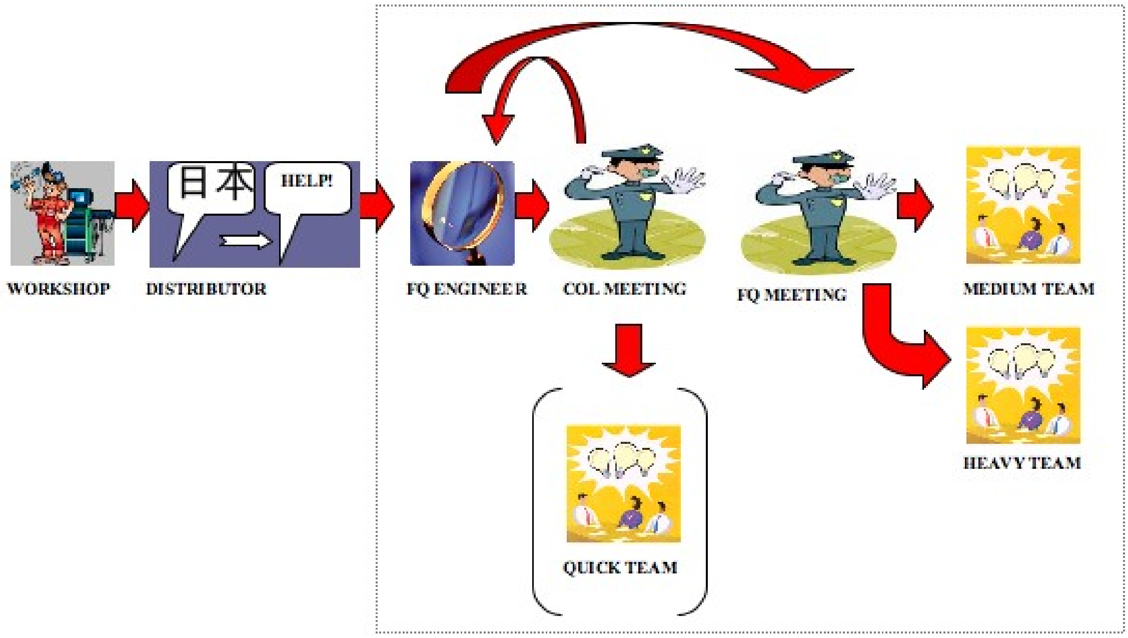
4.2.3 Engine

The Product Engineering Area Engine has the overall responsibility for every part of the Engine and its assembly quality.

Respondents from Engines were the Product Manager and an FQ Engineer.

4.3 Flows within the Process

The process is as mentioned a work method for the handling of deviations. This includes every work task from the collecting of deviation reports until the solving of an item and the communicating of the results. The Follow-Up Process can be seen as divided into following areas, performing their work tasks after one another in the way that the process describes:



Figur 1 Flows describing the Follow-Up Process

[56] Helene Sjöblom, *oral interview* 2008-04-09.

4.3.1 The Process is initiated with a Deviation Report

The Process starts with a deviation or a potential deviation. These are discovered either by a customer using the product or from someone within the factory (for example detected by a production operator).[57]

After experiencing a deviation, the customer attends a Scania workshop, which is the one reporting the customer experienced deviation. The workshop reports the deviation to Scanias Follow-Up process at the factory. This is done through an IT-system called FRAS (read more about the FRAS-system under 4.4). Before reporting, the workshop checks in FRAS whether this deviation has occurred previously in its country and, if it has not, the report is sent to the factory.[58]

A deviation suspected as FQ (Field Quality, i.e. affecting customers) within the factory is reported to a problem-solving group called a 'Q Team', which takes care of the further handling of the factory suspected deviation. (More about Q Teams in chapter 4.3.5).[59] In most cases, the deviation will be corrected before the product leaves the factory.

4.3.2 The Distributor Translates the Deviation Reports

The distributor, there is one in each country or business unit (group of countries), surveys the deviation reports from the workshops and checks whether the deviation in the report has occurred previously in any other country or business unit. If not, the report is translated into English (the company language of Scania) and forwarded to the factory.[60]

4.3.3 Field Quality Engineers Examines the Deviation Report

The deviation report coming from a distributor (and originally from a customer), is examined at the factory by an FQ Engineer. The FQ engineer goes through every deviation report sent to the factory. The FQ engineer then determines, among other things, whether this deviation already has been seen and or solved by the factory, whether the report contains all necessary facts or not and recommends if it will be opened as an assignment at the factory and given to one of the assignment-solving teams. The examination of deviations includes field investigations as well as analyzes in data bases.[61]

The FQ engineer is many times seen as the "customers advocate".[62]

The FQ engineer hands over the deviation report when an assignment containing the deviation is created. After this, the FQ engineer sometimes also prepares the item to be opened as a larger assignment by a larger team with deeper skills and larger time frames.[63] (More about these assignments in section 4.3.6)

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[57] Mikael Dahl, Scania Internal Document *Process Flow – Red Arrow*. 2006.
[58] Almér, 2008.
[59] Dahl, 2006.
[60] Almér, 2008.
[61] Romlin, Eva, Scania Internal Document *What we do at YSQ*, 2007.
[62] Björn Andersson, *oral interview* 2008-02-27.
[63] Almér, 2008.

When a deviation has been opened as an item and solved by the following task areas (the COL Meeting and either a Quick-team or a Medium- or Heavy-team), it is the FQ engineers job to inform the customer and the market of the results. The FQ engineer is the factory's face towards the customers (and distributors).[64]

4.3.4 The COL Meeting Transforms the Deviation Report into an Assignment

To get the deviation corrected, the factory has three different types of teams of which one will be assigned to the deviation: Quick (Q) Teams, Medium (M) Teams and Heavy (H) Teams. Every product area has at least one team of each type. The Q Teams are located in the assembly areas at each production site.[65]

The COL meeting (Customer OnLine) is the function in which the deviation report officially turns into an assignment. All deviation reports do not turn into a new assignment, some are connected to an existing assignment and some are judged not to affect field quality. Whether a deviation report becomes an assignment or not is already prepared by the FQ engineer before the COL meeting starts. The COL meeting is a formal decision point with these preparations as basis.[66]

The deviation reports from within the factory are, just like the deviation reports prepared by an FQ engineer, reported to the COL meeting if they are considered to be FQ and then on handled in the same way. The only difference lies in the fact that it is the Q Team, located near production in the factory reporting to COL, instead of the FQ Engineer.[67]

COL also decides which type of team that will be assigned to an assignment and this decision is also prepared before the meeting by an FQ Engineer. In short, since these teams are described in chapters below, if a short term solution is expected within 24 h the Q(uick) Team is assigned. Expected solutions within longer time-frames, and needing a more complex composition of the team, gets assigned to either an M Team or an H Team. These more extensive assignments have to be assigned by another meeting (i.e. The FQ meeting, read more about it in section 4.3.6) because of the cost and needed planning. COL therefore decides to send the assignment of larger complexity to the FQ meeting and asks the FQ Engineers to perform an additional preparation of the assignment before it reaches the FQ Meeting.[68]

This concludes the COL meetings tasks to be:

- Deciding on which deviation report to be transferred to an assignment.
- Deciding what type of team to be assigned to the assignment according to the following: Small assignments goes to a Q Team and large assignments goes to M/H Teams via the FQ meeting.
- Forwarding large assignments to the FQ meeting for further prioritizing and a decision between assigning an M or H Team.

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[64] Romlin, 2007.
[65] Almér, 2008.
[66] Almér, Feb – Sep 2008.
[67] Ibid
[68] Ibid.

- Following up the Q-assignments daily, noting phase transitions (the phases are described in Appendix C) in the FRAS IT system and close the Q assignments when finished.[69]

The COL-meeting is held in the afternoon daily. Each product area has a fixed slot time allotted, often between 5 to 15 minutes, to report all new deviations and to follow up running assignments.

To give an example, this means that all functions within the process for Scania Engines (the industrial and marine engines) have to be either in the room or on conference call between 1.30 and 1.35 p.m. and handle all their assignments in this time. This means that the FQ Engineers (which belongs to Engines), the COL-leaders (personnel from the process owner YSR) and representatives from the Q Teams from all productions units of Engines in the world have to be there. When the hour turns 1.35 Bus Chassis are to be in the room and on conference call instead. In these five minutes 5-15 new assignments has been created and assigned and just as many checked in on in a follow-up. This puts a strong demand on preparation, structure and discipline from the participants. Every participant has to have done their lesson from last time and report progress and it is important to know the answers to the questions ‘who?’, ‘what?’ and ‘when?’.

4.3.5 The Quick Assignment Team

The target for the Q Team is to find a short-term solution to deviations within 24 hours from being assigned to the assignment and to define a permanent solution within 10 working days. If a solution can not be defined within 10 days, the problem is passed on to the FQ Meeting (see next chapter) which directs it to the M Teams or H Teams (see section 4.3.7).

The Q Teams has an order of creating the solution, that is, when to do what. The team follows 8 checkpoints divided into phases (see Appendix C). The phase transitions are to be decided in COL and then reported into FRAS.

The Q Team daily reports the results of their appointed assignments to the COL Meeting. The team also has daily global meetings with the team members located in different production units. The COL meeting finally closes the completed assignments in the FRAS IT system.

Besides the above, the Q Team also handles deviations reported from the production unit (within the factory) where the team is located. The team reviews the deviation and reports to COL if it can be classified as FQ (Field Quality, i.e. affecting the end customer). The COL Meeting then opens an assignment and decides if the Q Team, or if any of the other teams, should be assigned to the assignment. This way, all FQ deviations are seen and controlled by the COL Meeting.

The Q Teams are staffed cross-functionally. A Q Team should consist of, among others, a team leader, designers, purchasers, supplier quality assurance engineers and production engineers.[70]

[69] Dahl, 2006.

4.3.6 The FQ Meeting Assigns the More Extensive Assignments

The FQ meeting for a specific product area assigns assignments to the Medium (M) and Heavy (H) teams when the needed type of team is available for a new assignment.

The meeting decides which type (M or H) and gives the assignment a priority according to a set of guide lines (see Appendix D). Representatives from both assignors (among others the Product Manager (PM), whom is head of the product area), and assignees prioritise the issues and resources as well as taking decisions on phase transitions (the phases are pointed out in Appendix D) in the process. Also, the FQ engineer is present at the meeting to hand over all the gathered information about the assignment.[71]

When resources are available, the FQ meeting considers the waiting list and picks the assignment with the highest priority.

The FQ meeting is held on average every second week in each product area.[72]

4.3.7 The Medium and Heavy Assignment Teams

The Medium (M) Team and the Heavy (H) Team are similar to the Quick (Q) Team but are assigned when there is a demand for a team with deeper skilled team members and with funding to work for a longer time period. Both the M and H Teams are assigned by the FQ Meeting of each product area and the assignments are retrieved from a waiting list.
The M Teams, like the Q Teams, are cross-functionally staffed with the emphasis on the designer. The M Team handles assignments where the solution is possible with M Team resources only. Normally there is no comprehensive verification and tool production within this part of the process to check the suggested solutions.

The H Teams handles assignments that could require expert resources as well as comprehensive verification and tool production.

The Product Manager (Manager within Product Development and belonging to the Follow-Up process) is the head of the M and H Teams. This means that the Product Development runs the assignments and has cross-functional resources at hand.

The assignment planning starts out from the 32 checkpoints (see Appendix D) belonging to the M- and H Teams and the results are documented in ECO:s, reports, pictures and minutes of meetings. The checkpoints are divided into phases (see Appendix D) and decisions regarding phase transitions are taken at the FQ Meeting.[73]

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[70]Almér, T and Melin, A, Scania Internal Document: *Job Description for Quick Teams*, 2008.
[71] Executive Board, 2008.
[72] Dahl, 2006.
[73] Executive Board, 2008.

The M and H Teams have a slight different constructed so-called ‘assignment pace’ to one another but this is easy put between one or two weeks (compared to the COL meeting which has a assignment pace of one day).[74]

4.4 The FRAS IT System Facilitates the Information Flow

The Follow-Up Process has an administrative reporting and follow-up system. This is a computerbased IT system. FRAS was created in 1997, in parallell with the Process itself and is built to resemble and support the Process.[75]

Before 1997, all deviation reports were sent in by fax, email and telephone. It was common for the FQ engineers to have a lot of reports piling up on their desks and the total amount of work in progress (WIP) was difficult to estimate. Today, the deviation reports are being sent in through the IT system FRAS, and everyone involved in the Process are able to see what is new, how many tasks every involved function in the Process has ’on their desk’ and where in the Process a report, or later on an assignment, is.[76]

That is, the reports and assignments are searchable and some statistics can be produced. Since FRAS is built as a IT version of the Process it not only forwards informations from the market but also works as a function that supports the Process. This is done by ’takting’ (a logistic expression, comes from the german word ”takt”, meaning ’pace’) the deviation report and assignments through the Process.[77]

[74] Almér, Feb – Sep 2008.
[75] Åsa Pettersson Arman, *Scania Internal Documents: FRAS presentation*, 2008.
[76] Åsa Pettersson Arman, *oral conversations* Feb – Sep 2008.
[77] Pettersson Arman, 2008.

5 Anlysis 1: The Challenges of the Process Determine the Types of KPIs Needed

This chapter sets out to determine the areas of indicators needed in the Process today. This is done through an analysis of the current state of the Process, as perceived through the empirical findings presented in this chapter and in Chapter 4.

5.1 The Process has two end-line customers - on opposite sides

This thesis is a study of the Process within the factory, mentioned in the delimitations in section 1.5. This means that the customer in question for the study is the distributor, not the driver, owner or the workshop. For an illustration, se the framed part of the Process in figure 1. With this in mind, the following applies:

The Process has two stakeholders, or end-line customers, making customer investments and expecting to be delivered a product. The service workshop is one and Scania CV AB itself is the other. The two parties are in opposite ends of the Process and are in the same time depending on one another to get the desired service. The Process is the way to fulfil these desires.

The distributor initiates the process by entering a deviation report (i.e. customer investment) when finding a deviation that is unknown within its country and then expects two things in return (i.e. products):

- An answer as to what was wrong with the product
- Information about a solution (such information could be either procedures which the workshop itself shall perform if the problem reoccurs on a Scania product, or a note on what is being done at Scania to prevent the deviation to reoccur).

The Follow-Up Process is a part of Scania CV AB, therefore is the whole existence of the Process a customer investment from the company into the Process. In return, the company expects the process to deliver the following products:

- Gather information
- Eliminate deviations
- Inform the market and workshops
- and in the end assert an excellent product quality at the company.

Being Lean means only producing what is necessary to meet the customer needs but exactly which necessity is supposed to be provided in different situations? This is a question which needs clarity, preceded by a discussion, which is very much needed in the Process today. In the mean time, many discussions about efficiency will be confusing.

5.2 Push and Pull Meets in the Waiting List for M- and H Teams

The Scania Production System (SPS) proclaims that pull systems are to be used in the company and this is something that the company strives to accomplish in all its processes. The idea of the pulling function as more effective than the push function originated at Toyota[78] and has been implemented at Scania. The Follow-Up process is therefore designed to be driven by a pulling function.[79]

In the Follow-Up Process, the M and H teams take on the assignments in a clear pull manner. When a team is available it pulls a new assignment from the waiting list. (The waiting list itself, as well as the assumed pulling force, is not a true part of a pull system, but that will be addressed later on in this section.) The assignment can be seen as an order from the customer and it starts the chain of work-tasks within the problem solving team. The solution is the product and it was requested for by the customer. This could be a pull system.

The FQ Engineer, on the other hand, has no way to know or control the number or size of deviation reports that arrives to their inbox every day. According to the process they are then supposed to brief, examine, and prepare every deviation report as soon as possible, preferably the minute the report arrives.[80]

The deviation reports are therefore handled to the FQ Engineer through a push system and neither one of the mandatory work-tasks connected to the arrival of a deviation report is created through pull.

The deviation reports are prepared for the COL Meeting and the COL meeting has no way to control how many deviation reports that comes to the meeting and no way to control how many new assignments that will have to be created.[81]

So, studying the work flow, this means that the deviation reports is pushed to the FQ Engineer, pushed through COL and pushed to either the Q team (since they are supposed to start working on all assignments immediately when assigned) or to the FQ-meeting.

The FQ-meeting puts the assignment into the waiting list, from which the assignment will be pulled, and so push and pull meets in the same process, at the waiting list. But, as will be shown in section 5.4, M/H only seems to be pull.

5.3 FQ Engineers has a Pushed Agenda

Considering the push side of the Process, and considering that the Q-process will not be handled in detail in this thesis, there are three major functions in this side of the process: The FQ Engineers, the COL Meeting and the FQ Meeting. The latter two, are meetings with clear directions and set out dates and times. They work as true functions which vary very little in time when performing and are to be

[78] Liker, p.105.
[79] Almér, Feb – Sep 2008.
[80] Mikael Dahl, *oral conversations*, Feb – Sep 2008
[81] Petterson Arman, Feb – Sep 2008

compared to a machine with a start button, giving a result. In this process their function is to direct resources and to check up on the work performed in the process. Push or pull does therefore not influence the efficiency of work performed in these functions.

In counter, The FQ Engineers are not merely a function. They are a service, adding value to the product in the eyes of the end-line customer, even though there is no internal customer in near sight for this service. The FQ Engineers therefore, not only, as described in section 5.2, gets the deviation report in a pushed manner, but also pushes the products forward in the Process.

Working in a push system, the FQ Engineer has very little overview or possibility for planning ahead. The deviation reports falls into their laps at all time in different numbers and with varying sizes and periods over time. Since the number of FQ Engineers are fixed and there are limits up to what speed and during how many hours they can be expected to work, there will be a pile building up, which prevents this push system to work effectively. These piles prevent the Process to work properly, since even safety items can be forced to wait in them when not reviewed for the first time yet, and create a stressful[82] working environment.

Handling the pushed new deviation reports are not the only work task for the FQ Engineer, though. As mentioned in section 4.3.3, they have a number of other work tasks to carry out. All of these tasks are important for the Follow-Up Process but they are to be carried out in different positions throughout the internal value chain in the Process and on different conditions.[83]

As previously mentioned, some of the FQ Engineers tasks are carried out as push (for example the screening of deviation reports) and some as pull (for example to provide an interested colleague in the Pre-development Process with information enquired). But being asked (pulled) to do something, almost always superseede being pushed, since it seems more urgent when someone is waiting.

The FQ Engineer is told though, that the handling of deviation reports is their prime work task.[84]

This naturally leads towards a need to prioritize among the many different work tasks that are waiting in a normal work day. The FQ Engineers are currently discussing this among themselves and asking management for help to do a prioritizing since they can not be everywhere and doing everything at once. So, having all these other tasks on top of handling the deviation reports, prohibits the FQ Engineer to effectively handle every work task in their job description and making the push system work. This also means that the factory is constantly not yet aware of all the information that has been provided to it.

The Process should therefore make the FQ Engineers more ready-to-answer the deviation reports. They are supposed to be the factorys face towards the customer,

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[82] Stephen P. Robbins & Timothy A. Judge, *Organizational Behavior.* (New Jersey: Pearson Education/Prentice Hall, 2007), p. 688.
[83] Dahl, Feb – Sep 2008
[84] Almér, Feb – Sep 2008

so the let them. This can be done by separating the work-tasks and dividing them into different roles, or adding more recources to compensate for customer visits, market responsibilities, vacations, sick-leave, etc. An indicator for this need is the fact that the FQ Engineers themselves already are asking for help regarding how to prioritize between the tasks. It has also been visible for some time that they have a hard time catching up after a vacation. The situation today is distressing, which, needless to say, does not provide a good working environment. The normal situation is somewhat chaotic and a new normal situation therefore has be found.

Visiting the Process makes it obvious that there are frustrations concerning the FQ Engineers. This frustration is demonstrated both from the FQ Engineers themselves and from the process owner YSR. While the FQ Engineers says ‘How am I supposed to find the time for all this and which task is really the most important?’, YSR wonders ‘Why are not all deviation reports examined at once?’. These two questions represent two different types of areas which seem to be of great importance to the people working in and with the Process. In section 5.6 these two areas are being identified and concluded to constitute the type of KPI:s that this thesis will focus on to help the Process with development from the current state.

5.4 M/H Only Seams To Be Pull and Has A Slow Pace

As mentioned in section 4.3.6 each product area holds an FQ Meeting in every second week to check up on the open assignments, assign a free M or H team to a new assignment and prioritize among the waiting list and the new assignments. Some product areas are holding their meetings every week although those are in a minority.

Two weeks between the meetings might seem as a reasonable period of time according to how the process is carried out today. Unfortunately it might send the wrong signal though. Having a work pace that leaves the teams waiting for sometimes up to two weeks until the next check-up can create a working environment in which it is ok to let some tasks to just sit and wait for up to two weeks.

If some tasks can wait, it might seem like others can as well.[85] A slow and vague pace also makes it harder to see, feel and manage the flow.[86]

The importance, of the end-line customer at the workshop, of a fast problem-solving process in the factory has to be made visible and built in to the Process. This can be done by introducing a faster pace, not allowing assignments to wait for so long. With the pace today, there is a risk that the assignment teams, encouraged by the pace, put more weight into finding solution that shines, then in finding this solution fast, while both are of equal importance if the Process shall be effective. It is important to state out that this behaviour is not to be blamed on the assignment teams, but their part of the Process. Today the Process tells the assignment teams in M and H that they will not get another assignment until they are finished with one of their open ones. At the same time there is not really anyone who is pulling from them, in the other end. The Process is designed so that, in theory, the customers are

[85] Robbins, p. 74ff.
[86] Rother & Shook, passim.

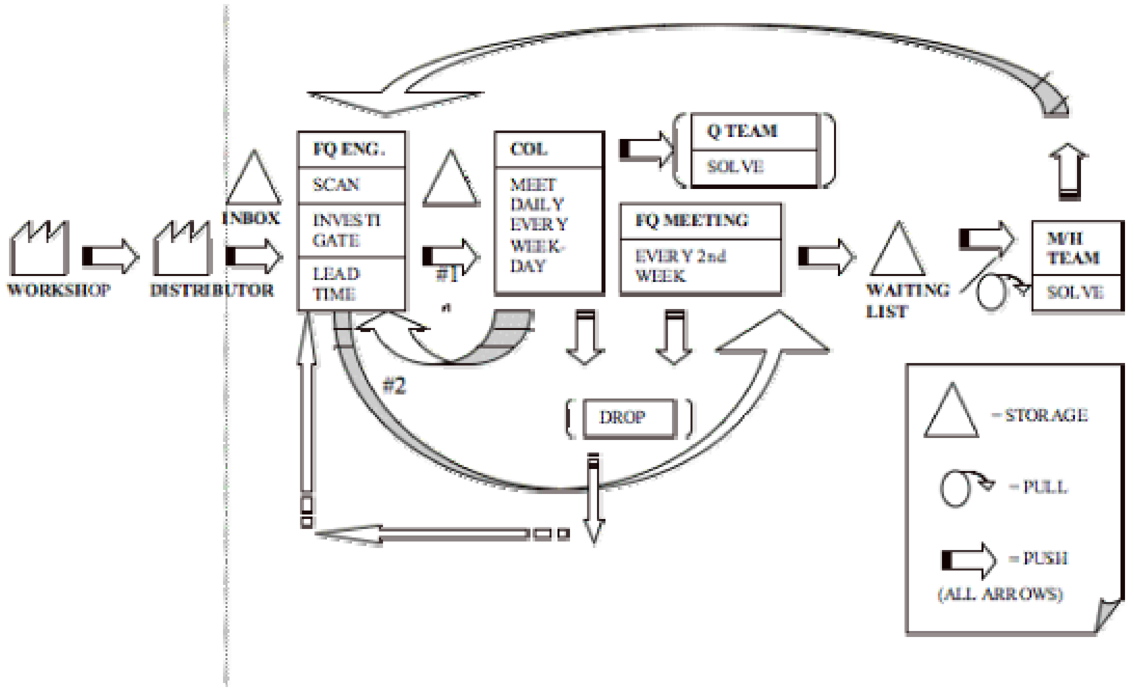
the ones pulling. Though, to the assignment teams, it might seem as if the customer already has waited for so long, so that adding another two weeks does not really matter in the long run.

Because of the risk for this behaviour to occur, the Process has to be changed to support the assignment teams with a new, faster, firmer and more powerful pace. Shorter meetings once or twice a week is a suggestion, though this pace has to fit the Process in the whole. These meetings should also be a more powerful pull function than today, advocating the customer’s interest in a fast solution. In fact, it is not really pull at all today, since the only so-called ‘pulling function’ is the picking of a new assignment from the waiting list. This is an alredy prioritized picking (when considering resource management in the Product Area and emergency level of the assignments). A prioritized picking is a violation of the pull system[87] and because of this, the M and H part of the Process can not be referred to as pull and neither can the rest of Process, since the M and H part was the only one left to be considered pull. A second suggestion is to monitor the flows in this part of the Process more actively, so to be able to see to that the amount of work in the process follows the pace and is levelled out and in control. Keeping a steady pulled flow is the best way to get productive.[88] These suggestions, especially the identified need for monitoring of the flow, leads towards the conclusion in the last section of this chapter.

5.5 A Value Stream Map Illustrates The Process Described

The mapping tool is designed to capture the way work is organized and to enable management to visualize the process and point to problems.[89] A natural step forward in this analysis, is therefore to create a Value Stream Map (see section 3.3 for Theoretical Background on the VSM).

[87] Rother & Shook, p. 23.
[88] Liker, p. 113-129.
[89] Keyte & Locher, p. 5.



Figur 2 Value Stream Map of the Process

5.6 Conclusion: Two Areas of KPIs are Identified

In the following sections, two areas are being identified and concluded to constitute the type of KPIs that this thesis will focus on.

5.6.1 Process Flow

Many answers to the problem presented by the question 'Why are not all deviation reports examined at once?' (asked by the Process owner YSR) in section 5.3, will be found when analyzing the flow of the Process. This was just what the discussion in the last paragraph in section 5.4 (this time concerning the M and H assignment teams) suggested and it is getting clear that one area of interest to the whole Process, is process flow management. Today the process flow is invisible and that creates, keeps and supports confusion concerning the state and effectiveness of the process. Since the aim of this thesis is to find suitable KPIs to measure efficiency, one group of such therefore will be constituted by aspects of *process flow*.

5.6.2 'Right Things' in the 'Right Way' and Work Situation

The managers of the M and H assignment teams expresses a wish to know whether they have prioritized their use of resources in the right ways. They are pondering on how to do 'the right things' and how to do them in 'the right way'.[90]

When the FQ Engineers say 'How am I supposed to find the time for all this and which task is really the most important?', as mentioned in section 5.3, they are in a way asking the same questions as the managers for the M and H teams do. The

[90] MacKaldener, 2008-03-11.

quest for doing *‘the right things’ in ‘the right way’*, will therefore be taken into concern in the design of KPIs for the Process.

The question above also reflects on another very important matter to the FQ Engineer. The many varying tasks, combined with the travelling included in the job, makes it hard for the FQ Engineer to perform as expected according to their job descriptions. They do not always have the time to conduct every work task that different functions in the process presents to them and they do not really know how to prioritize.[91]

Because of this, a work group has been put together, originally to prepare for a discussion concerning KPIs for the FQ Engineers in a seminar in Åre in Mars 2008. The group has continued its work due to a great interest among the FQ Engineers and due to the fact that the work itself has shown to be more extensive than expected. The group is discussing KPIs for the FQ Engineers *work situation* and are researching on what the FQ Engineers normal situation looks like.[92]

Doing ‘the right things’ in ‘the right way’ lies close to looking at the work situation since the investigation of one of them almost always will lead to investigations of the other and KPIs concerning one of them could therefore be used to discuss the other. Therefore, both of them will be kept in mind in this thesis, when designing KPIs for the Process.

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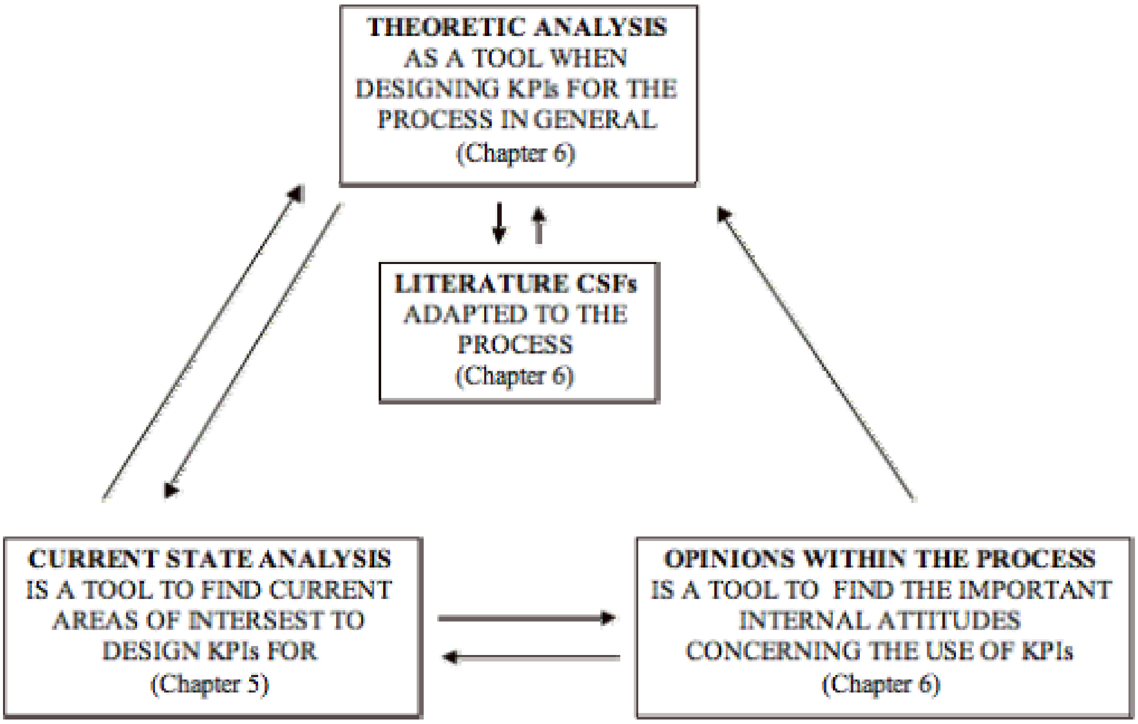
[91] Magnus Klingvall, *oral interview*, 2008-06-03.
[92] KPI work group, *meetings*, Feb – Sep 2008.

6 Analysis 2: The Concept of KPIs within the Process

This chapter compares the areas of indicators suggested in Chapter 5 (i.e. developed from the current situation of the Process itself and concluded in section 5.6.1 and 5.6.2) both with the opinions of KPIs from the people within the Process and with the theoretical methods to detect good indicators. This results in recommendations of indicators for the process and ways to continue the search, recommendations of how to overcome process inconsistencies when measuring and recommendations of how to start to use the indicators suggested.



Figur 3 Modelling of the Analysis Performed in Chapter 6

6.1 Current Measurements

As mentioned in section 4.3, YSR has no KPIs supporting the department with information about the process flow itself. The only official measurement that the department is using is the amount of output (number of solved assignments) and in some senses the amount of input (number of deviation reports). Of those two, only output is used for anything (annual reports etc) and the period of measurement is once a month.[93]

The current lack of official KPIs and the use of the existing one (mentioned in the paragraph above) has critics among the interviewees. The Product Area Engines sees the existing KPI as useless, using the metaphor of the KPI as measuring how

[93] Almér, Feb – Sep 2008.

well a firefighter is putting out fires, without any consideration of the character of the fire.[94] Is the current fire the same as the last one they put out and is a high number of fires put out really indicating effectivity? Electrics[95] experiences the current KPI as too difficult to affect. This shows that the current KPI is not a KPI at all, since it is not usable enough for the responsible manager.

Internally some other measurements are in use though. Most of them are performed locally in the line organisation. The information about those are not collected or displayed so that other product areas or parts of the process can access them or apply them in their own organisation. Examples of these are: Lead times in phases for M and H teams[96], number of design plans and ECOs[97], number of EFRs[98] and a 'who-does-what'-diagram[99].

Another measurement, provided by YSR as a service to the people in the Process, is Flashboard in FRAS. Flashboard shows the current state at all time concerning the number of Assignments per phase and product area in the Q Team part of the process. The extent of the use of such measurements are not known to the provider and the information showed by Flashboard is not saved anywhere, so only the instantaneous information is available and no historic one.[100]

Except from the local measurements and YSR's Flashboard in FRAS, there is another kind of measurement. This one is used as a base in a bonus system and measures how many Q assignments that have gone into the phase pending before being closed, as opposed to being dropped and then closed. This means that for every assignment that has gone to a Q team and become a solution and then been closed, every Scania employee gets a bonus in their salary.[101] (See section 6.5.3 for a discussion about the effect of using bonuses.)

It is evident that the Process has measurements but that, except for maybe it's output, it does not use them, or any other, as KPIs or other indicators, in internal or external presentations and reports or as tools for management and process development. The Process needs to find and start using indicators immediately.

6.2 Attitudes Towards KPIs

Everyone of the interviewees showed positive attitudes towards the search and use of new KPIs in the Process. Being measured did not seem to bother them and they contributed with a number of work-related situations and results that they would like to measure in some way. The notion of KPIs is already accepted in the Process and most of the employees asked to participate in the study has accepted and enthusiastically participated. KPIs seems longed for. The largest obstacle to overcome in this thesis work has therefore not been to persuade the Process of the

[94] Stefan Sylvander, *oral interview,* 2008-04-17.
[95] Sjöholm, 2008-04-09.
[96] MacKaldener, 2008-03-11.
[97] Sylvander, 2008-04-17.
[98] Ibid.
[99] MacKaldener, 2008-03-11.
[100] Dahl, Feb – Sep 2008.
[101] Ibid.

need for KPIs, as might be the case in other businesses as Parmenter mentions[102]. Instead, the largest challenge has been to manage all the different interpretations of what a KPI really is.

According to Parmenter all KPIs has some clear qualities in common, see Theoretical Background, section 3.2. To be allowed to call an indicator a KPI it needs to posses all these qualities.

None of the interviewees expressed thoughts has fulfilled this. Most of the time, what is hard to understand the need of, is the demands that says that the KPI is a tool for management and that this means that the KPI should tell everyone involved what action that needs to be taken based on the current indication.[103] The KPI notion is broader and more extensive at Scania. A KPI seems to be just a ‘key number’ of some kind; some data to collect and create statistics with.

Using indicators to pile up some statistics, instead of supporting the process with a well-thought tool and a action plan, is exactly what Parmenter argues to be the greatest misuse of the term ‘KPI’. He explains that a winning KPI is one that is created with the CSFs of the process in mind and an action plan for every kind of indication.[104]

It is argued from the Follow-Up Process that corrective action plans are hard to create in their kind of process.[105] The data from KPIs are often described as an absolute that falls in their laps. This attitude, that passively considers the data from KPIs as unchangeable, restrains a development of the Process. The collected data comes from a process created by the YSR department for the purpose of eliminating deviations in the field in an effective and organized way. The outcome of a created process can of course be changed, and if not, the Process must be changed to achieve better results. No KPI data is an absolute and to create some corrective action plan is always possible. It just takes time. But through trial and error, with an active follow-up on the action plans, a corrective action plan for each KPI can emerge. And in the creation process of the plans, and later on with the action plans closer to completion, the Process itself will be subject to development.

Furthermore, the interviewees expressed that they find it hard to create good, measurable KPIs for the Product Follow-Up Process.[106] What to measure to be able to see anything useful about the state of the Process, what the measurements should be designed to be used for and by whom, were the most common question marks throughout the interviews.

These shown question marks clearly states that the Process suffers from the broad and not always uniform understanding of the concept of KPIs. Section 6.3 below will address this problem by determining the use of KPIs to be a bit narrower than it has been in the Process, and introducing two more types of indicators.

[102] Parmenter, p.10.
[103] Almér, Feb – Sep 2008. MacKaldener, 2008-03-11.
[104] Parmenter, passim.
[105] Almér, Feb – Sep 2008.
[106] Sjöblom, 2008-04-09.

In opposite to the positive opinions concerning the search and use of new KPIs, most of the interviewees shared a fear for new administrative tasks and routines due to the new KPI:s. The FQ Engineers for example, posses a tiredness towards their large number of small work tasks to remember and execute over and over again.[107]. New routines due to new KPI measurements should therefore be introduced in as small numbers as possible and with great tenderness and a clear-presented motive.

6.3 Difficulties When Introducing Literature KPIs

Theories and concepts are not always presented in the same way in the literature and in a real process at a company. In this study, as shown in section 6.2, that clash appeared in the definition of the concept of a KPI. The Process suffers from a broad and not always uniform understanding of the definition and at the same time the literature is posing higher demands. Since this inconsistency also has shown to damage both the search and the use of KPIs at the Process (see section 6.2), it has to be further adressed.

The literature also said that KPIs should arise from the CSFs (Critical Success Factors) of a business and therefore we shall have a closer look at the CSFs of the Process. This step in the creation of a KPI is not so familiar at Scania Follow-Up Process and an attempt in using it will be performed in the section 6.3.3.

6.3.1 Not All Measurements Are KPIs

This thesis was set out to determine KPIs for Scania's Follow Up Process. According to Parmenter, everything worth measuring is not immediately a KPI. Some measurements are necessary but not worthy of the epithet 'KPI'. Since the Process is in need of measurements of any kind, this thesis will bring a variety of measurements to start with, but being somewhat more restrictive than the respondents in the interviews (see section 6.2), as to which recommendations that are referred to as KPIs.

It has to be said that the measurements not referred to as KPIs, are not of any less value to measure. The epithet of the measurements are merely an adress when it comes ro reporting the findings. All measurements recommended in this thesis are constructed to be used for Process improvement and many of them are used as elements of KPIs.

The types of measurement indicators used in this report therefore are: Key Result Indicator (KRI), Performance Indicator (PI) and Key Performance Indicator (KPI). These types are all explained in sections 3.2, 3.2.1 and 3.2.2.

Further on, Parmenter recommends 10/80/10 or less as a number of indicators (KRI/PI/KPI).[108] At least, the ratio 10%, 80% and 10% will be of interest to The Follow Up Process.

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[107] Klingvall, 2008-06-03.
[108] Parmenter, p 8, 26 & 30.

6.3.2 Winning KPIs Rises when Adjusted Through Iteration

This study offers a framework describing how the Process should approach the task of designing new indicators in the future, which obstacles to eliminate to be able to design these indicators and also a number of indicators to start using in the meantime.

The development of performance measures and performance-improvement strategies is an iterative process in time.[109] ’Trial and error and then correction’ is the only method that will assert an excellent quality of the indicators. This study offers a scouting ground reaserch of areas where there are a need for KPIs, and a comparison to literature. After this, a group of indicators to start with will be provided in the latter part of the thesis. Those indicators are in need of constant iterative reviews and evaluations to become truly useful. So, the Process has to appreciate and uphold this kind of work to improve performance.

6.3.3 CSFs Are The Ground for The KPIs

In Chapter 5, two groups of longed-for KPIs within the Process were identified. According to the Theoretical Background though, KPIs should be constructed for the organization as a whole, not just as a part of a quick-fix of a current problem or for the moment eagerly awaited .[110] This section will therefore take a step back, disregarding the suggestions of KPI areas from the analysis of the Process in Chapter 5, and contemplate the Process as a whole, instead of its current problems.

The literature states that KPIs should arise from the CSFs (Critical Success Factors, see section 3.2.3) of a business. Therefore we shall now have a closer look at the CSFs of the Process to be able to create KPIs that not only exist for the problem areas identified in Chapter 5, but also for the Process as a whole.

When the interviewees were asked to share Process CSFs, the answers often were created as the conversation went along and contained CSFs for each and everyones sub part of the Process, not CSFs to the Process itself. This is possibly a result of the interviewees interpretation of the question and there is little to be read in to these answers, accept for one thing. There seems to be no sign of any commonly-known CSFs for the Process. The argument for this is that if any such commonly-known CSF did exist in its rightful persona, it would pop up from the interviewee reardless of how the question were interpretated since she/he would know it like from the back of hers/his hand.

In the absence of CSFs for the Follow-Up Process, this thesis has a few suggestions. These are not created with the help of some literature, accept for Parmenters brief descriptions. The seven suggested CSFs that follow is the result of the summarized experience of the Process, during five months at YSR and none of the interviewees should be held responsible.

Suggested CSFs for the Process:

[109] Parmenter, p. 22.
[110] Parmenter, passim.

CSF	Description	Results shown by	Indicated by, for example
Persistance	The attitude that every deviation matters, every hour and every day. The Process just keeps on going, inexhaustedley	Quick and clear answers and, which are developed and implemented throughout the company.	Lead Time.
Customer Service	A willingness to understand and serve the customer	Quick answers and quick solutions, rapidly communicated to the distributor. Open assignments towards the distributor and progress shown in Time and Action Plan.	Lead Time. Number of open assignments towards distributor or Number of active Time and Action Plans. Tardiness and Serviceability[111].
Easy to Contact	Serving the Pre-development Process and Continuos Introductio Process at Scania with information about the deviations	A higher number of contact attempts from the other processes, FQ Engineers will be summond to CR0s in a higher rate, a need for new ways to contact the Follow-Up Process will emerge (Process development).	See Results (to the left).
Structurized Process	Process management. A clear and structurized process that is easy to control, lead and improve.	How easy it is to control, lead and develop the Process itself. Process maps and descriptions are clear, intuitive and easy to understand.	See Results (to the left).
Clearness	Clearness	Everyone working within the	An annual

[111] Tradiness and Serviceability are two measures outside of the delimitations of this thesis, since they are about queueing theories, but the theories around these (Mark L. Spearman & Rachel Q. Zhang, *Optimal Lead Time Policies*. (Management Science: Vol. 45, No 2, Feb. 1999), p. 290-295) and an other collection of theories about Customer Value (Djoko Setijono & Jens Dahlgaard, *Customer Value as A Key Performance Indicator (KPI) and a Key Improvement Indicator (KII)*. (Mearuring Business Excelllence: Vol. 11, No 2, 2007), p. 44-61), deserves a recommendation to be studied by the Process.

	within the Process as to how the Process works.	process knows what to do and why and it is easy to train and educate new employees.	interview study.
Visibility	How well known the Process is in the rest of the company.	A good, well used, well known and frequently visited homepage. A lot of enquiries from around the company. A random sample of employees from around the company knows about the Process.	Number of visits on the homepage. An annual statistical survey on knowledge of the Process.
Employee Satisfaction	Meaningfulness of the work performed.	Willing and engaged employees that feel listened to and want to engage further in workshops and improvment work, for example with FRAS.	An annual interview study.

These CSFs do not need to be the final ones for the Process, they are just a suggested start. The discussion above shows that several of the suggested CSFs demand a qualitative estimation since they can not be measured properly in quantitative numbers. Still, they are just as valuable as a ground for all work performed in the Process and for the search of KPIs. Those CSFs that are more easy to measure in numbers, describes the same area that was found in the analysis of the Process in Chapter 5, i.e. Process flow.

6.4 Overcoming Process Inconcistencies and Start Measuring

The Process is not easy to measure.[112] It consists of a number of different subprocesses with differing tasks or perception of such, a broad range of complexity in the assignments and also several IT systems. The design of indicators for this process has to be a job performed through iteration, as mentioned in section 6.3.2. To be able to choose some indicators to start with and later on evaluate, some simplification has to be made to overcome the difficulties in measuring. But first the process has to put more emphasis on what is measurable than what is not. In every one of the three categories of difficulties (mentioned in the beginning of this paragraph), there are also properties in common. To be able to start anywhere in the hunt for KPIs, some of these will be recognised:

No matter how many subprocesses the Process consists of, they are all designed to do at least one task in common, which is: Moving the deviation report, or later on the assignment, further on along the Process. In the question of what to measure to have a good measurement throughout the Process, one answer therefore is the item of concern in the Process, i.e. the assignment and its connected deviation reports.

[112] Stefan Malmberg, *oral interview*, 2008-04-09.

When discussing the measuring of assignments and deviation reports, one obstacle always keeps showing up and it is the different complexity in the assignments. The variation in time to process the assignments and its deviation reports is quite large. This will be further discussed in section 7.2.1 but for now, an appeal for a reconciliation with the idea to measure the assignments anyhow, is made. To be able to start anywhere, the obstacle of the different complexity has to be seen as minor one, since the measures still will mean something, just not everything.

The third difficulty mentioned in the beginning of this section was to perform measurement on a process that keeps most of its current state data in more than one IT system. Measures of the entire process, in every sense, is not possible to perform when you have to combine different systems. This stops being a problem as soon as we recognise that there will never exist one perfect measure of a whole process. We can only use what we have since the introduction of this imaginary complete system probably will not happen just so that we can measure one KPI more easily. If a new system already is about to be introduced or built, the Process should of course consider adjusting it to measure some KPI not yet measurable. In the mean time, using, and in some minor ways adjusting, the already existing IT systems, will be good enough.

Now, when we have overcome the largest inconcistencies often argued, we can see that it is possible to measure process flow. In the next section and in chapter 7, the suggestion and application of Lead Time as one measurement of process flow, will be laid out.

6.4.1 Lead Times As a Metric for Process Flow

Time as a metric, has so far been shown (both in the process analysis and in the Theoretical Background chapter) to be a possibility. Further on it is recommended to be a good metric according to some literature, when using for example Lead Time.[113] Time is seen as a universal metric, representing speed, quality and complexity problems.[114]

This study is an example of Lean thinking in service, since it is performed in the office environment of one of the research and development processes. Because of that, this is a somewhat different appliance of Lean (Lean thinking within logistics and management was formed within the production segment, to make the production flow more efficient). Though different, it is not a problem, since Lean fits at all levels of a company,[115] as shown by for example two Swedish banks which recently started to apply Lean in service.[116] The largest difference between production and service, is that service processes are usually slow and the work less visible.[117]

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[113] Keyte & Locher, p. 25.
[114] George 2003, p. 112.
[115] Liker, passim.
[116] BrittMari Lantto, *SEB Way innebär strukturiserat bondförnuft*. (Finansvärlden, No. 9, 2007), p. 10.
Åsa Berner, *SEB Way funkar bra i kundtjänst*. (Finsnsvärlden, No. 9, 2007), p. 11-13.
BrittMari Lantto, *Nu är Lean vardag på Nordea*. (Finansvärlden, No. 11, 2007), p. 20-21
[117] George 2003, p. 12, 29 and 38.

We have now seen that Lead Time could fit the Follow-Up Process, both through theory (which just now showed that Lead Time would work) and the performed process analysis (which made it clear that process flow is an area of interest for new indicators).

The people of the Process participating in the study, were all positive to a measuring of Lead Time. It could for example help Electrics to shine some light on the problem in the Q-process that the assignments keeps getting stucked in ’Pending’ (a phase in the Process) and running on a EFR (a while-waiting-solution) for a long time.[118] To be able to measure part Lead Times in subprocesses and even activities, would help the improvement of the Process, both through comparison and the visibility of changes.

A commonly delivered opinion (offered by every interviewee) are that the varying complexity of the assignments would the make the results of Lead Time measuring hard to interpret. As mentioned in section 6.4 the Process has to be overcome this obstacle and it is discussed further in section 7.2.1.

6.4.2 Optimizing Process Flow Through Elimination of Waste

When looking at Lead Times, it does not take long before the question of which times in the process that should be measured arises. The definition of Lead Time (section 3.4) says that Lead Time is all time that passes, not just the valuable ones. Value-adding time is often under 1% of the Total Lead Time though.[119] The will to measure the value-adding time and the non-value-adding time (Waste) in separate means that, in addition to Lead Time, the Process should have indicators for Waste Time as well. (See application in section 8.1.1)

Since waiting is a form of waste, and thereby queueing, it is clear that we can measure waste in other metrics than time. For example, queues have a length and so we see that therefore we can measure the Amount of Waste. (See applications in section 8.2.1 and 8.2.2).

Waste also proves important in discussions of efficiency. A indicator of efficiency is the Process Cycle Efficiency, which will be adressed in section 8.1.2.

6.4.3 ‘Right Things’ in the ‘Right Way’ and Work Situation Needs Some Sorting Out First

The wish to do the ’right things’ in the ’right way’ is a strong driving force in the search for new KPIs for the Process. For the M and H part of the Process on one hand, this wish is drafted in the prioritizing of the waiting list for the assignments but also in the search for bottlenecks that congests the subprocess.[120] The congestion issue rises the question of ’who does what and waits for whom?’, which many times forces anlysis based on queueing theories.[121] For the FQ Engineers part of the process on the other hand, there is another request for prioritization. They

[118] Sjöholm, 2008-04-09.
[119] Peter Bökmark & Jan Andersson, *Vinster med Lean.* (Teknik & Tillväxt: No. 1, 2004), p. 6.
[120] MacKaldener, 2008-03-11.
[121] Ibid.

simply but urgently would like to know how to prioritize among all of their work tasks.[122] This means that they need help with their whole work situation.

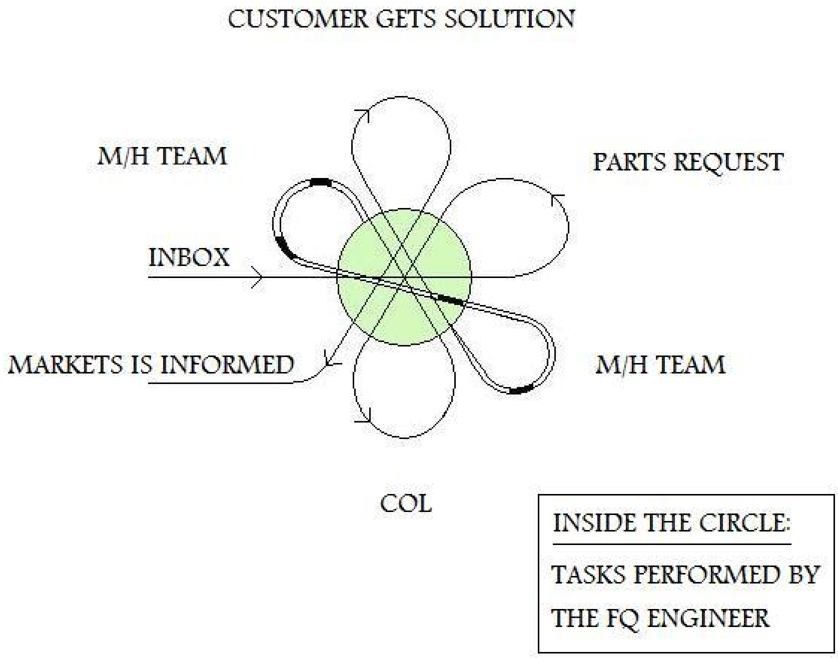
Extracting indicators based on ’right things’ in the ’right way’ and work situation, is, though very important to the Process, outside the delimitations of this thesis. Nontheless, a shorter analysis will be made, and some advice on useful indicators and how to move forward from the current situation, will be provided in this section.

Why are these two kinds of indicators so important? The answer has to do with the creation of a functionable process flow, which, stated above, is of a great interest to the Process. Both types of indicators are, as shown in the first paragraph of this section, in some way connected to prioritizing. According to Galloway the prioritization of work is the equivalent to the information flow in an office process.[123] The material flow (the deviation reports and assignments) and the information flow (the prioritization of work) are mutual dependent and both needs to be clearly mapped to make the process flow truly useful.[124]

The FQ Engineers Part of The Process

Starting with the FQ Engineers part of the process, the FQ Engineers are having trouble with their work situation. Without a less troublesome such, the FQ Engineers can not begin to talk about whether they are prioritizing ’right things’ in the ’right way’, since they are not prioritizing in any recommended way at all today. You need to have some priorities to be able to discuss whether those are good or not. The urgent query for a ’normal situation’ are being made by the FQ Engineers themselvess. There are simply too many pushed work tasks without a priorization among themselves, in an FQ Engineers work situation. The Process is described to everyone involved with figure 1 or 2 but to the FQ Engineers the Process is not as chronological as the figur is making an overall impression to be. An FQ Engineers is involved at least two more times as the Process runs along, than what is shown. Figure 4 offers a picture of how the process is experienced by the FQ Engineers.

[122] Klingvall, 2008-06-03.
[123] Dianne Galloway, *Mapping Work Process.* (Milwaukee: Quality Press, 1994), p. 53.
[124] Rother & Shook, p. 3.



Figur 4 The FQ Engineer's Perspective on the Process Flow. The order of when to deal with each line in the circle is not given.

Except from the activities tied to the process flow, the FQ Engineer also has other responsibilities and work tasks (see section 4.3.3). These are truly invisible when the process owner asks ‘Why are not all deviation reports examined at once?’ (see section 5.3), since they are not connected to the process flow. When the FQ Engineer asks ‘How am I supposed to find the time for all this and which task is really the most important?’ she/he calls out for help. They call for help to prioritize among every work task, each and everyone important to someone else in the Process, help to level out[125] the workload and help to get a structurized and visualized[126] process map of their own. The FQ Engineers have started to investigate themselves which work tasks that gets the most of their time, called ‘Work Week Mapping’ (see Appendix E for an example). They are doing this in the hope for the management to point out what’s right and what’s wrong with the current individual self-prioritization that the FQ Engineers is trying to apply in the absence of a management recommended one. Though the Work Week Mapping has some statistical shortcomings (having troubles with standardisation, question interpretation, selection of respondents and representation (the working group is seeing inferences and implications based on too few samples)), it is a step in the right direction but not enough.

[125] Liker, p. 113.
[126] Liker, p. 149.

It is strongly recommended that this chaotic work situation gets tangled out and transformed into a normal situation[127] with a visualized process flow. A search for KPIs, and a necessary specification of the Part Lead Time measurement for the FQ Engineers are dependent on a normal situation being worked first. Working out a normal situation includes a question of whether all FQ Engineers should do the same work and if all the work tasks really should be performed by an FQ Engineer. The following table contains suggestions of indicators for the FQ Engineers which can be important to consider in the future.

Indicator	Description
Available Time	The amount of time that the FQ Engineers are available and able to look at new deviation reports.[128] OBS! This does not include the actual work performed on a deviation report. If the FQ Engineers are supposed to keep all current work tasks, you have to ask how important the handling of deviation reports are and measure how much time the FQ Engineers are available for them. If the system shall continue to be push, the FQ Enginers also should be able to have available time for all pushed jobs.
Typical Batch Sizes or Practicies	Typical batch sizes or batching practices represent how often or how much work that is being performed.[129] In office work, typically, certain routines are established. This could mean that certain work tasks are associated with certain days in the week or that work is periodical in some other way, due to routines. Having typical batch sizes or practices affects the lead time with that same period and might be able to abolish.
Amount of Market Information	Informing the market takes a lot of time from the FQ Engineer, and it is not a part of their job that is visible enough yet. Exactly how to measure the amount is still to be worked out, since the number of produced TIs does not provide information about how much time a TI took or how long it was. If this is to hard to figure out, use the number of TIs to start with.[130]
Updates in Time & Action Plan	Days between updates in Time and Action plan for open assignments. The updates tends to occur to rarely and need to be visualized with an indicator.[131]

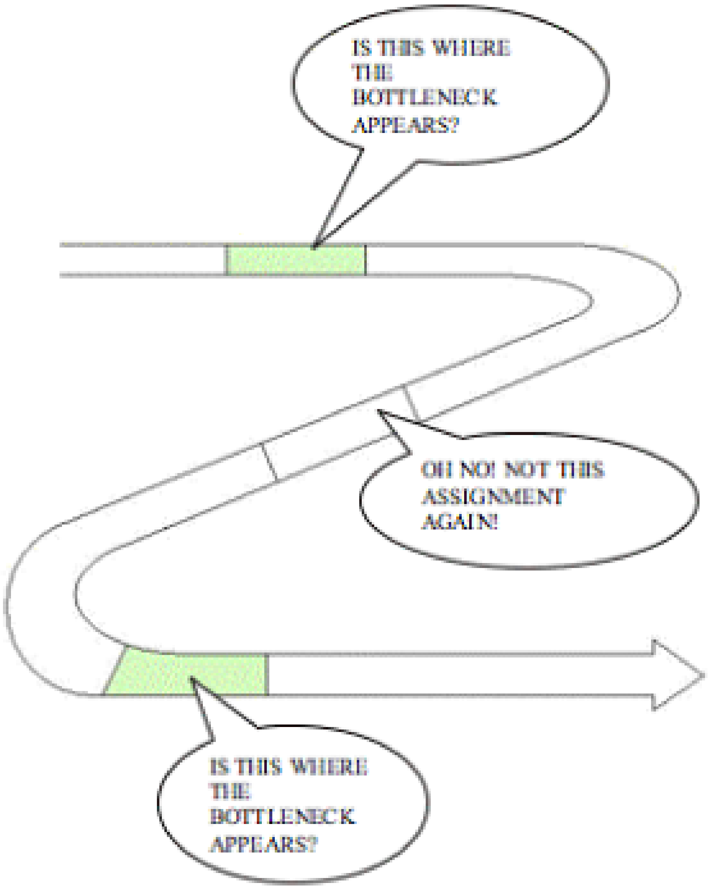
The M and H Assignments Part of The Process

In this part of the Process, the wish to do the 'right things' in the 'right way' is a strong driving force in the search for new KPIs. The responsible PMs wants to know how to prioritize their recources among the different assignments on the waiting list.

They also would like to know more about the bottlenecks (see figure 5) which slows their part of the Process down. One way of getting to know more, is to be

[127] George 2003, p. 255.
[128] Keyte & Locher, p.31.
[129] Ibid, p. 27.
[130] Klingvall, 2008-06-03.
[131] Ibid.

better at the reporting of phase changes in FRAS and maybe add some other transitions, so that the Lead Time measurements can offer information of interest. This will be adressed in chapter 7, which is about applied Lead Times, see sections 7.1.1 and 7.3.



Figur 5 The M/H part of the Process Wishes to do the 'Right Things' in the 'Right Way'

Congestions and their bottlenecks can also be studied, which some PMs alredy are doing, through different queueing theories.[132] An appliance of queueing theories, which might be helpful in this work, is a scientific article written by Lambrecht et. al.[133]

Another method to see where the hold-ups are in the Process and for each assignment, is a matrix developed at Bus Chassis. It is determined manually by the question 'who does what and waits for whom?' and at every FQ Meeting it is being studied, the bottlenecks pointed out and the congestion tried to be dissolved.[134] Contact Magnus MacKaldener for further information.

[132] MacKaldener, 2008-03-11 & Sylvander, 2008-04-17.
[133] Marc R. Lambrecht, Philip L. Ivens & Nico J. Vandaele, *ACLIPS: A Capacity and Lead Time Integrated Procedure for Scheduling.* (Management Science: vol. 44, No. 11, Part 1 of 2, Nov. 1998), p 1548-1561.
[134] MacKaldener, 2008-03-11.

6.5 Premise When Using The Indicators

When using the indicators of this thesis, some premises need to be considered (that is, the monitoring periods of the indicators, which levels in the Process that will use the indicators and for what, not to use bonuses or incentives connected to the indicators, which department that should generate, keep and distribute the indicators). The premises are the following:

6.5.1 Periods of Monitoring Should Be Maximum One Week

The indicators used today are too slow. They are measured too seldom or available too late. The number of solved assignments (see section 6.1) is the only KPI used by YSR and it is measured once a month.[135] In the M and H assignments part of the process, the PMs uses the warranty claim statistics to assess where to direct resources and theses are not available until, after earliest five months, but for the full statistics, after 18 months.[136] The indicators of this thesis have a different aim than the warranty statistics but as a comparison and axample of how the Process sees indicators, they have a place in this section. And they, together with the only KPI YSR uses, are way to slow to use as the day-to-day management tool that a KPI is supposed to be.

Discussing the warranty statistics, the PMs agree that up to 18 months are to slow, and a whish that a future KPI should be able to be received and affected much faster, at least within six months.[137]

In an office environment, the periods of monitoring can be a bit arbitrary; The KPIs and other PIs should be checked in everything between 10 minutes, one hour and daily according to Keyte & Locher.[138] Parmenter extends this, but no longer than up to a weekly measurement.[139] Accodring to him, the KPIs also should be prepared in real time, with even weekly ones available by the next working day.[140] KPIs can not be the *key* to your business if it is measured too late. Measurements with a longer monitoring period could only, at its best, be a KRI.[141]

Which period of monitoring that suites the Process could vary somewhat between different indicators. A recommendation to start with is to monitor most of them at least weekly. Daily monitoring would be to prefer for the most effective management of the Process but some consideration has to be taken to the fact that some Product Areas has fewer deviations reported. A daily monitoring of those might not be representative. The Process should therefore start with weekly KPIs and then shorten the period wherever it seems possible.

6.5.2 The Indicators are For The Managers Bottom-Up

One of the aims of the indicators of this thesis is to visualize the process flow in different ways. The purpose of this is to make them easily available to, and

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[135] Almér, Feb – Sep 2008.
[136] Sylvander, 2008-04-17.
[137] MacKaldener, 2008-03-11.
[138] Keyte & Locher, p. 70.
[139] Parmenter, p. 6.
[140] Parmenter, p. 9.
[141] Ibid, p. 6.

understood by, everyone working in the Process. This is critical to obtain a common view of both the way it flows as well as the current state of the flow.

Another aim of the indicators of this thesis is to be feasible to the managers and workers to use to evaluate and control the performance of the resources which they are responsible for[142]. In the Process this refers to for example the PMs, Assignment Managers, Assignment Leaders, managers of FQ Engineers among others.

A third aim of the indicators of this thesis is to guide the process owner YSR in the assessement of the functionality of the process.

6.5.3 Bonus, Incentives and Goals Should Not Be Applied

Bonus, incentives and goals for the Process performance compromises the indicators and the Lean philosophy[143] and should therefore not be applied to the indicators.

An incentive to make the Process run faster towards the phase 'Pending' (solved) exists in the Process today. It is a bonus that is being added to every employees paycheck for every assignment that makes the transition into 'Pending'.[144] This puts pressure on everyone within the Process to really hurry up untill 'Pending' is reached and makes everything after this phase a bit less imoportant.[145]

There also exists a goal for the only KPI that is kept, the number of solved assignments. This goal is calculated based on how high the figure has been and is set out as a higher number for every year.[146]

This goal is questioned from within the organisation. It shows the total number as process capacity but it is not correlated with the amount of resources consumed. This way, the Process is better the higher amount of assignments it solves, no matter the size or complexity of those assignments. This infers that everyone working in the Process will seem better at their respective job if they promote the smaller and easier-to-solve deviation reports and assignments. That would lead to a lower field overall quality and a process that looks efficient but are ineffective.

Another way to question the goal mentioned, is to ask whether the process really should be proud of a higher number of solved deviations. This, since it would imply that the Process has not 'cleaned up' as much as they could have, the years before. Scania has a modularized product that it should not have to change so much after the first years after every new smaller introduction. The question is why the amount of work in the Process should not be expected to decrease instead, rather than increase, every year.[147]

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[142] Fiorenzo Franceschini, Maurizio Galetto & Domenico Maisano, *Management by Measurement – Designing Key Indicators and Performance Measurement Systems.* (Turin: Springer, 2007), p. 10.
[143] Liker, passim.
[144] Dahl, Feb – Sep 2008.
[145] Sjöholm, 2008-04-09.
[146] Dahl, Feb – Sep 2008.
[147] Sylvander, 2008-04-17.

Other opinions, from within the process, on the matter of using goals for indicators, are also of negative understandings. It is not uncommon that people cuts corner in the phases to reach the goal, or that they just stop putting so much strain into the work after a goal is reached.[148]

Turning to the literature it is against the Lean philosophy to use incentives and goals. This since at least four of the Toyota principles will be violated when corners are cut. These are:

- Principle 2: ’Create continuous process flow to bring Problems to surface’.[149] Stressing some, peferably small and not so complex, deviation reports and assignments through the Process is not continous nor encouraging to bring problems to surface.
- Principle 5: ’Build a culture of stopping to fix problems, to get quality right the first time’.[150] Stressing anything towards a bonus, goal or some other sort of goal, does not promote the stopping-to-fix-problems.
- Principle 7: ’Use visual control so no problems are hidden’.[151] True visualization has to suffer when the Process is speeded up in an unnatural way for some part of the Process. This messes up the functionality of the Lead Times, since the actual problems might manifest themselves somewhere else in the Lead Times than where it happned in the Process.
- Principle 14: ’Become a learning organization through relentless reflection and contiuous improvement.’.[152] ’Relentless reflection are impossible when Principle 7 is violated, which means that the so important continous improvment is no longer possible to conduct. This was one of the aims with the indicators and this means that bringing a incentive or goal to the indicator might undermine the very ground to the indicator itself.

The recommendation for the indicators is to use no bonus, incentives or goals connected to the process performance. This will ultimately lead to tampering with the Process, process improvement, the Lean adjustment, other indicators or the indicator of interest itself. If, for some reason, an incentive or goal still will be applied, bare in mind that the consequences above will go into force, and use one as all-inclusive KPI as possible (if any such exists).

6.5.4 Responsibility to Carry Out the Measurements

The process owner, YSR, is already obliged to keep indicators and use them as tools for improvements (see section 4.1.3). It should therefore also be YSR that shoulders the tasks associated with the development of the indicators and later on also the generating, keeping and distributing of all indicators for to the Process. This will be an additional administrative function for the department with an aim to provide a service to the Process continuously.

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[148] MacKaldener, 2008-03-11.
[149] Liker, p. 87-103.
[150] Ibid, p. 128-139.
[151] Ibid, p. 149ff.
[152] Ibid, p. 250-266.

7 Analysis 3: Applying Lead times

This chapter applies one of the suggested indicators of Chapter 6: Lead Time. Chapter 7 displays the application of Lead Times by showing how to measure (intervals, metrics and time stamps), what to measure (describing which time that is of interest) and where to measure (offering suggestions of Lead Time intervals). This chapter also gives two examples of how to visualize the True Lead Time and the Current Lead Time. At the end, the First-Pass Yeld is introduced as a good overall indicator.

7.1 How to measure – Intervals, Metrics and Time Stamps

7.1.1 Intervals – Lead Time and Part Lead Times

The Follow-Up Process is constantly looking for ways to shorten the Lead Times. One way is to search for bottlenecks.[153] Doing so is hard without knowing so much about the Lead Times and a wish to be able to break those down into Part Lead Times is expressed[154] from the Process.

The FQ Engineers part of the Process is in great need for ways to measure Lead Times in all their different work tasks. A Total Lead Time can and will be measured on their work on the deviation reports, from the arrival of the deviation report to the inbox until it is posted for COL. This is not enough though. This Lead Time needs to be divided into Part Lead Times if the measure should be able to tell the FQ Engineers anything about their performed work. Due to the difficult work situation for the FQ Engineers, see section 5.3 and 6.4.3, which seems to needs sorting out before the engineers will be able to focus on Lead Times, this report has had some difficulties examining what Part Lead Times that would be suitable for the FQ Engineers. Some suggestions follow though, in section 7.3

The M and H parts of the process are already somewhat used to being able to study Part Lead Times since their work has been logged in different phases. But these lead times could be more specified. Although not to thourougly examinated how to in this essay, due to the delimitations, a recommendation is for the Process to immediately search for good Part Lead Times to complete the indicators in section 7.3. One of those should for example be a Lead Time for the purchase function. It should be recognized that the larger emphasize on a larger amount of intervals and the reporting of time in those, are questioned by some[155] as an obstruction of the work flow, while others[156] welcome it. This report is on measuring however, so it follows the believes that there need to actually be some produced data to measure, to get the wanted indicators.

As described, there will be a presentation later on in this chapter on how to measure Total Lead Times (in several sections but foremost section 7.4 and also some suggestions for Part Lead Times in section 7.3. The latter ones will need a further

[153] MacKaldener, 2008-03-11.
[154] Sjöholm, 2008-04-09.
[155] Sylvander, 2008-04-17.
[156] MacKaldener, 2008-03-11.

study to be complete. Section 7.5 visualizes the different Lead Times and shows the need for the Part Lead Times to be suggested in each part of the Process.

Using the intervals, such as phases and divided intervals of those, puts a greater pressure on the Process to offer input about the deviation reports and assignments in a consequent manner. The Process is not always that consequent in its time reporting today. For exampel, several shifts between phases can systematically be ignored[157] and shorter assignments can sometimes be found solved before the next FQ Meeting[158] (for example when an assignment jumps between prestudy and verification between two FQ Meetings). This behaviour leads to a strange Lead Time in the 'jumped' phases, since they will be given the same time stamp as the last completed phase in the sequence. The behavior therefore ultimately leads to less useful Lead Times. The Product Areas conducting this behaviour will be punishing themselves, since their Lead Times can not provide any usable information about their process.

Every group responsible for a Lead Time also need to take part in YSRs search for Part Lead Times and add more specified such to figures 7 and 8.

Using the Lead Times, such as phases and those divided into even shorter intervals called Part Lead Times, puts a greater pressure on the Process to offer input about the deviation reports and assignments in a consequent manner.

7.1.2 Average Time Is The Metric

When discussing the measuring of assignments and deviation reports, one obstacle always keeps showing up and it is the different complexity in the assignments. The variation in time to process the assignments and its deviation reports is quite large. It varies from under 24 hours up to 6 months, 24 months or longer.[159] This is due to the different complexity in the deviations and in the following product development. The argument is that this high variation in process time makes a KPI based on an average to be too far from the truth about the process time for one assignment, since this time, even with its standard deviation included, might not ever occur in reality.[160] In reality the total process time might, for example, be either really short or really long, with no middle ground. In this case an average will only show the middle ground and is therefore argued to be misleading or at least not so interesting to the Process.

7.1.3 Types of Time Stamping for Data Collecting in IT Systems

There exists a tiredness of tasks to perform in FRAS, the main IT system that the Process uses for support and documentation.[161] New tasks and routines in the FRAS-based work tasks due to the Lead Time measuring will not be happily received among the people working in the Process. Therefore this report has taken a

[157] Sylvander, 2008-04-17.
[158] Sjöholm, 2008-04-09.
[159] Almér, Feb – Sep 2008.
[160] Malmberg, 2008-04-09.
[161] Klingvall, 2008-06-03.

very restrictive position towards adding such. Unfortunately does not every event, which the same people are interested in measuring, automatically get logged with a time stamp (a time stamp is a date and time note information that is added to for example a deviation report). This is a dilemma which results in a compromise in this report: A few new tasks is added into FRAS and offers a start in measuring the important Part Lead Times. Better specification, which is guaranteed to soon be wanted, will only happen if FRAS is largely reconstructed or if a larger number of tasks are implemented for the users (either in FRAS or, for example Silbertime).

Measuring time will need a more extensive time stamping in FRAS and the data collected need to be organized in databases from which data are more easily extracted than today (some of the timestamping writes to text files[162], which is a detour with complications for extended use of the data). This means that FRAS needs to be reprogrammed in several functions.

One of the most important issues in how and what to make FRAS save, is time stamps. The second paragraph in this section stated the importance of making FRAS able to *produce* time stamps in every place such is wanted (see where in section 7.3. This paragraph and the following will give suggestions on how FRAS could be programmed to *save* the data produced by the time stamps.

Alternative 1: This is the cheaper and not so complicated alternative for the reprogramming of FRAS. As we will see, it does not give much information either. The suggestion is to simply put a stationary counter at the beginning and end of each Lead Time interval in the process. This enables the system to count how many visitors each interval has had every decided time period. The stationary counter contains a number that corresponds to each of the deviation reports or assignments that has passed it. And that is it. With a simple database connected to the stationary counters, the Process should be able to search it for any time period. The stationary counters have the following large disadvantages when using Lead Time to be able to tell anything about the Process: It does not know or remember anything about the objects passing, except what time it passes. One will not be able to find out any of its history in the process. This means that one will not be able to say how long time any of the subjects spent in any of the intervals, only the average time for the total number of objects passed at every interval. This alternative is not recommended as a single solution for obvious reasons.

Alternative 2: This suggestion might mean a large reconstruction of FRAS, depending on how it is coded today. The suggestion is to create a time stamp in the beginning and end of every interval, with a stationary counter as in Alternative 1, but to add the time stamp (and an adress telling in which interval this time is spent) to the *object that passes,* i.e. the deviation report or the assignment. Every time the object passes a stationary counter, it collects a new time stamp and adress, like passing through customs with a passport, and when it has passed through the process it is carrying every time stamp it has ever gotten. The Time Stamps should be consisting of one entering and one for leaving each interval. In this way it is possible to look at each object and see how long time it has spent in every interval of the Process and it will be possible to tell both the intervals, the order of visited

[162] Pettersson Arman, Feb – Sep 2008.

intervals and also the objects apart. This can be tricky if the code of FRAS is not created in an object oriented programming language (Java for example), but it should be possible anyhow. Each object has its own small database, which of course will be connected to the other objects databases in a large database (based on SQL, for example MySQL) which, through a software interface is easy to use to produce the visual presenation in section 7.5.

FRAS needs to be able to not only produce better time stamps, but also to store them in an accessable way. This means for a limited number of new tasks to be carried out by the users but also what might be a major reconstruction in the code of FRAS. The latter should follow Alternative 2 above (which includes Alternative 1 as well).

7.2 What to Measure - Time of interest

7.2.1 It is The Customers Clock that Ticks

Which Lead Time is of interest? The answer to that question depends on who you are asking and what part of the Process that person belongs to. But at the same time do most people and groups emphazise the importance of keeping the customer satisfied and serving the customer as fast as possible. Looking at the Theoretical Background (see for example section 3.4) and talking to the Process owner YSR, it soon stands clear that it is the time which the customer has to wait which is the Lead Time of interest. This corresponds to the total time that it takes to deliver your service once an order has been triggered,[163] which means adding every elapsed time, associated with the completing of an activity (including the waiting time until the activity is started, i. e. queues), to each other[164]. This might upset some parts of the Process, which might not see their Lead Time as this long (see section 7.1.1 for an example), but it is the only way that every part of the process starts taking responsibility of their time consuming.[165] There is a way for a subpart of the Process to ’prove’ that a certain (not yet named) Part Lead Time is not totally one of their responsibilties. It simply has to participate in the continuous development of the Lead Time Measurement and incert another Part Lead Time which is measurable and name the group which is responsible for it (see section 7.3 for some examples).

7.2.2 Using and adding ’Waiting Days’

For the M/H teams part of the Process, there exists an option in the FRAS documenting for assignments. It is to choose between having the assignment as ’Running’ or as ’Waiting’. When extracting an assignment from the Waiting List, the FQ Meeting changes this option to ’Running’, since the assignment is up and running. Sometimes an assignment that is ’Running’ has to be put back on the Waiting List, since some other assignment has gotten a higher priority and therefore is in greater need of the team. The assignment which is put back will then get the status ’Waiting’, untill the FQ meeting decides to run it again.

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[163] George et al., p. 40.
[164] Keyte & Locher p. 26.
[165] Almér. Feb – Sep 2008.

Since fairly recently, FRAS also has a counter counting the number of days that an assignment is either running or waiting, called 'Running Days' and 'Waiting Days'.

Measuring Lead Times, this distinguishment can be to some help assessing the total time an assignment spends in the Waiting List, given that FRAS is, or will be, coded to do so. If this, for some reason, is not possible, the Lead Time for both Running Days and Waiting days should be put on the M/H teams Part Lead Time (untill a new Part Lead Time with a group responsible is created in the Lead Time statistics), since it is their part of the Process which causes the delay in Waiting Days.

To be able to make FRAS save the time which the assignment spends in Waiting as extra time spent in the Waiting List, the code needs to be designed to do as follows: FRAS has to put an assignment in Waiting on the Waiting List, meaning that when an assignment gets the status 'Waiting', it should also be given a new time stamp (which of course will not overwrite any old ones from any function of the code) as if it entered the Waiting List. When having the status changed to 'Running' again, the assignment should be given a time stamp and leave the Waiting List. (See section 7.1.3 to read more about time stamps.)

It is important to state that this is under the assumption that Waiting will not be used when M/H Teams are waiting for an FQ-meeting or for some other group handling it, like the department of Purchase. (This kind of waiting, though not explicitly due to the purchase function, sometimes happens at for exampel Bus Chassis[166] and in theory at Electrics[167].) Instead, these matters should be automatically measured in their own designated Part Lead Time. If no such exist – create one!

Waiting Days shall only be used when the assignment is put back on the waiting list due to being outranked by an other assignment with a higher priority. Waiting Days and Running Days both should be counted as Lead Time. It is therefore important to check, and if required, change, the program code in FRAS according to the description in the fourth paragraph in this section.

If this, for some reason, is not possible, the Lead Time for both Running Days and Waiting Days should be put on the M/H teams Part Lead Time (until a new Part Lead Time with a group responsible is created in the Lead Time statistics), since it is their part of the Process which causes the delay in Waiting Days.

7.2.3 Measuring Time in Days

The unit for the Lead Time should be days. The FQ Engineers are already used to the unit in other measurements and the Product Managers of Bus Chassis[168], Electrics[169] and Engines[170] all agreed during this study to measure the Q team assignments in days. The PMs then conveyed to the suitness in using weeks as a

[166] MacKaldener, 2008-03-11.
[167] Sjöholm, 2008-04-09.
[168] MacKaldener, 2008-03-11.
[169] Sjöholm, 2008-04-09.
[170] Sylvander, 2008-04-17.

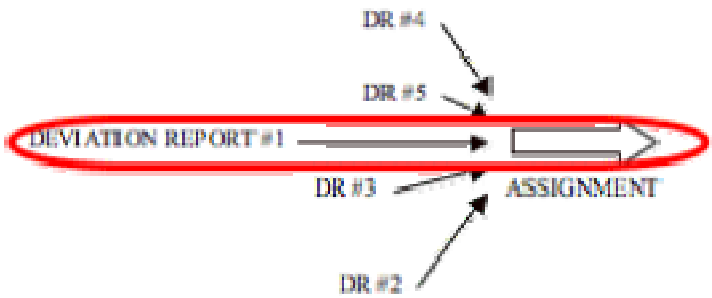
unit for the Lead Time in M/H assignments, since these assignments run for longer periods. This study recommends days as a unit for Lead Times for every part of the Process, because of the argument of uniformity but also to stress the fact that every day counts for the customer.

7.2.4 Only The Time of The First Deviation Report Is of Interest

Measuring Lead Times over the whole Follow-Up Process inside the Scania Process makes discussions and different opinions unavoidable. One difficulty which easily involves different opinions is how to measure Lead Time for the deviation reports. This, since many deviation reports can be connected to the same assignment. When COL decides to open an assignment, every deviation report that has lead to its opening, will be attached. Every deviation report on the subject that will be sent in to the factory as long as the assignment is unsolved, will be attached. It is soon clear that the measuring on the M/H teams part of the process is less controversial than at the FQ Engineers side: In the M/H teams part the Lead Time of every assignment is measured, but how do we measure the first part of the process for each of these assignments, the part when the assignment were one or many deviation reports?

Some alternatives are to take an average of the Lead Time for every deviation report attached or to add the Lead Times of every attached deviation report to each other to illustrate the total number of working days that has been put in.

A third alternative is to only count the Lead Time of the first submitted deviation report (see figure 6 below). This means that the Lead Time would correspond to the amount of time it has taken for the factory to produce a soulution for the first customer reporting the deviation. When considering that we sat out to measure the time which the customer had to wait, this seems like a fairly decent way to measure the Lead Time for the handling of the deviation reports.



Figur 6 The Suggestion to only Count the Lead Time of the First Submitted Deviation Report

This will unfortunately make some FQ Engineers unhappy, since it will not give any indication as to the Lead Time of the the total amount of deviation reports: including the ones appearing after the first deviation report and the ones which gets dropped. This of course also deserves an indicator of some kind and one is actually offered in figure 8 where the Current Lead Time in each interval is displayed.

The Total Lead Time of the Process is recommended to follow the third alternative above. It should be made up by the Lead Times of activities associated with the closed assignment, added with the Lead Time of the deviation report which first reached the factory and is attached to the assignment. See figure 6. This corresponds to the amount of time for which the customer has been waiting.

To be able to have some more up-to-date data, figure 8 offers the Current Lead Times of the Process. Observe that this is the Lead Time of the total amount of WIP, i.e. all deviation reports (not only the first submitted) and the assignments. (Opposed to figure 7 which displayed the Total Lead Time for the customer and is the ’True’ Lead Time)

7.3 Where to Measure – Lead Time Intervals

This section aims to give examples of how (in which actual intervals) the Process can divide its Total Lead Time into smaller units.

As explained in section 7.1.1, the Process is recommended to measure the Total Lead Time consisting of a continuous number of intervals of Lead Times for the different groups and functions which provide the activities of the Process. Since these intervals of Lead Times might be seen as to extensive and therefore not being able to offer enough information, those interval will be divided to. The divided Lead Time intervals are called Part Lead Times and the group responsible for each Lead Time interval (like the FQ Engineers part of the Process) are also responsible for any Part Lead Time which they can come up with (for example Time In Inbox). (’Responsible’ is to be interpretaded as answerable for the time spent, not as forced to conduct the measuring (which is YSR’s job)). The group responsible for the Lead Time also decides whether their Part Lead Times has to be continuous intervals or not (since it is important to be clear on whether the Part Lead Times of every Lead Time interval can be added and seen as corresponding to the Lead Time interval itself, or not).

To measure these Lead Time intervals (for example A in figure 7 and their Part Lead Times (for example A_1, A_2, and A_3 in figure 7) the Process needs to programme FRAS to perform Time Stamps (TS) according to what was described in section 7.1.3.

These TSs and the objects distributed databases can be used to measure Lead Times and Part Lead Times in FRAS for, for example, the intervals descibed in the following table:

Lead Time	Part Lead Time	Description of interval
A*		**FQ ENGINEER PREPARING DEVIATION REPORT** The first interval offers the time spent on the deviation report. It is the FQ Engineers which are responsible for this Lead Time. This should be measured (counting backwards to get it accurate) from the TS (see section 7.1.3) created when the assignment gets its

		'Create Date'. The second TS, closing this interval, should be the Create Date of the attached deviation report which first reached the factory.
	A_1	**INBOX** This is one of the Part Lead Times for the larger interval of the FQ Engineer and describes the time which the deviation report spends in the inbox of an FQ Engineer. This happens when the deviation report is created but also, as a new feature since autumn 2008, in a number of different cases when the FQ Engineer has sent an answer to the customer. To be able to measure the time spent in the inbox, a TS should be stamped to the object when it receives the status 'Inbox' and the second (and interval closing) TS should be stamped when the object shifts status from Inbox to some other status.
	A_2	**INSUFFICIENT INFORMATION** When a deviation report submitted by the customer does not have the information required for the deviation report to be prepared by the FQ Engineer, the deviation report gets the status 'Insufficient Information' and is sent back to the customer.[171] For every received deviation report, the FQ Engineers has to work without performing any actual work for the deviation istelf, i.e. Waste. To be able to measure the time spent on Insuff., a TS should be stamped to the object when it receives the status 'Insuff.' and the object should be able to keep this status when it goes back to the distributor for completion. The second (and interval closing) TS should be stamped when the object shifts status from Insuff. to Inbox. It also needs to be possible for every object to add several visits in this interval to each other, not owerwriting, since it sometimes takes several rounds before the deviation report is correctly filled.
	A_3	**TIME UNTIL FIRST ANSWER** A rapid first answer is of everyones interest in the Process but still even more so for the customer whom is wondering if any work has been perfomed at all. Time Untill First Answer has previously been discussed and longed[172] for as an indicator in the Process and a group[173] has been working on how to measure this Part Lead Time. The reader is referred to their work but with a reminder of the need for TSs to be created for a uniform measuring in FRAS.
B		**FQ ENGINEER PREPARING ASSIGNMENT**

171 Johan Carlsson, *oral interview,* 2008-06-18.
172 Klingvall, 2008-06-03.
Sjöholm, 208-04-09.
173 The group where initiated by a request from the FQ Engineer Jonatan Elnäs and some work has been perfromed by Åsa Pettersson Arman (YSR) and Adriana Dominguez (Scania Latin America).

		When an M/H assignment has been created in COL, it will be sent to an FQ Engineer to write an Opening Criteria before the FQ Meeting. To be able to measure the time spent on the work on the Opening Criteria, a first TS should be stamped to the object when the assignment receives the Create Date and a second (and interval closing) TS should be stamped when the 'Assignment Leader' of the object is shifted from an FQ Engineer to an Assignment Manager from M/H. This of course demands the choices (i.e. names) in this category of scroll list to be background coded as belonging to one out of two groups: FQ Engineers and or Assignment Managers. Except existing, theses two groups also needs to be given as a recognizable outputs from the code function of the scroll list.
	B_1	**PARTS REQUEST** A deviation report does, at its best, still only contain pictures. The FQ Engineers oftentimes need more information than what these pictures can provide. A Parts Request is therefore made so that the FQ Engineer can receive the product parts expressing the deviation and examinate them themselves. Getting the parts requested is a slow process (three month is not at all unusual as a waiting period) of which the transporting part oftentimes is the shortest.[174] To be able to measure the time spent at Parts Request, a TS should be stamped to the object when it receives a check in the box named 'Parts Request' (exists already). A second (and interval closing) TS should be stamped when the object gets a box named 'Parts Arrived' checked by the Material Inspection inside the factory (this excludes any material collected at Scania Sverige by the FQ Engineers themselves). These measures assumes that the FQ Engineers have agreed to perform Parts Request according to one uniform process description. Today two exists: one when the Parts Request is performed before the assignment is created and one when it is performed after the assignment is created. For compatability with the rest of this reports measurements, the latter one is recommended. A second assumption made to make it possible to measure Parts Request, is that the a third box named 'Parts Request Runtime Time Out' is checked when COL or any other function drops the deviation report or assignment due to undelivered parts. In these cases a TS is created, when the third box is checked, and this TS serves as the second and closing one for the interval.
C		**WAITING LIST** When the Opening Criteria has been written by the FQ Engineer, the FQ Meeting decides whether an assignment should get the status Open (and whether it should be running or waiting in the Waiting

174 Klingvall, 2008-06-03.

		List) or not. If the assignment gets the status Open, it will either be Running or Waiting. Running means investigated for a solution and Waiting mean doing just that, in the Waiting List. An assignment can swing back and forth between those two, depending on the recources at hand. To be able to measure the time spent in the Waiting List, a TS should be stamped to the object when it receives one of the Assignment Managers in the scroll list named 'Assignment Leader' (see Lead Time B for a additionary exlplanation). The second (and interval closing) TS should be stamped when the object shifts status from Waiting to Running. Section 7.2.2 discussed ways to measure Waiting and is recommended for handling of the additional Waiting periods that might be invoked upon the assignment along the Process.
D		**PRESTUDY** This interval is already measured in the Process but some Part Lead Times offered by the M/H part of the Process would be a good idea to use. Note that todays measuring might need some updates with Time Stamps (TS) to an object (discussed in section 7.1.3 and applied in the Lead Time measuring above) in order to implement a uniform measuring software code in FRAS.
E		**DEVELOPMENT** See the Lead Time interval description for Prestudy (D) above.
F		**VERIFICATION** See the Lead Time interval description for Prestudy (D) above.
G		**IMPLEMENTATION** See the Lead Time interval description for Prestudy (D) above.
	G_1	**ECO 4:4 UNTIL SOCOP** Inquirys has been made[175] for a display of the Lead Time from when an Engineering Change Order (ECO) has a time table (called '4:4') until the Start Of Customer Production (SOCOP) has commenced. How to measure this, or a Part Lead Time like it, is outside the delimitations of this report but of great interest and should be carried out. Alf Mattsson at Scania Engines (the Product Area of the industrial and marine engines) might be of some assistance since he extracts data, at least some of the data involved, from the different IT systems.
	G_2	**PURCHASE**

[175] Sjöholm, 2008-04-09.

		The process of the purchase function is somewhat of a black box today and Lead Time measures of it is recommended but outside the delimitations of this report.

*To make it possible for the FQ Engineers to measure which steps of their part of the Process that consumes which part of their Lead Time in an other way of measuring or additional measuring, TSs should be applied to the different changes in the'status' of a deviation report. The 'Status' is a number of choices of what label to put on the deviations report when it has reached the factory. The status shows internally where in the Process the deviation report is and this could be interesting when measuring Lead Times. Unfortunately, this status is also displayed externally, to the customer (i.e. the distributor) as a show of courtesy by sharing information. This is a Lean way of thinking, but it could preferably be carried out in a way not connected to the process procedure internally. The problem is that currently the FQ Engineers can not always use the status as they should according to the Process, since showing the status externally sometimes means giving the customers a sign which can be wrongfully interpreted. Instead of displaying the status externally, the FQ Engineers should communicate through the Time and Action Plan[176]. This demands the following: That the deviation report is open externally, that the Time and Action Plan is kept updated and that the customer knows about it and is able to find it in FRAS.

A recommendation for the intervals in the table above is to programme FRAS to be able to produce the Time Stamps (TS) as described in this section and in section 7.1.3.

7.4 Total Process Lead Time

The measuring of the Total Lead Time was described in section 7.2.4 as the activities associated with the assignment, added with the Lead Time of the deviation report which first reached the factory and is attached to the assignment. It should therefore be measured from the first TS of the FQ Engineers first Lead Time interval (A) until the last TS (G) of the interval of Implementation (for details, see the table in section 7.3).

Total Lead Time: Time between the *first TS of A* and the *last TS of G*.

7.5 Visualization of Lead Times with Batches

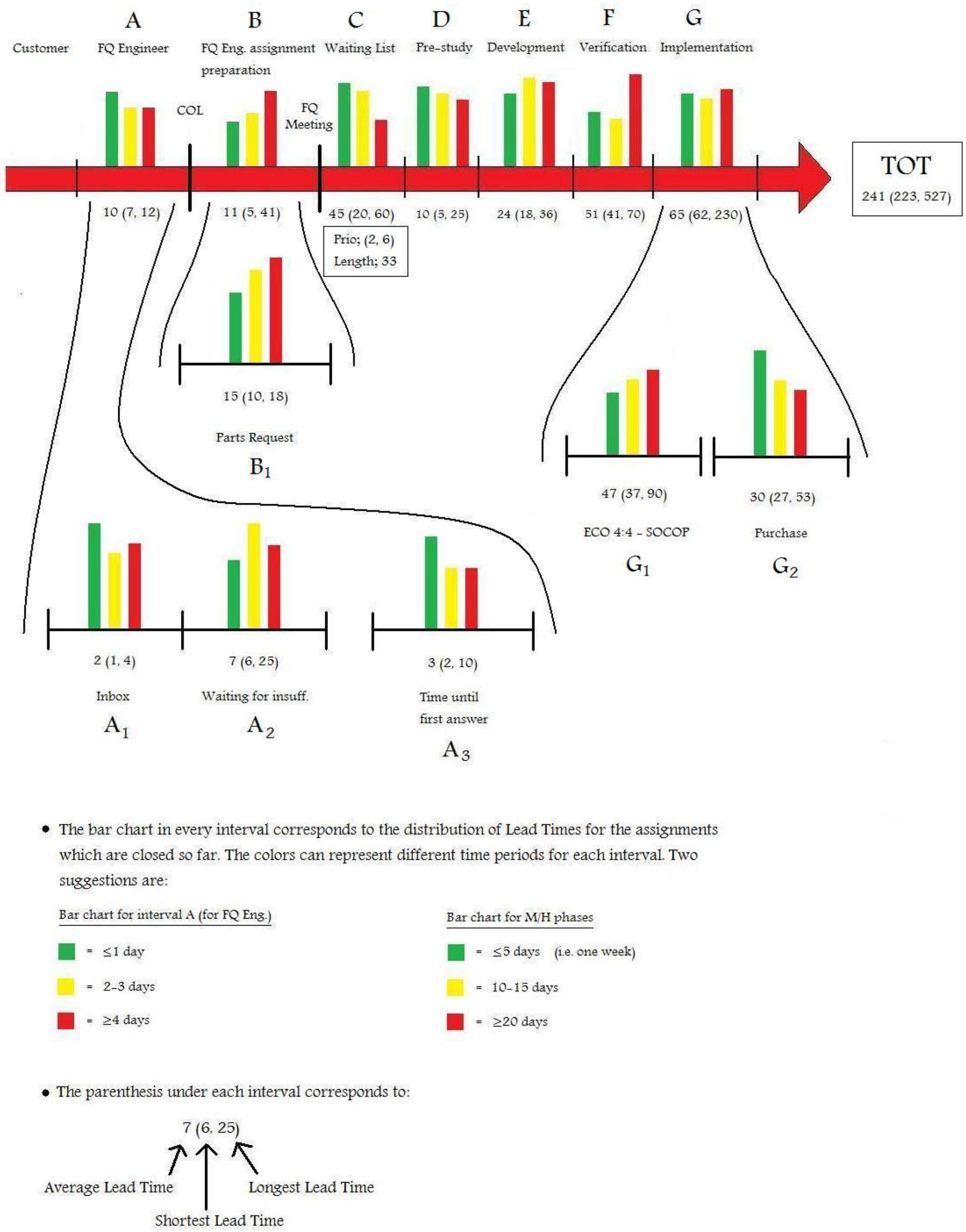
The following two sections are examples of how to visually communicate the Lead Time information described in this chapter and some other indicators as well. The need for a way to present the Lead Times is obvious but how to carry it out is not always as obvious. The figures 7 and 8 in the sections below are inspired by the theories of how to avoid the Bullwhip Effect[177] through the sharing of information along the process flow. The idea of the figures (and for the whole process to come together in one long picture) is to share information of Lead Times and amount of

[176] Klingvall, 2008-06-03. Kjell Jedbring, *oral conversations*, Feb – Sep 2008.
[177] Hau L Lee et al., *The Bullwhip Effect in Supply Chains*. (Sloan Management Review: Vol. 38, No 3, p 93-102, Spring 1997), passim.

work along the Process and to help support the mental picture of the process as a whole.

It is important to note that the figures which the sections are based upon are suggestions for *two different types of indicators* and that both are recommended to the Process and has to be told and held apart by everyone in the Process.

7.5.1 True Lead Time Visualization

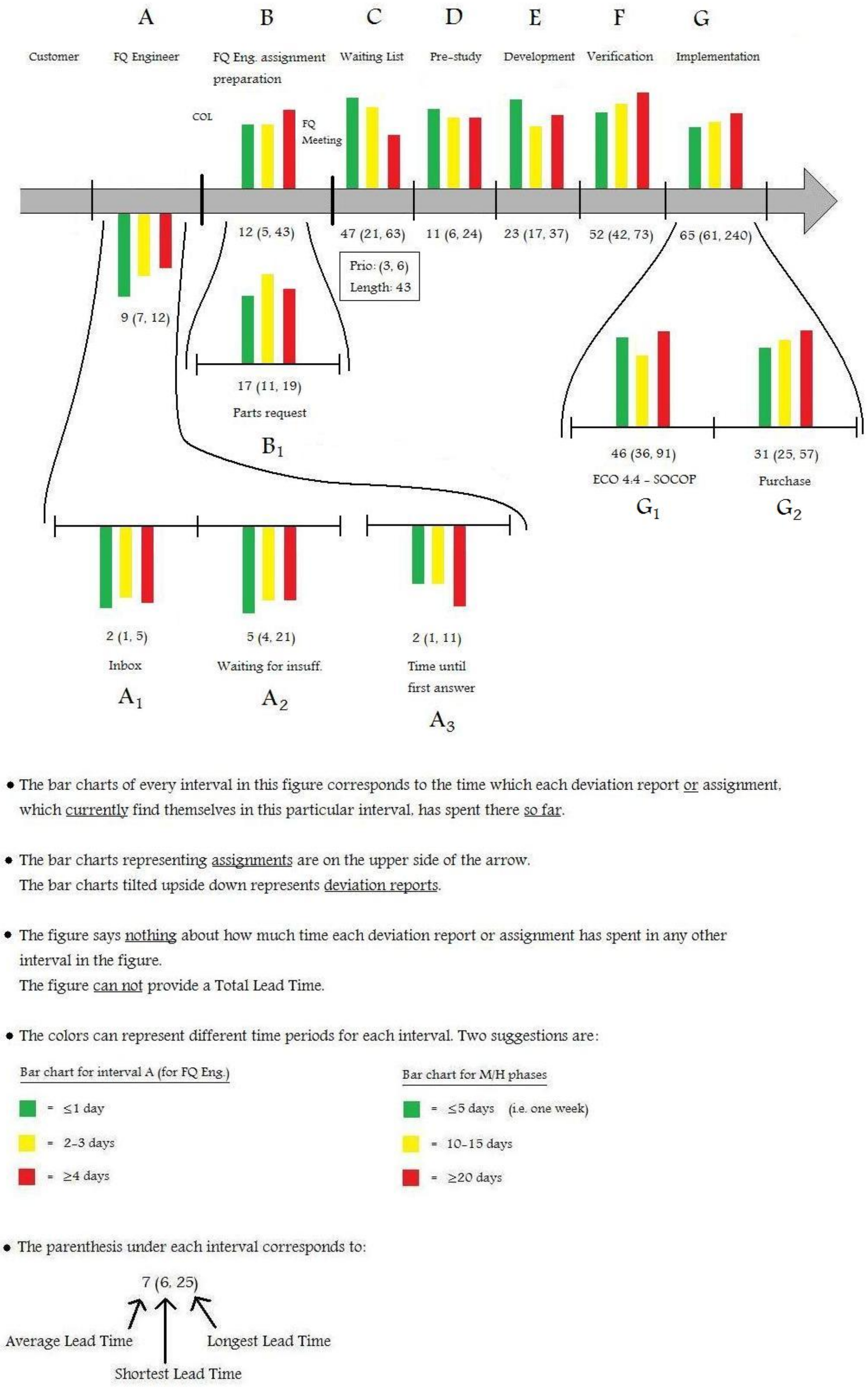


Figur 7 True Total Lead Time Visualization

Figure 7 shows a visualization of the *True* Total Lead Time and its intervals (Lead Times and Part Lead Times). This is the statistics for the *closed* assignments and the activities associated with the closed assignment, added with the Lead Time of the deviation report which first reached the factory and is attached to the assignment.

This presentation is the result and efficiency of the Process, measured in time. According to the KPI Theoretical Background (section 3.2), this would count as either an KRI (historic data) or maybe even a KPI, depending on how it is used.

7.5.2 Current Lead Time Visualization



Figur 8 Current Lead Time Visualization

Figure 8 shows a visualization of the *Current* Lead Time and its intervals (Part Lead Times). This is the statistics for the *open* assignments and *every open deviation report*, i.e. all WIP. (Opposed to figure 7, which has only the closed ass. and its ’first’ deviation report).

The Lead Time of every interval in this figure is the time which each deviation report or assignment, which currently find themselves in this particular interval, has spent there *so far*. It says nothing about how much time each deviation report or assignment has spent in any other interval in the figure.

Measuring current Lead Time means using the first TS in each interval described in section 7.3 as a starting time for each object currently placed in a interval. The last (and closing) time of the interval should be the current date (the date of the day when the statistics are being updated).

Since this figure shows current Lead Times (and for *all* deviation reports), it can not provide a Total Lead Time.

This kind of current indicator has been asked for in the Process[178]. This visualization should be used as a KPI

7.6 Supervising Amounts in the Flow

7.6.1 First-Pass Yield Is A Good Overall Indicator

An indicator of interest, which is not a Lead Time but connected to the intervals described in section 7.3 and 7.5, is the First Pass Yield (FPY) (referred to as ’Quality Rate’ at Toyota)[179]. This indicator has a percentage as its metric and it is the percentage of ’things-in-process’ that make it all the way through the Process the first time without needing to be fixed or rehandled in some way.[180]

FPY is a good overall indicator of how well the process is functioning.[181] It also reflects a Lean goal: in order to have a high FPY, the Process must operate smoothly (i.e. with good process flow) and with few errors.[182] The Process has been asking for a measure of this kind, for a way of knowing how many deviations that are reoccuring in the process and handled more than once, i.e. not fixed the first time around.[183] With this definition, the deviation report status ’Insufficient information’ also should be counted as a repetition.

FPY should be measured by adding the number of repetitions discovered in the closed assignments with the number of closed deviation reports that has had an ’Insufficient Information’ Part Lead Time interval added to its database or list. This number of repetitions are then to be subtracted from the total number of closed deviation reports and assignments, giving us the number of of ’things-in-process’ that make it all the way through the Process the first time. To get the FPY percentage, this number will be divided with the total number of closed deviation reports and assignments:

[178] Sjöholm, 2008-04-09.
[179] Liker, p. 281.
[180] George 2003, p. 282.
[181] Ibid.
[182] Ibid.
[183] Sylvander, 2008-04-17.

$$\text{FPY} = \frac{(\text{Total \# of closed D.V.\& As.}) - (\text{\# of Repetitions such as Insuff. in closed D.V. and rep. discovered in closed As})}{(\text{Total \# of closed D.V.\& As.})}$$

To be able to perform this measurement, two changes is needed in FRAS: FRAS needs to able to pick up the Time Stamps from Isnufficient Information and add a mark (an output in a function of the code) to the object that says that 'this object has been in Insuff. and can be counted for FPY statistics' and then sum up those marks. FRAS also needs a new box for the FQ Eng., COL or M/H team to check if they have seen this deviation before. The box, checked or not, will follow the object and seen from wherever you are in Process, inside the factory.

The Process should use the First-Pass Yield (FPY) as an overall indicator of how well the Process is functioning.

7.6.2 Why The Number of Solved Assignments is NOT a Good KPI

Section 6.1 mentioned that the only so-called KPI that YSR are keeping today, is the number of solved assignments. This is not a usable KPI since it is not related to anything, it is just an amount without meaning: It can not be used to talk about the efficieny of the personnel, since the variety in complexivity in the assignments is too great. And it can not be used for shoulder padding or describing effectivness just by itself, since *the number has contradictive interpretations*: Is a high number good or bad? A higher number could both mean that the Process has not performed its work properly since there is more to report a efficient Process should in theory mean that there is less to fix in the products) or that the process has been more efficient.

Contemplating Little's Formula (section 3.4), which gave an often used equation for Lead Time, gives another explanation to why the total number of solved deviations is a bad indicator. Little's Formula is admittedly about average, but the theory works for the mentioned total number as well. It is very possible that the Process would like to use this seemingly easy-to-use equation to determine the Average Completion Rate to describe both WIP and Lead Time in one combined indicator. This is not possible though. Little's Formula is *only good for steady state systems, which the Process is not* (since the complexity (as argued above) of the assignments are high just as the variation in time). The WIP can therefore not be assumed to have a linear connection to the Lead Time and this means that the Average Completion Rate can not be described by Little's Formula. A use of the equation would result in an Average Completion Rate that is deduced from the current WIP and a historic Lead Time. This would give no true indication of the process flow.

8 Analysis 4: Measurements of Waste

When looking at Lead Time, as in Chapter 7, questions arises pretty fast as to which time that really counts, i. e. is value-adding. Everything non-value-adding is referred to as Waste and when discussing efficiency, it is important to be able to discuss Waste. KPIs to determine efficiency were an expressed desire in the objective of this thesis, and therefore, this chapter sums up some of the different kinds of Waste which is measurable in the Process.

8.1 Lead Time as Waste of Time

8.1.1 Total Waste Time

The indicator named Total Waste Time consists of every interval which can be described as Waste. It is important to note that there are more and still hidden Wastes in the Process than what is included in the sum below. It is therefore of great importance to continue the work of dividing intervals into smaller ones and adding the Waste Lead Times to this sum:

Total Waste Time = $A_1 + A_2 + B_1 + C + \ldots$

8.1.2 Process Cycle Efficiency as An Indicator

Process Cycle Efficieny, mentioned in Theoretical Background section 3.5, is about measuring what is creating value to the product and therefore are worth waiting for in the eye of the customer, compared to for how long the customer actually has to wait. The outcome of the equation is a percentage which shows how effective the Process has been towards the customer.

In the Follow-Up Process, this could be represented lightly by the following re-made equation from section 3.5:

$$\text{Process Cycle Efficiency} = \frac{\text{Total Lead Time - Total Waste Time}}{\text{Total Lead Time}}$$

This is described as ’light’ since the ’Value-added Time’ in the original equation is replaced by the Total Lead Time minus the Total Waste Time. This condition is probably not true, rather far to forgiving, since the Total Waste Time is the sum of every today easily measurable waste times. This will result in an exaggerated Process Cycle Efficency. Still the Process is recommended to use this indicator for now, as long as it continuously evaluates what measurements that are put in instead of ’value-added’ as the numerator.

8.2 Amount of Waste in the Process

Since waiting is a form of waste, and thereby queueing, it is clear that we can measure waste in other metrics than time. For example, queues have a length. Therefore we can measure the Amount of Waste.

8.2.1 Ratio of Insufficient Deviation Reports as A Waste

When a deviation report submitted by the customer does not have the information required to be prepared by the FQ Engineer, the deviation report gets the status 'Insufficient Information' and is sent back to the customer.[184] Dividing the amount of deviation reports which has received this status with the total amount of deviation reports offers a ratio. The ratio is describing to what percentage of the received deviation reports that the FQ Engineers had to work without perform any actual work for the deviation istelf, i.e. Waste. This ration can be used as a KPI.

$$\text{Insuff as Waste} = \frac{\text{\# of Deviation Reports ever received Status Insuff.}}{\text{Total Amount of Deviation Reports}}$$

To be able to extract the number of deviation reports which have ever received the status 'Insufficient Information', some changes might have to be done in FRAS, making it able to count every time status shift towards 'Insufficient Information' ever occured.

8.2.2 Ratio of Parts Request Runtime Time Out as a Waste

To be able to talk about value-adding work when discussing the FQ Engineers work with the assignments preparation, a ratio of the number of deviation reports which is dropped because of a Parts Request Runtime Time Out (see interval B_1 in section 7.3) could be of interest. This PI would be an indicator on how often it occurs.

$$\text{Ratio of Parts Request Runtime Time Out} = \frac{\text{Number of P. R. Runtime Time Out}}{\text{Total number of Parts Request}}$$

The number of Parts Request Runtime Time Outs will be easily retreived if the Process introduces the changes recommended in interval B_1 in section 7.3, aiming at the third box in FRAS, to be checked by for example COL. The total number of Parts Request is retreivable today already, i.e. the number of checkings performed by the FQ Engineers when ordering a Parts Request.

A PI giving the ratio of the number of deviation reports which is dropped because of a Parts Request Runtime Time Out is recommended. This needs some changes to be executed in FRAS, as decribed above.

8.3 The Waiting List

The Lead Time of the Waiting List (interval C in the table in section 7.3) is Waste, since queuing is Waste according to our Theoretical Background section.

But measuring a Lead Time on the Waiting List (and the shortest and the longest object in an interval) just is not enough since not only a larger number in time unit is poorly, but also a larger number of assignments (i.e. deviations not handled) and a higher priority of an assignment on the list, is bad.

[184] Johan Carlsson, 2008-06-18.

Therefore are the Length of the Waiting List and also the Highest Priority of the Waiting List, recommended indicators. These were both displayed in figure 7 and figure 8 in section 7.5.

9 Summary

This chapter provides an extensive summary of the analysis and appliance of indicators in chapters 5, 6, 7 and 8. To receive information about the objective, methods, theoretical background or the Follow-Up Process, the reader is referred to their respective chapters (1, 2, 3 and 4). For a brief summary, see the Summary of Recommendations in Chapter 10.

9.1 Chapter 5 Offered Analysis of The Current Process

…and this analysis determined the first two areas of KPIs.

The Process has two end-line customers on opposite sides of the flow: The distributor and Scania CV AB. These two types of customers expect different products from the process, sometimes maybe even products opposing each other. Being Lean means only producing what is necessary to meet the customer needs but exactly which necessity is supposed to be provided in different situations? This is a question which needs clarity, preceded by a discussion, which is very much needed in the Process today. In the mean time, many discussions about efficiency will be confusing. (Section 5.1)

The Scania Production System (SPS) proclaims that pull systems are to be used in the company and this is something that the company strives to accomplish in all its processes. The idea of the pulling function as more effective than the push function originated at Toyota and has been implemented at Scania. The Follow-Up process is therefore constructed to be driven by a pulling function, though it is not. A first analysis shows that **push and pull meets in the Process, at the waiting list**. (Section 5.2)

A closer look at the pulling function at the waiting list, reveals that it is not really a pull function**. M/H only seams to be pull**. It also exposes a Process which is **slower** than what applying Lean would suggest. The slowness is partly to be blamed on the long intervals between the FQ Meetings (up to two weeks) and the effects in both physical waiting time but also in mind sets, which these long intervals causes. The Process therefore has to be changed to support the assignment teams with a new, faster, firmer and more powerful pace. A second suggestion is to monitor the flows in this part of the Process more actively, so to be able to see to that the amount of work in the process follows the pace and is levelled out and in control. (Section 5.4)

Considering the push side of the Process and more specifically the **FQ Engineers, they have a pushed agenda** with very little overview or possibility for planning ahead. The number of FQ Engineers are fixed and there are limits up to what speed and during how many hours they can be expected to work, there will be a pile building up, which prevents this push system to work effectively. These piles prevent the Process to work properly, since safety errands can be forced to wait in them, and creates a stressful working environment. The Process should therefore **make the FQ Eningeers more ready-to-answer the deviation reports**. They are supposed to be the factory's face towards the customer, so the Process has to let them. This can be done by separating the work-tasks and dividing them into different roles, or adding more recources to compensate for customer visits, market responsibilities, vacations, sick-leave, etc. (Section 5.3)

Handling the pushed new **deviation reports is not the only work task** for the FQ Engineer, though. All of these tasks are important for the Follow-Up Process but they are to be carried out in different positions throughout the internal value chain in the Process and on different conditions. Figure 4 (in section 6.4.3) paints a picture of what the Process looks like from the FQ Engineers point of view. **Some of these work tasks are carried out as push and some as pull**. This results into a mind-tearing situation, when being asked (i.e. pulled) almost always superseedes being pushed and the FQ Engineers in the same time are told that the contradictive relationship should prevail (i.e. that the pushed job should be prioritized higher than the more natural first prio which pull represents). This naturally leads towards a **need to prioritize** among the many different work tasks that are waiting in a normal work day. So, having all these other tasks on top of handling the deviation reports, prohibits the FQ Engineer to effectively handle every work task in their job description and making the push system work. This also means that the factory is constantly not yet aware of all the information that has been provided to it. (Section 5.3)

A Value Stream Map illustrating the process described in the analysis of Chapter 5 is offered in figure 2. (Section 5.5)

Visiting the Process makes it obvious that there are frustrations concerning the FQ Engineers. This frustration is demonstrated both from the FQ Engineers themselves and from the process owner YSR. While the FQ Engineers says 'How am I supposed to find the time for all this and which task is really the most important?', YSR wonders 'Why are not all deviation reports examined at once?'. These two questions represent two different types of areas which seem to be of great importance to the people working in and with the Process. Those areas were also found in the suggestions in section 5.4, especially in the identified need for monitoring of the flow, and are being identified and concluded to constitute the **two types of KPIs that this thesis will focus on** to help the Process with development from the current state. (Section 5.6)

The first types of KPIs will be constituted by aspects of *process flow*. Today the process flow is invisible and that creates, keeps and supports confusion concerning the state and effectiveness of the process. The question asked by YSR in the section above ('Why are not all deviation reports examined at once?'), as well as the suggestion in section 5.4 for M/H to monitor the flows more actively, points towards Process flow management as important to the Process as whole. (Section 5.6.1)

When the FQ Engineers says 'How am I supposed to find the time for all this and which task is really the most important?', as mentioned in section 5.3, they are in a way asking the same questions as the managers for the M and H teams do. **The quest for doing *'the right things' in 'the right way'* and *work situation*,** will therefore be taken into concern as a **second type of KPIs,** when designing those for the Process. (Section 5.6.2)

9.2 Chapter 6 Merged KPI Opinions and Theory with Results of Chapter Five

It is evident that the Process has **current measurements** (for example output, FRAS Flasboard and some locally performed ones in the line organisation) but that, except for maybe it's output (number of solved assignments), it does not use them, or any other, as KPIs or other indicators, in internal or external presentations and reports or as tools for management and process development. The Process needs to find and start using good indicators immediately. (Section 6.1)

Theories and concepts are not always presented in the same way in the literature and in a real process at a company. In this study, that **clash appeared in the definition of the concept of a KPI**. The Process suffers from a broad and not always uniform understanding of the definition and at the same time the **literature is posing higher demands**. Since this inconsistency also has shown to damage both the search and the use of KPIs at the Process, it has to be further adressed and will be so in the following three paragraphs. (Section 6.2)

Everything worth measuring is not immediately a KPI. Some measurements are necessary but not worthy of the epithet 'KPI'. Since the Process is in need of measurements of any kind, this thesis will bring a variety of measurements to start with, but being somewhat more restrictive than the respondents in the interviews (see section 6.2), as to which recommendations that are referred to as KPIs. The types of measurements used in this report therefore are: Key Result Indicator (KRI), Performance Indicator (PI) and Key Performance Indicator (KPI). These types are all explained in sections 3.2, 3.2.1 and 3.2.2. Further on, the ratio 10/80/10 or less as a number of indicators (KPI/PI/KPI) is recommended. (Section 6.3.1)

This study can, at its best, only contribute in a small scale when it comes to which exact indicators that should be applied on the Process. The development of performance measures and performance-improvement strategies is an **iterative process in time**. 'Trial and error and then correction' is **the only method that will assert an excelent quality of the indicators**. (Section 6.3.2)

In Chapter 5, two groups of longed-for KPIs within the Process were identified. According to the Theoretical Background though, KPIs should be constructed for the organization as a whole, not just as a part of a quick-fix of a current problem or for the moment eagerly awaited. The thesis therefore decides to, for a moment, disregard the suggestions of KPI areas from the analysis of the Process in chapter 5. Instead the thesis contemplates the Process as a whole, instead of its current problems, in an attempt to find other suggestions of KPI areas. The literature also said that **KPIs should arise from the CSFs** (Critical Success Factors) of a business and therefore, that's what the thesis has had a closer look at: The CSFs of the Process. During the investigation there were **no signs of any commonly-known CSFs for the Process**. (Section 6.3.3)

In the absence of CSFs for the Follow-Up Process, this thesis has a few suggestions. These are **not created with the help of some literature**, except for Parmenters brief descriptions. The seven suggested CSFs that follow are the result of the summarized experience of the Process, during five months at YSR and none of the interviewees should be held responsible. The suggested CFSs are presented in a clear table in section 6.3.3, containing names, descriptions, how their results can be shown and what they are indicated by. (The CSF names were: **Persistance, Customer Service, Easy to Contact, Structurized Process, Clearness, Visibility and Employee Satisfaction**.) The CSFs which of these, which are easier to measure in numbers, describe the same area that was found in the analysis of the Process in chapter 5, i.e. *Process Flow*. This means that the very same results which we were supposed to disregard when looking at the CSFs also became the result of the CSF analysis. **This proves that indicators for *Process Flow* would be good overall indicators for the Process**. (Section 6.3.3)

The Process is not easy to measure. When attempting to measure, you will probably stumble over these three problems among others: The Process consists of a number of different **subprocesses with differing tasks or perception of such,** a broad range of **complexity in the assignments** and also **several IT systems**. The key to these problems is for the Process to, first and foremost, **put more emphasis on what is measurable than what is not.** In every one of these three categories of problems **there are also properties in common**. To be able to start anywhere in the hunt for KPIs, some of these properties will be recognised: (Section 6.4)

No matter how many subprocesses the Process consists of, they are all constructed to do at least one task in common, which is: Moving the deviation report, or later on the assignment, further on along the Process. In the question of what to measure to have a good indicator throughout the Process, one answer therefore is the item of concern in the Process, i.e. the assignment and its connected deviation reports. The problems with the different complexity in the assignments is further discussed in section 7.2.1 but for now, an appeal for a reconciliation with the idea to measure the assignments anyhow, is made. **The indicators will still mean something, just not everything.** On the count of the third problem, the one about performing measurements on a process that keeps most of its current state data in more than one IT system, stops being a problem as soon as we recognise that there will never exist one perfect measure of a whole process. (Section 6.4)

Three major groups of indicators have been discussed so far. In the following three paragraphs, recommendations concerning the continued work (after this degree project), are being provided:

Time as a metric, has so far been shown (both in the process analysis in Chapter 5 and in the Theoretichal Background in Chapter 3) to be a possibility. Further on it is recommended to be a good metric according to some literature, when using for example Lead Time. Time is seen as a universal metric, representing speed, quality and complexity problems. The Follow-Up Process is therefore **recommended to use the metric Lead Time**. (Section 6.4.1)

When looking at Lead Times, it does not take long before the question of which times in the process that should be measured arises. Lead Time is all time that passes, not just the valuable ones. Value-adding time is often under 1% of the Total Lead Time though. The will to measure the value-adding time and the non-value-adding time (Waste) in separate means that, in addition to Lead Time, **the Process should have indicators for Waste Time as well**. (See application in section 8.1.1).

Waste can be measured in other metrics than time, such as **Amounts of Waste** (see sections 8.2.1 and 8.2.2 for applications in the Process). Discussions about **efficiency** should also involve the notion of Waste (see section 8.1.2 for an application in the Process). (Section 6.4.2)

Extracting indicators based on **’right things’ in the ’right way’ and work situation**, is, though very important to the Process, **outside the delimitations of this thesis. Nontheless, a shorter analysis is made** in section 6.4.3, and some advice on useful indicators and how to move forward from the current situation, will also be provided in this section (summarized in the following two paragraphs): (6.4.3)

It is strongly recommended that the **FQ Engineers chaotic work situation** (se for example figure 4 gets tangled out and transformed **into a normal situation** with a clear and visualized process flow and easy-to-follow prioritizations. A search for KPIs, and a necessary **specification of the Part Lead Time measuremen**t for the FQ Engineers (Interval A and B in section 7.3) are dependent on a normal situation being worked first. Working out a normal situation includes a question of whether all FQ Engineers should do the same work and if all the work tasks really should be performed by an FQ Engineer. The table in section 6.4.2 contains suggestions and descriptions of **indicators (Available Time, Typical Batch Sizes or Practicies, Amount of Market Information and Updates in Time & Action Plan)** for the FQ Engineers which can be important to consider in the future. (Section 6.4.3)

In the **M/H part of the Process, the wish to do the ’right things’ in the ’right way’ is a strong driving force** in the search for new KPIs, as well as knowing more about the bottlenecks slowing down their part of the Process. One way of getting to know more, is to **be better at the reporting of phase changes in FRAS and maybe adding some other transitions as Part Lead Times** (see section 7.3 for application), so that the Lead Time measurements can offer information of interst. Congestions and their bottlenecks can also be studied, which some PMs alredy are doing, through different **queueing theories**. Another method to see where the hold-ups are in the Process and for each assignment, is **a matrix** developed at Bus Chassi. It is determined manually by the question **’who does what and waits for whom?’** and at every FQ Meeting it is being studied, the bottlenecks pointed out and the congestion tried to be dissolved. (Section 6.4.3)

The indicators used today are too slow. They are measured too seldom or available too late. Which period of monitoring that suites the Process could vary somewhat between different indicators. A recommendation to start with is to monitor most of them at least weekly. Daily monitoring would be to prefer for the most effective management of the Process but some consideration has to be taken to the fact that some Product Areas have fewer deviations reported. A daily monitoring of those might not be representative. **The Process should therefore start with weekly KPIs and then shorten the period wherever it seems possible.** (Section 6.5.1)

The indicators in this degree project are for the managers bottom-up. The indicators have different aims for different levels and they are as follows: Number one is to visualize the process flow in different ways. The purpose of this is to make them **easily available to, and understood by, everyone** working in the Process. Another aim of the indicators of this thesis is to be **feasible to the managers and worker**s **for evaluating and controlling performance of the resources** which they are responsible for. A third aim of the indicators of this thesis is to **guide the process owner YSR in the assessement of the functionality** of the process. (Section 6.5.2)

The recommendation for the indicators is to **use no bonus, incentives or goals connected to the process performance**. This will ultimately lead to tampering with the Process, process improvement, the Lean adjustment, other indicators or the indicator of interest itself. (Section 6.5.3)

The process owner, YSR, is already obliged to keep indicators and use them as tools for improvements (see section 4.1.3). It should therefore also **be YSR that shoulders the tasks associated with the development of the indicators** and later on also **the generating, keeping and distributing of all indicators for the Process**. This will be an additional administrative function for the group with an aim to provide a service to the Process continuously. (Section 6.5.4)

9.3 Chapter 7 Applied Lead Times to the Process

The Process is recommended to **measure the Total Lead Time consisting of a continuous number of intervals of Lead Times for the different activities of functions within the Process**. Since these intervals of Lead Times might be seen as to extensive and therefore not being able to offer enough information, those interval will be divided too. **The diveded Lead Time intervals are called Part Lead Times** and the group responsible for each Lead Time interval (like the FQ Engineers part of the Process) are also responsible for any Part Lead Time which they can come up with (for example Time In Inbox). ('Responsible' is to be interpretaded as answerable for the time spent, not as forced to conduct the measuring (which is YSR's job)). The group responsible for a Lead Time also decides whether their Part Lead Times have to be continuous intervals or not (since it is important to be clear on whether the Part Lead Times of every Lead Time interval can be added and seen as corresponding to the Lead Time interval itself, or not). See section 7.1.1 and 7.3 and figure 7 and 8 in section 7.5.

Every group responsible for a Lead Time also **needs to take part in YSRs search** for Part Lead Times and add more specified such to figures 7 and 8. Using the Lead Times, such as **phases and those divided into even shorter intervals** called Part Lead Times, **puts a greater pressure on the Proces**s to offer input about the deviation reports and assignments in a consequent manner. (Section 7.1.1)

The suggestion for Lead Time metrics is to be an *average* Lead Time. This means that the Total Lead Time for every assignment (and its first deviation report, see section 7.2.4) shall be added together and then divided with the total number of solved assignments. To be able to get an idea of the reach between the fastest and slowest assignment, the average should be followed with a paranthesis containing min and max. Thus **the Lead Time should be presented on the form: Average (fastest, slowest): 37 (12, 89).** A second way to broaden the picture using the Lead Times is to present them in batches as section 7.5 approaches. (Section 7.1.2)

FRAS needs to be able to not only produce better time stamps, but also to store them in an accesable way. This means for a limited number of new tasks to be carried out by the users but also what might be a **major reconstruction in the code of FRAS**. The latter should follow Alternative 2 in section 7.1.3 (which includes Alternative 1 as well). (Section 7.1.3)

It is the time which the customer has to wait which is the Lead Time of interest. This corresponds to the total time that it takes to deliver the service once an order has been triggered, which means adding every elapsed time, associated with the completing of an activity (including the waiting time until the activity is started, i. e. queues), to each other. Every group working in the Process can contribute to the clearity as to whom are responsible for what time of the total by participating in the continuous development of the Lead Time measurement and incert new Part Lead Times. (Section 7.2.1)

'Waiting Days' shall only be used when the assignment is put back on the waiting list due to being outranked by an other asssignment with a higher prio. Waiting Days and Running Days both should be counted as Lead Time. It is therefore important to check. and if required, **change, the program code in FRAS** according to the description in the fourth paragraph in this section. If this, for some reason, is not possible, the Lead Time for both Running Days and Waiting Days should be put on the M/H teams Part Lead Time. (Section 7.2.2)

Days should be used as a unit for Lead Times for every part of the Process, because of the argument of uniformity but also to stress the fact that every day counts for the customer. (Section 7.2.3)

The **Total Lead Time** of the Process is recommended to be made up by *the Lead Times of activities associated with the closed assignment, added with the Lead Time of the **deviation report which first reached the factory** and is attached to the assignment.* See figure 7. This corresponds to the amount of time for which the customer has been waiting. (Sections 7.2.4 and 7.4)

Section 7.3 contains **a table with suggestions of intervals for Lead Times and Part Lead Times of the Process**. To be able to perform measurements in these intervals, a recommendation is for the Process to **reprogramme FRAS** to be able to produce the Time Stamps (TS) as described in this section and in section 7.1.3. (Section 7.3)

Sections 7.5.1 and 7.5.2 offers **two examples** of **how the Process can visually communicate the Lead Time information** described in this chapter and some other indicators as well. The idea of the figures (and for the whole process to come together in one long picture) is to share information of Lead Times and amount of work along the Process and to help support the mental picture of the process as a whole. It is important to note that the figures which the sections are based upon are suggestions for *two different types of indicators* and that both are recommended to the Process and has to be told and held apart by everyone in the Process. (Section 7.5)

Figure 7 shows a visualization of the *True* Total Lead Time and its intervals (Lead Times and Part Lead Times). This is the statistics for the *closed* assignments and the activities associated with the closed assignment, added with the Lead Time of the deviation report which first reached the factory and is attached to the assignment. (Section 7.5.1)

To be able to have some more up-to-date data, figure 8 offers a visualization of the Current Lead Times of the Process. Observe that this is the Lead Time of the total amount of WIP, i.e. **all deviation reports (not only the first submitted) and the assignments**. (Opposed to figure 7 which displayed the Total Lead Time for the customer and is the ’True’ Lead Time). The Lead Time of every interval in this figure is the time which each deviation report or assignment, which currently find themselves in this particular interval, has spent there *so far*. It says nothing about how much time each deviation report or assignments has spent in any other interval in the figure. Since this figure shows current Lead Times (and for *all* deviation reports), **it can not provide a Total Lead Time**. (Section 7.5.2)

The Process should use the **First-Pass Yield (FPY) as an overall indicator of how well the Process is functioning**. This indicator has a percentage as its metric and it is the percentage of ’things-in-process’ which make it all the way through the Process the first time without needing to be fixed or rehandled in some way. Section 7.6.1 has some suggestions of what could make up ’repetitions’ and a formula which illustrates FPY. The FPY measurement will need some changes in FRAS to be able to be performed. (Section 7.6.1)

The Process should **terminate the use of the total number of closed assignments as a KPI**. This, since that number has a contradictive interpretation and therefore is useless. Contemplating Little’s Formula also helps us to prevent a possible suggestion to use the Average Completion Rate, since the Process is not a steady state system (and Little’s Fromula therefore can not be applied). (Section 7.6.2)

9.4 Chapter 8 Applied Indicators of Waste to the Process

The indicator named **Total Waste Time** consists of every interval which can be described as Waste. It is imortant to **note that there are more and still hidden Wastes in the Process** than what is included in the sum descibed in section 8.1.1. (Section 8.1.1)

Waste also proves to be important in discussions of efficiency. **An indicator of efficiency is the Process Cycle Efficiency**. The Process should use this and a formula is offered in section 8.1.2. The indicator compares the activities which are creating value to the product, and therefore are worth waiting for in the eye of the customer on one hand, to the time which the customer actually has to wait on the other. It is important to note that for as long as all Waste or Value-added activities are still not defined, this indicator will indicate a unrealisticly high Process Cycle Efficiency. (Section 8.1.2)

Since waiting is a form of waste, and thereby queueing is too, it is clear that we can **measure waste in other metrics than time**. For example, queues have a length and so we see that therefore we can measure the Amount of Waste. See applications in section 8.2.1 (**Ratio of Insufficient Deviation Reports**) and 8.2.2 (**Ratio of Parts Request Runtime Time Out as a Waste**). (Section 8.2)

The Process should, in addition to the Lead Time for the Waiting List (and the shortest and longest object in an interval), measure and display the **Length of the Waiting List** and also the **Highest Priority of the Waiting List**. An example of this is included in figure 7 and figure 8 in section 7.5. (Section 8.3)

10 Recommendations

This chapter offers a brief summary of the recommendations provided throughout the report, followed by a compilation of every recommendation, section, by section.

10.1 Summary of Recommendations

Chapter 5 determined the areas of indicators needed in the Process today (*Process Flow* and/or *doing 'the right things' in 'the right way' and Work Situation*) and recommended some *actions to be taken to bring the work to find indicators forward*. This was done through an analysis of the current state of the Process, as perceived through the empirical findings presented in this chapter and in chapter 4.

Chapter 6 compared the areas of indicators suggested in Chapter 5 (i.e. developed from the current situation of the Process itself) both with the opinions of KPIs from the people within the Process and with the theoretical methods to detect good indicators. This resulted in recommendations of indicators for the process (see below in the compile for more, but some were: *Lead Time for Process Flow, Waste Time, Amount of Waste* and *Process Cycle Efficiency*) and ways to continue the search (developing its own *Critical Success Factors* using the ones offered in the report, *narrow down the use of the term 'KPI', to let it be an iterative development* and also to help the *FQ Engineers with priorities* and then to develop *indicators such as Available Time, Typical Batch Sizes or Practicies, Amount of Market Information and the matrix of 'who does what and waits for whom'*). Other results were recommendations of how to overcome process inconsistencies when measuring (*to put more emphasis on what is measurable than what is not*) and recommendations of how to start to use the indicators suggested (*to measure indicators at least weekly, to use no bonus, incentives or goals connected to process performance, to be better at reporting phase transitions* and *add some other transitions and to let YSR shoulder the administrative function*) .

Chapter 7 applied one of the suggested indicators of Chapter 6: *Lead Time*. Chapter 7 displayed the application of Lead Times by showing HOW to measure (*intervals, divided into Lead Times and Part Lead Times, using the metric Average Lead Time* and *to add Time Stamps and the storage of such into the code of FRAS*), WHAT to measure (describing which time that is of interest: *It is the customers time which ticks and it should be measured in days and by only counting the first deviation report*) and WHERE to measure (offering suggestions of *Lead Time intervals* in the table of section 7.3). This chapter also gave two examples of how to *visualize the True Lead Time and the Current Lead Time*. At the end, the *First-Pass Yeld is introduced as a good overall indicator.*

When looking at Lead Time, as in Chapter 7, questions arises pretty fast as to which time that really counts, i. e. is value-adding. Everything non-value-adding is referred to as Waste and when discussing efficiency, it is important to be able to discuss Waste. KPIs to determine efficiency were an expressed desire in the objective of this thesis, and therefore, **Chapter 8** summarized some of the different kinds of Waste which is measurable in the Process: *Total Waste Time, Process Cycle Efficiency, Amount of Waste (Ratio of Insufficient Deviation Reports* and *Ratio of Parts Request Runtime Time Out as a Waste)* and both *Length and Height of the Waiting List.*

Chapter 9 contained an *extensive summary* of the analysis and appliance of indicators in chapters 5, 6, 7 and 8. To receive information about the objective, methods, theoretical background or the Follow-Up Process, the reader was referred to their respective chapters (1, 2, 3 and 4).

Chapter 10 offered a *brief summary* of the recommendations provided throughout the report, followed by a *compilation of every recommendation, section by section*.

Chapter 11 provided a summary of which indicators (PIs, KPIs and KRIs) the Process should use.

10.2 Continued Research

Not all recommended indicators can be applied at once. Some preparations is needed and is described in the recommendations in section 10.3. The preparations will mean both process and system changes. In the mean time, this study offers a framework describing how the Process should approach the task of designing new indicators in the future, which obstacles to eliminate to be able to design these indicators and also a number of indicators to start using almost immediately.

The work remaining after this thesis are therefore of several categories and some of those are:

- Studying the thesis and focusing on the indicators which is currently measurable.
- Learning from the thesis about what preparations that is needed for the rest of the recommended indicators to be applicable and then implement those.
- Using the presented framework in Chapter six to design new suitable indicators for the Process.

The development of performance measures and performance-improvement strategies is an iterative process in time.[185] 'Trial and error and then correction' is the only method that will assert an excellent quality of the indicators.

The last recommendation is therefore for the Process to embrace the work suggested in the list above and the section below, to assert the obtaining of feasible indicators of effectivity. A leap forward is to appoint someone to lead the work that lies ahead.

10.3 Compilation of Recommendations

This table offers the compilation of every recommendation, section by section.

5.1	The Process needs to **bring clarity**, preferably through a clarifying discussion, as to which of the two customers (the distributor or Scania CV AB) who are supposed to be provided in different functions of the Process. Without this clarity, discussions concerning efficiency will stay confusing.
5.3	The Process should **separate the work tasks for the FQ Engineers and divide them into different roles**, and/or add more resources to compensate

[185] Parmenter, p. 22.

	for customer visits, market responsibilities, vacations, sick-leave, etc. This will make the FQ Engineers more ready-to-answer and the existing push system (concerning the deviation reports) to work more efficiently.
5.4	Because of the risk for an unnecessary slowness to occur (because of the long intervals between the FQ Meetings and the effects in both physical waiting time but also in mind sets, which these long intervals causes) **the Process has to be changed.** It has to support the assignment teams with a new, faster, firmer and more powerful pace. **Shorter FQ Meetings once or twice a week** is a suggestion, though this pace has to fit the Process in the whole. These meeting should also bee a more powerful pull function than today, advocating the customer's interest in a fast solution.
5.4	A second suggestion is to **monitor the flows in the M/H part of the Process more actively**, so to be able to see to that the amount of work in the process follows the pace and is levelled out and in control. Keeping a steady pulled flow is the best way to get productive.
5.6.1 5.6.2	To be able to have KPIs which **fits the Process** current situation, the **KPIs should be based on one or both of the following two areas:** *Process Flow* and/or *doing 'the right things' in 'the right way' and Work Situation.*
6.1	**The Process needs to find and start using indicators immediately**. It is evident that the Process has current measurements (for example output, FRAS Flasboard and some locally performed ones in the line organisation) but that, except for maybe it's output (number of solved assignments), it does not use them, or any other, as KPIs or other indicators, in internal or external presentations and reports or as tools for management and process development.
6.3.1	**The Process is recommended to narrow down the use of the term 'KPI' and at the same time introduce two new types of indicators.** The indicators should be: Key Result Indicator (**KRI**), Performance Indicator (**PI**) and Key Performance Indicator (**KPI**). These types are all explained in sections 3.2, 3.2.1 and 3.2.2. Further on, the ratio 10/80/10 for the number of indicators (KPI/PI/KPI) is recommended.
6.3.2	**The development of performance measures and performance-improvement strategies should be an iterative process in time.** This study can, at its best, only contribute in a small scale when it comes to which exact indicators that should be applied on the Process.
6.3.3	The Process has to **open up a discussion on, and develop commonly-known, CSFs.** This work should start with an evaluation of the seven already offered CSFs in the table in section 6.3.3.
6.4	The process is encouraged to **put more emphasis on what is measurable than what is not.** The Process is not easy to measure but it has to be recognized that in the different categories of problems, there are just as well properties in common. The indicators will still mean something, just not everything.
6.4.1	The Process is recommended to **use the metric Lead Time to measure Process Flow.** Time is seen as a universal metric, representing speed, quality and complexity problems. Time has also been shown to be a good metric in the Process. Further on it is a good metric according to some literature, when using for example Lead Time.
6.4.2	The Process should **use the following indicators involving Waste**: **Waste Time, Amount of Waste and Process Cycle Efficiency**. See Chapter 8 for

	recommendations of more precise indicators in the Process.
6.4.3	It is **strongly recommended that the FQ Engineers chaotic work situation** (se for example figure 4 **gets tangled out and transformed into a normal situation with a clear and visualized process flow and easy-to-follow prioritizations.** A search for KPIs, and a necessary specification of the Part Lead Time measurement for the FQ Engineers (Interval A and B in section 7.3) are dependent on a normal situation being worked first. Working out a normal situation includes a **question of whether all FQ Engineers should do the same work** and if all the work tasks really should be performed by an FQ Engineer. The table in section 6.4.3 contains **suggestions** and descriptions of indicators (**Available Time, Typical Batch Sizes or Practicies, Amount of Market Information and Updates in Time & Action Plan**) for the FQ Engineers which can be important to consider in the future.
6.4.3	The M/H part of the Process has to be **better at the reporting of phase changes** in FRAS and maybe **add some other transitions** as Part Lead Times (see section 7.3 for application), so that the Lead Time measurements can offer information of interest. An implementation of the matrix based on the question **’who does what and waits for whom?’ and developed and** used at Bus Chassi, should offer some assistance in the search for bottlenecks at FQ Meetings.
6.5.1	**The Process should start with weekly KPIs and then shorten the period wherever it seems possible**. The indicators used today are too slow. They are measured too seldom or available too late. Which period of monitoring that suites the Process could vary somewhat between different indicators. A recommendation to start with is to monitor most of them at least weekly. Daily monitoring would be to prefer for the most effective management of the Process but some consideration has to be taken to the fact that some Product Areas has fewer deviations reported. A daily monitoring of those might not be representative.
6.5.3	The recommendation for the indicators is to **use no bonus, incentives or goals connected to process performance**. This will ultimately lead to tampering with the Process, process improvement, the Lean adjustment, other indicators or the indicator of interest itself.
6.5.4	**YSR is recommended to shoulder the tasks associated with the development of the indicators and later on also the generating, keeping and distributing of all indicators for to the Process**. This will be an additional administrative function for the departement with an aim to provide a service to the Process continuously.
7.1.1	The Process needs **to measure the Total Lead Time for each of the Product Areas, but also dividing those Times into Lead Times and Part Lead Times**. See section 7.1.1 and 7.3. and figures 7 and 8.
7.1.1	**Every group responsible for a Lead Time also needs to take part in YSRs search for Part Lead Times** and add more specified such to figures 7 an 8.
7.1.1	**Using the Lead Times**, such as phases and those divided into even shorter intervals called Part Lead Times, **puts a greater pressure** on the Process **to**

	offer input about the deviation reports and assignments in a **consequent manner.**
7.1.2	The suggestion for **Lead Time metrics** is to be an ***average*** **Lead Time**. This means that the Total Lead Time for every assignment (and its first deviation report, see section 7.2.4) shall be added together and then divided with the total number of solved assignments.
7.1.3	**FRAS needs to be able to not only produce better time stamps, but also to store those in an accessable way**. This means for a limited number of new tasks to be carried out by the users but also what might be a major reconstruction in the code of FRAS. The latter should follow Alternative 2 in section 7.1.3 (which includes Alternative 1 as well).
7.2.1	**It is the time which the customer has to wait which is the Lead Time of interest**. This corresponds to the total time that it takes to deliver the service once an order has been triggered, which means adding every elapsed time, associated with the completing of an activity (including the waiting time until the activity is started, i. e. queues), to each other.
7.2.2	**'Waiting Days' shall only be used when** the assignment is put back on the waiting list due to **being outranked by an other asssignment with a higher prio**. Waiting Days and Running Days both should be counted as Lead Time. It is therefore **important to check. and if required, change, the program code** in FRAS according to the description in the fourth paragraph in this section. If this, for some reason, is not possible, the Lead Time for both Running Days and Waiting Days should be put on the M/H teams Part Lead Time.
7.2.3	This study recommends **days to be used as an unit for Lead Times** for every part of the Process, because of the argument of uniformity but also to stress the fact that every day counts for the customer.
7.2.4	When measuring Total Lead Times (visualized in figure 7 in section 7.5.1), **only the deviation report which first reached the factory** (see figure 6) and is attached to the assignment which is being measured, will be added to the Lead Time of the assignment. This corresponds to the amount of time for which the **customer has been waiting**.
7.4	The **Total Lead Time** of the Process is recommended be made up by the Lead Times of **activities associated with the closed assignment, added with the Lead Time of the deviation report which first reached the factory and is attached to the assignment.**
7.3	**Start the Lead Time measuring with the suggestions of intervals for Lead Times of the Process presented in the table in section 7.3**. To be able to perform measurements in these intervals, a recommendation is for the Process to **reprogramme FRAS** to be able to produce the Time Stamps (TS) as described in this section and in section 7.1.3.
7.3	To make it possible for the FQ Engineers to measure which steps of their part of the Process that consumes which part of their Lead Time in an other way of measuring or additional measuring, **TSs should be applied to the different changes in FRAS of the 'status' of a deviation report**. To provide the FQ Engineers some freedom of action when using the status

	options, and in the end get more meaningful Part Lead Times, the **communication with the customer should be through the Time and Action Plan instead.** The deviation report should therefore be kept open externally, kept updated and the customer has to be informed about this and able to find the Time and Action Plan in FRAS.
7.5 7.5.1 7.5.2	**The Process should display the True Lead Times with figure 7** and the **Current Lead Times With figure 8.** It is important to **educate everyone in the Process to tell the two figures apart**. The idea of the figures (and for the whole process to come together in one long picture) is to share information of Lead Times and amount of work along the Process and to help support the mental picture of the process as a whole. (7.5.1, 7.5.2) The Process should use the **True Lead Time (figure 7) as a KRI/KPI and the Current Lead Time (firgure 8) as a KPI**.
7.6.1	The Process should use the **First-Pass Yield (FPY) as an overall indicator of how well the Process is functioning.** This indicator has a percentage as its metric and it is the percentage of ’things-in-process’ which make it all the way through the Process the first time without needing to be fixed or rehandled in some way. Section 7.6.1 has some suggestions of what could make up ’repetitions’ and a formula which illustrates FPY. The FPY measurement will need some changes in FRAS to be able to be performed. See section 7.6.1 for more details.
7.6.2	The Process should **terminate the use of the total number of closed assignments as a KPI.** This, since that number has a contradictive interpretation and therefore is useless. Contemplating Little’s Formula also helps us to prevent a possible suggestion to use the Average Completion Rate, since the Process is not a steady state system (and Little’s Fromula therefore can not be applied).
8.1.1	The indicator named **Total Waste Time should consist of every interval which can be described as Waste**. It is imortant to note that there are more and still hidden Wastes in the Process than what is included in the sum given in section 8.1.1. It is therefore of great imoprtance to **continue the work of dividing intervals into smaller ones and adding the Waste Lead Times to the sum**
8.1.2	The Process should **use the KPI named Process Cycle Efficiency** and a formula is offered in section 8.1.2. The indicator compares the activities which is creating value to the product, and therefore are worth waiting for in the eye of the customer on one hand, to the time which the customer actually has to wait on the other. It is important to note that for as long as all Waste or Value-added activities are still not defined, this indicator will indicate a unrealisticly high Process Cycle Efficiency.
8.2.1	The Process should measure the ratio describing to what percentage of the received deviation reports that the FQ Engineers had to work without performing any actual work for the deviation istelf, i.e. **Waste.** This is the **ratio of deviation reports getting the status ’Insufficient Information’**. Dividing the amount of deviation reports which has gotten this status with the total amount of deviation reports offers the ratio. This ratio can be used as a **KPI**.

	To be able to extract the number of deviation reports which has ever gotten the status 'Insufficient Information', some changes might have to be done in FRAS, see section 8.2.1 for a brief description.
8.2.2	A **PI** giving the **ratio of the number of deviation reports which is dropped because of a Parts Request Runtime Time Out** is recommended. This needs some changes to be executed in FRAS, see section 8.2.2.
8.3	The Process should, in addition to the Lead Time for the Waiting List (and the shortest and longest object in an interval), **measure and display the Length of the Waiting List** and also the **Highest Priority of the Waiting List**. An example of this is included in figure 7 and figure 8 in section 7.5.

11 Compiled Indicators for the Process

This chapter provides a summary of which indicators (PIs, KPIs and KRIs) the Process should use.

Review section 10.2 for more details about each of these indicators, as well as the remaining recommendations.

The indicators with a bracket around is recommended but not for immediate use. They usually need the Process to sort some things out first.

The Process is, according to Chapter 5, recommended to use indicators within the areas of: *Process Flow* and/or *doing 'the right things' in 'the right way' and Work Situation*.

For information on the terms PI, KPI and KRI, see sections 3.2, 3.2.1 and 3.2.2.

11.1 Process Flow

- Lead Times and Part Lead Times, PI (Section 7.1-7.3)
- Total Lead Time, KPI (Section 7.4)
- Visualization of True Lead Time, KRI (Section 7.5.1)
- Visualization of Current Lead Time, KPI (Section 7.5.2)
- Total Waste Time, PI (Section 8.1.1)
- First-Pass Yield, KPI (Section 7.6.1)
- Process Cycle Efficiency, KPI (Section 8.1.2)
- Ratio of Insufficient Deviation Reports, PI (Section 8.2.1)
- Ratio of Parts Request Runtime Time Out, PI (Section 8.2.2)
- Length and Height of the Waiting List, PI (Section 8.3)
- [Other indicators developed to measure developed Critical Success Factors could be used as KPIs.] (Section 6.3.3)

11.2 Doing 'the right things' in 'the right way' and Work Situation

These indicators were outside the delimitations of this degree project but some suggestions were provided anyhow in section 6.4.3:

- [Available Time, PI] (Section 6.4.3)
- [Typical Batch Sizes or Practicies, PI] (Section 6.4.3)
- [Amount of Market Information, PI] (Section 6.4.3)
- [Number of Updates in Time & Action Plan, PI] (Section 6.4.3)
- ['Who does what and waits for whom?', PI] (Section 6.4.3)

12 References

12.1 Printed Sources

Aronsson, Håkan, Ekdahl, Bengt & Oskarsson, Björn, 2008, 2nd ed. *Modern logistik – för ökad lönsamhet*. Lund: Liber AB.

Berner, Åsa. *SEB Way funkar bra i kundtjänst*. Finansvärlden: No 9, 2007.

Bökmark, Peter & Andersson, Jan. *Vinster med Lean*. Teknik & Tillväxt: No. 1, 2004.

Franceschini, Fiorenzo, Galetto, Mauritzio & Domenico, Maisano, 2007. *Management by Measurement – Designing Key Indicators and Performance Measurement Systems*. Turin: Springer.

Galloway, Dianne, 1994. *Mapping Work Processes.* Milwaukee: Quality Press.

George, Michael L., 2002. *Lean Six Sigma: Combining Six Sigma Quality with Lean Speed.* New York: McGraw-Hill.

George, Mike, Rowlands, Dave & Kastle Bill, 2002, *What Is Six Sigma?* New York: McGraw-Hill.

George, Michael L, 2003. *Lean Six Sigma for Service – How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions*. New York: McGraw-Hill.

Johansson, Lars-Göran, 2000. *Introduktion till vetenskapsteorin.* Stockholm: Thales.

Keyte, Beau & Locher, Drew, 2004. *The Complete Lean Enterprise: Value Stream Mapping for Administrative and Office Processes*. New York: Productivity Press.

Lambrecht, Marc R., Ivens, Philip L. & Vandaele, Nico J.. *ACLIPS: A Capacity and Lead Time Integrated Procedure for Scheduling.* Management Science: Vol. 44, No. 11, Part 1 of 2, Nov. 1998.

Lantto, BrittMari. *SEB Way innebär strukturiserat bondförnuft*. Finansvärlden: No. 9, 2007.

Lantto, BrittMari. *Nu är Lean vardag på Nordea*. Finansvärlden: No. 11, 2007.

Lee, Hau L, Padmanabhan, V. & Whang, Seungjin. *The Bullwhip Effect In Supply Chains.* Sloan Management Review: Vol. 38, No. 3, p. 93-102, Spring 1997.

Liker, Jeffery K., 2004. *The Toyota Way – 14 Management Principles from the World's Greatest manufacturer.* New York: McGraw-Hill.

Patel, Runa, Davidson, Bo, 2003. *Forskningsmetodikens grunder: att planera, genomföra och rapportera en undersökning.* 3 uppl. Lund: Studentlitteratur.

Parmenter, David, 2007. *Key performance indicators: developing, implementing, and using winning KPIs*. New Jersey: John Wiley & Sons Inc.

Robbins, Stephen P. & Judge, Timothy A., 2007, 12th ed. *Organizational Behavior*. New Jersey: Pearson Education/Prentice Hall.

Rother, Mike & Shook, John, 2003, version 1.3. *Learning to See. Value-Stream Mapping to Create Value and Eliminate Muda.* Cambridge: The Lean Enterprise Institute Inc.

Råde, Lennart & Westergren, Bertil, 2001, 4th ed.. *BETA Mathematics Handbook for Science and Engineering*. Lund: Studentlitteratur.

Saunders, Mark, Lewis, Philip, Thornhill, Adrian, 2000. *Research Methods for Business Students*. 2 uppl. Harlow: Financial Times/Prentice Hall.

Scania AB (publ), 2008. *Scania in Brief*. Trosa: Trosa Tryckeri

Setijono, Djoko & Dahlgaard, Jens. *Customer Value as A Key Performance Indicator (KPI) and A Key Improvement Indicator (KII)*. Measuring Businell Excellence: Vol. 11, No. 2, 2007.

Spearman, Mark L. & Zhang, Rachel Q.. *Optimal Lead Time Policies*. Management Science: Vol. 45, No 2, Feb. 1999.

Tellenback, Sten, 1992. *What Is Lead Time? A Research Note*. Luleå University of Technology, Research Report, TULEA 1993:36, ISSN 0347-0881.

Teorell, Jan, Svensson, Torsten, 2007. *Att fråga och att svara*. Stockholm: Liber.

12.1.1 Scania Internal Documents

Almér, Thomas, 2008-05-08, *Product Follow-Up Process Presentation*. Inline/YSR.

Almér, Thomas & Melin, Anders, 2008-04-16, Job *Description for Quick Teams*. Reg. No.:RQ 02.11, Issue p4.1.

Executive Board, 8 January 2008, *Product Development Process*. Document ID: STD4303en.

Dahl, Mikael, 2006-10-30, *Process Flow – Red Arrow*, InLine/YSR/Processes

Pettersson Arman, Åsa, 2008, *FRAS presentation*, FRAS presentation_Homepage_2008_02.ppt

Romlin, Eva, 2007-08-07, *What we do at YSQ*. InLine/YSQ

12.2 Oral Communication

12.2.1 Interviews

Carlsson, Johan, FQ Engineer Cabs, oral interview 2008-06-18.

Klingvall, Magnus, *FQ Engineer Engines*, oral interview 2008-06-03.

MacKaldener, Magnus, *Product Manager Bus Chassis*, oral interview 2008-03-11.

Malmberg, Stefan, *Assignment Manager Electrics*, oral interview 2008-04-09.

Sjöblom, Helene, *Product Manager Electrics*, oral interview 2008-04-09.

Sylvander, Stefan, *Product Manager Engines*, oral interview 2008-04-17.

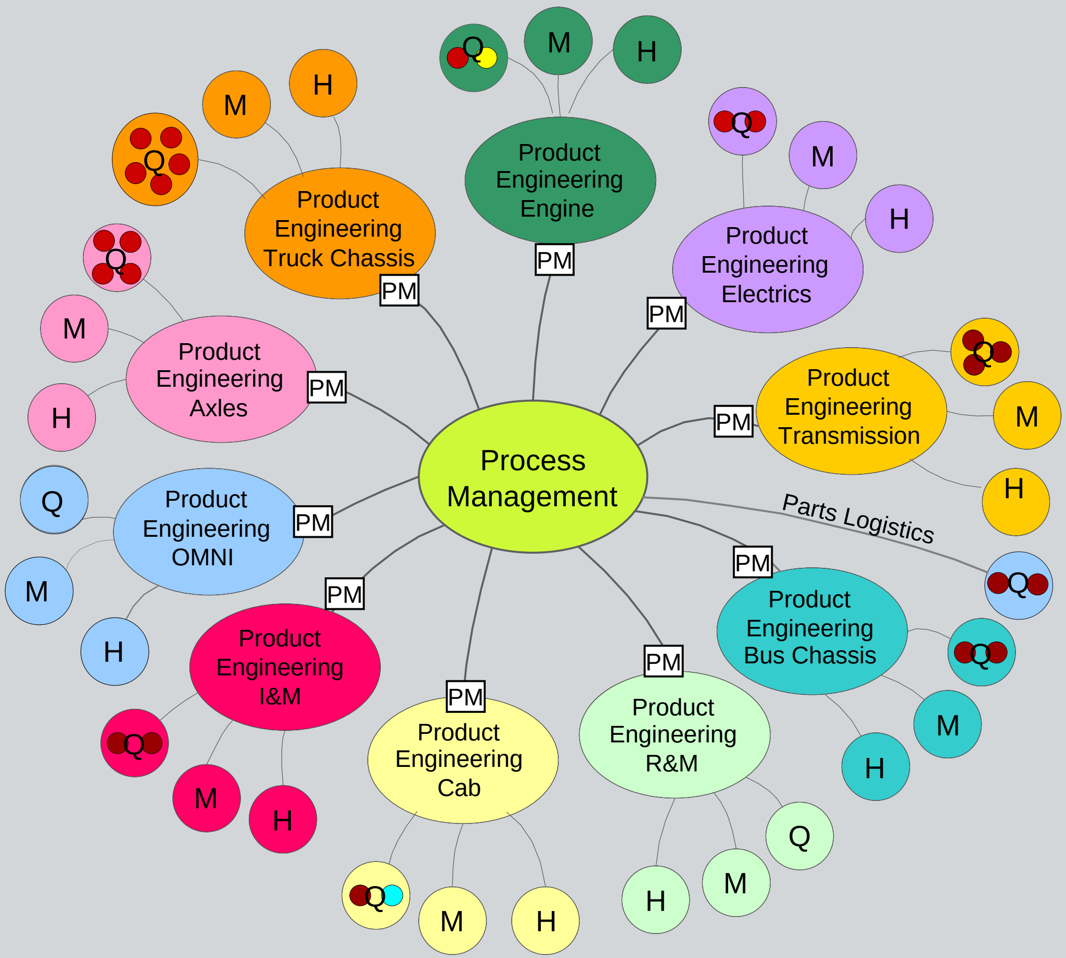
Öhman, Rickard, *Q Team Leader*, oral interview 2008-03-11.

12.2.2 Conversations and Interviews with Low Structure

Andersson, Björn, *FQ Engineer Cabs*, oral interview, 2008-02-27.

Almér, Thomas, *New Process Leader*, oral conversations, Feb – Sep 2008
Dahl, Mikael, *Process Developer*, Feb – Sep 2008.
Jedbring, Kjell, *Process Developer*, Feb – Sep 2008.
Pettersson Arman, Åsa, *FRAS System Manager*, Feb – Sep 2008.

Appendix A - Product Engineering Areas



Appendix B – Base of Questions

Presentation of the project and Master thesis

1. Which are your work tasks?

2. What are you curios about within your own part of the process? How would you measure it?

3. Which are the critical success factors (CSF:s) for your part of the process? (Your own opinions as well as factory directives are of interest)

   Please share the 3 most important!

4. This project is mainly about how to measure lead times. What is your view on measuring lead times? (Sv: Vad tror du om att mäta ledtider?)

5. What would you like to use the lead time information for?

6. Are you conducting any lead time measurement already?

7. How should one measure lead times in your part of the process?

8. What goals do you have concerning lead times for your part of the process?

9. Do you have any methods to measure the fulfilment of those goals? Which?
   -If YES: Do you response to deviations? Are you saving/creating statistics? How often do you perform the measurements?

10. Do you in any way compare information about your lead time with other groups within the process conducting similar tasks to yours?

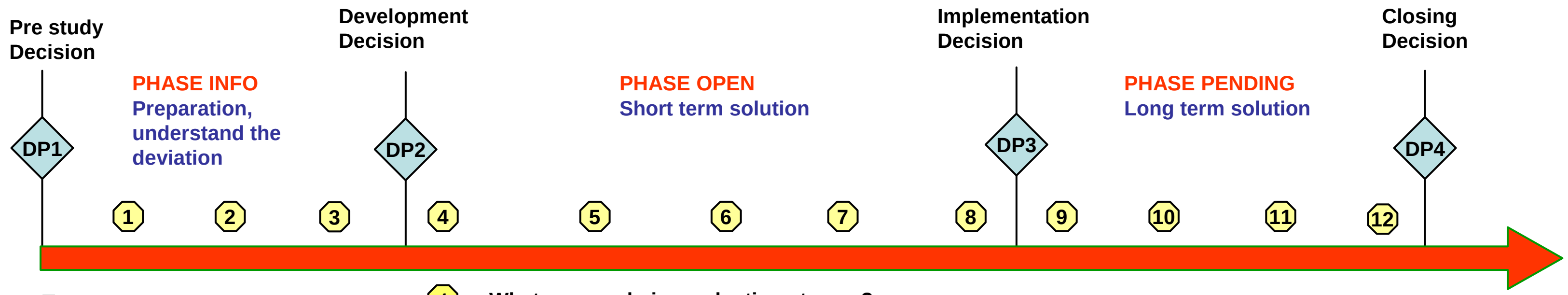
11. Which other key performance indicators or such measurements do you use? (How, when and for what?)

12. Now, we will turn to some more technical information concerning the FRAS system. At first, I would like you to tell me how/ when you use FRAS in your part of the Red Arrow Process.

13. In front of us we a process map for lead time measurement. Could you help me figuring out where to find interaction points of value for lead time measurements?

Appendix C - Checkpoints for the Q-process

Basis for cross-functional activities in the assignment



1 **Information from Production/Field** /Supplier is clear and understood.

2 **Will this affect end customer?**
Yes => FQ; Inform COL
No => PR; Not to inform COL

3 **Identify cause**
•Check production (man, machine, method)
•Analyze the involved parts, inside or outside of specification (material)
•Check design (tolerances and so on)

Handling time for checkpoint
1 to 3: First COL follow-up 24 hours
4 to 8: target 24 hours
4 to 12: target 10 working calendar days

Info to Open with trigger *"Q-team starts to solve assignment"*
Open to Pending with trigger *"Short term solution implemented"*
Pending to Closed with trigger *"Long term solution implemented"*

4 **•What can we do in production at once?**
•Inform production about deviation
•Change/sort/adjust parts in production
•Note materials batch number
•Introduce an extra check in production
•Decide consequence and extent of problem
•Delivery stop?
•Note Chassis/Component No for this actions

5 **Is it possible to introduce a short term solution?**
•Could we improve the standards in production?
•Could we sort the material in stock/buffer?
•Could we improve the design?
•Do we need a temporary instruction for the short term solution?
•Is EFR needed?
•Report Chassis/Component No for the short term solution.

6 **Will spare parts and other design areas be involved?**

7 **Verify short term solution**.
•Are we delivering according to specification?
Is the new design satisfactory?

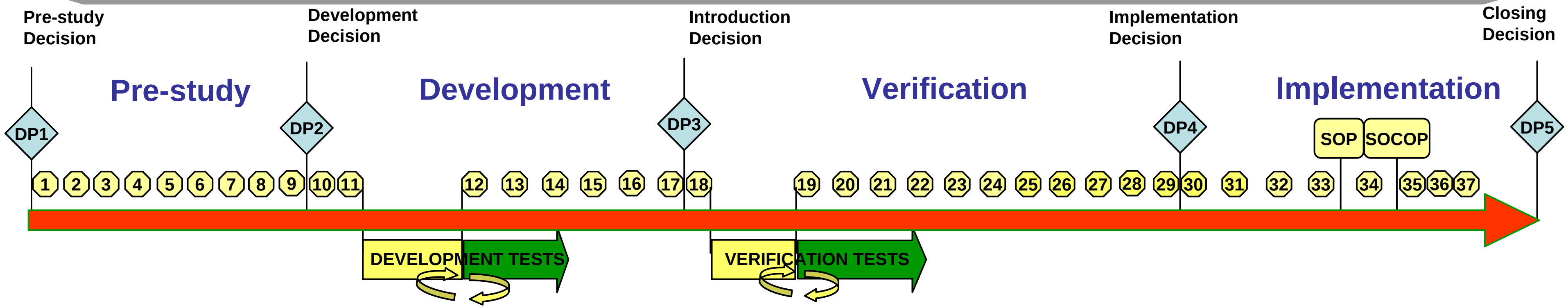
8 **Recommendation for phase transition**

9 **Determine long term solution**
•Do we need to change dies, tools, fixtures, buffers in production?
•Long term corrective actions introduced/ developed at supplier?
•Do we need to change any parts, drawings, documents (ECO)?
•Improve the process causing the deviation

10 **Follow up introduction in production**
•When could long term solution be introduced?
•Long term solution introduced and verified in production
•Report Chassis/Component No for the long term solution.

11 **Recommendation to close item**
a) Long term solution implemented.
b) Parts in all stores concerned.
c) Customer not affected by quality deviation and short term solution closed.
d) All administration ready.
e) Lesson learned written (if decided).
f) Recommendation to close item

Appendix D - Checkpoints for assignment managers in M/H



- DP1 Pre-study decision
- 1 Start up meeting
- 2 FQ ECO created
- 3 Root cause identified
- 4 Service solution
- 5 Alternative solutions identified
- 6 Analysis of solution
- 7 Planning of aftermarket activities
- 8 Decide recovery
- 9 Planning for next phase
- DP2 Phase transition to development
- 10 Design of prototype parts and digital mock up
- 11 Part priming and first spare part demand defined
- 12 Prototype parts ordered and delivered
- 13 Prototype parts verified
- 14 Prototype assembly
- 15 Decided product improvements introduced in specification
- 16 P-status on all parts and documents
- 17 Planning for next phase
- DP3 Phase transition to verification
- 18 Serial alike parts ordered and delivered
- 19 Serial parts verified
- 20 Test assembly ready
- 21 Decided product improvements introduced in specification
- 22 PR status on decided drawings and documents
- 23 Serial tools ordered
- 24 Decision of aftermarket activities
- 25 ECO distributed in status 4.4
- 26 Spare part preparation ready
- 27 Purchase order placed on all involved parts
- 28 SOP/SOCOP is set on the ECO
- 29 Execute recovery
- 30 Planning for next phase
- DP4 Phase transition to implementation
- 31 PPAP approved
- 32 Verification of serial parts
- 33 Production ready for introduction
- 34 First serial delivery at Scania (FSH)
- 35 Verification of introduction (SOP+SOCOP)
- 36 Spare parts available for customer
- 37 Decided information is available for the aftermarket
- 38 Assignment documentation archived and communicated
- DP5 Phase transition to termination or closed

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Appendix E - Work Week Mapping

Operation		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Failure reports	**(e.g. preparation incl statistics before COL and answer to distributor after COL)**							
	Parts request material handling							
Assignment work	**Market info (e.g. TI / TM I / AMI / Campaign, TPM preparation)**							
	Update T&A-Plan							
	Assignment related meetings							
Market visits	**(e.g. PSM / EWS, field quality Item follow up)**							
	Travel time 16.45-08.00							
	Travel time 08.00-16.45							
Meetings	**(e.g. COL, FQ meeting, information meeting, CR0, group meeting)**							
Statistics	**(e.g. for assignment OC, PLC)**							
Other	**Education**							
	Improvment board work, fairs etc							
	Helpdesk questions							
	IT malfunction (81795 jobs)							
	Not specified							
Mail work								
Total work time	**Fill in worked time**							