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Measuring Performance of an Order-to-Delivery Process

A study at Scania CV AB

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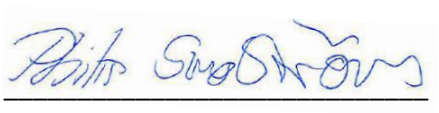

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Abstract

The Order-to-Delivery (OTD) process covers the entire flow from an initiated order until the product or service is delivered to the customer. OTD is considered a core flow in order to successfully deliver products according to the customer's needs. Therefore, is it of importance to track the performance of this flow and all intermediary processes through performance measurements. The key to successful performance measurement is to identify critical factors that can be measured towards previous states, future goals and industry best-practices. However, there are no standardized solutions that can be adopted. Instead performance measurements need to be adapted to each organization's capabilities, limitations and needs. Effective performance measures and indicators can help steer a company in the right direction.

In this thesis, Scania's industrial OTD process and the connecting indicators has been studied. The company would like to know possible indicators to measure the performance of this process so that it will contribute to find deviations, continuous improvement and challenge the current state. There is also a need to increase the knowledge of how to interpret and manage indicators.

The project has been conducted through both empirical and theoretical studies. An extensive literature review has been performed. The study concluded in methods and best practices for performance measurements, as suggested by literature. It has also resulted in an identification of relevant OTD measures. Empirical studies have been conducted through a current state analysis of Scania and a company comparison. Five companies were interviewed on the topic of performance measurements. The aim was to identify the measurements used in each of the companies OTD flow and to investigate if any best practices could be identified. The empirical findings have been analyzed towards the theoretical findings in order to find gaps and improvement suggestions. It was found that lead time and delivery performance are two strategic elements to evaluate a company's OTD flow.

Lastly, a concept has been developed as an additional approach to measure the part of a lead time that has the largest variance - transport time. The concept can, with further work, be extended to include the entire lead time. The aim with the concept was to fairly compare different transport times against each. It is believed that the approach can be used as a tool to visualize the efficiency of the transport flow to different delivery countries and therefore determine if the country behaves according to a normal situation.

The thesis has resulted in recommendations to implement new measures that could be of value to Scania. Process wise it is suggested to better differentiate between indicators and to improve the way they are presented and reported. It is also suggested that that quality of the input data and the reporting process for this should be reviewed.

Keywords

Logistics, Supply Chain Management, Order-to-Delivery, Performance Measurements, Key Performance Indicators, Lead Time, Delivery Performance

Sammanfattning

Order till leverans-processen täcker hela flödet från orderläggning tills att slutprodukten eller servicen levereras till kund. Processen anses vara en kärnprocess och är kritisk för att kunna leverera produkter enligt kundens behov. Det är därför viktigt att följa upp prestandan av detta processflöde genom olika prestationsmått. För att lyckas med prestationsmätning är det viktigt att identifiera kritiska faktorer och mäta dessa mot tidigare lägen, framtida mål och best practices inom industrin. Det finns dock inga standardiserade lösningar som kan implementeras på företag. Prestationsmått måste anpassas efter varje organisations kapacitet, begränsningar och behov. Genom att använda effektiva prestationsmått och indikatorer kan ett företag styras i önskvärd riktning.

I detta examensarbete har Scanias industriella order till leverans-process och dess tillhörande prestationsmått studerats. Företaget har en önskan om att identifiera möjliga indikatorer för att mäta prestandan av order till leverans-processen, vilket kan bidra till att hitta avvikelser, ständiga förbättringar och att utmana den nuvarande situationen. Det finns även ett behov av att öka kunskapen om hur prestationsmått ska tolkas och hanteras.

Detta projekt har utförts genom empiriska och teoretiska studier. En omfattande litteraturstudie har resulterat i lämpliga metoder och utföranden gällande prestationsmått. Studien har även resulterat i relevanta order till leverans-mått enligt akademisk forskning. De empiriska studierna har bestått av en nulägesanalys av Scania och en jämförelsestudie där fem olika företag har blivit intervjuade inom ämnet prestationsmätning. Målet med jämförelsestudien var att undersöka de olika mått som företagen använder i sin order till leverans-process och för att ta reda på hur de arbetar med prestationsmätning. De empiriska studierna har analyserats i förhållande till teori, för att hitta kunskapsluckor och förbättringsförslag. Det kan konstateras att ledtid och leveransprestanda är två strategiskt viktiga faktorer för att kunna utvärdera ett företags order till leverans-process.

Slutligen har ett nytt ledtidskoncept blivit utvecklat. Konceptet mäter transporttiden, vilket är den del av ledtiden där störst variation uppstår. Konceptet har potential att utvecklas och förlängas till att mäta den totala ledtiden. Målet med konceptet var att jämföra olika transporttider på ett rättvist sätt mot varandra. Konceptet kan användas som ett verktyg för att visualisera effektiviteten av transportflödet till olika leveransländer och därav avgöra om landets processer presterar enligt ett normalläge.

Examensarbetet har resulterat i rekommendationer om att implementera prestationsmått som kan skapa värde för Scania. Det rekommenderas också att särskilja olika typer av prestationsmått samt förbättra hur dessa presenteras och rapporteras. Även kvalitén på indata och hur data rapporters bör ses över.

Nyckelord

Logistik, försörjningskedja, order till leverans, prestationsmått, nyckeltal, ledtid, leveransprestanda

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Abbreviations

ADD – Actual Delivery Date

ARD – Actual Release Date

ATA – Actual Time of Arrival

BC – Batch closed

BSC – Balanced Scorecard

CBU – Completely built up

CDD – Confirmed Delivery Date

CO – Commercial Operations

CRD – Confirmed Release date

DDD – Desired Delivery Date

DTL – Delivery Time List

EA – End Assembly

F&BC – Financial services & business control

FD – Finished date

FOD – First Order Date

KAP – Kundenauftragsprozess (German expression for Order-to-Delivery process)

KD – Knock down

M.O.D – Mathematical order date

OTD – Order-To-Delivery

P&L – Production and Logistics

PDD – Preliminary Delivery Date

PRU – Production Unit

R&D – Research & Development

S – Purchasing

ST1 – Status 1

S&M – Sales & Marketing

1 Introduction

This chapter introduces the background of the thesis. It highlights the problem description that has led to the creation of this thesis project. Following this it defines a purpose for the project and the research questions that have been formulated to approach it. Lastly the chapter states the delimitations for the project and gives an overview of the report structure.

1.1 *Background*

Scania is a global company, with sales and services in more than 100 countries. In 2017 the company produced and delivered 82 472 trucks and 8 305 buses (Scania, 2018). Apart from this Scania also delivered industrial and marine engines, spare parts and other components to customers (Scania, 2017). To be able to do this, Scania has a network of complex processes and flows within the company. One of the core flows in order to successfully deliver according to customer demand is a company's Order-to-Delivery process (Forslund, Jonsson, & Matsson, 2008).

The Order-to-Delivery (OTD) process is the entire flow from an initiated order until the product or service is delivered to the customer. This includes all intermediate processes that are required in order to fulfil the customer need. Scania qualifies their Order-to-Deliver process as one of the critical flows within the company. They recognize that the performance of the OTD process is of utter most importance for the success of the company.

According to Catasús et al. (2008) are companies always looking for success factors and ways to perform better. But how can a company determine when they have accomplished improvements. Catasús et al. (2008) argues that it is difficult or even impossible to steer a company towards success alone. However, one can steer a company with the use of different factors that are believed to accomplish success. These factors can be measured and compared towards previous states, future goals and industry best-practices. This process is referred to as performance measurement (Neely, Mills, Gregory, & Platts, 1995). Parmenter (2015) argues that appropriate performance measurements cannot only help to steer the organization towards its intended goals but it can also help create a wider ownership where employees can clearly see the progress and by that motivate actions. Performance measurements are also a useful tool in decision-making, but it does not only have positive impacts. A measurement can have unintended effects by encouraging wrongly behavior or even steering the company in the wrong direction. Since there are no general success factors, are there no standard way or solutions to work with performance measurements. Parmenter (2015) further argues that many companies work with the wrong type of measure and that the commonly used Key Performance Indicator may not have the intended purpose.

It is important for a company to define the measurements that are relevant for their specific company according to their own processes and targets. Therefore, Scania wants to be better at working with measurements in order to handle deviations and drive improvements within their Order-to-Delivery process. However, it is not a straightforward task to measure and determine how well the process is in fact performing due to the length and complexity of the OTD process.

1.2 *Problem Description*

Today, Scania use so called Key Performance Indicators (KPIs), which can allow to analyze the current state towards a defined target or baseline. There are three different KPIs measured within their OTD process, when looking at an end-to-end perspective. The indicators measured are the following:

- Lead time
- Delivery precision
- Stock level

However, Scania themselves states that they have difficulties interpreting these measurements and how to use them to drive the process forward. They express a need to better understand and work with measures and indicators in the OTD process. Employees want to better recognize what the measurements mean to the company and how to work with them in order to handle deviations and drive performance. Some problems stated at Scania today are:

"We need to be better on measuring and follow up KPIs"

"We want to understand KPIs"

"What do they actually indicate?"

"What should we do with them?"

Investigating other ways to measure and manage the OTD process can help Scania bring in new ideas and viewpoints to improve their performance measurement processes, with their own values, goals and processes in mind.

1.3 *Purpose*

The purpose of this thesis is to study performance measures and indicators in the Order-to-Delivery process, in order to achieve and meet the statements mentioned above. The aim is to find best practices and alternative measures by performing an extensive literature review and an empirical study of other companies OTD performance measurements. The theoretical and empirical findings should then be used to suggest alternative approaches and methods that can help improve Scania's performance measurement process.

1.3.1 Research Questions

The purpose, and in extent the statements, are translated into more specific and manageable research questions. The questions are meant to focus and drive the work in the desired direction. The research questions that are stated for this thesis are the following:

Research question 1:

"How should performance measurements be used in an organization in order to be efficient?"

Research question 2:

"Which are suitable performance measures, for an Order-to-Delivery process, according to academic research?

Research question 3:

a) *"How does Scania measure and manage the performance of their Order-to-Deliver process?"*

b) *"How do other manufacturing companies measure and manage the performance of their Order-to-Delivery process?"*

Research question 4:

"*Are there additional approaches that can be beneficial for measuring the performance in Scania's Order-to-Delivery process?"*

1.4 *Delimitations*

The project will be focused on the industrial side of Scania's Order-to-Delivery process, which is shown in figure 1. This part of the flow is located under their Production and Logistics (P&L) function. Before and after the P&L function are sub-processes belonging to Scania's Commercial Operations (CO). The CO processes will not be considered in the study. As a result of this delimitation, the KPI *Stock Level* will not be investigated further, since this is only linked to the commercial side of the OTD process.

Today Scania produces several different products. Roughly the products can be divided into separate product groups: truck & bus chassis, complete busses and components (e.g. gear boxes and engines). This project will only consider the OTD process flow for truck and bus chassis, which are similar enough to be grouped together. Components and completes will be excluded from the scope due to differences in the processes.

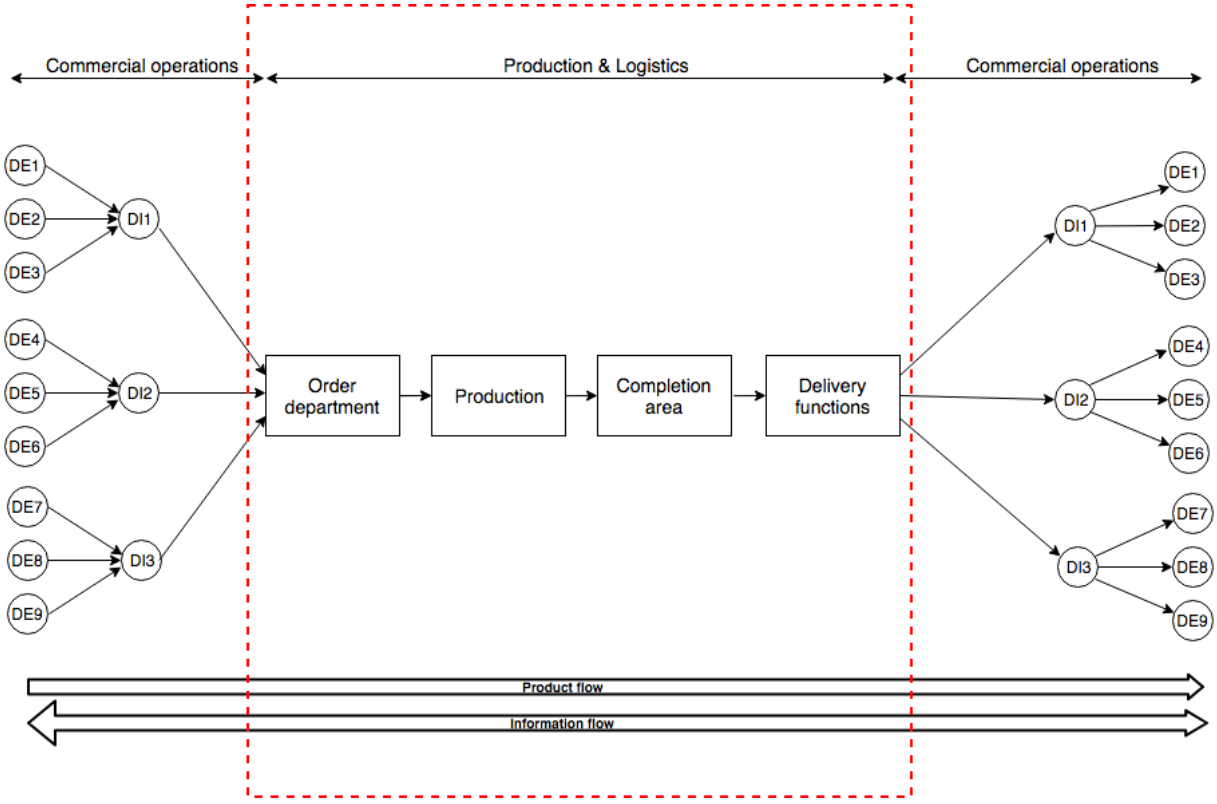

Figure 1: Delimitation of the project scope. The abbreviation DE stands for dealer and DI stands for distributor in the figure.

2 Methodology

The following chapter introduces the methodology and methods used in the thesis project. Firstly, the research approach is introduced and the different methods for data collection are presented. Lastly the reliability, validity and objectivity of the report is discussed.

When a subject and research questions are defined, the next step is to gather the information needed (Bell, 2006). The thesis project has been divided into two different focus areas: a theoretical and an empirical. The theoretical area is based in a literature study while the empirical is divided between the processes at Scania and also a comparison towards the processes of other manufacturing companies. The information collected within these areas, shown in figure 2 are compiled in the report and analyzed as to find possible adaptations to real-life. This clarification has been done to determine relevant methods for data collection, which are presented under section *2.2 Data collection*.

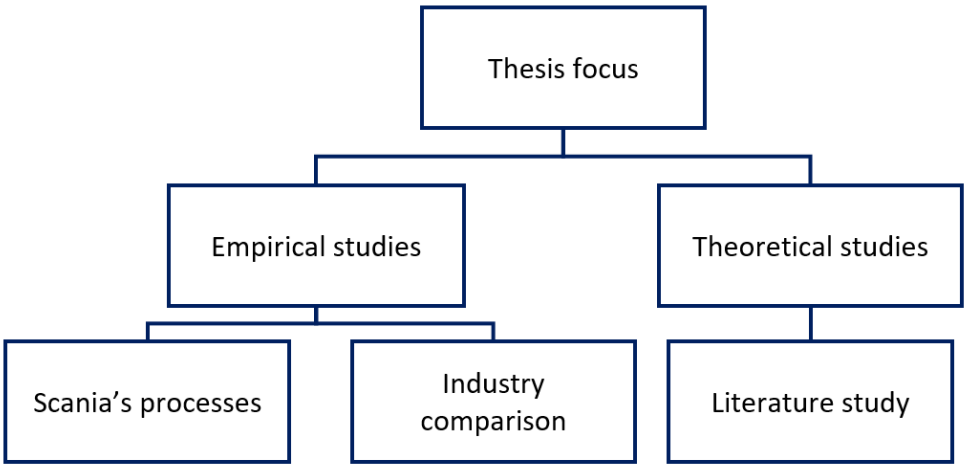

Figure 2 : The figure illustrates the thesis focus structure.

2.1 *Research Approach*

There are two main research approaches: a deductive approach and an inductive approach. When using an inductive approach, is empirical data collected and used to see patterns and to construct theories. With a deductive approach, the theories are studied beforehand to form new theories that are then tested on empirical studies to verify the information. The theories are considered general in abstraction level and the empirical studies are considered specific in abstraction level. In either approach the researcher wanders from one level of abstraction to another. If the researcher instead wanders back and forth between the levels of abstraction throughout the project, is it considered a third approach called abduction. (Björklund & Paulsson, 2003). This project takes an abductive approach where both theories and empirical information is gathered to form an understanding of the problem situation and possible solutions. The collected information is then used and adapted to real-life situations in order to reach conclusions.

2.2 *Data Collection*

Hartman (2001) mentions that there are different methods to collect data and that the data should be collected systematically. Bell (2006) also argues that no scientific approach consists of only one method of collection and that different views are important in an extensive information and data collection. There can be one primary source of information, but this source should be supported by alternative data sources. Further the extent of the data collection should be in line with the scope and resources

of the project, in both time and monetary aspect. When defining data, certain key attributes can be used to differentiate the type of data: primary versus secondary and qualitative versus quantitate.

Primary versus secondary data

Primary data is data collected by the researcher first hand and for the purpose of the project. This kind of data includes observations, interviews or questionnaires. Secondary data is data that is collected for another purpose and usually interpreted by another researcher or furthered analyzed by the authors themselves to gain new knowledge. An example of secondary data collection is a literature study. The type of data collected and used in a project is usually a consideration of time and resources. It is common that both primary and secondary data are used. (Saunders, Lewis, & Thornhill, 2016)

Qualitative versus Quantitative data

Data is it also possible divide it into two different categories: qualitative and quantitative. Qualitative data refers to data that is collected through the interpretation of words or images and the conceptualization of their meaning. Observations and interviews are examples of methods to collect qualitative data. Qualitative studies can be used when a deepened or focused understanding of a specific subject or situation is wanted. (Saunders, Lewis, & Thornhill, 2016),

Quantitative data refers instead to numerical data and statistics. Quantitative data is difficult to interpret in is original form and usually needs to be analyzed by using graphs, tables or statistical tools. This kind of data is useful when analyzing trends and relationships (Saunders, Lewis, & Thornhill, 2016). Whether qualitative or quantitative data is collected depends of the purpose of the study. (Björklund & Paulsson, 2003). In this study both primary and secondary data is used. Below follows an explanation and motivation for the chosen methods used for data collection.

2.2.1 Literature Study

A literature study consists of a study of all written material. This includes books, journal articles, conference proceedings etc. It is important to keep in mind that the information found in a literature study has been compiled for a different reason than the thesis objectives and is therefore secondary data. This means that the material can be angled or include information gaps that may be of importance. Therefore, it entails that a critical thinking should always be adopted when conducting a literature review. However, a literature study is an efficient method to gather extensive data with little resources. It can also be useful to map current knowledge within the area and to build a frame of reference. (Björklund & Paulsson, 2003)

Since this thesis aims to fill a knowledge gap about performance measurement at Scania, a literature reviews is considered as a useful tool to investigate the academic knowledge within this area and present the relevant findings in this report.

2.2.2 Internal Presentations

Björklund and Paulson (2003) states that presentations are a method to gather a lot of information with little resources. One of the sources of information used in the project have been internal presentations from different departments within Scania that are linked to the Order-to-Delivery process. These are primarily used to gather an initial understanding of the different physical and information flows in Scania's OTD process. Presentations are often a secondary data, i.e. the information has been compiled with another purpose than for the thesis.

2.2.3 Interviews

An interview can be held both in person, through a phone conversation or through written format, e.g. email (Saunders, Lewis, & Thornhill, 2016). Interviews allows the authors to obtain primary data for

the study. (Björklund & Paulsson, 2003) Interviews can be divided into three different categories: structured, semi-structured and unstructured interviews.

Structured interviews are verbal and based on a fixed set of questions that should be followed with minimum deviation. This type of interview has its best use when goals and main issues in a project are clearly understood. A structured interview can be based on both open and closed questions in order to collect the desired information. Closed questions means that there is some predefined answers to choose between. The idea is that every interviewee should be asked exactly the same questions and in the same sequence. Structured interviews are useful when comparing results from different groups or evaluating knowledge of a subject (Chauncey, 2013). Semi-structured interview are also based on pre-determined questions but follow-up questions can be asked regarding the interviewees answer. There is also a possibility to conduct an unstructured interview. This allows the interview to be held as a conversation where the questions are thought up and asked along the way. (Björklund & Paulsson, 2003)

The time of an interview varies between short interviews held in minutes to extensive interviews that lasts for hours (Chauncey, 2013). The number of participants can also vary between one person, to a group of people (Björklund & Paulsson, 2003). In this project both semi-structured and unstructured interviews have been held. The semi-structured interview have had the initial layout of a structured interview, where the respondents have been given access to the questions beforehand. However, follow-up questions have occurred to clarify certain answers or when an interesting topic has been raised. Unstructured interviews have been held with employees at Scania to gather information.

2.3 *Reliability, Validity and Objectivity*

When discussing an academic study and its credibility, are there three aspects that need to be considered: reliability, validity and objectivity. Validity refers to if the right things are measured, reliability refers to if the measures are done right and objectivity refers to what extend values and presumptions affect the study (Hartman, 2001) (Björklund & Paulsson, 2003). A consideration of these aspects need to be present throughout the whole thesis project. This includes criticism of sources and information collected and used to support the findings that are presented in the report.

Reliability and validity can be illustrated as tarts in a dartboard, shown in figure 3. The first dartboard shows a spread of result which are out of target. This indicates low reliability and low validity. The second dartboard illustrates a low spread of the result, but they are still out of target. This board therefore indicates low validity but high reliability, i.e. the measures are done right and can be repeated but the right things are not measured. The last, and third, dartboard shows both a low spread and on target which indicates that there is high reliability and high validity.

Figure 3: From left to right, low reliability and low validity, high reliability but low validity and high reliability and high validity. Source: Adapted from Björklund and Paulsson (2003).

Reliability

The reliability can be ensured by controlling findings again and being able to reproduce the same findings given a redo of the experiment (Bell, 2006). According to Björksson and Paulsson (2003) can this be done by adding control questions in an interview or through triangulation. Triangulation refers to the use of different methods to investigate the same purpose and in that way incorporating different perspectives. There are different types of triangulation. One type of triangulation that have been used in this project is the use of different data sources to attain data triangulation. This is to incorporate different views and to support claims made in one research paper with non-biased information. Another type of triangulation used is through the use of different evaluators of the material. This is done through the two authors of this report. In the project, the report and progress of the project is also evaluated from different viewpoints of supervisors. (Björklund & Paulsson, 2003)

Biggam (2008) mentions another way to ensure reliability through documenting the empirical studies and presenting this in the report, e.g. through defining with who, for what and where an interview was held. In this project, interviews are taped when it is possible. This allows that authors can go back and listening to the material again which ensures that information from interviews are not only based on subjective memory or notes.

Validity

Validity can be ensured by using different perspectives, for example through triangulation. In an interview situation can this be done by asking clearly formulated questions that are not angled (Björklund & Paulsson, 2003). Information can also be validated by comparing findings with reference data, information or experience. Biggam (2008) states that the most important aspects for a valid study is that tested and acceptable research strategies and data collection methods are used. These strategies and methods should also be deemed appropriate for the particular study.

In this project multiple companies are interviewed to understand the performance measurement processes in different companies, that both vary geographically and business wise. A structured interview format is also used to not angle or vary the questions between the companies.

Objectivity

The objectivity can be increased by motivating the choices made throughout the project. This allows the reader to make a judgement themselves of the presented result. Throughout the writing of this report, the authors have tried to objectively present the findings. This means avoiding factual errors and emotionally charged words and avoiding to only present facts that support a specific claim. (Björklund & Paulsson, 2003)

3 Theoretical Framework

This chapter covers the theoretical framework that the thesis project is built upon. The theories gives the reader an introduction to main concepts within supply chain management, order-to-delivery process and performance measurements.

3.1 *Supply Chain Management*

The supply chain and the management of it, is a broad subject that has many definitions. The definitions stated below give a general understanding of the subject.

"A supply chain is the set of entities that are involved in the design of new products and services, procuring raw materials, transforming them into semi-finished and finished products, and delivering them to the end customers" (Swaminathan, 2001)

"A supply chain is a network of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage" (Alan Harrison, 2014)

"The integration of business processes from end user through original suppliers that provides products, services, and information that add values for customers" (Paul Cousins, 2008)

The OTD flow is a part of the Supply Chain and therefore the concept needs to be described. All above definitions agrees that a supply chain consists of linked processes that affect each other regarding information and physical flow from the supplier to the end customer. These processes must be managed in a complex network of companies worldwide and the challenge is to integrate and synchronize these flows to guarantee cost-effective and fast deliveries. Competition is no longer played between individual firms, but between value chains and how these chains are coordinated. (Urciuoli, 2017)

Not only the forward flow is considered in a supply chain. An increasingly important part of a supply chain is the reverse flow of material due to sustainable and economical aspects. The objective is to recover the economic and ecological value as much as possible and reduce waste. (Daoud Aït-Kadi, 2013). Reverse logistics is the flow of goods that return in the supply chain for different reasons, for instance repairs, maintenance or end-of lifecycle returns. Reverse logistics is something that must be considered already in the design phase so that products are easy to disassembly and recycle. (Alan Harrison, 2014). An illustration of one type of a Supply chain is illustrated in figure 6. Both the physical flow and the information flow is illustrated as well as the direction of the flows.

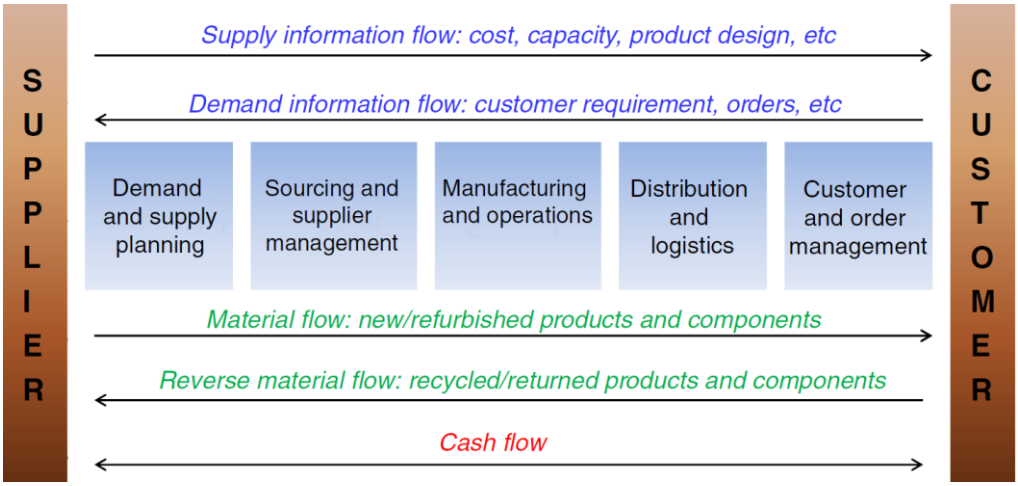

Figure 4: Supply chain process. Source: Swaminathan (2001).

The supply chain featured in this thesis is limited to Scania's Production & Logistics processes, reaching from order department, production, completion area and the delivery functions. This means that the sourcing part of the supply chain is excluded from the scope. However, sourcing will affect the performance of the supply chain. For instance if suppliers have problems delivering components to Scania in time, it will affect the performance of the entire production system negatively.

3.1.1 Hierarchy Levels of a Supply Chain

Planning, control and the related decision making in a supply chain can be viewed in three different levels of hierarchy. The hierarchy is based on the relevance of the decisions or activities and their time horizon. Within the different levels can policies and trade-offs be determined (Gunasekaran, Patel, & McGaugheyc, 2004). The three levels are strategic, tactical and operational. Performance measurement can help feed information to each level. (Busi, 2007)

Strategic level: Long term decisions regarding the supply chain and the design. Measurements here affect and influence the top level management decisions and often corresponds against organizational goals.

Tactical level: Short to medium term decisions which affect policies and principles within the supply chain. The measurements here can help aid in decisions regarding resource allocation and result targets set in the above strategic level. The tactical level corresponds towards mid-level management decisions.

Operational level: Short term decisions linked to operations planning and control. The measurements here corresponds towards lower level management. They help determine whether operational goals and objectives are met. The measurements at this level require accurate real-time data.

3.1.2 Supply Chain Effectiveness & Efficiency

Companies today self-assess their performance to be able to improve processes and make sure to achieve operation excellence in many areas. The two concepts effectiveness and efficiency are commonly used expressions to describe the performance of a company. The two terms are often interchangeably used in organizations but the meaning of the words are different. Therefore it is important to define the two concept to be able to communicate in a correct way.

Effectiveness

The term effectiveness often refers to ***doing the right things***, i.e. focus to produce a demanded output that corresponds to strategic objectives. (Sundqvist , Backlund, & Chronéer, 2014). The concept of effectiveness refers to a company's ability to produce the intended results according to its goals, missions and visions. It is about fulfill a purpose and see how the process outputs affects the social and economic environment. Effectiveness can be seen from a big picture perspective where all employees in a workplace together creates value added outputs that affects the overall effectiveness of an organization. (Bartuševičienė & Šakalytė, 2013)

Organizational effectiveness can be analyzed through commitment. Commitment can be seen in various forms such as the relationship between staff and the management or how well the employees can identify with the organization. To be able to improve effectiveness in the organization, the managers should focus to create an positive environment, better communication and overall effective leadership. Tools for effective management are for instance outsourcing and benchmarking. (Bartuševičienė & Šakalytė, 2013)

Efficiency

The term efficiency often refers to **doing things right,** i.e. doing things in the optimal way**.** This does not entail that the right things are done (Sundqvist , Backlund, & Chronéer, 2014). The concept of efficiency refers to a relationship between inputs and outputs and to what degree of success it has been transformed. This could be with regard to speed, cost or other factors such as waste. To be able to achieve the desired output, waste must be removed to utilize the resources in an optimal way.

Note that a process can be performed right according to optimal procedures, but they might not be the right processes for strategic objectives. If so, then the advantages of being efficient are missed. The ultimate goal is to be both effective and efficient at the same time, to be able to produce high level results. The matrix in table 1 illustrates how companies can achieve success by being both effective and efficient at the same time.

Table 1: Effectiveness and efficiency described in a matrix.

Effective	Right things according to goals but NOT in the most optimal way	Right things according to goals and in the most optimal way
Ineffective	Wrong things according to goals and NOT in the most optimal way	Wrong things according to goals but in the most optimal way
	Inefficient	**Efficient**

3.2 *Order-to-Delivery Process*

Order-to-Delivery is a common term in the automotive business. The concept of OTD process is relatively consistent within the automotive industry even if the process can be described in different levels of detail (Brabazon & MacCarthy, 2017).

Order-to-Delivery is a process that flows over multiple different functions within an organization. It can be considered one of the most critical processes within logistics. The flow starts when a customer places an order and ends with the customer receiving a finished goods or services (Forslund, Jonsson, & Matsson, 2008). To realize this, there are certain sub-processes that need to be fulfilled. The starting processes can be tracked back to the recognition of a need at the customer. This recognition will lead to an order placement with the supplier, i.e. the manufacturer. After the order is placed, the supplier performs the necessary actions to fulfil the order and provide the finished goods. Here the transportation process takes place, when the finished goods is picked up at the supplier until it is delivered at the customer or other delivery address. The last set of sub-processes consist of making the goods available to use after delivery to costumer. (Forslund, Jonsson, & Matsson, 2008)

According to Jonsson and Mattson (2016) the Order-to-Deliver can in short be described as the following steps:

- Order reception from customer
- Order handling
- Finishing of ordered goods
- Internal transportations of goods

- Packaging and loading
- Transportation
- Billing

3.2.1 Order Lead Time

Total order cycle time, or order lead time, is the time for the process that starts from when the customer initiates an order until the customer receives the product. The lead time consists of different sub-processes that will add to the total lead time to the customer. The order lead time can be described as a summation of the following processes times (Gunasekaran, Patel, & Tirtiroglu, 2001):

- Order entry time
- Order planning time
- Order sourcing time
- Assembly time
- Follow up time
- Finished goods delivery time

The lead time is not only important for the customers satisfaction. It is also an competitive advantage for the producing company. Short lead times reduces the tided up capital. It also visualize problems in the chain and simplify the identification of root causes to the problem (Scania, 2017). A reduction of order lead time will reduce the response time in the supply chain and create reliability and consistency with less variability. (Gunasekaran, Patel, & Tirtiroglu, 2001)

Lead time flexibility and adaptability

Forslund, Jonsson & Mattson (2008) discuss different aspects concerning lead time performance. The authors suggest that except for only measuring lead time length and on-time delivery, measures such as lead time adaptability and lead time flexibility plays an important role. Further it is mentioned the importance of sub-process performance on the overall performance. Therefore, the performance should be managed from an overall performance perspective and that a performance model for the whole process could be valuable. Figure 7 below, shows a schematic picture of different lead time measurements in respect to the Order-to-Delivery process.

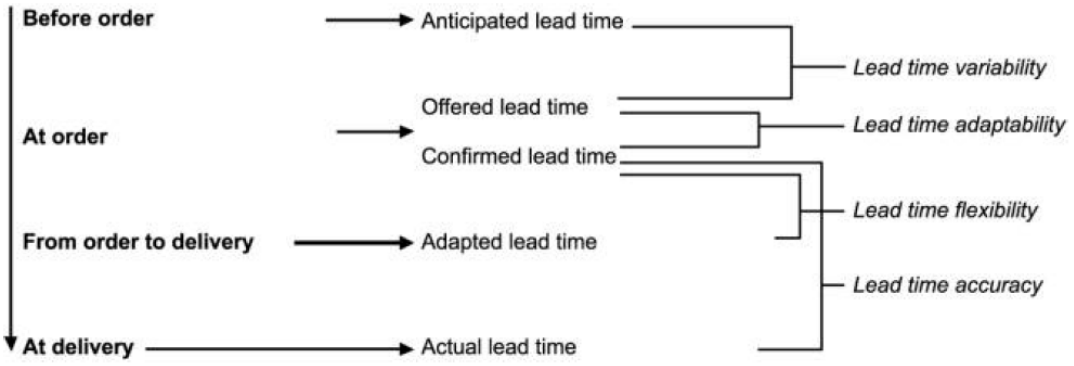

Figure 5: Different aspects of lead time. Source: Forslund, Jansson & Mattson (2008).

Forslund et al. (2008) performed an empirical study consisting of a part supplier, an Logistics service provider and an end customer who is an OEM manufacturing. In this type of triadic relationship, they identified that flexibility and adaptability is often more important than accuracy. The two concepts are shortly explained below.

Lead time adaptability refers to the ability of the manufacturer to adapt the lead time to a customer need, before an order is placed. (Forslund, Jonsson, & Matsson, 2008)

Lead time flexibility refers to the ability to adapt the lead time to a customer need, when an order has been placed i.e. during the order-to-deliver phase. One example is delivery flexibility, which refers to the extent that delivery dates can be brought forward or backward. Flexibility can qualify as a leading indicator. (Forslund, Jonsson, & Matsson, 2008)

3.2.2 Delivery Performance

Delivery performance can be defined as delivery accuracy, delivery reliability or On-time delivery. On-time delivery, also referred to as delivery precision, is one of the most common Order-to-Delivery performance measurement (Forslund, Jonsson, & Matsson, 2008). It determines if an perfect delivery has been achieved or not. The measurement is a driver for customer satisfaction and supply chain excellence. (Gunasekaran, Patel, & Tirtiroglu, 2001). Delivery performance can be measured according to different dates, such as Delivery-to-request date and Delivery-to commit date (Stewart, 1995).

The delivery performance deeply relies on the quality of the information exchanged across the distribution channels and the way the information is presented. To be able to achieve high delivery performance, are location, delivery channel and vehicle scheduling important factors. To be able to improve delivery performance, is a reduction of lead time important. (Stewart, 1995)

3.3 *Measuring Performance*

The process of measuring performance is important for a company to be able to know how well the firm is performing in overall as well as on detailed levels. Sub-processes build up the complete performance of an company and therefore it is important to keep track of the performance on all levels and perspectives. Individuals, teams, systems and the organization are different perspectives when measuring performance. Performance refers to an output of a financial or non-financial result compared against predefines goals and threshold values. Neely et al. (1995) defines performance measurement and performance measures as:

"Performance measurement can be defined as the process of quantifying the efficiency and/or effectiveness of action."

"A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of action."

3.3.1 A Historical View on Measuring Performance

The concept of performance measurement has developed and changed focus during the years but it originates from the Japanese quality management philosophies from the 1940s and 1950s. In the beginning companies mainly looked at a financial result when evaluating one's performance. But during the 1980s, a new need and interested started to grow within performance measurement. The focused shifted towards seeing performance measurements as a not only a management philosophy but as a way to quantify and evaluate the efficiency and effectiveness of previous activities (Busi, 2007).

As mentioned under chapter *3.1 Supply chain management (SCM)* is competition no longer focused on sole companies but rather on complete value chains (Urciuoli, 2017). This shift opens up for new possibilities to measure and improve a company's performance. Therefore, scientist and practitioners alike have started to discuss the relevancy of the old measurement in this new environment of

integrated value chains. The older measurement where mainly focused on the boundaries of the own company and the measurements reaching outside the company where limited and not interlinked with the company. So, a new need is starting to arise again in order to meet the demand of today's business environment. Busi (2007) suggest three major shift when thinking of and working with performance measurements:

- A new focus on performance management and a holistic thinking rather than only performance measurements.
- To widen the measurements, outside the boundaries of the own companies, to include the whole supply chain.
- And lastly to focus on present and future measurements, i.e. leading measurements, that can help with decisions in comparison with traditional measurements that tend to look at historical data and actions, i.e. lagging measurements.

3.3.2 Definitions

Often different concepts are discussed within supply chain literature, in relation to performance measurements, but they are rarely well defined. Therefore it is important to state these concepts to be able to distinguish and use the right term when discussing them. Below follows a short introduction of different concepts proposed by Wang et al. (2007).

- **Performance management** is the use of performance measurement information in a systematic way to affect positive change in companies processes, systems and culture. This is done by setting performance goals that all agree upon and to prioritize and allocate resources well.

- **Performance management framework** gives guidelines how to manage and measure performance.

- **Performance measurement** is the systematic procedure of measuring performance and evaluation of how well companies are managed. The process of quantifying effectiveness and efficiency of an action is a performance measurement.

- **Performance measurements system**, PMS in short, is a tool to find a balance between different measurements and levels. A PMS consists of a set of metrics to quantify effectiveness and efficiency of actions.

- **Performance measure or indicator** express how well an objective is being met, illustrated with a numerical value. The use of the words measures and indicators will be used interchangeably in this report.

3.4 *Performance Management*

KPIs and metrics are an important part of performance management and belonging frameworks. A performance management framework provides guidelines on how to measure and manage performance. According to Eckerson (2009) is the point of a performance management framework to align performance with strategy. A performance measurement framework is a suitable starting point for development of a measurement system. It should not be confused for an actual measurements system, but it can help clarify measurement boundaries and different viewpoints (Busi, 2007).

Performance management can be seen as a continuous circle consisting of four different steps, see figure 8:

1. Create strategy
2. Plan how to achieve strategies
3. Monitor execution of activities and plans
4. Make adjustments and act on problems

The wheel is an iterative and continuous process that needs to be incorporated in the company culture.

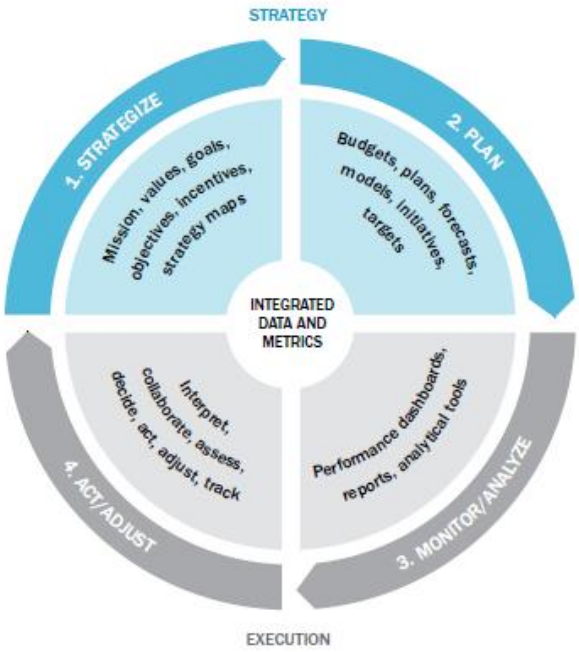

Figure 6: The continuous circle of performance management. Source: Eckerson (2009).

3.4.1 Performance Management Maturity

Eckerson (2009) defines that there are three levels of maturity when discussing organizations and their use of metrics through performance management.

Level 1: At this level the focus is on visualizing the measurements. The company have some initial key performance indicators that are displayed in visualization tools and reports. The measures used might not be aligned with strategic objectives.

Level 2: At this level the focus is on managing the performance. The measures are assigned owner who have the responsibility to manage them and are hold accountable. The measurements are used to identify issues, discuss improvements and display performance across different teams.

Level 3: At this level the measures are used to drive strategy and achieve strategic objectives and goals. Both leading and lagging indicators are used and the KPIs are correlated with outcome. There is also an understanding of the relationship between behavior and outcomes. At this stage a complete performance management system is needed.

3.5 *Performance Measures and Indicators*

Among companies there are often misunderstandings regarding indicators and the belonging terminology. Result Indicators (RI), Key Result indicators (KRI), Performance Indicators (PI) and Key Performance Indicators (KPI) are all different measures used to determine companies results and performances. Often the term KPI is misused by the other three and the difference between them need to be explained. (Parmenter, 2015)

Result indicators (RI)

RIs gives a summation of a teams combined activity and shows management how different teams are working together to produce the final result. RIs is measured broadly and in more detail compared to KRIs, for instance in weeks, days or months. RIs are often measures in financial performance. Examples of RIs are "*yesterday sales"*, *"complaints from key customers*" or "*number of workers educated to use specified systems".* KRI is a more important and overall summary of past activities, compared with RIs. (Parmenter, 2015)

Key result indicators (KRI)

A KRI is an appropriate overall summary measurement that combines the result of numerous actions made by several teams. KRIs gives management an indication if the company is performing at the right speed and in the right direction according to their strategy. KRIs are usually reviewed in cycles, for instance monthly or quarterly. A problem with KRIs is that it tells what has already happened but not why it happened. This information is of little use for the management team because the information is reported too late to take action. Basically a KRI, is a useful summary measurement, but it will not tell the management what to do to improve result. Examples of KRIs are *"customer satisfaction", "employee satisfaction"* or *"return on capital employed"* showed by a trend over a specific time horizon. To conclude, KRIs gives the management board an general summation of how the company is performing. (Parmenter, 2015)

Performance indicators (PI)

Performance indicators are nonfinancial indicators that can be traced back to a specific process, team or employee. PIs help the team to fit to the company's strategy. PIs are important but not crucial for the company's overall wellbeing and complement KPIs. Examples of PIs are "*late deliveries to customers", "*number of sales visits organized with key customers next week" or "*number of innovations made by each division".* So basically, PIs tell managers what the teams actually are delivering. (Parmenter, 2015)

Key performance indicators (KPI)

Key performance indicators focus on the most critical aspects of a company's performance and take into account current and future success. Relevant measurements for KPIs are often already known to an organization. However, they might not have been recognized as an KPI or the measurement might be unknow to the current management team. Examples of KPIs within Supply Chain Management are "*percentage of backorders"* , "*emergency purchases"* and *"late deliveries to key customers"* (Baroudi, 2010). Since KPIs express the company's performance of the most critical factors, by taking control of these factors, the managers can be able to enhance the performance drastically. A KPI should also provide the CEO with the ability to ask "Why?". (Parmenter, 2015)

Typical for a KPI is that it has a flow-effect. This means that other measurements can experience a positive impact from the improvement of one critical key measurement. That indicates the importance of finding and using the right indicators.

Relationship between indicators

The relationship between the four mentioned indicators can be illustrated by the onion analogy illustrated in figure 9. The layers in the onion represents different result and performance indicators. The outer shell is a KRI and describes the general condition, for instance the amount of nutrients and water it has received and how it has been treated during the transportation process to the store. Deeper into the onion we find more information and the inner core is a Key Performance Indicator. (Badawy, El-Aziz, Idress, Hefny, & Hossam, 2016)

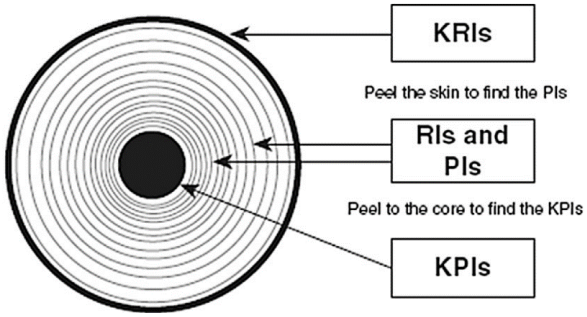

Figure 7: The onion analogy Badawy, El-Aziz, Idress, Hefny & Hassam (2016).

Summary of indicators

The following table 2 summarizes Parmenter's (2015) suggestions regarding the nature, the number and the frequency of indicators used within a company with more than 500 employees. The limits suggested, for the amount of measures, is an upper recommendation and a lesser number could be sufficient enough. The number of PIs may seem insufficient at first but should be possible if the measures are standardized. Often the case might be that several variations of measures exist for the same purpose. It is then better to standardize the measure for use in the entire organization. One deviation from the 10/80/10 rule presented below is if the organization includes many business from different sectors, whereas the rule should be applied to each separate business area.

Table 2: Overview of indicators. Source: Parmenter (2015).

Terminology	Characteristic	Description	No. of measures	Frequency
Result Indicator (RI)	Financial and non-financial	• Summarizes how teams collectively are producing results • Difficult to indicate what actions are needed to improve the result	Around 80 (not more than 150)	Hourly, Daily, Weekly, Monthly, Quarterly
Key Result Indicator (KRI)	Financial and non-financial	• Give an overview of the organizations past performance • Do not indicate what actions are needed to improve the result • Suitable measures to present to board	Up to 10	Monthly, Quarterly
Performance Indicator (PI)	Non-financial	• Shows what the teams are delivering • Not critical for the overall strategy • Indicates what actions need to be taken	Around 80 (not more than 150)	Hourly, Daily, Weekly, Monthly, Quarterly

Key Performance Indicator (KPI)	Non-financial	• Evaluates how well the overall process is performing • Corresponds to critical success factors • Indicates what actions can improve the performance drastically	Up to 10	Hourly, Daily, Weekly

3.5.1 Leading and Lagging Indicators

Indicators can be classified into two groups – leading and lagging. It is important to understand the difference between these measures to be able to develop the right KPIs. The main difference between the two approaches is the possibility to affect and steer the business. A lagging indicator is an outcome measurement, focused on past performance and tells what has already happened. A leading indicator is a measure that makes it possible to predict and affect the future performance. Leading indicators are viewed as proactive measurements. (Nolan & Andersson, 2015). Harrison states examples of lagging and leading indicators (2016):

Lagging indicators:

- Total problems
- Number of units sold
- Product returns in July

Leading indicators:

- Amount of sales in the pipeline at 90%
- Average handling time
- Average speed of answer

To be able to anticipate performance as well as correct inefficient performance, a balance between leading and lagging indicators is needed to run a successful business. A shift is ongoing to the usage leading indicators instead of solely lagging. This makes it possible to foresee problems in time and take decisions on real time information aligned with company strategy. (Wang, Heng, & Chau, 2007)

3.6 *Different Measurement Levels*

Organizational measurements can be seen in different levels, also linked to the hierarchical levels presented under section *3.1.1 Hierarchy levels of a supply chain*. The ones at the highest level have a high strategic relevance and high aggregation. On the other hand the lowest level of measurements are highly diagnostic and frequently measured. When deciding which performance measurement level to adapt to, a starting point is to use generic performance objectives, such as cost, quality, flexibility, dependability and speed. These objectives can then either be broken down to detailed measures or aggregated into composites. The composites can then be aggregated into functional strategic measures and then to broad overall measures. The higher up in level, the better overall understanding of the company's performance the measurement gives. The measures in lower levels gives an understanding what is happening within the operations and are monitored more closely. Companies mostly use measurement from all levels. In figure 10 the relationship between the different levels are illustrated. (Slack, Brandon-Jones, Johnston, & Betts, 2015)

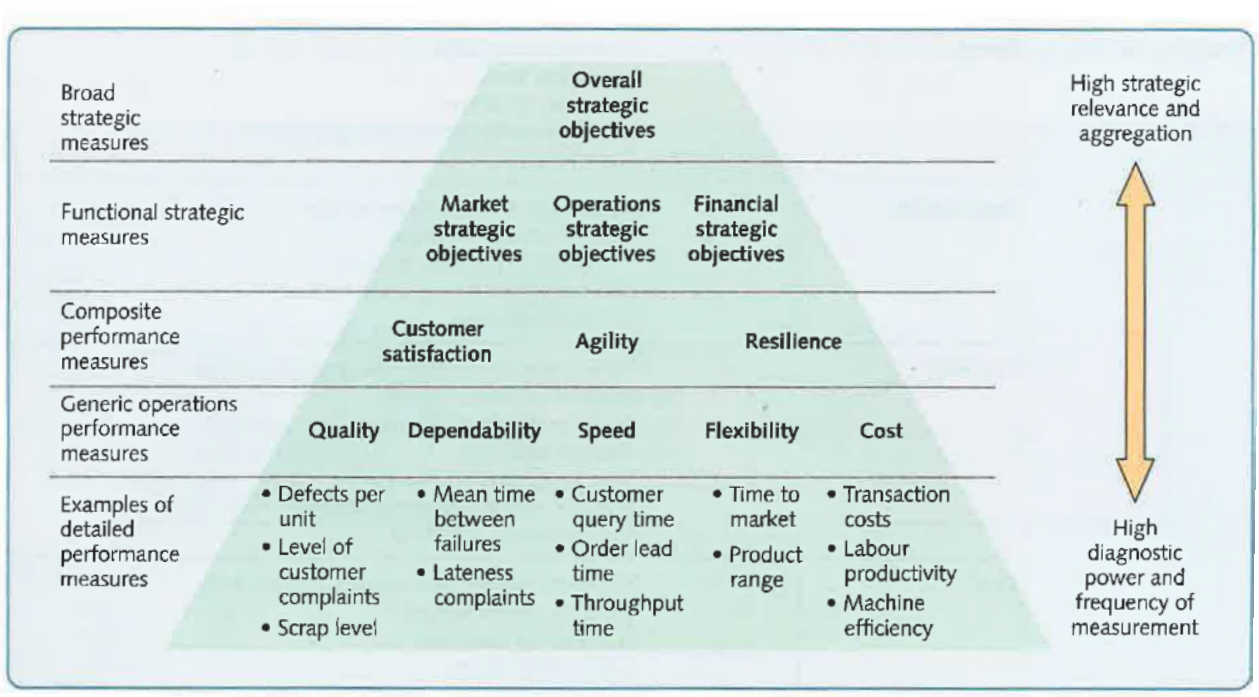

Figure 8: Measurements seen from different levels of aggregation. Source: Slack, Brandon-Jones, Johnston & Betts (2015).

3.6.1 Aligning with strategy

One of the most important aspects of KPIs, compared to other measures, are that they should be aligned with strategy and correspond towards critical success factors and strategic objectives (Eckerson, 2009) (Parmenter, 2015). This is to ensure that they actually drive the company in the intended direction. One way to align KPIs with strategy is to derive them from the strategic vision and mission in the company. The vision should in turn be derived from the critical success factors, which should correspond to customer requirements. Figure 11 below shows an overview on the relationship between vision, mission, goals, objectives, measures, KPIs and action plans in an organization (Asif, 2017).

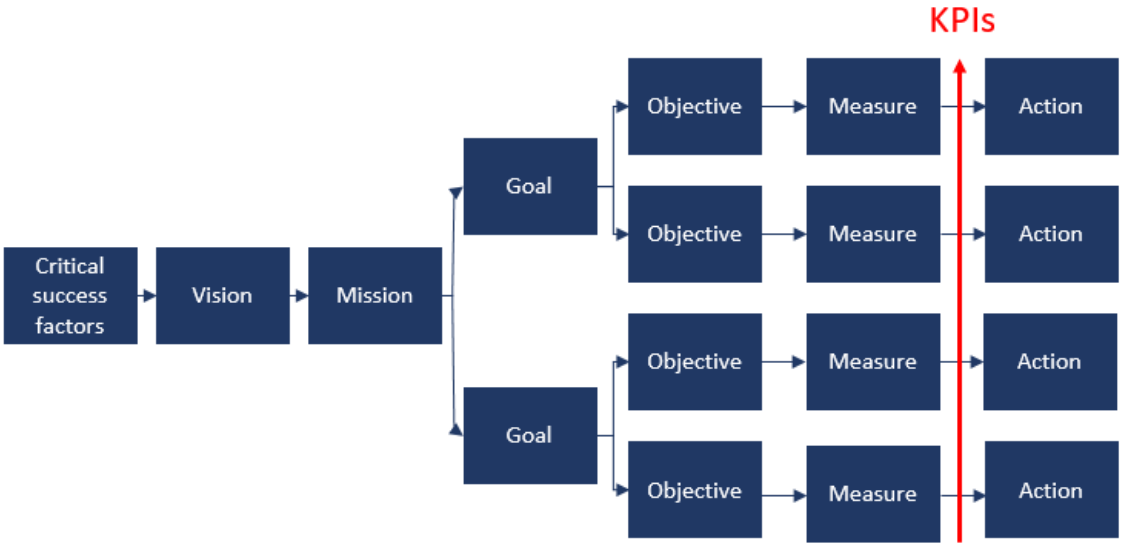

Figure 9: How KPIs are aligned with strategy. Source: Asif (2017).

Cascading KPIs

A way to aligning different levels of measurement within a company is by cascading the higher level measurements down in the organization. Eckerson (2009) performed a survey that shows that it is common that KPIs are cascaded in two or three organizational levels. In all the respondents of the survey cascaded their KPIs between zero and five levels. There are two approaches to cascading the KPIs, the first is through vertical cascading and the second is horizontal cascading.

Vertical Cascading

Vertical strategy is built on the idea that the strategy is rolled down in the organization, while the metrics are rolled up. This allows management to wide sight across all groups and levels. At the same time it also allows employees at all level to see how their effort and actions contribute to the overall performance. There are different ways to roll up metrics, for example by a adding two lower-level measure to one higher level or by deriving lower level measures for the same activity that might be measured in different ways. (Eckerson, 2009)

Horizontal Cascading

Horizontal cascading aims to align the KPIs between different dashboards and scorecards to achieve coordination. Horizontal cascading can be driven by a governance group that has a business driven approach and focuses on dissemination and alignment through coordination and cooperation across groups. This is to bring together top-down and bottom-up approaches within the same organizations. (Eckerson, 2009)

3.6.2 Correlation between KPIs

A way to analyze indicators can be to correlate these to outputs and among themselves. The cause-and-effect relationship of a PMS system is an important aspect to be able to manage it. Additionally a correlation between different indicators could provide an organization with meaningful information and provide feedback to the strategic management. (Rodríguez, Saiz, Bas, & Sáez, 2010)

The identification of KPI relationship can help reduce the number of KPIs, clarify focus areas, construct cause-and-affect diagrams to show behavior over time. Furthermore the relationships can be translated upstream within the PMS to determine relationships between different strategic objective and provide a dynamic model. (Rodríguez, Saiz, Bas, & Sáez, 2010)

If you cannot measure what is actually desired then it is necessary to find measurements that can shows the performance through correlation. An everyday example of this is, if one cannot measure your weight, due to lack of a scale, then you could measure the change in weight compared to a pair of skinny pants and the fit of these.

3.7 *Methods for Performance Measurements*

Two methods and frameworks that are frequently discussed in the academic world are Performance Measurement Systems and the SCOR model. The first can be divided into several different models that aims to achieve the same objective. One of the most common models used in industry is the Balanced Scorecard model. (Striteska & Spickova, 2012)

When defining what performance measurement is, Bourne et al. (2003) gives the following explanation:

- Performance measurements are the use of multi-dimensional set of measures. The measure should include both internal, external, financial, non-financial measures as well as show a previous state (lagging indicators) and help predict the future (leading indicators).

- To be successful in performance measurement, the measures need to be defined in relation to each other through a framework. This allows for a reference to compare the efficiency and effectiveness of different actions. The most popular approach to a framework is to compare towards strategy.

- The performance influences the surrounding environment and brings with consequences. It therefore needs to be a part of the management planning and control systems in the organization.

3.7.1 Performance Measurement System (PMS)

A performance measurements system is a management tool used to control and monitor the performance of an organization. There are two main aspects with using a PMS. One is to benchmark against other companies and the other is to monitor and check the performance in relation to the company specific objectives. Neely et al. (1995) makes the following statement about PMS:

"A performance measurement system can be defined as the set of metrics used

to quantify both the efficiency and effectiveness of actions."

There are several different approaches to PMS that have been made available and presented throughout the years. The main aspect of all approaches is to connect strategic objectives with performance indicators and balance multiple metrics across multiple levels (Busi, 2007). A PMS provides a structured way to identify improvement opportunities and threats. The system can help to link the strategy to goals, targets and actions across the company (Striteska & Spickova, 2012). The metrics can be seen as the base of the business architecture linking strategy to processes and in that way embodies the approach to the levels above (Eckerson, 2009). However, it is not an easy task to do. Bourne et al (2003) mentions that research show that many performance measurement initiatives fail. Therefore, it is important to understand what approaches there are and what factors can affect the success or failure of an implementation effort. More recent research also suggest that the PMS need to be adaptable to a changing strategy and objectives within an organizations (Striteska & Spickova, 2012).

According to Toni and Tonchia (2001) are there different ways to classify and divide different performance measurement systems.

1. Models that are strictly hierarchal/vertical with cost and non-cost measurements on different levels of aggregation.
2. Models which considers different performance measurements from different perspectives, such as balanced scorecards.
3. Models that synthesis low-level indicators into more aggregated ones.
4. Models that distinguished between internal and external performance to reflect the customer perception.
5. Models that are related to value chains and therefore also take into account internal customers.

So, performance measurement systems can be built with vertical, horizontal and balanced structures. However, a PMS alone does not provide a full solution. The system framework allows for a structuring and consideration of different perspectives. But it also needs to be integrated with the management to specify which objectives should be met and what measures to use in order to do this. (Bourne, Neely, Mills, & Platts, 2003)

3.7.2 SCOR Model

The SCOR model is short for Supply Chain Operations Reference model. It is a model developed by the Supply Chain Council (SCC) with the purpose of providing a cross-industry standard and framework for managing a supply chain (Mattson, 2012). SCC merged in 2014 with APICS and changed name to APICS SSC. The organization is an independent non-profit association that brings together private corporations, public sectors and academic institutions. The goal is to help organizations address supply chain challenges by unbiased research, benchmarking and publications. The SCOR model allows for benchmarking against other companies and the APICS organization provides benchmarking data. (APICS, 2018)

The SCOR model, shown in figure 12, is based in the overall flow from the supplier's supplier to the customer's customer. It focuses on the physical flows and the processes required to realize them, such as procurement, production and distribution. The model does not feature product development or sales (Mattson, 2012). The purpose of the model is to introduce a standardize way to describe, measure and analyze a company's supply chain. To do this, the model is divided into five different processes types: Plan, Source, Make, Deliver and Return. The process types can be defined as plan, source, make, deliver and return. (Bolstorff & Rosenbaum, 2012) (Mattson, 2012)

PLAN: The plan processes are all processes linked to planning to ensure sourcing, making and delivering as efficiently as possible in accordance to demand.

SOURCE: The source processes are all processes for procurement of material and service so that the company's products and services can be produced to meet demand.

MAKE: The make processes are all processes that are linked to the transformation of inbound material to a finished products or service.

DELIVER: The delivery processes are all the processes that ensures that finished products are delivered according to demand.

RETURN: The return processes are all handling the return of products for customers as well as the return of material and products to suppliers.

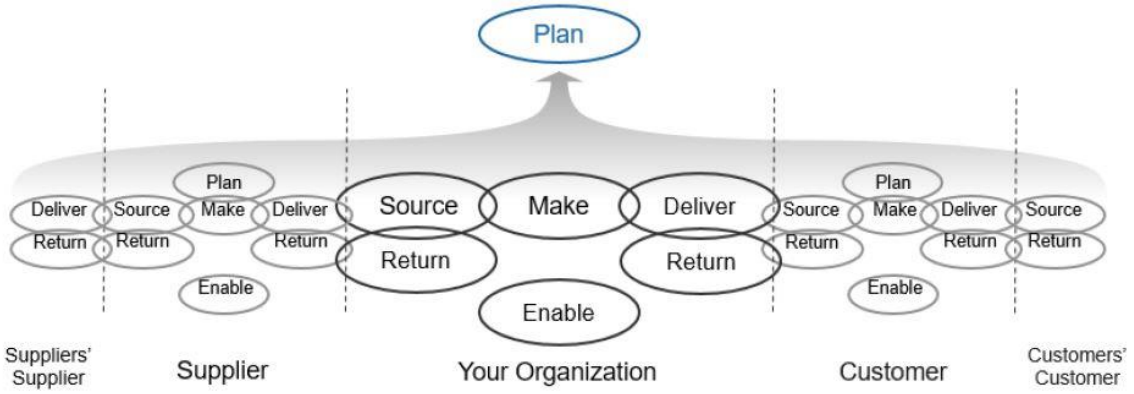

Figure 10: The Score model according to APICS. Source: APICS (2017).

There are three levels of metrics in the SCOR model to analyze the overall state of the supply chain. The different levels have a varying degree of detail, but all are important for the analysis of the performance. (Bolstorff & Rosenbaum, 2012) (APICS, 2017)

Level 1: Are the strategic measures that tell then supply chain's overall health. Level 1 metrics are also recognized as strategic measurements or KPIs.

Level 2: Are the metrics that support the measures in level 1. They help to identify a gap or root causes for performance issues.

Level 3: Are the metrics that in turn supports the level 2 metrics.

Performance attributes

The SCOR model recognizes five types of performance attributes. The first three are customer-focused while the two last are internal-focused. Each of these attributes consist of three hierarchical levels of measurements. (APICS, 2017) . In the table 3 below, the five performance attributes an the belonging level 1 metrics are presented.

Table 3: The five types of performance attributes and belonging level 1 metrics. Source: APICS (2017).

Performance attribute	Definition	Level 1 Metrics	Definition
Reliability	The ability to perform a task.	Perfect order fulfillment	The percentage of orders meeting delivery performance, with complete and accurate documentation and no delivery damage.
Responsiveness	The speed of the task performed.	Order fulfillment cycle time	The average cycle time to fulfill customer orders. From order receipt until delivered to customer.
Agility	The ability to respond to changes and fluctuations.	Upside supply chain adaptability	The maximum sustainable percentage increase, in quantity delivered, that can be achieved in 30* days.
		Downside supply chain adaptability	The reduction in quantities ordered sustainable, at 30* days prior to delivery, with no inventory or cost penalties.
		Overall value at risk	The sum of probability of risk events times the monetary impact of the event.
Costs	The operating cost.	Total supply chain management cost	Total cost linked to the plan, source, make, deliver and return process.
		Cost of goods sold (COGS)	The cost of purchasing raw material and producing the finished goods. Includes both direct and indirect cost.
Assets Management Efficiency	The ability to efficiently use assets.	Cash-to-Cash cycle time	The time until money invested, e.g. on raw material or other resources, flows back into the company.
		Return on supply chain fixed assets	The return received on capital invested in fixed assets.
		Return on working capital	Measure the magnitude of investments relative the company's working capital position vs. the revenue generated in the SC.

*The 30 days is set for benchmarking purpose and might not be applicable to all industries

3.8 *Supply Chain Measures and Indicators*

Pettersson (2008) investigated 30 Swedish companies from various sectors, that all operate on a global scale. The aim of the investigation was to determine how these companies are working with performance measurements in their supply chains. From the answers about what performance measurement was used at each company, Pettersson (2008) distinguish eight different groups or types of measure, presented in table 4 below. However, the actual metrics used differs between companies and sectors. The most common to measures the supply chain performance are:

1. Delivery precision
2. Inventory turnover
3. Lead time

The least common measure was customer satisfaction.

Table 4: Eight types of performance measurement. Source: Petterson (2008).

Type of measurement	Type definition	Example of measurements
Delivery Precision	Goods delivered according to promised date	• Delivery precision • On time in full (OTIF) • Delivery reliability
Lead time	Time from placement of order until it is finished	• Production lead time • Order lead time
Cost	Different types of cost measurements	• Distribution cost • Capital cost • Logistics cost/unit
Inventory turnover	Measurements that are linked to tied-up capital	• Inventory turnover • Tied up capital in stock (money or number of days)
Internal performance	Measurements linked to the internal performance	• Yield in production • Ordering entry time • Capacity utilization
Customer satisfaction	Measurements linked to customer satisfaction	• Customer satisfaction score
Quality	Quality measurements from the customer perspective	• Warranty claims • No. of replaced goods
Service grade	Measurements linked to the service grade towards customer	• Fill rate • Back order • Safety stock • Service level

3.8.1 Identified Order-to-Delivery Measures and Indicators

Research articles by Keebler & Plank (2009), Gunasekaran, Patel & McGaugheyc (2004), Gunasekaran, Patel & Tirtiroglu (2001), Fraser, Manrodt & Vitasek (2008), Hausman (2002), Fast (2015) and Forslund, Johnsson & Matsson (2008) have been used to identify performance measures for an OTD process. The articles have been focused on supply chain measures or on logistics measures. Since these measures either represent a broader or more narrow scope, than the OTD process, have relevant measures for OTD been selected from the sources and presented below. The measures have been sorted, in table 5, into the groups suggested by Petterson (2008) above. Some of the measures

presented are suggested by the SCOR model. However, not all SCOR model metrics are represented below.

Table 5: Identified OTD measures. Source: Keebler & Plank (2009), Gunasekaran, Patel & McGaugheyc (2004), Gunasekaran, Patel & Tirtiroglu (2001), Fraser, Manrodt & Vitasek (2008), Hausman (2002), Fast (2015) and Forslund, Johnsson & Matsson (2008).

Type of measurement	Measure	Definition
Delivery Precision	Delivery reliability	Measures if the delivery is made before or on the agreed upon date.
	On time delivery	Determines if products are delivered within a specified time window or not. Can also be referred to as delivery precision.
	On time in full (OTIF)	Measures if the delivery is made on time and in full extent, i.e. excluding partial deliveries.
	Carrier performance reliability	Measures how the carrier is performing according to target or agreement.
	On Time Shipments	Percentage of the orders shipped at the planned time.
	On-Time Ready to Ship	Percentage of the orders ready to be shipped at the planned time.
	Percentage of finished goods in transit	Number of products that are currently being transported to the customer.
Lead time	Customer inquiry response time	The time it takes for a company to respond to a customer request with the required information.
	Order entry time	The time required for a customer order to be entered and recognized in the system.
	Order lead time	Time between the receipt of the customer's order and the delivery of the product.
	Production lead time	Time to manufacture the goods, from the release of order to production to the finished goods is available.
	Delivery lead time	Portion of the total order lead time where the delivery process occurs.
	Lead time variability	The difference between lead times for the same type of item or product
	Product development lead time	The time for a company to design a product and be ready to manufacture it, including designing manufacturing processes.
Cost	Distribution Cost Per Unit Shipped	Distribution cost per product
Inventory turnover	Cash-to-cash cycle time	Average number of days that is needed to transform cash invested in resources into cash collected from customer.
	Inventory turnover (ITO)	Ratio of how many times the inventory is sold and replaced over a period of time.
	Total inventory/stock	Can be measured as stock level, work-in-progress, scrap level and finished goods in transit (monetary value, no of days or no. of products).

	Days sales outstanding	Average number of days that it takes for the company to collect the payment from the customer after the sale has been made.
Internal performance	Lead time adaptability	The percentage of what the confirmed lead time can be reduced in relation to the offered lead time before the order.
	Lead time flexibility	The percentage that lead time can be reduced in relation to the lead time confirmed at the order point.
	Responsiveness to urgent deliveries	Number of orders that an organization is able to meet, that are requested on abnormal delivery times.
	Capacity utilization	How much of the total capacity that is being used, can refer to space, equipment, labor etc.
	Orders scheduled to request	Measures how well the company can meet customer request, e.g. No. of Work Orders Scheduled to Customer Request Date ÷ No. of Total Work Orders Scheduled.
	Forecast accuracy	Difference between forecasted and actual demands.
	Order entry accuracy	Measures the accuracy of entered order, e.g. orders entered without fault.
	Order picking accuracy	Measures the accuracy of the order picking process.
	Invoice accuracy	Measure if the invoice is accurate and on-time.
Customer satisfaction	Customer satisfaction score	Average rating of customer satisfaction.
	Net Promoter Score	Measures the likeness of a customer referring someone else to the company
Quality	Quality of delivered goods	Measures percentage of goods delivered with quality issues. Can be divided between quality issues caused by production and quality issues caused by delivery.
Service grade	Percentage of urgent deliveries	Percentage of products that are considered to be important and therefore placed prior other products in sequence.
	Late Orders	Late orders, can be expressed in days late, monetary value or in no. of products.
	Backorders	Number of backorders, can be measured as no. of backorder days, or value of backorders as a percentage of sales.
	Fill rate	Percentage of customer orders that are filled on the first shipment. Can be measured as items or order value.

3.9 *Developing and Reporting Measures and Indicators*

So far has an introduction to performance measurements been presented as well as methods and frameworks. Academically suggest measures have also been listed. The next section will feature how to instead develop indictors from the start and how to report and visualize them when they have been developed.

3.9.1 Development of Key Performance Indicators

Both researchers and practitioners alike talk about the key aspects of an efficient KPI. They focus on different frameworks and design processes that can be helped to determine an appropriate measure. According to Rohm and Nisbet (2017), should KPIs in general:

- Reflect and track the progress towards achieving a strategic objective
- Measure what is intended
- Support decision making
- Be able to show the degree of change in performance over a time period
- Be balanced between leading and lagging indicators
- Be valid and verifiable

When finding new measurements, one should keep in mind that these might not be found in a book. Instead an appropriate process to develop KPIs is to gather the right people in a room and perform a of workshop (Rohm & Nisbet, 2017). A workshop can also help incorporate different voices in the process and to build and align the corporate culture and core values into the process. However, before developing KPIs, the company must start with strategy and goal setting. Basically, one must know what is going to be accomplished, to be able to develop successful KPIs. (Rohm & Nisbet, 2017)

According to Rohm and Nisbet at the Balanced Scorecard Institute (2018), there are six process components or steps, see figure 13, to follow when developing or redesigning existing KPIs within an organization.

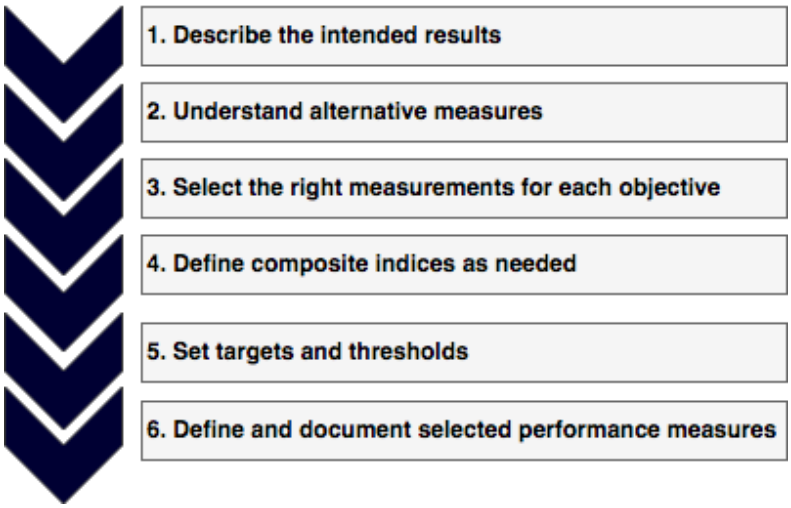

Figure 11: KPI development process. Source: Rohm and Nisbet (2018)

1. **Describe the intended results**
   Meaningful measures requires clear intended results. One must agree on definitions and expectations. For instance the strategic objective *Product Quality* can be perceived differently depending on personal viewpoint. From one viewpoint it means that product meets certain specifications. Another viewpoint is quality in the form of usability or reliability for the customer after purchase.

2. **Understand alternative measures**
   Analyze alternative ways to measure the intended objective. If it can be measured directly, identify these measurements. If the intended objective cannot be measure directly, identify measurable components instead. The components should be able to describe the intended objective through contribution or through correlation.

3. **Select the right measurements for each objective**
   In this step it is time to select the final measure. Narrow it down from potential measures identified. Choose the measure that have meaning and relevance. Select the one that best reveal how strategic performance is changing over time.

4. **Define composite indices as needed**
   If the individually developed measures provide useful data on different dimensions or components of the objectives intended result, construct an index. The index groups together several measures under one heading, to assist in analysis.

5. **Set targets and thresholds**
   It is important to describe desired performance levels and determine how data is interpreted. In this step one agrees on what is acceptable or not acceptable performance and how the data is used. Targets must be stated and after that the threshold values can be set with an upper and lower limit around that target value. In figure 14 below, target and threshold values are illustrated.

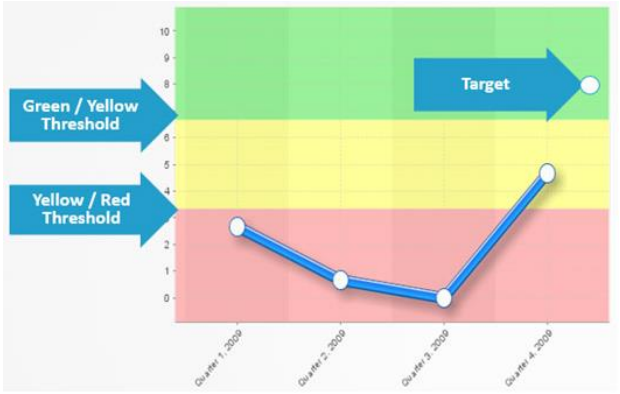

Figure 12: Targets and thresholds. Source: Rohm and Nisbet (2018)

6. **Define and document selected performance measures**
   Create a definition sheet, see section *3.9.3*, that defines the performance measure data. This is done by each objective ownership team. This is the critical step in the transition from development phase to implementation phase, and the usage. This is especially important if the company plan to use a performance management or a business intelligence software to report performance information for decision making.

3.9.2 Performance Analysis

After developing KPIs one need to analyze the data in order to turn it into useful information and knowledge. The point of KPIs is to help management make informed decisions that moves the company in the right direction according to strategy.

During this process is what need to consider the following:

- How the company is performing?
- Are the strategies working? Why and why not?

- Are the right things actually measured?

There is no quick way to analyze and understand data, even when having the right cornerstones such as:

- The right measurements
- A performance measurement system
- A performance culture where information is acted on

Even then a thorough and comprehensive number analyzes is needed. There are available tools and software that can help spread information to the right people. According to the Balanced Scorecard institute (2018), the performance analysis process can be divided into four steps, see figure 15. This process is typically driven by a team who selects tools, creates structures and implement the project and data collection in coordination with the objective owners. The owners are then responsible for the ongoing measurement and development of these measures. (KPI.org, 2018)

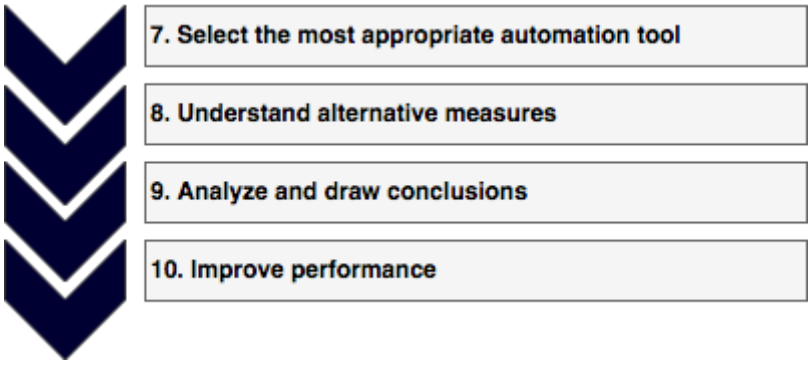

Figure 13: Performance analysis process according to Balanced Scorecard Institute (2018)

7. **Select the most appropriate automation tool**
   Automation lets the process of analyzing and spreading performance information easier and more standardized. Using one system also allows for better coordination and communication between different parts.

8. **Collect and monitor performance**
   The data does not only needs to be collected and tracked. It needs to be described and monitored. In describing the performance, it needs to be analyzed thoroughly enough to understand what the information actually says. It needs to be linked to the environment and other parameters to determine if the performance is acceptable or not. The data also need to be visualized with trends and targets to be able to tell a story of the development in respect to the strategy. In this step it is needed to clarify questions such as what needs to be answered, how often does the information need to be updated and what stakeholders to consider. It should also clarify if there might be a broader purpose for the analysis.

9. **Analyze and draw conclusions**
   In this step data needs to be discussed and analyzed. An underperformance needs to be identified and it is vital that the information is shared to the right people at the right time. The team needs to have a dialogue about how, where, when and why the company is performing to this level.

10. Improve performance

The last step is based on monitoring whether actions are improving the performance result or not. The actions themselves can be determined by different improvement tools that are available, such as value stream mapping and Ishikawa diagrams. When an initiative takes place, the responsible employee should focus on the implementation while the performance is monitored over time. The measures then need to be evaluated to whether the initiative had an impact or not. The information learned during this process should also feed the strategic planning cycle.

There is no point in collecting data and measuring just for the sake of it. Instead, there needs to be an idea about what it should be used for. The data should then be used to identify and implement improvement actions as well as to evaluate the effect of the improvement initiatives and towards long term targets and goals. It is important to maintain a focus on continuous process improvement. To tie the circle back together, the information learned need to be used in future evaluation and improvement of strategic planning and decisions. In an initial phase, the strategy is more of an hypothesis that can then be verified and validated, or not, through analysis.

3.9.3 Defining and Reporting Measurements

When a performance measure has been developed it needs to be determined how it should be reported and visualized. To ensure a common understanding and way of working, a definition sheet should be developed.

Definition sheet

Neely et al. (1997) recommends a record sheet for the indicators and measure with the purpose of clearly defining the measurement and how it should be used. The exact information put in the record sheet, and the level detail, can vary depending on need but there are a few key aspects that should be included. These aspects are stated in table 6 below.

Table 6: Example of a definition sheet. Adapted from kpi.org and Neely et al. (1997)

Definition Sheet	
Title	A clear and descriptive title.
Purpose	States the purpose of the measurement, i.e. what it aims to do.
Relates to	States what business objectives does the measurement relate to.
Objective owner	Individual or department responsible for the strategic objective.
Measurement owner	Individual or department responsible for collecting and reporting the data.
Target	A target towards the measurement is compared.
Formula	The mathematical formula used to calculate the measurement.
Frequency	How often is should be collected and reported (daily, monthly, quarterly etc).
Source of data	States from where the data should be collected.
Who acts on the data	The person responsible for taking actions according to the measurement.
What do they do	Definition of action plans or process step to take when necessary.
Presentation	States how the data should be presented.
Notes and comment	Other relevant facts.

Balanced scorecards and dashboards

When researching performance measurements and ways to report these metrics, two expressions stands out which are balanced scorecard and dashboard. According to Mihai and Zamfir (2014) and Savkin (2017) are these two expressions often confused for the other. The confusion could be based

on that both alternatives often use the same kind of graphic elements and software tools to visualize them. However, there is a clear difference in the objective and content of the two tools. A balanced scorecard is used for performance management whereas a dashboard is used for performance monitoring (Savkin, 2017). The following section aims to clarify these expression and the difference between them.

Balanced scorecard

A balanced scorecard (BSC) is not only a way to report measures. It qualifies as a performance measurement system and is one of the most commonly used PMS models. According to Slack et al (2015) is a balanced scorecard an approach to include not only financial measurements in the reporting, but also measurements for other factors that affect an organization and in extent the financial performance. In that way a balanced scorecard incorporates other perspective into the measurement of the performance. While ***financial measurements*** are still important, other aspects to include are performance from ***customer perspective***, ***process performance*** and ***learning & growth***, sometimes referred to as innovation. The four perspectives are shown in figure 16. (Slack, Brandon-Jones, Johnston, & Betts, 2015)

A BSC monitors the way an organization achieves its strategical goals and is aimed at higher level management (Mihai & Zamfir, 2014) (Jackson, 2016). The main idea of the BSC is to implement and manage strategy at all levels of the organization. In this way the BSC both allows for a measurement system, a way to manage strategy and a way to visualize and spread information within an organization. The idea of the different perspectives is to allow a transparency between drivers and the performance of the organization. This in combination with short-term and long-term objectives allows for a balanced view. (Striteska & Spickova, 2012)

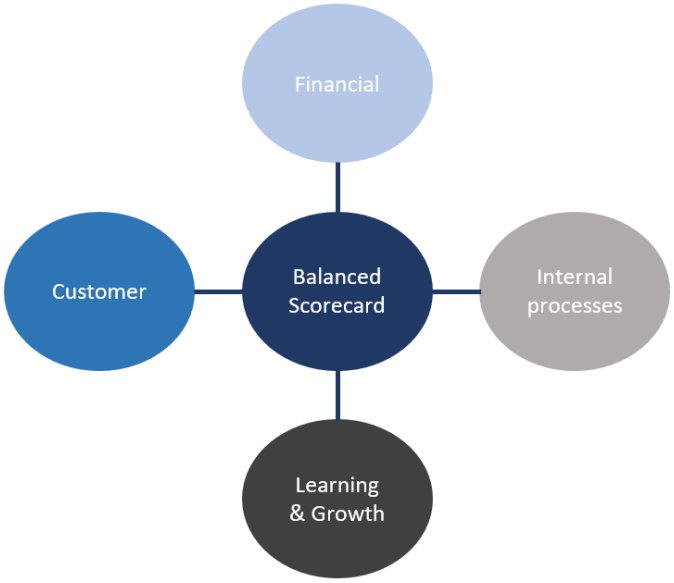

Figure 14:The four perspectives of a Balanced Scorecard. Adapted from: Slack, Brandon-Jones, Johnston & Betts (2015).

Dashboard

In contrast to BSC that is focused on the long-term strategic goals, a dashboard is aimed at the short-term tactical and operational goals and objectives. Therefore, a dashboard should monitor real-time performance and can be used for the managers responsible for achieving these short-term goals. A dashboard can be suitable to help visualize large set of data. It can be ideal to use if there is a need to

monitor and understand how the process is performing. (Jackson, 2016). Dashboards can be used for different focus areas: strategic, tactical and operation. (Eckerson, 2009)

Strategic dashboard: Enables executive management to visualize outcome KPIs and facilitate in monthly strategic reviews and planning sessions. They consist of aggregated lower-level KPIs into summary-level KPIs. An example of a strategic dashboard is a scorecard.

Tactical dashboard: Enable mid-level or department management to optimize performance. The dashboard compromises both outcome and driver KPIs and are compiled on a daily or weekly bases.

Operational dashboard: Enables front-line workers to monitor the daily and intraday activities. They consist of driver KPIs and operational metrics that help drive higher level KPIs.

Summary Balanced Scorecard vs Dashboard

Mihai and Zamfir (2014) and Savkin (2017) distinguishes the following differences between a Balanced Scorecard and a Dashboard. The differences are illustrated in table 7.

Table 7: The differences between BSC and Dashboard. Source: Mihai & Zamfir (2014) and Savkin (2017).

	Balanced Scorecard	Dashboard
Used for:	Managing performance	Monitoring performance/operations
Type of measure:	KPI (Metric + target)	Metric
Measures:	Progress	Performance
Update frequency:	Periodically	Real-time
Focus/goal:	Strategic	Operational or tactical
Graphical layout:	More symbols and icons	More charts and tables
Helps with	Align KPIs, objectives and actions to visualize connections	Visualize performance and understand the current state
In an car it is:	The GPS	The car dashboard

4 Company Description

This chapter provides a brief historical background and introduction to Scania as a company and the products and services that they are producing. It also introduces "The Scania Way", which is considered the foundation of the corporate culture and the way of working.

4.1 *Company Introduction*

Year 1891, was a Swedish company named Vabis was created through a merge with an existing company that created wheels and components to railway wagons. Vabis started to produce wagons and later on also cars and trucks. In 1900, a company named Scania started producing bicycles and later also cars and trucks. Vabis and Scania merged into Scana-Vabis and at the same time the production of bicycle and railway wagons ended. Scania-Vabis merged with Saab in 1969 and became Scania-Saab. (Scania, 2016)

Since 1995 has Scania been an independent company and is today one of world's leading manufacturers of heavy trucks and busses. The portfolio also consist of industrial and marine engines as well as components such as gear boxes and spare parts. The company has approximately 49 000 employees working in more than 100 different countries around the world. Scania's production sites are located in Europe, Latin America and Asia. In addition to this there are regional production centers in Africa, Asia and Eurasia. Scania also provides an extensive service offering to their customers. These services include financing and rental service, insurances solutions and assistance, driver coaching and fleet management among others. (Scania, 2018)

Scania's vision is to act as a driver in the shift towards a sustainable transport system. The company wants to create a mobility world that benefits environment, society and the business (Scania, 2018). Scania believes that profitability and sustainability works together and the aim is to improve customers profitability by providing them with sustainable solutions (Scania, 2018).

Since 2014, is Scania a wholly owned subsidiary of the Volkswagen Group. (Scania, 2017). The group consists of twelve brands focused on motorcycles, cars and commercial vehicles such as pick-ups, trucks and buses. (Volkswagen, 2017)

4.2 *The Scania Way*

Scania is built around the company's culture and its commitment to continuous improvement. It is considered as the foundation for the company's success. Scania's core values and management systems, supported by the main principles, are called "The Scania Way". The culture at Scania is well rooted and it is important to understand it when studying the company and its processes. Below are three corner stones of *The Scania Way* presented.

4.2.1 Scania's Core Values

Scania is managed according to their core values. These values are critical for the company's success and sets the corporate culture and mindset. (Scania, 2018)

- **Customer first** means that Scania is only successful when their customers are successful. To be able to customize solutions they need to understand and integrate the customer in the entire value chain.

- **Respect for the individual** means that the general rule is that Scania workers treat all people the same way they want to be treated. Scania focuses of taking care of each individuals potential and make it possible to develop people and business processes.

- **Elimination of waste** is an important part in Scania's focus on continuous improvements. By finding wastes and deviations in processes the company can ensure that they maintain quality in output areas and ensure less environmental damage.

- **Determination** means that Scania employees are dedicated and motivated to reach extraordinary results. Workers are excited to meet new challenges and create new innovative solutions, by having a feeling for details as well as the big picture.

- **Team spirit** means that Scania employees work together in diverse teams across borders. By having an open working climate and a common direction brings a collective strong group feeling.

- **Integrity** means that Scania has a social responsibility and acts according to their culture, core values and working principles. Scania keep promises and strives to do the right things. Scania builds relationships with all affecting partners and the society.

4.2.2 The Thinking Model

Scania's thinking model is illustrated in figure 4. The core values are the foundation of the way of thinking and the way of working at Scania. The core values are used to establish and improve the principles, which provides a common way of thinking. The principles are in turn are supported by the methods and represents a common way of working. This foundation will feed the results achieved at the company. If something is not working, and the expected results are not reached, then the methods are reviewed and further developed if needed.

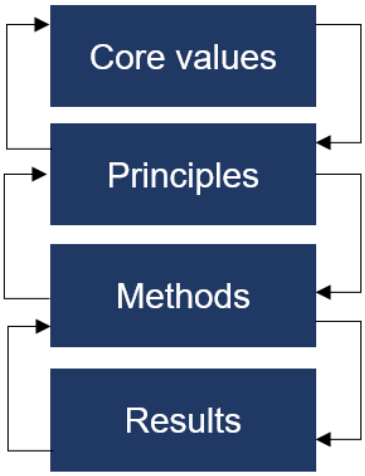

Figure 15: Scania's thinking model. Adopted from Palmgren (2013).

4.2.3 The Scania House

The Scania House is based on the core values and supported by the main principles:

- Continuous Improvements
- Right from Me
- Demand Driven Output
- Normal Situation
- Leadership

The Scania house has its roots in the lean principles introduced by Toyota and Toyotas Production System (TPS). Lean is a method, philosophy or way of thinking to ensure efficient processes and a fundamental part is the elimination of waste. The work with implementing the house started with a need to improve the performance of Scania's production. The need of a higher performing production system was based in high absence and high people turnover (Palmgren, 2013). The development was initiated in the 1990s when staff from Scania visited a Toyota plant in the USA. Some of the first improvements steps after the visit was to arrange processes, equipment's and workplaces (Bellgran & Säfsten, 2010). Since then Scania have continuously developed their own version of TPS, called Scania Production System (SPS). The principle of this house is today developed and adapted at all functions at Scania. There is a general house, shown in figure 5, representing the foundation of the company and from that is it adapted to fit and support different areas within the company.

The house is based on values, principles and priorities. The ground of the house consists of Scania's core values and the floor, walls and roof consists of the four principles *normal situation*, *right from me*, *demand-driven output* and *continuous improvements.*

Scania's priorities are:

1. Safety, health and environment
2. Quality
3. Delivery
4. Cost

To be able to follow-up values, principle and priorities, is active leadership required. The leader needs to teach and communicate the Scania way of working. (Granath, Svedlund, & Wiberg, 2009)

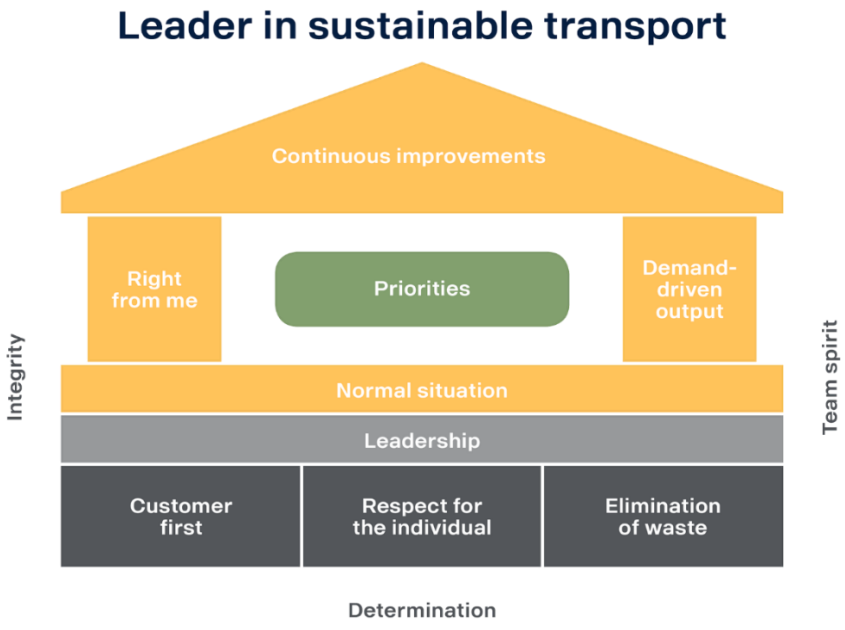

Figure 16: The Scania House. Source: Scania (2018)

5 Current State Analysis

This chapter gives an overview of the Order-to-delivery process at Scania and how the performance of it is measured.

5.1 *Scania's Order-to-Delivery Process*

The Order-to-Delivery flow at Scania is considered one of the company's core flows and is essential for the success of the company. The Order-to-Delivery is viewed as a cross-company process, which also means that all the main functions are linked to the process. Other flows that are considered as cross-company flows are product development, sales, and service delivery. The main functions are visualized as the columns in figure 17.

- **R&D** – Research & Development
- **P&L** - Production and logistics
- **S&M** – Sales and marketing
- **CO** - Commercial operations
- **F&BC** – Financial services and business control
- **S** – Purchasing

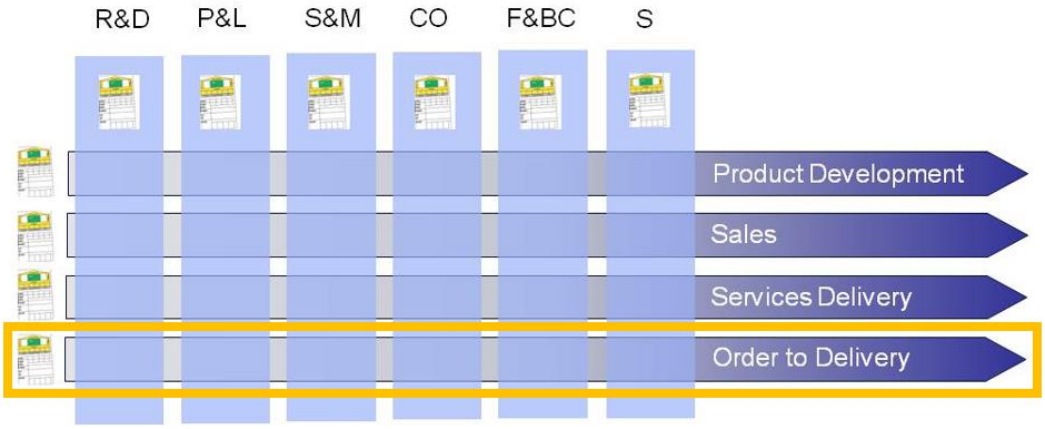

Figure 17: The figure shows the main functions at Scania and the core cross-company flows. Source: Scania (2017).

The Order-to-Delivery process starts when a customer places an order. The order is usually placed with a dealer who then places it at a distributor, but an order can also be placed directly at the distributor. Depending on the market is the distributor either Scania-owned or an independent actor.

Orders are placed from the distributor to Scania and made visible for the Order department. This is where the industrial part of the flow starts. Orders are automatically allocated in batches according to production restrictions, market restrictions and a Desired Delivery Date (DDD) that is stated by the customer. These restrictions are entered into system databases, which the order passes through. Orders that cannot be automatically allocated due to error codes, are manually handled by the order department.

All orders that are received are automatically allocated to production slots up until a specific date, named Batch Close (BC). After BC, orders can only be manually changed in the current batch. Manual changes are done by the order department and are possible to make until Status 1 (ST1). ST1 defines when the whole batch is closed for changes and sent to production for production mixing.

The production mixing is done at every separate plant, referred to as production units (PRUs) at Scania. The products are then assembled according to the production sequence at the end assembly line. After

the end assembly line, extra time is added for completion and adaption of the chassis, these are operations that are not able to be performed on line. Instead this is done at a separate line in the end assembly facility. After necessary modifications are done, the chassis is released to the yard to be shipped out to customers by the outbound department. The P&L departments take responsibility of the shipment until it is sent to the first delivery address. This is where the industrial part of the OTD process stops. Scania's department for commercial operations take over after the delivery is made to the first delivery address. Scania's OTD process is illustrated in figure 18.

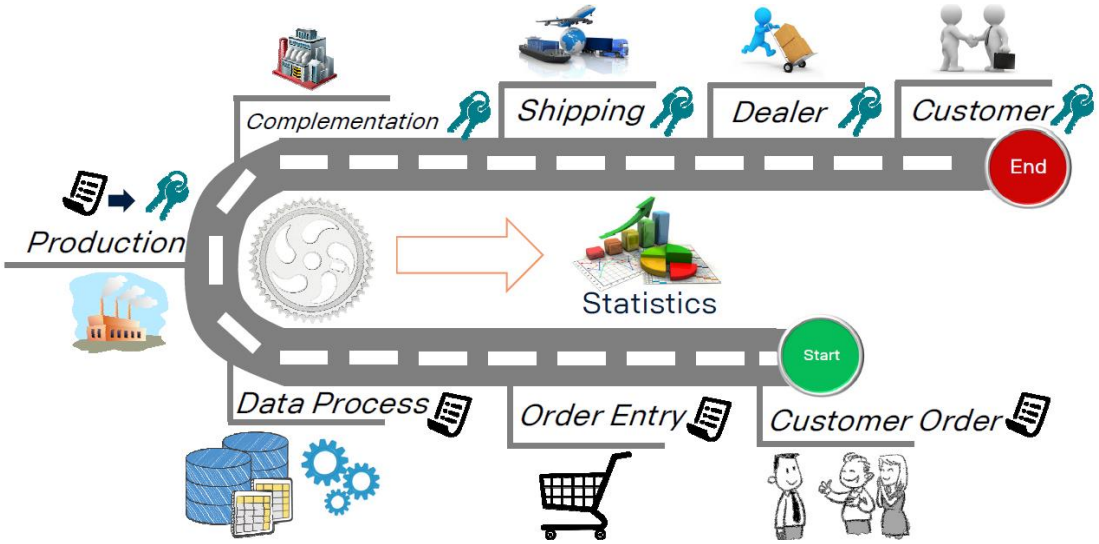

Figure 18: Overview of Scania's OTD process. Source: Scania (2017).

5.1.1 Flow Control

Flow control is a concept implemented in Scania's order-to-delivery process. The vision is to establish a stable flow with short lead time that fulfils the customer needs. The flow control concept looks at the timeline from the moment the customer gives an order until the moment Scania collects the payment. This line can be shorten by removing non value added wastes. Flow control is the basis for Order-to-Delivery improvements. The reasons for implementing flow control are many, e.g. that Scania can speed up the delivery process and at the same time make sure to minimize tied up capital. At Scania there is a trade-off between resource efficiency and flow efficiency. The aim is to strengthen flow efficiency and make decisions based on what is best for the total flow instead of optimizing on resources.

Flow control project

Different flow control projects have been implemented for different markets during the past years, for instance Russia and Hong Kong. The implementation process has been tailor made for each market's need and the different markets has had their own standards on how to implement flow control. The projects have been extensive and executed in different time periods. The project steps in figure 19 illustrates the implementation process.

Figure 19: Flow control implementation process. Source: Scania (2017).

The current idea and work with the flow control concept is to create a standardized way of implementing flow control for all markets. This will save time and resources and the opportunity to faster expand to new markets.

5.2 *Measuring Performance on Strategical Level*

On a strategical level is a variant of a Balance Scorecard approach used, see figure 20. The scorecard can also be referred to as the "egg" and features the following perspectives:

- Top employees
- Customer satisfaction
- Volume growth
- Profitability

The current KPIs and expected deliveries, according to the four perspectives, are reviewed and set annually during strategy break down work. The strategies are first set on an executive level. These strategies are then derived to a functional level which in turn is translated to a department level. Each levels interprets the above level's strategic objectives and decides what actions and targets are that they need to set in order to help achieve these. The KPIs are followed monthly and the strategic activities that they correspond to are followed on a quarterly basis.

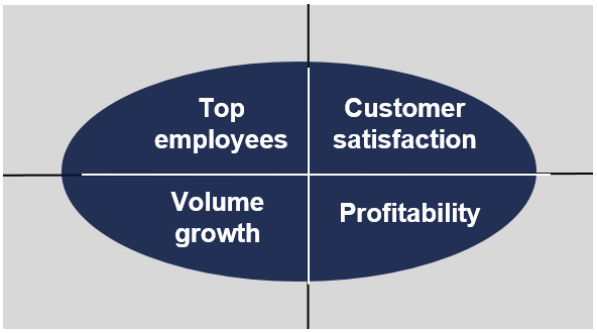

Figure 20: The figure shows a representation of Scania's Balanced Scorecard. Source: Scania (2018).

5.3 *Measuring Performance within Order-to-Delivery at Scania*

The following measurements are used to measure the cross-functional flow of the OTD process. They are therefore considered the main KPIs. On Commercial Operations side of the flow is also stock levels used as a measurement. Apart from this, are there also functional KPIs that are enablers for the process but are not considered cross-functional. The functional KPIs are not presented here.

5.3.1 Average Lead time

Lead time is measured both on the industrial side and the commercial side of the OTD process. This section will further explain the lead time calculations used in the industrial part of the flow. The lead time calculations consists of average values, meaning that data from different individual chassis are compiled into one aggregated average value.

The lead time today is calculated and visualized in a few different ways:

1. Total lead time measurement
2. Allocation Precision
3. Sequencing Precision
4. Delivery Performance

The lead time can be divided into regions, countries, production units, product types and assembly levels. Scania also makes a distinction between a Desired Delivery Date (DDD) that is considered reasonable or not. This is to reduce a negative impact on the lead time performance if the DDD inquired is not considered reasonable, i.e. that it could not be met even in an ideal situation. The lead time system with its including dates and status points are illustrated in figure 21. In a ideal situation are Preliminary Delivery Date (PDD), Confirmed Delivery Date (CDD) and Actual Delivery Date (ADD) equal to Desired Delivery Date (DDD). They are separated by dotted arrows, in the figure, to show what is measured in case of deviation. Each date is further explained below.

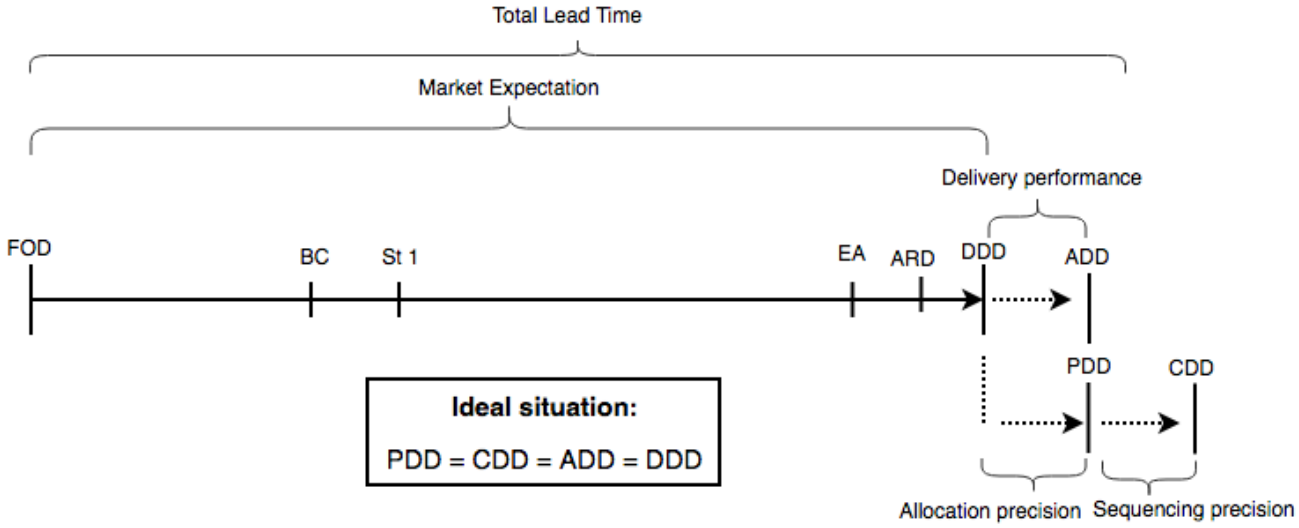

Figure 21:The lead time and belonging dates

Total lead time measurement

The total lead time is split and calculated in different steps, which are then compared towards an expected parameter that equals a normal situation. This parameter allows to see how many days are lost or saved towards an expected value. The total lead time is visualized for the last 13 months as well as for the last month as an average value. The different steps or measuring points used are the following:

Market expectation is calculated by:

The actual number of days between First Order Date (FOD) and the Desired Delivery Date (DDD). This is the timeline that the customer expects when placing an order.

First Order Date to Batch Closing is calculated by:

The actual number of days between the First Order Date and Batch Close (BC). BC represent the date when the production batch is closed for allocation.

Certain adaptions to the measured time period can be made if the order is placed earlier than needed to fulfill the Desired Delivery Date.

Batch Closing to End Assembly is calculated by:

The actual number of days between Batch Closing (BC) and End Assembly. EA represents the date when the vehicle is finished on line.

End Assembly to Actual Release Date is calculated by:

The actual number of days between End Assembly and Actual Release Date (ARD). This timeslot is used for alterations that cannot be made on line. The ARD is the date when the chassis is completely finished and made available for transportation in the yard.

Actual Release Date to Actual Delivery Date is calculated by:

The actual number of days between the Actual Release Date and the Actual Delivery Date (ADD). This timeslot represents the transport time, from that the truck is released at the yard until it is delivered to customer.

Allocation precision

Determines whether it is possible or not to allocate an order in production towards the Desired Delivery Date (DDD). This is done by comparing the Preliminary Delivery Date (PDD), which is given at allocation, to DDD.

Sequencing precision

The Preliminary Delivery Date is compared toward the Confirmed Delivery Date, i.e. the date that is set when the allocated batch is mixed in a production sequence.

Delivery performance

The Desired Delivery Date (DDD) is compared to Actual Delivery Date to determine whether the order is delivered early, on time or late.

All measures described above are compiled in table 8 below.

Table 8: The table compiles all dates used in the lead time measurements.

Measurement	What is measured
Total lead time measurement	First Order Date – Desired Delivery Date
	First Order Date – Batch Close
	Batch Close – End Assembly
	End assembly – Actual Release Date
	Actual Release Date – Actual Delivery Date
Allocation precision	Desired Delivery Date – Preliminary Delivery Date
Sequencing precision	Preliminary Delivery Date – Confirmed Delivery Date
Delivery performance	Desired Delivery Date – Actual Delivery Date

Data collection and visualization

Data is collected from a data warehouse and imported into an excel sheet that is made for the purpose of calculating and also visualizing it in a dashboard.

Current use of data

The measurements are so called lagging measurements, that is showing historical data. The excel sheet is updated at a monthly basis and forwarded to management. Due to the use of lagging measurements, the dashboard visualizations can be used to spot trends from the historical data. It is of limited use to make improvements and deviations are only spotted in after hands.

Challenges

The challenges today are that the measurements primarily tells something about how the process has performed (lagging KPIs). This makes it more difficult to steer and link it to actions in the future.

In general there are challenges when using average values in the calculations. One aspect is that extreme deviations can be lost in the average data. Another aspect is that short or long lead times can biase the large value, which is the opposite of hiding extreme deviations.

5.3.2 Ideal Flow

The ideal flow concept is an initiative to increase the transparency in the flow and to understand the performance in all steps. The main aim of the measurement is to follow how well products are delivered according to plan. The concept is developed as an alternative approach to the Average Lead time measurement.

This is performed by looking at the individual level of how many chassis are delivered within or without a specified “ideal” parameter. The parameter corresponds to the plan and depends on delivery address and the specification level that is defined in the system. In the ideal world, or in a normal situation, should the performance be within this parameter.

The ideal flow concepts is a way to measure deviations towards a normal situation and to find flow stability. With the historical data is it possible to see a percentage and also a number of chassis that are delivered within or outside of the parameter. The visualization tool will show if the chassis was OK or NOK, an example of this is shown in figure 22. If the actual value differs one or more days, the lead time is classified as out of the parameter and therefore not meeting the plan.

The Ideal Flow concept can be applied between different lead time dates to be able to investigate different sub-processes of the total lead time measurement. The dates used are the same as presented in the *Average Lead time* measurements above. The aim is to understand each order event compared to the total flow, and to find a connection between statistics and real action. In the system is it possible to sort between a specific month, production unit, product class, assembly level and region.

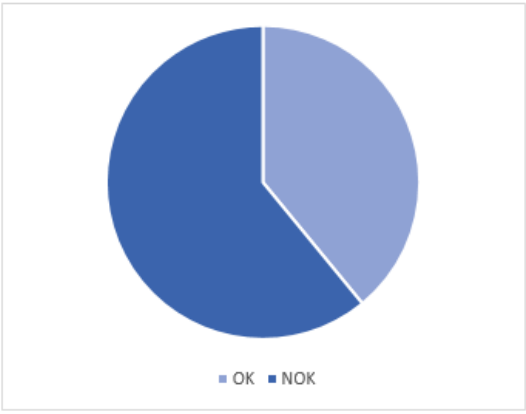

Figure 22: Example of a graph showing no of individuals within (OK) or outside the parameter (not OK).

Data collection and visualization

The data is collected from a data warehouse, calculated in excel and visualized in PowerBI. Power BI is a cloud-based business analytics tool provided by Microsoft.

Current use of data

This concept is planned to replace the above lead time calculations and the same use and frequency of update will apply to it.

Challenges

The Ideal Flow concept has some challenges that needs to be highlighted. The concept is recently implemented at Scania which means that there is a problem for employees to fully grasp the new approach. The new approach still has some problems remaining from the average lead time measurement. The usage of past data, i.e. a lagging indicator, is one problem, meaning that the approach will not be able to predict the future. Another problem is that the "ideal" parameter is measuring the in/out values in average. That means that Scania is not fully skipping the idea of using average data in the measurement approach. Something that also is also a challenge with the approach is to decide what an acceptable bandwidth might be for the ideal parameter. Right now, if a process step is one day late it is considered out of parameter, but a larger tolerance might be acceptable.

5.3.3 Delivery Precision

Delivery precision is used to measure the delivery performance at Scania. The responsible department for the measurement is the Outbound department. Prior to the implementation of delivery precision was delivery reliability used to measure the performance. This meant that all deliveries made up until a specific date was considered acceptable. However, too early deliveries could be as problematic as late deliveries to a customer. Due to this was delivery precision introduced instead, that allows a time windows as an acceptable range for delivery.

Delivery precision is measured as the difference between Confirmed Delivery Date (CDD) and Actual Delivery Date (ADD). The CDD is the confirmed date that the chassis should be delivered to the first delivery address. The measurement is performed in a time window of CDD +/- *xx* days. The window differs between inland and overseas markets. A delivery is considered acceptable when the ADD is within this time window.

The measurement shows the percentage of chassis that are:

- Early
- On time
- Late due to production
- Late due to transportation

It also shows amount of chassis that are delivered on each day in relation to their CDD, e.g. one day early, on time, one day late etc.

Data collection and visualization

The data is extracted automatically from a database and visualized in a QlikView tool. QlickView is a business intelligence and visualization tool, provided by QlikTech International.

Current use of data

Delivery precision is measured every day and used in weekly meetings. The data is analyzed to see deviations so that extra resources can be deployed or if the deviation needs to be communicated to the customer. Two to four times per year, the measurement is compiled in a report together with other measures and presented at supplier meetings. Delivery precision is also compiled once every quarter, as one of the measurements, in a “Supplier Quarterly Evaluation”.

Challenges

One challenge today is that the different production units does not work in the same way. An example of this is how and when different dates are reported into the system. This will affect the measurement in the sense that it has different meaning depending on viewpoint.

Another challenge that the outbound department faces is when production is late which can both affect the planning for their carriers and in extent the performance of them. Problems with production can also directly affect the delivery precision measurements. An example of this is when chassis are reported as finished and ready for transport but are still held due to a delivery stop. The system does not allow to change the status of the chassis and the time that it is held due to a delivery stop is counted as transport delay even though the problem arises from production.

Another issue is demand fluctuation for outbound transport. Even though an increase in demand can be predicted when the production batch is closed, it might not be possible to apply extra resources since the type of transport and drivers can be a shortage.

6 Company Comparison

The following chapter features the interviews and the company comparison conducted in the thesis project. Initially is the approach behind the interviews presented, followed by an overview of the performance measurements found. Lastly a section is presented for each of the interviewed companies.

Introduction

Research question 3 b) states "*How do other companies measure and manage the performance of their Order-to-Delivery process?"*. To answer RQ 3 b) was a comparison towards other companies carried out. The aim of the comparison was for the authors to get an understanding of the culture and view of performance measurements in other companies and to investigate if any additional measurements or best practices could be identified. This was done by understanding the flow of other companies Order-to-Deliver process, how the performance of it is measured and how the company works with these measures. Part of the comparison was also focused on current projects that other companies are working on regarding this area and to identify what was considered as challenges or problematic with performance measurements.

Interview approach

The interviews were held in written form, through skype and in person, depending on the agreement between the company and the authors. The agreements were based on time and distance limitations from both sides. The length and number of interviews have varied from several short interviews to a single longer one. For all companies have follow-up question been asked by email to clarify questions and answers. Table 9 below shows an overview of the contact with each company.

Table 9: Interview information

Company	No. of interviews	No. of Interviewees	Interview form	Email follow-up
Audi AG	2	3	Written form + Skype	Yes
MAN Truck & Bus AG	1	1	Skype	Yes
SSAB AB	1	5	In person	Yes
Sandvik AB	2	2	Skype	Yes
Volkswagen AG	2	1	Skype	Yes

The interviews were held in a semi-structured format, meaning that predetermined questions where primarily asked to ensure the same structure to all interviews. As the point of this subtask was to make a comparison, the authors were interested in receiving answers about the same questions from the different companies. Apart from the predetermined questions were follow-up questions also asked depending on the interviewees answers. The predetermined questions sheets can be found in *Appendix 1*.

Choice of companies

The choice of companies where done with the following aspects in mind:

- To include companies within different business areas, i.e. manufacturing different products.
- To include companies within the same group as well as companies outside the Volkswagen group.

The above criteria's were decided to allow for a spread between different companies, both culture wise and regarding processes. The purpose of this was to gather information from as many views as possible.

6.1 *Overview of Company Comparison*

Table 10 below shows an overview of the performance measurements found at each company. Below follows a section for every company with a more detailed description of what was learned during the interview.

Table 10: An overview of the performance measurements found during the interviews.

Company	Performance measurements
Audi AG	• Delivery performance depot • Order scheduling performance • Production program performance • Dispatch performance
MAN Truck & Bus AG	• Delivery time • Delivery reliability • Delivery precision • Capital employed • Percentage of unsold stock
SSAB AB	• Delivery Performance • Lead time • Stock volume • Delivery Delays • Number of complaints • Net Promoter Score
Sandvik AB	• Lead time • Fill rate • Forecast accuracy
Volkswagen AG	• Lead time • Delivery precision

6.2 *Audi AG*

The interview questions were answered in written form by two employees at Audi working at the *Dispatching department for finished vehicles* and the department for *Brand logistics planning – OTD process.* A follow up interview was held, where a third person also was present, whom was also working with *Brand logistics planning – OTD process* (G. Rottenwaller, A. Wesener & B. Rehm, personal communication, Mar 20, 2018). The Order-to-Delivery process at Audi is named the Kundenauftragsprozess (KAP).

Audi's Order-to-Delivery process

Audi produces vehicles at seven different productions units, located in six countries. The customer, from Audi's view, depends on the country of destination, but is usually a national sales company, often referred to as an importer. The order-to-delivery (KAP) process, consist of the following steps:

1. Ordering
2. Order scheduling
3. Production
4. Distribution
5. Handover to customer

When the vehicle leaves Audi's production facilities is it usually completely finished and ready for delivery to customers. A few orders, e.g. police cars, go through adaption services after production and before arrival to customer.

The different functions within the company that are linked to the OTD process are logistics, production, sales and quality management. The sales function along with dealers are responsible for step 1, ordering. Step 2, order scheduling, is performed by sales and the program planning function of logistics. The production responsibility, step 3, is with the plants. Logistics is responsible for step 4, distribution. The handover, step 5 is handled by sales and the dealers again.

Audi divides the Order-to-Delivery process in different checkpoints to signal the status of the vehicle. An important checkpoint when talking about the OTD process is Checkpoint 8. Checkpoint 8 is located when the car is produced and ready for delivery. Within distribution, are the checkpoints used to measure the different transport sections in order to see how long it takes for a vehicle to be transported between different points. The checkpoints can be transportation times as well as handling times.

The company has a department that is responsibility for Order-to-Delivery process development, which is called *Brand logistics planning - OTD process (I/PL-15).* This department is also responsible for delivery reliability, delivery dates, transparency in the pipeline and change flexibility. Transparency in the pipeline is further introduced below. Change flexibility refers to the service Audi offers the customer, to change items in the order, up until the car is in production.

Performance measurement

When talking about performance measurement within the OTD process, Audi uses the terminology KPI. To measure the performance of this process is the company using four different KPIs.

Delivery performance depot is the main measure. This measure can be divided into measures 2,3 and 4 to better locate where the problem occurred. The delivery performance depot is also considered the most critical measure to track in the OTD process.

1. Delivery performance depot: to measure the whole timeline from ordering to hand over to importer, i.e. the lead time.

It is measured as a comparison between the actual arrival time at the depot and the calculated week of depot arrival time, which is given to the customer in the beginning. The calculated arrival time is based on the first possible production week, when capacity and equipment is available, and the individual transport target time.

2. Order scheduling performance: to measure the order scheduling.

It is measured as a comparison between the first possible production week and the date when the planned weekly production program is handed over to the factory.

This measure answers the question if the order is handed over in the right week to the plant.

3. Production program performance: to measure the production.

It is measured as a comparison between the planned production week (including correction time) and the actual week when the car should be produced and ready for sales (Checkpoint 8). This measure answers the questions if the production builds the car in the right week

4. Dispatch performance: to measure the distribution.

It is measured as a comparison between the actual arrival time at the depot to the calculated arrival time. The calculated arrival time is based on the actual Checkpoint 8 and the individual transport target times. This measure answers the question if the distribution transports the car in the right time to the markets.

Responsibility

The responsibility for the KPIs is divided between the I/PL-15 team and the responsible department for measures 2, 3 and 4. However, the I/PL-15 team has the overall responsibility for updating and developing of the KPIs, as well as for reporting them to management.

Tools and analysis

The KPIs are evaluated on a weekly and cumulated basis and includes all Audi factories. The measures are divided into different areas: Europe, Asia, North-South America and Germany separately. They are measured on different levels of detail. The most detailed level consist of every plant, destination and model combination.

To collect data, a Volkswagen system named TAF is used along with SAP Business Objects. The KPIs are presented through the company's intranet and PDF slides. To visualize the measures are tools such as dashboards, excel documents and SAP Business Objects used.

The weekly or monthly interval is also how often they are forwarded to management. The forwarding is done through the company's intranet. The KPIs are also forwarded to relevant departments if a deviation occurs. Apart from this, are the KPIs also used for analysis, when a deviation occurs and to make improvements. However, there are no formal methods to work with KPIs but the informal methods is to perform a detailed analysis of the causes over the whole OTD process. In the first step, the responsibility is with the I-Pl/15 department to perform a cause analysis and define counter measures. In the second step, when more detail is needed, the responsibility is handed over to the department, where the cause arises from. The I-PL/15 department is also responsible for following up that improvement initiatives have the intended effect.

Projects and challenges

Audi are not working with any projects at the moment to improve performance measurements. Over the past months, the focus has instead been on transparency in the pipeline. Transparency in the pipeline is to enable dealers and national sales companies to always see the status of the vehicles, especially in cases of delays.

The main aim with the transparency is to let the customer know immediately when there is a delay and that the customer is given a new delivery date. This is something that has been done before when a problem arises in production. Since two years, this concept has also been implemented within distribution, to let the customer know if there is a problem during the transportation. This implementation has been done after feedback and requests from the customers. Currently Audi is working with a map service provider to implement a map tool to further enable the transparency in the pipeline through visibility of vehicle status.

The biggest challenge at Audi right now is to extend the delivery performance and the measurement of this to the end customer. Today, the measuring stop at the hand-over to the national sales company (i.e. importer). It is considered a problem that the delivery performance to the end customer is not known. Apart from this, the interviewed employees believed that their KPIs were sufficient to measure the performance of Audi's order-to-delivery process.

6.3 *MAN Truck & Bus AG*

The interview was held with an employee working with logistics at the brand logistics department (M. Brieke, personal communication, Mar 19, 2018). The brand logistics department bridges the gap between production, i.e. the plants, and the central sales organization representing the markets and regions. The interviewee's department is closely linked to departments working with program planning and order processing for production logistics. The aim of the interview was to understand MANs Order-To-Delivery process and the connecting KPIs.

MAN's typical customers are distributors, dealers, MAN owned sales companies and external sales partners. For the Knock down (KD) business are there partners that offers the service of building up the truck from the KD set.

MAN's Order-to-Delivery process

The overall OTD process at MAN is separated into different responsibilities within the organization. On one side is Sales which includes the commercial order processing and also the demand volume planning. The other side is production and logistics, driving the production volume planning and operational order processing within the assembly of the product.

The OTD process for a single order starts with a customer placing the order with a sales representative within a local sales company. The sales representative forwards the order to the central sales organization. The order is placed towards production based on the customer desired date. This is done between central sales and central production based on Ex Works (EXW), thus the end of production corresponds to the customer desired date and is ground for calculating lead times. When the order is handed over to production is it checked against the production capacity, shortages constraints and equipment constraints, to determine if the date is possible or if a new date needs to be proposed.

A date is agreed upon and called "First date". This date, which is a single day, is frozen and also represents the date that delivery reliability is measured against later on in the process. The next step is that the vehicle is brought into "Fixing" which is similar to the production ordering. The order is then sent to the different plants where the production sequencing and later the actual production of the vehicle is performed.

Production and logistics (P&L) handover the responsibility to commercial side again, i.e. Sales, as soon as production is ready and the vehicle is produced without any faults and no need for rework. Sales steers the outbound transport and is responsible for the shipping documents. However, the personnel within the shipping department are located at the plants and belong to P&L.

In certain cases, are bodybuilders also involved in the production chain. The vehicle will then be transported from one of the plants to be body builders and the responsibility is shifted to the local sales company in that country. They will also conduct pre-inspection before handing over and starting the invoice process.

Other functions within MAN that are also linked to the OTD process, for specific customer orders, are engineering and purchasing.

Performance measurement

MAN uses the terminology KPI for their measurements. The different KPIs linked to the OTD process are listed below and then further described individually.

- Delivery time
- Delivery reliability
- Delivery precision
- Capital employed
- Percentage of unsold stock

According to the interviewee is Delivery reliability the most important KPI to measures, since this relates to keeping customer promises. The second most important KPI is delivery time (i.e. lead time). This is because it relates to if MAN is able to react to the market. If MAN cannot deliver in time the customer might go to another brand instead. The third most important is capital employed. That is a question of how lean or how well structured the processes are in the supply chain.

Delivery time

MAN differentiates between Lead time and Delivery time. From MAN's point of view, lead time is the real physical time that the process has, i.e. the throughput time. The throughput time is the time it takes to produce a truck from the first to the last tact. When a customer orders a vehicle the order will be placed in the order stock before it is processed. The time in the order stock is not a part of MAN's lead time, but will add to the delivery time. MAN is therefore using delivery time as a key indicator, but it has the same meaning as lead time for Scania. The delivery time measures if the company is within the boundaries that are acceptable for the market. Delivery time is used as a general number, because it is not possible, according to the company, to differentiate for each regions due to different transport times that needs to be added. MAN uses, from a production point of view, KPIs just to measure what the general lead time or delivery time is towards any market in average values and in what market they see strength and weaknesses.

Delivery reliability

Delivery reliability refers to if the delivery is on time or not according to a promised date. Delivery reliable comprises all time before the agreed upon date, hence early deliveries are considered acceptable. The measurement is only counted against realistic acceptable goal, hence delivery reliability can only be measured if the request from the customer is realistic. If the customer request to have a specific vehicle in a short time frame, then MAN will not give any promises but instead propose a possible delivery time to the customer. If the delivery time is too long towards the market needs then this does not mean that MAN does not have delivery reliability, but that the request was not realistic.

MAN does not talk about delivery reliability for certain countries because the plants are not steered to orders for specific countries. MAN is rather trying to differentiate between different product lines, for

instance truck and bus is not equally comparable from the point of business perspective. MAN also differentiate between standard trucks and trucks that undergoes an modification or have customer special requests.

Delivery precision

MAN also uses delivery precision as a KPI. This means that if the delivery is made within a defined time window, it is considered on time. A delivery that is too early is equally unacceptable as a late delivery. The precision time window for trucks is five days, starting from day zero to minus 4.

Capital employed

The Capital employed is measured in two ways. The first is how many euros are employed in the finished goods. The second is a measure of finished inventory in terms of pieces, meaning how many trucks and buses there are in the supply chain. MAN also measures vehicles that have a very long standing time without being sold to the customer. Capital employed is measured on a detailed level and is reported monthly to the board members of Finance and Control in terms of capital employed in the whole organization of P&L.

Percentage of unsold stock

MAN is also measuring the percentage of unsold stock in the supply chain. This means differentiating between orders placed by an actual customer and order placed by a dealer but where the vehicle has not yet been sold.

Responsibility

At MAN there are common objectives for the OTD process, for instance delivery reliability goals. There is no central group responsible for OTD process development but sub-optimization is made with the common goals taken into consideration.

KPIs at MAN are reported and updated in different forums. The forums have different focuses, for instance one focus on quality and another on delivery reliability. One forum, on board level, is focused on capital employed. The responsibility of deriving and updating the KPIs presented above are divided into different departments or areas. For example is financial KPIs produced by Controlling with the support from logistics while solely logistics KPIs are produced by the logistics department alone.

Tools and analysis

MAN uses different tools for collecting and visualizing data. Microsoft Excel and PowerPoint are two commonly used programs. For the financial figures MAN is using SAPs two modules Business Intelligence (BI) and Business Objects (BO).

For non-financial KPIs such as delivery reliability, is MAN using separate systems. For delivery reliability is an internally programmed tool used. The tool collects dates from different systems and shows status for each vehicle, that is if they are red or green in terms of delivery reliability. In the program is there also a commenting function where deviations and root causes can be entered for each vehicle. It is also possible to see error codes with the classification of errors and what department was responsible for the error. Therefore it is possible to do evaluations and see trends using this program.

The financial figures in terms of Capital employed are reviewed on a monthly basis. Lead time can be retrieved daily. The delivery reliability is also accessible on a daily basis but is compiled in weekly reports for each plant and a more detailed monthly report reflecting reasons and the root causes. The

values from the plants are accumulated upwards into the whole organization until one delivery reliability for truck and for bus is presented.

The measurements are used both in the daily work to make improvements and when a deviation occurs. A deviation triggers a process of deviation handling to make sure the reason is found and to secure that it will not happening again. From the financial point of view it is possible to see if the budget follows the budget plan.

MAN has both formal and informal methods and follow-up procedures to work with the measurements. Regarding the financial figures is there a networking capital board where the capital employed is reported and any "red light" has to trigger some actions against it, which is then followed up on. On the non-financial side, is MAN establishing forums to discuss more deeply the processes or topics that have to be improved in order to lift the production reliability to a higher level. This will allow to work with KPIs and follow-ups in a more structured way than it is done today.

Projects and challenges

The interviewee argues that Production & Logistics are quite organized when it comes to target setting and following up on deviations. In the sales area is it sometimes a little bit different, maybe due to a different culture. They are more focusing on sales and not on reporting as an example. So, there is a gap between these two areas. Another aspect where there is room for improvements is on the follow-up level, so that there is a larger focus not only on the deviation itself and the reason behind it, but also on who is handling it and what is done to eliminate it. It is important that the measurements are followed up on a higher management level to make sure that the deviations are eliminated in full, not only that a reason has been identified.

One of the biggest challenge for MAN today is to gain an overall and online transparency into the supply chains. There is high transparency in some markets regarding the steps in the supply chain but less so in other markets, for instance when sea freight is a mean of transportation. Another challenge is to make sure that when making decisions, the impact on production reliability is transparent to everyone that makes decision. Program or volume changes, investments or using speed transport are decisions where the impact need to be transparent for instance.

At MAN machine learning approaches are being tested to improve planning processes towards the topic of the lead time in the plant. The company works with technology to improve the prediction how long certain vehicle types actually need in production and how much rework needs to be performed. On the topic of performance measurement and follow-up is MAN discussing how to incorporate big data approaches to simplify the updating of KPIs that today is made manually from an heterogenous landscape of IT systems. Regarding follow-up for single measures are they, on an organizational level, trying to focus the management's attention towards these topics by regularly informing about the measurement and its status.

6.4 *SSAB AB*

SSAB is a Swedish steel manufacturer with a global production. The interview was held with five employees at SSAB Oxelösund, Sweden. The employees represented the supply chain organization and relevant departments within the supply chain organization linked to SSAB's Order-to-Delivery process (J. Norén, M. Kågström, M. Carman, C. Kohler-Råd & V. Rozic, personal communication, Apr 10, 2018).

SSAB has over 15 000 employees in 50 countries. Production is located in three countries, Sweden, Finland and the US. Apart from this are there subsidiaries and workshops linked to SSAB all over the world. The company has an annual production capacity of 8.8 million tons steel.

SSAB's Order-to-Delivery process

SSAB's has a strong focus on the end user and customer. This is done through close collaboration and partnership. The typical end customer of the company is usually an OEM manufacturer, a subcontractor to an OEM manufacturer or smaller workshops who produces small batches or do repairs. Only a small fraction of the volume is sold through a third party.

SSAB does not have the same focus on an Order-to-Delivery process specifically, in contrast to Scania. However, a similar flow can be identified and described on a high level as: Create sales/stock order, Produce and Deliver. The flow can be divided in two different parts: goods made to order and goods sold from stock. For goods made to order, the flow can in more detailed be described as:

1. An order is placed through the sales organization
2. The order is forwarded to the supply chain organization which performs a capacity and planning control. The control gives the customer an initial delivery week. Internally the process gives a finished date on a daily scale. A quality check is also performed by the Quality department before handing the order over to production.
3. The order is handed over to production around two weeks before the production start.
4. Production is then responsible for the detailed production planning and reports back with an updated delivery date. Throughout the entire production are updated prognosis forwarded to relevant departments.
5. When production is finished, the material goes directly to the finished goods storage and is made available for distribution.
6. The distribution is planned on each carrier for pick-up.

For goods sold from stock, is the flow similar but with the following differences:

1. The orders is placed and the goods are sold and distributed from stock.
2. The stock is then refilled by the Inventory management department who places the order towards production.

The functions related to the Order-to-Delivery environment is the supply chain function and production function. Within the supply chain function are the departments for master planning, order management, inventory management and external logistics linked to the process.

Performance measurement

SSAB is mainly using the terminology KPI to describe their measurements. In certain cases, for measures looking at Moving Annual Total, or "rolling" measures, is a 12 month measure considered as the official measurement while the three month measurement is considered as an indicator.

Every year SSAB's work with their strategy to develop it and break it down to lower levels. Most KPIs are developed during this strategy work. Relevant KPIs are derived from the strategic objectives and the current KPIs are reviewed regarding their continued relevance.

Within SSAB's OTD environment are several performance measurements identified. Some of the measures are on an aggregated level while there are also department specific measure. The aggregated measures are the following:

Delivery Performance: measured in tons delivered in time.

The delivery performance is measured in how many tons are delivered according to the promised amount. The actual delivery is compared towards the promised delivery date in terms of weeks. It is

measured as delivery reliability. This means that everything delivered up until the promised date, including too early deliveries, are considered on time. The material is followed all the way to delivery destination, if shipped by car and container. The forwarder fill in an Actual Time of Arrival (ATA) in the system. But the KPI only looks at when the shipment leaves SSAB, not when it arrives at destination.

The delivery performance is divided in two different parts, one part falls under the supply chain organization's responsibility and the other part falls under production's responsibility. The supply chain organization is responsible for the delivery reliability after the material is produced e.g. the different transportations options, transportation resources and tactical questions regarding distribution. The production is responsible for the delivery linked to the production such as quality issues, material shortages and break-downs.

Lead time: is measured in days**.**

The lead times is measured between the different steps in the OTD process to determine the service level to customer. In an overall measure is it defined as the time from when an order is booked in the system until it has been delivered. For stock replenishment is it measured until the material has been sorted into the receiving stock and has been reported in the system.

Stock volume: measured in tonnage.

The stock volume is measured on a weekly basis to monitor the tied-up capital. The stock volume is measured as:

- Availability in the central stock
- Availability of the local stocks in total
- Dead stock
- Stock turnover rate

Delivery Delays: measured both in tons and numbers of weeks late.

Number of complaints: that are caused by the supply chain organization

Service level to customer: is measured as a Net Promoter Score to determine the customer experience.

NPS is measured every month by asking the customers to rate "How likely are you to recommend SSAB to your colleagues and/or friends?" on a 0 to 10 scale. Those who respond with a score of 9 to 10 are called Promoters and those who respond with a score of 0 to 6 are labeled Detractors. The Net Promoter Score is calculated by subtracting the percentage of customers who are Detractors from the percentage of customers who are Promoters. A NPS above 0 is considered "good", +50 is "excellent," and above 70 is considered "world class."

Apart from this they also follow ***LTI – Lost Time Injury***. LTI looks at the loss of productive working-time due to an injury incurred during a work-related task. SSAB also has a strong focus on implementing the lean philosophy. They are therefore measuring the progress of ***lean implementation*** within each department as a percentage score. Temporary measures might also be put in place for a specific initiative, i.e. the lean implementation. Process changes can led to new measures being introduced.

Responsibility

SSAB does not have a department that is responsible for the overall flow in the Order-to-Delivery process. Instead each department is responsible for the KPIs related to their processes. To align the measures with each other, and avoid sub-optimization, are the KPIs linked to the overall strategy of

the company during the annual strategy work. Updating and development of KPIs can be done within each department or escalated within the organization.

Tools and analysis

Targets for the KPIs are set during the strategy work and review of the KPIs. It is either set from a discussion within the group or from directives from higher management.

Most of the data is collected from a data warehouse to build reports. The numbers are updated on a daily or weekly basis, but reports are built on a less regular basis. In the daily work, is data often used directly from the systems, not from reports. Reports are often compiled on a weekly or monthly basis and forwarded to management, if they are not already accessible for them in the system. Apart from this are the reports also distributed once a week to relevant employees that have use for the numbers. Although the company have tools such as SAS and Power BI, is much of the reporting still done in excel. SAS is a system that allows data management, reporting and analysis. The company also uses reports from their ERP system. The amount of manual work increases for higher level measures since these usually are aggregated from different parts.

SSAB is mainly using average values for their KPIs. An example is the distribution that can be broken down to “car”, but not “car to Poland”. The stock levels are broken down to different regions and countries, but an overall KPI states the total for all stocks. Usually is there a possibility to drill down in the numbers to look at different levels of detail. When talking about lead times is land codes and destinations (postal codes) used to compare different production units. Dynamic reports that are build from the bottom up helps the company analyze reports. When a trend is showing a deviation on high level, it must be able to drill down to investigate where the deviation actually occurs.

When analyzing the KPIs are there usually no formal limits to when numbers are deviating enough to take actions. The decisions are made on individual basis. Some reports will show red numbers and then actions should be considered.

Projects and challenges

SSAB say that they have large focus on tied-up capital at the moment. The company have identified the delivery performance as their most important measure and are working on projects to improve deliver plans and delivery reliability from production. As for performance measurement in general, has the lean initiative, called SSAB ONE, increased the focus on KPIs. The process of breaking down the strategy and reviewing KPIs according to it, originates here. The company is also attempting to foresee the future better by using KPIs. An example of this is in the distribution department where they are looking at availability of systems and resources, to predict how the week will play out. Another example of a project is working with lead time analysis for finished products to increase customer service.

One of the challenges that the company see with performance measurement is the different sources of data and that the quality check of data takes a long time. SSAB is working on changing the process and mindset around data capture and to introduce standardized definitions. The company is also continuously working on developing reports. They are working with their business development team to add more data to the data warehouse in order to build more precise and dynamic reports. There is also an issue with agreeing to what measures to use and how to measure them i.e. standardized definitions.

Another challenge is that different measures contradict each other and steer in different directions. Although it is recognized that this also has a positive effect if KPIs can be identified as opposites to each other. Often the end aim is to find a balance between different opposites. There is also a difficulty

when a process changes or grow in complexity to make sure the KPIs still can be used for the intended purpose. Lastly there is a challenge to have time to work with the measures and to understand why things are actually happening.

6.5 *Sandvik AB*

Two interviews have been conducted with employees involved in the OTD process at Sandvik's divison for Rock tools. The rock tools division is within the business area of Mining and Rock Technology. One interview was arranged with a regional planner (M. Hörting, personal communication, Feb 8, 2018). The other interview was conducted with the Head of Supply Chain Development (E. Valtonen, personal communication, Apr 9, 2018). The aim with these interviews was to understand Sandvik Rock Tools Order-To-Delivery process and the connecting KPIs. Rock tools manufactures consumable products that is used for mining, usually wear and tear components for hole drilling. Five internal production units, located in six countries all over the globe are linked to the interviewees business area. In general cases the company sells its products directly to the end customer. In 10-20 % Rock Tools using dealers to sell the equipment or the tools to the construction companies.

Sandvik Rock Tool's Order-to-Delivery process

The OTD process starts when a customer placing the order at a service desk or through an IT system. An e-commerce go-to-market model is also an option for order entry. After the order has been placed, the customer receives an confirmation with expected delivery date. The OTD process can be classified into four steps:

1. Customer order
2. Order entry
3. Inventory replenishment
4. Shipping to the customer

From the customers perspective the OTD process reaches from order confirmation until the delivery arrives, named Proof Of Delivery (POD). The order is initially placed in the sales regions system and then sent to the main computer system. The customer receives an estimated time of arrival from Rock Tools, done automatically or manually. Rock Tools uses an make to stock production approach. This means that the order desk checking the inventory to see if the physical order exists, or if it needs to be produced. The products do not need to be complemented after production end. The last step in the OTD process is the shipping process to the customer, with or without dealer involved.

Performance measurements

At Rock tools the terminology for measuring performance is KPI. Multiple detail levels of KPIs are used depending on who is using the KPI and the purpose - high levels for executives management review and low level for operational steering. KPIs are usually bottom up built, from detailed to aggregated level. The KPIs used are related to the performance of the inventory on the commercial side, as well as the operations and performance of the inventory and planning. KPIs are also related to warehousing and production. The KPIs are therefore split based on organizational structure.

There is no formal way of linking and visualize KPIs at Rock Tools. Employees experiences of working with KPIs has result in knowledge about how each KPI impact each other. The way of handling KPIs and avoid sub-optimization is to see each KPIs side by side to get a 360 degree view. This means that many KPIs are equally important and no isolating KPI is the most critical. Rock Tools using different KPI reporting packages for different purposes, for instance executive packages and inventory and planning

packages. These report packages of KPIs are presented in PDFs and predetermined to what KPIs are visualized in each package.

Rock tools is trying to balance the customer service level. The service level is connected to several aggregated KPIs in the OTD process, from an end-to-end supply chain perspective. Three KPIs are aiming to complete the big picture of how Rock tools is performing:

- Lead time
- Fill rate
- Forecast accuracy

These KPIs are updated and reported on a monthly basis.

Lead time

The total lead time is built up of different process steps and spread on different employees that are involved in the entire lead time chain. The lead time measure the efficiency of the steps in the chain, for instance how fast the lead time was from the warehouse that it got replenished from to the POD. The freight forwarders efficiency is also measured as well as warehouse logistics lead times. Logistics lead time measures if Rock Tools manage to deliver against the requested date. Inventory handling lead time, order lead time and release lead time are also measures within Lead time.

The lead time is compared against a target. The target is estimated from Rock Tools supply chain model, which defines how far away from the customer the company is located. Rock tools compare deviations against that value. Because Rock Tools running a global business, the lead time expectations and targets needs to be configured depending on different regions.

Lead time is the most frequent measured KPI. Sandvik Rock Tools has no specific pronounced lead time requirements to take action when deviations occurs. If actions are taken it often consists of follow-ups, measuring and monitoring against transportation providers. The precision within lead time is also measured. What defines the precision is that late is not acceptable while early is acceptable.

Fill rate

Fill rate, or inventory availability, is also a measurement used. Fill rate can be describes as “Was it in stock?”. Fill rate should be on a specific percentage value. If the value is below the reference number it means low stock levels and if the value is above it is probably a result of too much inventory.

Forecast accuracy

Another measurement that is used is the commercial related forecast accuracy. The forecast is sent from the sales region. The forecast accuracy gives an estimation of how much to sell at a specific time. A reliable forecast accuracy makes it possible to achieve an efficient inventory. Low forecast accuracy can reduce the reliability of the forecast in the future, which in turn forces Sandvik Rock Tools to build higher safety levels. Forecast accuracy and fill rate are connected. High forecast accuracy makes it easier to achieve high fill rate.

Responsibility

At Sandvik Rock Tools there is one central process group for OTD process development with an overall responsibility. If a problem occurs, each specific region or department takes responsibility for it. However, the responsibility is not directly linked to a specific person to solve a problem when a deviation occur and no general solution for problem solving is implemented.

The production side creates the KPIs but responsibility for the measurements lies within the central group. If each department wants to escalate the deviation, an action plan is created. So, the development of the KPIs will be in a joint effort between the different departments and the central group.

Tools & Analysis

At Rock tools is an infrastructure built in to give transparency to the Enterprise Resource Planning (ERP) systems. Different warehouses are used for storing the data. On top of the warehouses are different tools such as QlikView and Power BI used to increase the transparency. Also different optimization tools for planning and inventory management is implemented. Often the order system, inventory system and production systems communicate with the report tools, which collects lead time and fill rate for instance. The report tool makes it possible to present the values in different ways, for instance graphs, stacks and diagrams.

Some KPIs are presented visually and some not. It depends which person is presented and the objective. Follow-up is suitable with a graph, but it is also possible to present with a number as well. Forecast accuracy is presented with an excel report. It is possible to separate between different production units and markets in the report tool. It is also possible to sort the lead time in a way that shows orders on the shelf and orders from a specific country that should go to another country. The filter can be adjusted in the way the user wants. No dashboard or scorecard is implemented at Rock Tools for illustrating data.

The measured KPIs are mostly used at an average level, not at a specific level. However, it is possible to go down to a granular level due to the detailed data in the systems. The large amount of data is hard to handle and it requires a certain level of knowledge. Too little information is almost never a problem.

Projects and challenges

The central OTD process development group is responsible for running improvement projects. The group is mostly interested in the end-to-end view. The projects can be aimed at refining logistics KPIs and the data quality of KPIs. The aim with improving data quality is to improve the global visibility, for instance improve the level of detailed data. The projects can also aim to improve the way employees enter the data in the systems, or find a better angle of looking at things.

The challenges when working with performance measurements is the control and the transparency. When making a decision each specific product or region must be kept in mind and find a balance between cost and profitability, while at the same time optimizing the customer service level. Another problem with performance measurements is that is it difficult to measure soft values. For instance it is not possible to measure customer interaction with a KPI. This makes it hard to combine soft values with hard strict KPIs. The aim is to find a balance between hard and soft values.

6.6 *Volkswagen AG*

The interview was arranged with a logistics planner within Volkswagen's (VW) group logistics (Employee A, personal communication, Feb 27, 2018). The interviewees department is responsible for information processing and the department is strongly linked to production, logistics and IT.

The following material cannot be directly compared towards the other companies presented. This is since the interviewed person is not directly linked to the company's OTD process and the full extent of the performance measurements used, in this part of the process, could not be recounted. However, the interview person had insight to the general OTD process and some performance measurements which are presented. The interviewee also had extensive knowledge about the topic of performance

measurements and worked with this area for inbound and inhouse logistics. The authors therefore see value in the information learned during the interview and it is therefore presented in the report.

Volkswagen's Order-to-Delivery process

The first step of the OTD process is the order handling process from the customer, followed by requirement and capacity management, where the need is broken down to part level. A check is done which tells how much is available in stock and how much to order from suppliers. The order need is calculated and then communicated to the suppliers in months, weeks and days. The material is then transported, controlled and steered from the suppliers. It is finally received, stored and managed at a warehouse. The two final steps are production and outbound logistics. VW has no direct customer relationship, they use dealers and distributors to hand-over the cars to the final customer.

Performance measurement

No distinctions are made between KPIs, PIs, RIs and KRIs at the VW. The only terminology used is KPI, which the interviewee is critical about. This creates problems because there are too many measurements and no one knows which ones are the right ones to steer the processes. More than 700 different indicators where initially counted within logistics, which leads to a complicated measurement culture and environment. The basic idea with the indicators is to get some information about processes. It gives a lever on how to steer. Most indicators are created in a problem situation, as firefighting activity, and often not connected with the company strategy. This means that many measures are created to measure a temporary deviation or fix. The indicators are then only used around the time for that specific problem solving and after that left idle.

Lead time and delivery precision are used for both inbound and outbound logistics. At the inbound function, precision is used to measure how punctual suppliers and forwarders are. They measure if the material is delivered in the right time, type, quality and amount. Information processes are also measured.

Responsibility

There is an overall department responsible for the control and development of the OTD process. The different functions are also responsible for optimization of their own process.

Tools and analysis

Both average and detailed values are measured and used at the company. It is possible to break down aggregated values to a detailed value and vice versa. Detailed values are for instance part number, unit container number.

VW uses different tools for handling measurement data. The data storage is located in the company's data warehouse LOAD (Logistics analysis and data warehouse) and different source systems are connected and united in this system. Microsoft Excel is a tool used for calculations. Different web applications are also used, such as Oracle APEX and QlikView. They are used to distance the work from the manual reporting, which is usually a consequence with Excel databases and calculations. QlikView is an application used for analysis, SAP Business Objectives is used as a report tool and Oracle APEX is used for monitoring data. The data can be used to control logistics providers for instance. The data warehouse is updated every day for most of the databases, so the actual data is a result from yesterday. In the end of every business day, ETL (Extract, Transform and Load) processes transfers the data from the source systems to the data warehouse. Certain data is updated more frequently, for instance stocking and truck control within the plant. Monthly reviews within management is made to

improve processes. The information is forwarded to management mainly on an aggregated level. There is no standard way of how to work with indicators. There is a daily practice of how to work with them and actions are taking when there is a need.

VW is trying to achieve a standard portfolio of indicators which everyone can use so that the same formulas and the same databases are used. This is to allow better benchmarking between the different plants and processes. According to the interviewee, the most important measurement to keep track of is cost per car. That KPI is also one of the most complicated KPIs to measure from a logistics point of view.

Projects and challenges

Performance measurement system within Inbound and Inhouse logistics

The company has been working on a major project regarding performance measurement in collaboration with the Technical University of Munich. In an article published by the project team (Dörnhöfer, Schröder, & Günthner, 2016), an approach is presented to implement a standardized Performance Measurement system (PMS) for inbound and outbound logistics. The reason behind the project is that the company has a large number of existing KPIs that are hard to handle. The idea with the PMS is to be able to standardize and create a common KPI understanding for all plants. The indicators used in the PMS are focused on efficiency, lead time, quality and external aspects.

The approach has been to use a balanced framework approach in an hierarchal model. The project team have mapped currently used measures and weighing the relevance of them. In addition to this have workshops been held with relevant employees to discuss alternative measures. During the workshops the full scope of the project has not been disclosed, as to not influence the participants. From these workshop sessions the responsible group has determined top-level KPIs. The top level measurements have been broken down into lower-level performance indicators. A system of interlinked measures have been developed in this way, and the measures can then be combined in different modules to suit different parts of processes. There is also room in the PMS to add plant specific measures as necessary. For each of the measure, a specific (K)PI definition sheet has been develop to create a common understanding of what is measured, why it is measured and who is the responsible for the measurement. The project is now being implemented at the company's plants through an web based tool, that allows visualization of different data and to drill down in different measures.

Logistics flow metric

In the previous mentioned article, Dörnhöfer, Schröder, & Günthner (2016) propose an alternative way of measuring lead time. Within a lean dimension of the PMS system, there is an objective to increase the flow of material. The authors propose a flow metric to be able to make waste in terms of transportation time transparent. The parameter is suggested to better analyze different lead times against each other. As of now, a lead time to one country cannot be compared to a lead time to another country.

The flow metric is based on the fact that the logistics processes only should include activities that are required to fulfil the customer need and add value to the product. Other processes such as additional transport, quality issues and storage are considered as waste. For the inbound logistics case, the definition says that value is added as long as the transportation is performed with an efficient speed of 80 km/h. All other processes for inbound logistics can be seen as waste and will increase the lead

time. The flow metric equation below defines a standardized way of lead time comparison between different countries (Dörnhöfer, Schröder, & Günthner, 2016):

$$\boldsymbol{Flow_{Transportation\ Inbound}}[\%] = \frac{\left(\sum_{(i)} \frac{\boldsymbol{Transport\ time_i}}{\frac{\boldsymbol{Distance\ supplier_j to\ manuf.site}}{\mathbf{80}\ \frac{\boldsymbol{km}}{\boldsymbol{h}}}} \boldsymbol{x\ Value\ of\ shipment\ part_i} \right)}{\sum_{(i)} \boldsymbol{value\ of\ shipment\ part_i}}$$

The parameter has not yet been implemented at the company. The interviewee does not think that the company is ready to use the parameter and analyze it in a proper way. However, the flow metric approach gave the thesis authors ideas of how to implement a similar approach to Scania's logistics system. The approach was the initial start point of the development of a new lead time measurement presented in chapter 7.

Challenges with Performance measurements

According to the interviewee, the major challenge when working with indicators is people. Most people do not want to be transparent and measured, because it will give a quantified information about how well they perform. When implementing a new PMS, there will always be resistances due to change management problems. People do not want to change their actual work they have done for the part time. Most people want to know how their surrounding is working but do not want to be transparent of how their own processes performs.

7 Development of a Performance Measurement Concept

The following chapter presents a development process of a new performance measurement concept for measuring lead time in the OTD process. The development process is based on the first three steps of the section 3.9.1 *Development of Key Performance Indicators.*

7.1 *Introduction*

Regarding performance in a supply chain or a logistics environment, the measurement of lead time plays an important role. An alternative approach of measuring lead time was discovered during the company comparison and literature study. The approach was based on a unitless measure of lead time compared to the more typical measurement in a time unit. The purpose of this approach was to be able to compare different lead times towards each other. It was decided to further investigate this approach to see if it could be beneficial to Scania. The development of the process is presented below.

7.2 *Step 1 - Describe Intended Results*

The first step in the development process is to understand what objective Scania has when measuring lead time in the OTD process. Three managers were interviewed regarding their view of lead time and why this is an important measure. The managers were selected from three different levels of hierarchy in the organization. The levels were group level, department level and finally management level. These levels corresponds towards operational, tactical and strategic levels presented earlier. To be able to answer this, open questions have been asked as a foundation for discussion:

"Why should lead time be measured?"

"What should the lead time measurement show?"

The managers answers are presented and summarized below.

Senior Vice President Logistics

Today Scania is working towards a more flow oriented business, rather than the traditional silo functions. For this reasons are ***cross-functional flows and measurements*** becoming more and more important. According to the Vice President is lead time a key indicator to measure since it is ***important to the customer***. This is not only something that has been assumed but it has also been expressed from the customers themselves. From the customers viewpoint is the first step that a need arises. This need is met by Scania by, both the specifications of the product that the company can offer, but also ***by the speed that it can be delivered***. Scania's customers have customers of their own that also have targets and goals to reach, making the company a part of a whole chain.

Furthermore does the manager mention that a shift towards a more dynamic environments also entails that lead times play an increasingly important role. Another important aspects is the ***flexibility in the supply chain***. Scania has a desire to be able to fast track cars through the process in the future.

Regarding the measurements around lead time, the Vice President expresses a desire to have them visualized in a way that makes them ***easy to understand, to work with and to explain***. They should be ***understandable by everyone***, not only a few experts that in turn need to explain them to other colleges. They should also be ***easy to break down*** to identify root causes. The main aim is to see the ***results of the initiatives that are undertaken to improve the flow***. The improvements that are made should be reflected in the KPI.

Head of "Order, Planning and Export" Department

According to the manager is lead time a ***must to achieve corporate strategies***. The aim is that lead time should give an overview of the entire flow and make it possible to answer if the situation is acceptable or not. To do this, there needs to be ***a normal situation established*** which allows to work with deviations and to challenge the current state. Today they are measuring but do not understand what the measurement tells them since they lack knowledge about this. If a normal situation can be established then it is possible to ***challenge efficiency and effectiveness of the flow***, which is the end goal. Apart from this does lead time also correspond to cost factors such as ***cash flow and tied-up capital***.

Furthermore, the manger highlights the importance of seeing the lead time as a measure of the effectiveness and performance of all involved parties in the chain. Lead time is the ***effect of everyone's efforts*** and consists of many processes that needs to communicate. The manager mention that a challenge with lead time improvements is that it consists of different owners. Each owner must understand what the changes means for themselves and for the whole. Because of this, is it important with ***transparency in the flow*** and that ***everyone can take responsibility of their part*** as well as to see how their efforts effect the entire chain. When analyzing lead time they need they also need to ***be able to break it down*** and to work with deviations and link it to root causes. The manager mentions using ***clusters and a top 3 approach*** when working with deviations. This meaning that every related department should be able to identify top three priorities for improvements.

A future aim with lead time measurement is to be able to break it down and to make it more transparent, so that ***everyone's part becomes clearer***. The first part is to find components of the flow that can be effected. If it is possible to link the lead time to different parts, then everyone can take responsibility to analyze.

Head of "Order to Delivery development P&L" Department

According to the manager is one of the reason to measure lead time to ***reach the positive effect of short lead times*** such as less tied-up capital, shorter reaction times and fewer products in the flow when problems occurs or when new product changes are introduced. Lead times are important when designing processes with the customer demand in mind and there should be a focus on ***planning for short lead times***. It is also important with a ***transparency in the flow*** which leads to a need to measure lead time at an aggregated level to avoid sub-optimization.

The connection to strategy is that the efficiency of the flow can be measured through lead time. Through lead time and delivery precision can also the reliability of the flow be ensured. When reliability is established is it possible to ***achieve trust in the supply chain***. From this, is it then possible to challenge the lead time and cut out buffers. ***Working with buffers*** is an important aspects of measuring lead time according to the manager. The manager argues that each buffer should have a specific purpose and not cover up for many purposes. When defining one purpose for each buffer, the buffers can be tighter and therefore the total lead time shorter.

The key point of each interview are summarized in table 11 and 12.

Table 11: A summary of key point of why lead time should be measured.

Why should lead time be measured?		
Senior Vice President Logistics	**Head of Order, Planning and Export**	**Head of Order to Delivery development P&L**
• Cross-functional measurements important • Lead time and delivery speed important to customer • Flexibility in the supply chain required	• Lead time is must to achieve corporate strategies • Allows to challenge efficiency and effectiveness of the flow • Linked to cash flow and tied-up capital • Shows the effect of everyone efforts	• Short lead time results in positive effects • Increases transparency in the pipeline • Enables trust in the supply chain

Table 12: A summary on key points of what the lead time measurement should show.

What should the lead time measurement show?		
Senior Vice President Logistics	**Head of Order, Planning and Export**	**Head of Order to Delivery development P&L**
• It needs to be easy to understand for everyone • Easy to work with and to break down • Should reflect the results of initiatives that are undertaken	• Compare towards a normal situation • Be able to identify clusters → top 3 priority list • Transparency in how processes effect end results • Easy for everyone to take responsibility and analyze of their own part • Easy to break down	• Increased transparency between processes to avoid sub-optimization • Allow to challenge the current state by planning for short lead times and challenging buffers

According to the managers above, the measurement or measurements, to measure lead time should:

1. Easy to understand the visualization
2. Be easy to break down to detailed level
3. Be able to identify clusters
4. Be possible to compare towards a normal situation
5. Reflect results of improvement initiatives
6. Measure efficiency
7. Measure effectiveness
8. Measure flexibility

7.3 *Step 2 - Understand Alternative Measurements*

Step 2 consist of understanding alternative measurements. This section will describe the measurement approach developed in the thesis.

7.3.1 Normalize Transport Time

Today lead time differs significantly between markets. One of the most affecting factors to this is the transport time to the delivery country. The transport time has a relatively high variance compared to other parts of the lead time. Other factors such as mode of transportation can also affect. They all link back to the flow of one product to each market. Only comparing lead time to lead time provides for an unfair comparison. An example of this is provided in the figure 23 below. Market A and B can be fairly compared as they have the same distance but different lead times. However, Market C cannot be directly compared towards the other two, since it differs both in time and days.

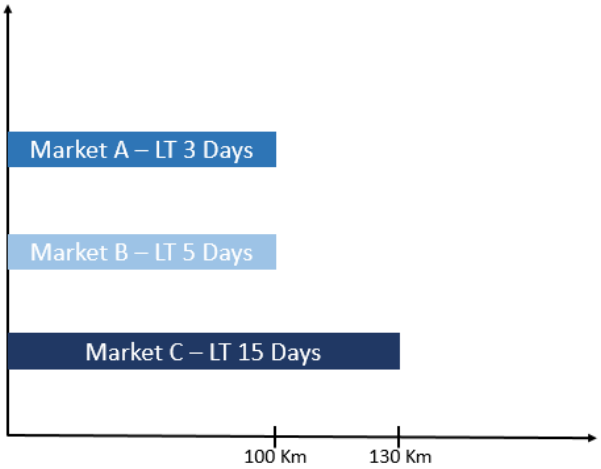

Figure 23: The figure shows examples of lead times that are comparable and lead times that are not comparable.

Therefore, inspired by Dörnhöfer, Schröder and Günther's (2016) theoretical approach to better compare inbound transport times, the authors wanted to explore the possibility to normalize lead time. The reason for this was to illustrate different lead times on a more comparable scale in order to identify clusters and show improvement opportunities. Initially is only the transport time used to test the concept.

Development process – Collect data

The development process of normalizing transport time can be divided into these main steps:

1. **Import data from data warehouse**
2. **Selection of suitable factors/parameters**
3. **Clean up the dataset to work with reliable data**
4. **Perform the calculations**
5. **Show the data in a pivot table**
6. **Plot the dataset in a scatter chart**
7. **Analysis of the result**

1. Dataset imported from a data warehouse

To be able to find suitable factors, there was a need to collect available OTD data. The data was collected from a data warehouse and then exported to an Excel file. The file consists of all relevant

information about every individual chassis for a selected time period. The selected dataset consisted of historical data for trucks from year 2017 with approximately 18 000 data points included.

2. Selection of factors/parameters

When selecting factors one must decide the aim. The aim is to be able to measure the efficiency of the flow to each market. The parameters used will therefore be the actual transport time and the planned transport time, i.e. the given parameter. The ratio between Planned Transport Time and Actual Transport Time (difference between ARD and ADD) will determine the efficiency.

3. Clean up the data set

The next step was to clean up the dataset to be able to work with reliable data in the calculations. Data points with the following abnormalities are excluded:

- **If ADD or ARD data is not available**
  The data point does not include all necessary data.
- **When ADD is earlier than ARD**
  Data deemed incorrect as it has a negative transport time, i.e. it is delivered to customer before it is released from production.
- **When transport time = 0**
  All parameter should be ≠0, data therefore deemed incorrect.

Approximately 1000 data points was deleted and the remaining dataset consisted of around 17 000 data points.

Development process - Calculations

The transport time and the efficiency for each delivery country was calculated. The values are then normalized and plotted against each other.

Transport time calculation

The time in between the Actual Release Date, and the Actual Delivery Date are used to calculate the transport time. ARD is when the chassis is made available for transportation and ADD is when the chassis is delivered to the first delivery address.

Efficiency calculation

Efficiency is expressed as a percentage unit where 1,0 is considered ideal and represent 100% efficiency. The ratio used to calculate efficiency is the *Planned transport time* (i.e. the parameter) versus the *Actual transport time.* This indicates the efficiency and the degree of flow in the transportation process.

$$Efficiency = \frac{Planned\ transport\ lead\ time}{Actual\ transport\ time}$$

Normalization calculation:

The aim was to plot a normalized transport time (x) and normalized efficiency (y) in an x-y scatter chart. To be able to normalize one must find the MIN and MAX values in each markets dataset, for both the transport time and the efficiency. The plotted graph will then scale both x and y values from 0 to 1 and the markets position in this relationship will be illustrated. For the normalization procedure, an general MIN-MAX approach have been selected. This approach will scale the data between 0 and 1. The normalization equation is presented in the equation below (Patro & Kumar sahu, 2015).

$$x = \frac{\mathrm{X} - \mathrm{MIN}}{MAX - MIN}$$

The two following equations illustrates the calculation of Normalized transport time and normalized efficiency:

$$Normalized\ transport\ time = \frac{\text{Average of transport time (per market)} - \text{MIN of transport time(all markets)}}{\text{MAX of transport time(all markets)} - \text{MIN of transport time (all markets)}}$$

$$Normalized\ efficiency = \frac{\text{Average of efficiency (per market)} - \text{MIN of efficiency (all markets)}}{\text{MAX of efficiency (all markets)} - \text{MIN of efficiency (all markets)}}$$

Development process - Results

To test the concepts of normalization was also the average value for each delivery country plotted. The plots, in figure 24 and 25, shows that the idea of normalization had no actual effect on the plots. The only difference is the range on each axis. Therefore, going forward the average values will instead be used, to exclude the extra calculations and to easier interpret the axis values.

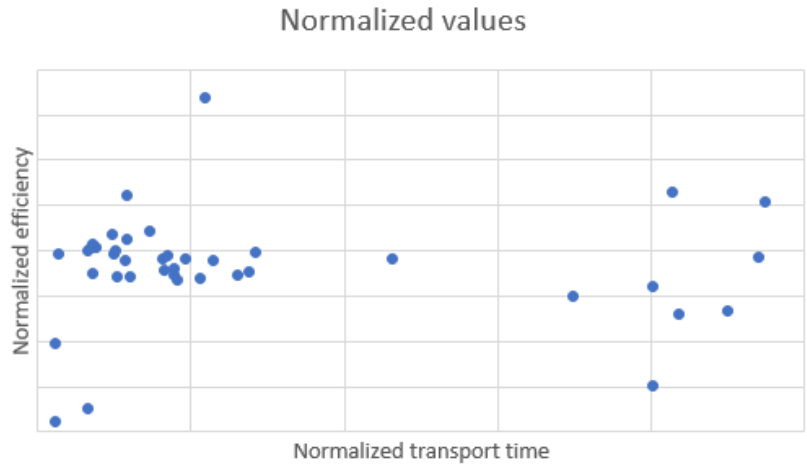

Figure 24: The plot shows the normalized transport time vs the normalized efficiency.

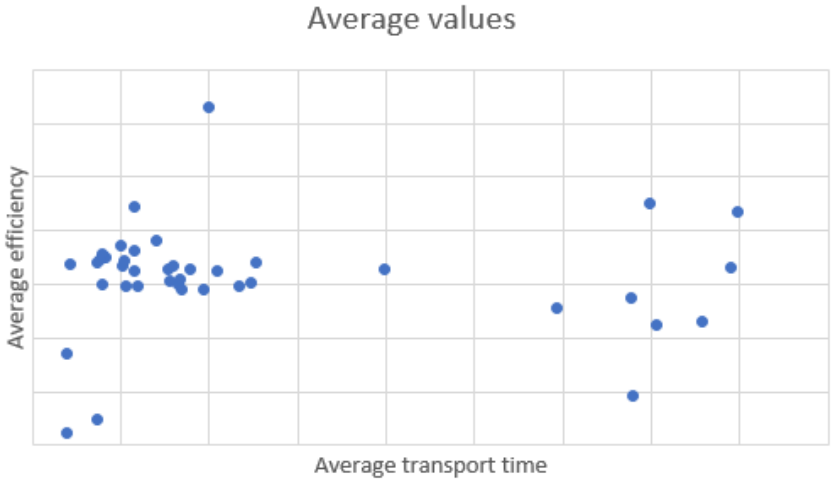

Figure 25: The plot shows the average transport time vs the average efficiency.

Clusters were identified to see if any markets stood out both in terms of either high or low efficiency, shown in figure 26. The right clusters is the most defined clusters with a majority of the markets. The left cluster only contains five markets. However, it was still identified as a cluster since they all are within the same spread of efficiency versus transport time as the right cluster. The figure can also be found in a larger scale in Appendix 2.

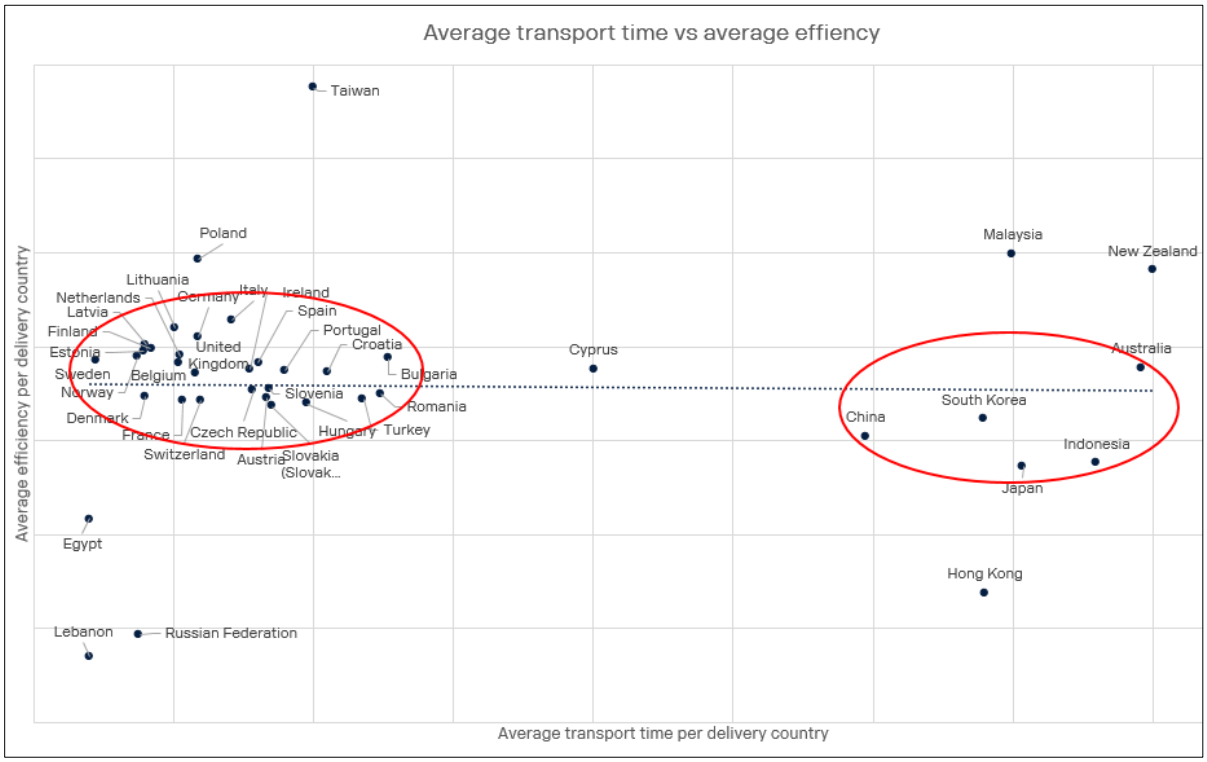

Figure 26: Identified clusters.

Analysis of the result

The plots visualize where the markets are located in an efficiency-transport time relationship. The plotted data set can be classified into different clusters. Two clusters have been identified in the data set. The different clusters can be used to determine if a market is behaving according to what is expected. For instance the markets in cluster 1 are mainly located in Europe, and therefore it is also expected that the data points should be located close to each other. Markets within the cluster can from this be classified as behaving in accordance with other markets in the same area and that it might be less urgent to react or act on deviations, although there still can be improvement opportunities. However, markets that are out of the clusters are of interest to analyze further. Taiwan and Hong Kong are examples of markets where something differs. There is only a short distance between Hong Kong and Taiwan and it would be expected that the efficiency and transport time of these countries should be similar, which they are not. This case indicates that further investigation to the source of difference need to be taken.

The developed method has its restrictions by its nature. The output of the data will be directly affected by the quality of the input data. Therefore, accurate input data is important for the validity and reliability of the method. It is also noticed that some orders have comments or abbreviation codes that will decrease the reliability of the data. These data points might bring some disturbances into the dataset. Another aspects to consider is that the amount of individual data points for the markets differs. This means that the average value for a market with more data points than another market can

be considered as a more reliable in terms of average value. In the current plot the challenge with average values is still remaining. However, it is believed that the concept can be applied to plot each chassis against it other, removing the factor of average values.

7.4 *Step 3 - Select the right measures from objective*

The measurement approach described in the section above will be compared towards the existing lead time measurements, *Average Lead time* and *Ideal Flow,* described in section 5.3.1 and 5.3.2 The baseline for the comparison will be the objectives expressed by the managers, which was presented under step 1. Worth mentioning is that the two other lead time concepts covers the entire lead time process while the developed concept looks at one part of the OTD process. However, the same concept could be applied between other process parameters and the result can be combined as a total lead time.

Matrix for lead time comparison

To be able to compare the different lead time approaches a matrix is created, it is shown in table 13. The idea is to compare different objectives. The classification used is yes, no and partially.

Table 13: The different concept evaluated towards the stated objectives.

Objective	Average lead time	Ideal flow	Normalize transport time
Easy to understand the visualization	Yes	No	Yes
Be easy to break down to detailed level	Yes – easy to understand lead time for a specific market No – when understanding what causes deviation on total lead time	Yes – easy to understand lead time for a specific market No – when understanding what causes deviation on total lead time	Yes
Be able to identify clusters	No	No	Yes
Be possible to compare towards a normal situation	Yes	Yes	Yes
Reflect results of improvement initiatives	Yes - through shorter lead times	Yes – through more individuals within parameter	Yes – through increased efficiency
Measure efficiency	Partially – expressed as days in difference between parameter and actual value	Yes	Yes
Measure effectiveness*	n/a	n/a	n/a
Measure flexibility	No	No	No

*Non applicable (n/a) is set for the objective with measuring effectiveness. This is due to that a measure is effective if it well measures the intended goal. That is, if a short lead time is the goal than

a measurement for number of days will tell if this is achieved or not. At the same time a measurement of effectiveness only tells if a planned time is achieved, but not if the planned time is short or not. Therefore, efficiency does not measure the goal of short lead time as effectively. One sole goal with lead time has not been identified during the interviews and it is therefore chosen to not evaluate this objective.

7.5 *Future work*

Steps 4, 5 and 6 will not be featured in this thesis. The first three steps were used as a basis for developing and evaluating a concept. In order to go forward with the concept, the entire lead time should be included before moving to the next step. The result of this development process should be seen as a conceptual method for further development of Scania. A few aspects to keep in mind when moving forward are:

- Extend the concept to include the whole lead time.
- Extend to concept to plot each individual against all chassis delivered to the same delivery country.
- Check and improve the quality of the data (No error orders, no empty cells etc.).
- Decide on a time frame (one month, six months, one year etc).
- Frequently update the data, to be able to come close to actual situation.

8 Analysis

The analysis chapter has been divided into four different parts. The first section analyzes identified methods and best practices when working with performance measurements. The second section covers suitable performance measurements that can be used in an Order-to-Delivery process. The third section discusses the information found in the company comparison and the last section covers the development process of a new performance measurement concept.

8.1 *Methods and Best Practices*

The literature study compiles different frameworks, models and best practices that can be used to improve a company's performance measurement process. In the following section are the findings analyzed to find important aspects when working with performance measurements. Scania's processes are analyzed in comparison, to be able to determine if the company is performing according to what the literature suggest.

Performance Management Frameworks and Performance Measurement System

Within literature, different frameworks and systems are described. The aim for using them is to structure the way of thinking and working with performance measurements. They provide a standardized view of how to manage performance measurements. However, the frameworks and system are generally guidelines or references to follow a process or to keep different aspects in mind. Since the reality at companies differs, there are no already finished solutions to implement. To be able to implement performance measurement successfully, companies must tailor their measurements to their actual situation and the company culture. One of the most commonly used PMS models is the Balanced Scorecard. On a strategic level is this approach already in use at Scania featuring the following four aspects:

- **Top employees** - corresponds to learning and growth
- **Customer satisfaction** - corresponds to customer perspective
- **Volume growth** - corresponds to process performance
- **Profitability** - corresponds to financial perspective

The opposite to a strategic Balanced Scorecard would be an approach that can link low level measurements to higher, more aggregated ones. Implementing this type of PMS could help make connections between deviations in for example production, to deviations in OTD flow level. However, implementing this kind of system is a long process and there is no guarantee that the implementation will be successful.

On a general level of how to work with performance management is the mentioned Performance Management Cycle a suitable and clear tool to use. This circle also aligns with the concept of continuous improvement which is a foundation at Scania. However, the authors believe that this way of working is already in place at Scania today, through the annual strategy meetings and cascading of strategy down in the organization.

Cascade strategy through the organization

The overall strategy of a company is set on a strategic and highest management level. This strategy is then broken down to the different levels and departments within the company. Each department needs to have their own strategy and measurements implemented to be able to steer the business according to their target, based on the overall strategic goals. Each developed indicator should take the strategic viewpoint in mind. When all KPIs are anchored in a company's strategy, the organization can be steered in the right directions with the right decisions taken. When the strategy is pushed back and forth within organizational levels it is called cascading. At Scania, strategies are set on all

organizational levels, based on the overall strategies defined on a Top Management Meeting once a year.

Performance measurements in strategical, tactical and operational level

As previously mentioned, measurements should be implemented in different levels of the organization. These levels are strategical, tactical and operational. Each of the levels should have measurements connected to it, which can help guide the work and aid decision making. The higher up in the organization, the more aggregated the measurements will be. Lower in the organization can operational steering KPIs be found. Important is to understand that employees have different knowledge in the different levels. The challenge is to communicate effectively between the levels. At Scania, lead time is an example of an KPI that can be seen from an aggregated OTD view, as well as be broken down to more specific process times in production for instance.

Indicators in different levels of detail

Aggregated measurements are appropriate to show the overall performance of an organization. However, when finding root causes that creates deviations, it is needed that the measurement can be tracked down in the organization. The same applied for the other way around. Employees working in an operational environment should be able to see how their performance applies to the total performance. At Scania, is it experienced to be a problem to break down indicators and to find the root cause to deviations. The *Average Lead time* approach is one example when it is hard to break down and find the root cause.

Combining leading and lagging indicators

Traditional performance measures and indicators are often lagging indicators. This means that they will measure the past and show how the organization has performed historically. Lagging indicators can be useful when analyzing trends to make improvements. However, they are not useful when trying to make predictions and affect future performance. Therefore, leading indicators also needs to be included in the portfolio. A leading indicator will give the organization indications on how to steer the business to affect the future. At Scania only lagging indicators are used, this means that it is hard for Scania to predict the future.

Combining different perspectives

In the set of implemented indicators, is it beneficial for the organization to have measurements linked to different perspectives. This is to incorporate different views in the process and show how the organization is performing from different viewpoints. Example of different views are a mix of financial and non-financial measurements as well as internal and external measurements. Result indicators are often measured in financial terms and Performance indicators are often referred to as non-financial. This setup of indicator gives an indication of how teams collectively are producing results as well as gives an indication of what actions need to be taken for the future. Scania use both financial and non-financial measures but they are separated between different groups. The authors have only come in contact with measures regarding the physical flow and that are therefore non-financial.

Using the right terminology

Introducing a common understanding through standardize terminology and way of working with measurements will help the organization to effectively communicate and to be able to differentiate and to be more specific. For now when organizations implement performance measurements they refer them to KPIs, when they in fact might not be KPIs. This can in turn undermine the importance of the actual KPIs that drive the strategic objectives. At Scania, there is no distinction between the different terminologies. All measurements are referred to as KPIs. A differentiation between KPIs and

PIs and the difference between them could be beneficial for the company to be able to communicate more effectively.

Measure and Indicators need to be clear

The measures and indicators used should be clear on what they actually measure, how this is measured, who is responsible, when it is updated, and with what data. In scenarios where there are multiple measures available is this an even more critical aspects. In the Order-to-Delivery process, only a few indicators are today used and therefore the need is not as critical. A suitable way to report the necessary information is to use a record sheet.

Understanding cause-and-effect relationship between KPIs

To understanding what an indicator shows and how it effects its surrounding is it useful to identify relationships between the output and also among themselves. This could be done by constructing cause-and-effect diagrams that show the behavior over time. Understanding the correlation can help balance indicators, clarify the focus area and provide feedback to strategic management.

8.2 *Suitable OTD Performance Measures*

During the literature study it has been identified that there are several available measures that can be used to assess the performance of a supply chain or of logistics processes. These have been evaluated to find measures that can be appropriate for an Order-to-Delivery process. The aim was to identify measures that could be useful for Scania to implement. It was found that the identification was more difficult than first expected. One of the reasons was the lack of clear OTD measurements and to determine what is actually inside the scope of the OTD process. The other reason was the lack of clear description to what proposed measures actually meant. The measures found in academic research often lacked both an explanation and/or formula, clarifying what they intended to measure.

The measures identified, in s*ection 3.8.1*, are all considered appropriate to measure a general Order-to-Delivery process. However, they may not all be applicable to Scania in its existing processes. Therefore the measure have been analyzed together with an employee at Scania to determine which measures are already used today, which could be of value and which are not suitable for the company's processes or believed to be out of scope for what Scania consider as their OTD process. The result is presented in the table 14. Certain measure found might be relevant for other companies OTD flow, but they might not be a suitable fit for Scania due to process differences. Example of this type of measurement is order picking accuracy and fill rate. Several measures that were found already exist at Scania, either directly or in a similar version. These are not presented under current state since they are measured at a function level, and not considered a cross-functional flow measurement. However, they are considered to be linked to OTD process and to be an enabler of it.

One aspects that was found during the research is that multiple types of categorization are applied to measures presented in academic research articles. These type of categorization could for example be process related, related to different perspectives or defined by levels in an organization. This also ties back to the idea of a Performance Measurement System and the aim of balancing different types of measures. Keeping the different perspectives in mind could be helpful to achieve a balanced view when choosing relevant performance measures. Since lead time has been determined to be an important measurement in an OTD process, it could also be of value to consider the managers perspective of lead time and if there are any of the stated objectives that are not fulfilled today. When interviewed about lead time, the managers talked about the objective of flexibility and to have a flexible lead time. To the authors understanding, no such measurement is currently applied within the company. Therefore, flexibility and adaptability are two types of measure that could be useful when

evaluating the performance of the Order-to-Delivery process, to complement accuracy measures that are more widely used today.

Table 14: Measurements that exists, not exists, and that are not suitable or out of scope.

Type	Existing measures at Scania	Non-existing measures that can be of value	Not suitable or not evaluated as an OTD measure
SCOR Model measures	Order fulfillment cycle time	Perfect order fulfillment (partly existing)	Total supply chain management cost
	Upside supply chain adaptability	Overall value at risk	Cash-to-Cash cycle time
	Downside supply chain adaptability		Return on supply chain fixed assets
	Cost of goods sold (COGS)		Return on working capital
Other measures	On-time delivery	Lead time adaptability	Delivery reliability
	Carrier performance reliability	Lead time flexibility	On time in full (OTIF)
	On-Time Shipments	Responsiveness to urgent deliveries	Customer inquiry response time
	On-Time Ready to Ship	Order entry accuracy	Lead time variability
	Percentage of finished goods in transit	Invoice accuracy	Product development lead time
	Order entry time	Percentage of urgent deliveries	Distribution Cost Per Unit Shipped
	Order lead time		Days sales outstanding
	Production lead time		Order picking accuracy
	Delivery lead time		Net Promoter Score
	Inventory turnover (ITO)		Customer satisfaction score
	Total inventory/stock		Fill rate
	Capacity utilization		
	Order scheduled to request		
	Forecast accuracy		
	Late Orders		
	Quality of delivered goods		
	Backorders		

8.3 *Company Comparison*

The company comparison gave an insight to other companies OTD processes and how they measure and manage the performance of this process. The aim was to investigate if any measurements or practices could be useful for Scania to adopt in order to improve their own process of performance measurement. Best practices identified are in relation to academic research and what has been found during the literature study.

As the literature mentions, the OTD process at different companies are similar by its nature. This is also experienced in the company comparison. All interviewed companies processes customer orders, manufactures the products and finally deliver the products to the customers. Within these processes

are measurements implemented to keep track of the performance. A large focus in Scania's OTD process is lead time and delivery precision. This is also an important focus for the compared companies. All compared companies have these measurements implemented in one way or another and they are considered to be critical for measuring the internal performance as well as customer satisfaction. Some customers might want the products as fast as possible, i.e. short lead time, while other want the product in the agreed upon time to be satisfied, i.e. delivery precision.

Which KPIs are used

As mentioned before, lead time and the delivery performance, through delivery precision or delivery reliability, are something that has been found to be measured at almost all companies for the OTD process. The way lead time is measured differs slightly between companies depending on their processes and if they divide the measurement between different departments or in different level of aggregation.

The identified measurements are currently already in use at Scania or not of relevance. However, a best practices identified relating KPIs are:

- Using a mix of financial and non-financial indicators to measure the performance.
- Using workshops to develop and review indicators and measures

A gap that is identified between academically suggested best practices and what is currently adopted at companies is the use of leading indicators. It is found that the companies tend to use lagging KPIs that show historical data. No leading indicators have been identified during the interviews. The literature also discuss the importance of using the right terminology for indicators. This is something that has neither been adopted at Scania or at any of the companies investigated. All companies are using KPIs when referring to their performance measures, often without being critical about the used terminology.

How KPIs are structured

Only aggregated measurements for the OTD process have been considered in the company comparison. However, the companies were asked for how they work with performance measurements and how the aggregated measurement are used to identify deviations and root causes. A few best practices were identified:

- The usage of a bottom-up approach to link lower level KPIs to the more aggregated ones. This is based on aggregating low level KPIs into an aggregated KPI, creating a sort of index. This allows to drill down and to find root causes.
- The use of different standardized report packages that show related KPIs next to each other. This also entails that an identification of KPIs affecting each other has been done. It can also help prevent sub-optimization through balancing of opposites.
- The use of performance measurement system to standardize measures and indicators in the entire organization. This is especially helpful for departments using multiple measures and have a large, spread out organization (e.g. several different production plants).

Often measurements are needed to achieve both internal and external performance. One measurement that is important from a customer perspective is delivery performance. Apart for improving the delivery performance has the topic of transparency been discussed at some companies. For these companies is it important to track the process in order to update their customer on the current status. This does not correspond directly to measuring the performance but it is believed to be an important aspect of the same area. A best practice identified is the following:

- Working with transparency in the entire flow from order to delivery, not only using “black boxes” for example the distribution. Also allowing the customer to access this transparency and follow the status of their order.

How KPIs are used

The way data is analyzed and presented at the different companies is similar to the way Scania is working. Something that is common is to try to steer the business with the implemented KPIs. Best practices found, are listed below. However, the authors believe that these practices are already in place at Scania today:

- Annual strategy meetings where KPIs are derived and reviewed to ensure that they are linked to the current strategic objectives, relevant and up-to date.
- Cross-functional forums with related parties to discuss deviations and improvement initiatives.
- Continuously working on development of reports and data warehouses.

How KPIs are presented

The Balanced Scorecard Institute (2018) suggest to use automation tools to easier analyze data and spread performance information in a more standardized way. It allows for better coordination and communication. They mean that data needs to be monitored, described and analyzed. The use of tools is found both at the compared companies and at Scania. Business intelligence (BI) tools, such as Power BI and QlikView are used as well as more traditional data management through Microsoft Excel. It can be argued that these new BI tools will replace the traditional data management systems in the future, due to the automation possibilities and up to date information that it entails.

Challenges with performance measurements

When measuring performance in an OTD process, different challenges are experienced at the compared companies. One aspect that seems to be important is the measurement culture in different departments. The culture can affect the way they work with performance measurements. According to literature KPIs should be cascaded, broken down or aggregated between levels in the organization. To be able to achieve this in an effective way it can be argued that having a common way of thinking is important to be effective in measuring performance. A problem experienced is a contradiction between to measure and being measured. By its nature people want to have control and therefore measure, but at the same time people do not want to show how they perform. It can be argued that this problem will prevent the effectiveness when using performance measurements.

Another challenge is the quality of input data for measurements performed as well as having the time to actually understand and analyze the measurements. In addition to this, is it also important to understand what measurements might be contradicting and to make sure that a proper balance between these are achieved. There is also a challenge in connecting soft values, such as customer interaction with KPIs and to measure these types of values in a fair way.

Criticism of the company comparison

Something that needs to be highlighted is the degree of reliability and validity in the company interviews. The number of employees that are interviewed and their knowledge about the OTD process can affect the result. In the Volkswagen interview, the interviewee had a different perspective when answering the questions and was not directly responsible for the processes. The single interviewee was also the only source for the collected information. The SSAB interview consisted of five employees from different functions and management levels, creating a common understanding and agreement of the answers given. This makes the interview situations for the two companies different and

something that should be kept in mind. The interview/s perception and knowledge about the topic of performance measurement will also affect the answers received during the interviews.

8.4 *Development of a Performance Measurement Concept*

It is not uncommon that indicators either needs to be redesigned or replaced with new measurements, when strategic objectives or processes change. When doing changes in the setup of indicators, is it suitable to follow a development process. For the development of the new concept, a KPI development process proposed by Rohm and Nisbet (2018) have been used as a foundation.

The initial idea with the developed approach was to calculate unitless values so that different lead times could be put on a more comparable scale. The aim was to be able to see if a transport time to one delivery address could be considered efficient in comparison to another delivery address with longer or shorter transport time. The approach with the flow metric (Dörnhöfer, Schröder, & Günthner, 2016) was to divide the distance of transport with an average speed, but the authors wanted to try a different approach. It was also believed that it was still not a fair comparison to directly compare a short transport time to a long lead time, due to process differences. After some thought it was decided instead to try to classify groups and to find clusters. The idea with using a normalization formula was to put the values on the same scale of 0-1. This was believed to be helpful when plotting two axis against each other and that it could help to classify different intervals of transport time and to see patterns in the efficiency of these intervals. However, the results shows that there is no difference in the scatter chart when normalized values are compared with average values. This is due to that the relationship between the two axis are still the same. Instead the average value approach turned out to be more useful because the data was easier to calculate and to interpret.

So, it was proven that the idea of normalizing the values, in order to put them on the same scale did not fulfill the intended purpose. However, the concept of plotting two axis against each other does provide a valuable input and partially fulfills the intended purpose. The main benefit with the developed concept is instead to be able to visualize all countries in one scatter chart to compare them towards each other. When clusters are defined in the chart it is possible to categorize and link each country to one cluster. This can help provide transparency to whether a market clearly stands out towards other markets in the same region. If one country deviates from the cluster then it can be further investigated to why this is happening. The scatter chart also helps to visualize differences in efficiency between markets with long or short transport times. The plotted dataset gives an overview on an aggregated level that is easy to understand. When a deviation occurs in a market it is easy to drill down in the dataset, in excel, to analyze the markets on a more detailed level. The concept gives an indication if there is a normal situation in the flow, which can help visualize improvement opportunities in the current state and to improve the transparency between different markets and different flows.

The new developed performance measurement concept can provide Scania with a tool to give a quick indication if the markets are performing according to target. The concept is conceptual in the sense that it can be further developed by Scania. However, the concept is based on facts and true values and therefore can be seen as a preliminary work. The next step with this measurement approach is to develop it to include the entire lead time, not only transport time. After this, it would also be useful to not only plot market, or delivery countries towards each other, but to also plot one country towards itself. This would allow to see the spread of flows to the same country. Countries with an inconsistent flow could then be target for further investigations to why this is happening.

During the development of this approach it was pointed out to the authors that the way of calculating efficiency might not be fully reliable. This is because the Actual Release Date is reported differently

between different production units (PRUs). In some PRUs it is reported immediately when the chassis are ready, in some PRUs they wait until the day it is supposed to be released. Factors like this could affect the end result and something that would need to be further investigated if the approach is to be implemented.

Another challenge found during the development phase is the reliability of the data. It was not uncommon that data was either missing or that is was reported in a way that meant that it could not be true. An example of this is when a chassis has been delivered to the customer before it is released in the yard at Scania. This is not possible and therefore the authors have excluded data points like these in the plots. The quality of the input data is something that effects all performance measurements at Scania, not only this approach. It is therefore a factor that needs to be considered when measuring performance and analyzing the measurements.

9 Conclusions and Recommendations

In this chapter, the final conclusions from the thesis project are presented to answer each of the research questions. Lastly recommendations are proposed to Scania.

9.1 *Conclusions*

The conclusions, presented below, are a result of the findings and analysis performed in this thesis. A conclusion has been made for each of the research questions.

RQ1: "How should performance measurements be used in an organization in order to be efficient?"

To be able to answer RQ1 has an extensive literature study been conducted and the findings have been analyzed to determine an efficient way of working with performance measurements. The key points have been summarized below. These are the most critical aspects to keep in mind when working with performance measurement within an organization.

- Measurements should be aligned with the company's strategy and relate to strategic objectives.
- The strategy should be cascaded through different organizational levels, i.e. strategical, tactical and operational, either through vertical or horizontal cascading.
- Measurements should be implemented in each level to guide the work and support decision making.
- Measurements should be able to be broken down from an strategic, aggregated level to a detailed operational level - and vice versa.
- Frameworks and systems can help the organization to structure and balance the measurements.
- A mix of leading and lagging indicators should be implemented, to be able to see historical data and to predict the future.
- The measurements should reflect different perspectives to be able to incorporate different views, e.g. a mix of financial and non-financial measures as well as internal and external measurements.
- Make sure to use the right terminology, to be able to communicate effectively and avoid confusion.
- Business intelligence tools are efficient to store and visualize data.
- Performance measurements should be customized to the organizations capabilities, limitations and needs.
- New measurements can be created or redefined with experienced employees, following a development process.

RQ2: "Which are suitable performance measures, for an Order-to-Delivery process, according to academic research?"

To answer RQ2 has a literature study been performed to identify suitable measures for an OTD process. The task was proven difficult since the measures found was either related to a supply chain environment or strictly logistics measures. There was also a lack of information regarding what suggested measures actually meant and how they should be calculated. The authors have selected relevant measures from different sources, that are considered to be linked to an OTD process. These measures are presented in section *3.8.1 Identified Order-to-Delivery Measures and Indicators.* The measures have in turn been analyzed to determine what measures are already in place at Scania today and what measure are unknown and could therefore be of interest to the company. Certain measures have also been determined to be irrelevant for Scania processes or out of scope for what the company consider as their OTD process. The classification of the measures to each of the categories can be found

in section *8.2 Suitable OTD Performance Measures*. Several of the measures identified are not cross-functional measures and they should not be defined as Key Performance Indicators. However, they could be applied in process enabling functions. The measures that already exist, either directly or in a version of it, as well as previously unknown measures are presented in table 15. These are the measures that are considered suitable for Scania. Below follows a more thorough explanation to the non-existing measures and a suggestions for how they could be calculated.

Table 15: Existing and non-existing measures

Existing measures		Non-existing measures that can be of value
Order fulfillment cycle time	Production lead time	Perfect order fulfillment
Upside supply chain adaptability	Delivery lead time	Overall value at risk
Downside supply chain adaptability	Inventory turnover (ITO)	Lead time adaptability
Cost of goods sold (COGS)	Total inventory/stock	Lead time flexibility
On-time delivery	Capacity utilization	Responsiveness to urgent deliveries
Carrier performance reliability	Order scheduled to request	Order entry accuracy
On-Time Shipments	Forecast accuracy	Invoice accuracy
On-Time Ready to Ship	Late Orders	Percentage of urgent deliveries
Percentage of finished goods in transit	Quality of delivered goods	
Order entry time	Backorders	
Order lead time		

Overall value at risk

Overall value of risk is a way to evaluate a supply chain risk. It is one of the metrics suggested by the SCOR model. It can be calculated by:

$$VaR = Probability\ of\ Risk\ Event\ (P)\ x\ Monetized\ Impact\ of\ Risk\ Event\ (I)$$

Lead time adaptability

Lead time adaptability is defined as to what extent a company can reduce the lead time *before* an order, in accordance to customer needs. It is suggested that this is measured as the percentage of what the confirmed lead time can be reduced in relation to the offered lead time before the order:

$$Lead\ time\ adaptability[\%] = \frac{Offered\ lead\ time - Confirmed\ lead\ time}{Offerred\ lead\ time} x100$$

Lead time flexibility

Lead time flexibility is defined as the ability to adapt the lead time *during* the Order-to-delivery phase. It is suggested that this is measured as the percentage that lead time can be reduced, in relation to the lead time confirmed at the order point:

$$Lead\ time\ flexibility[\%] = \frac{Confirmed\ lead\ time - Actual\ lead\ time}{Confirmed\ lead\ time} x100$$

Responsiveness to urgent deliveries

Responsiveness to urgent deliveries refers to number of orders that an organization is able to meet, that are requested on abnormal delivery times. The differences between this measures and *percentage of urgent orders*, is that this measure considers if the delivery is met or not.

$$\text{Responsiveness to urgent deliveries [\%]} = \frac{No.of\ orders\ delivered\ according\ to\ request\ on\ abnormal\ delivery\ times}{Total\ no.of\ orders\ requested\ on\ abnormal\ delivery\ times} x100$$

Percentage of urgent deliveries

Percentage of urgent deliveries refers to percentage of products that are considered to be important and therefore placed prior other products in sequence. This could be orders that are entered as urgent by the distributor when the order is placed and should then be measured as the first formula:

$$\text{Percentage of urgent delivieries [\%]} = \frac{No.urgent\ orders/deliveries}{Total\ no.oforders/deliveries} x100$$

It could also be orders that Scania recognizes as important and treats thereafter. It should then be measured as the below formula:

$$\text{Percentage of urgent delivieries [\%]} = \frac{No.orders/deliveries\ that\ are\ treated\ as\ urgent}{Total\ no.oforders/deliveries} x100$$

Order entry accuracy

Order entry accuracy refers to the accuracy of entered orders, e.g. orders entered without fault.

$$\text{Order entry accuracy [\%]} = \frac{No.of\ order\ without\ fault}{Total\ no.of\ orders} x100$$

The order entry method could also be measured as to if the information is useful and timely provided to those in need of the information.

Invoice accuracy

Invoice accuracy refers to if the invoice is accurate and on-time. It could be measured

$$\text{Invoice accuracy [\%]} = \frac{No.of\ invoices\ without\ fault}{Total\ no.of\ invoices} x100$$

Perfect order fulfillment – Documentation accuracy

Order entry and invoice accuracy are both measures corresponding to an error free order fulfillment. Other measures relating to this are order picking accuracy and the quality and quantity of the delivered goods. These can all be aggregated and combined into a cross-functional order fulfillment measurement. To fulfill the level 1 SCOR model metric of *Perfect Order Fulfillment*, three parts need to be fulfilled. It needs to be **delivered on time**, **damage free** and with **correct documentation.** The first two parts are already measured at Scania, but to the authors knowledge is documentation accuracy is not measured.

$$\text{Documentation accuracy [\%]} = \frac{Total\ numbers\ of\ orders\ delivered\ with\ accurate\ documentation}{Total\ numbers\ of\ ordered\ delivered} X100$$

RQ 3 a): "How does Scania measure and manage the performance of their Order-to-Deliver process?"

There are different levels to consider when discussing Scania's performance measurement process. The highest level of strategic significance is the use of a Balanced Scorecard. The Balanced Scorecard incorporates the following perspectives:

- Top employees
- Customer satisfaction
- Volume growth
- Profitability

Measurements defined in the Balanced Scorecard for each perspective are those that, according to academic research, correspond to the Key Performance Indicators and that can be considered critical for the success of the company. This is because they are the ones that correspond towards the strategy of the company and that are vertically cascaded down in the organization. Apart from this, are there also several measures used in different teams to measure their specific performance. These are also referred to as KPIs but are actually Performance Indicators. Scania's cross-functional OTD measurements are presented in table 16.

Table 16: The cross-functional OTD measurements at Scania

Measurements	Measured as	Divided as
Average Lead time	Measured in days	Total lead time measurement
		Allocation Precision
		Sequencing Precision
		Delivery Performance
Ideal flow	Measured as a percentage within or outside an ideal parameter	
Delivery precision	Measured in days within a specified time window	

In RQ1 it is concluded what the most important aspects are when measuring performance in an organization. These aspects should ideally be applied to Scania and a comparison has therefore been made to if they are applied or not, presented in table 17.

Table 17: A comparison between Scania processes and identified best practices.

Best practices	Status
Measurements should be aligned with the company's strategy and relate to strategic objectives.	Fulfilled
The strategy should be cascaded through different organizational levels, i.e. strategical, tactical and operational, either through vertical or horizontal cascading.	Fulfilled
Measurements should be implemented in each level to guide the work and support decision making.	Not fulfilled
Measurements should be able to be broken down from an strategic, aggregated level to a detailed operational level - and vice versa.	Partially fulfilled
Frameworks and systems can help the organization to structure and balance the measurements.	Partly fulfilled

A mix of leading and lagging indicators should be implemented, to be able to see historical data and to predict the future.	Not fulfilled
The measurements should reflect different perspectives to be able to incorporate different views, e.g. a mix of financial and non-financial measures as well as internal and external measurements	Partially fulfilled
Make sure to use the right terminology, to be able to communicate effectively and avoid confusion.	Not fulfilled
Business intelligence tools are efficient to store and visualize data.	Fulfilled
Performance measurements should be customized to the organizations capabilities, limitations and needs.	Fulfilled
New measurements can be created or redefined with experienced employees, following a development process.	Not fulfilled

RQ3 b): "How do other manufacturing companies measure and manage the performance of their Order-to-Delivery process?"

The performance measurements found during the company comparison are presented in table 18. A more thorough explanations to the measurements can be found in chapter *6 Company comparison*.

It is concluded that the compared companies consider lead time and delivery performance as two important measurements for their OTD process. However, each company have different approaches on how to define and measure the *lead time* and *delivery performance* measurements. Only one company presents a financial measure as part of their OTD performance measurements. Another company is also alone in presenting a measurement directly linked to customer satisfaction, even though lead time can also be considered to correspond towards the customer perspective as well.

Table 18: Performance measurements at the compared companies

Audi AG	MAN Truck & Bus AG	SSAB AB	Sandvik AB	Volkswagen AG
Delivery performance depot	Delivery time	Delivery Performance	Lead time	Lead time
Order scheduling performance	Delivery reliability	Lead time	Fill rate	Delivery precision
Production program performance	Delivery precision	Stock volume	Forecast accuracy	
Dispatch performance	Capital employed	Delivery Delays		
	Percentage of unsold stock	Number of complaints		
		Net Promoter Score		

In relation to what has been concluded in RQ1, have the following best practices been identified at through the company comparison:

- Annual strategy meetings where KPIs are derived and reviewed to ensure that they are linked to the current strategic objectives, relevant and up-to date.
- Using workshops to develop and review indicators and measures.

- The use of performance measurement system to standardize measures and indicators in the entire organization. This is especially helpful for departments using multiple measures and have a large, spread out organization (e.g. several different production plants).
- The usage of a bottom-up approach to link lower level KPIs to the more aggregated ones. This is based on aggregating low level KPIs into an aggregated KPI, creating a sort of index. This allows to drill down and find root causes.
- Cross-functional forums with related parties to discuss deviations and improvement initiatives.
- Using a mix of financial and non-financial indicators to measure the performance.
- Continuously working on development of reports and data warehouses.
- The use of different standardized report packages that show related KPIs next to each other. This also entails that an identification of KPIs affecting each other has been done. It can also help prevent sub-optimization if balancing of opposites is involved.

In opposite to best practices, has it been concluded that none of the companies interviewed are using leading indicators to measure the performance of their OTD process. There is also no differentiation in the terminology used for measures and indicators. All measures are referred to as KPIs.

RQ4: "Are there additional approaches that can be beneficial for measuring the performance in Scania's Order-to-Delivery process?"

During the thesis project has a concept for measuring transport time been developed. The concept covers the time period from that the chassis are released at the yard at Scania until it arrives at the first delivery address. The concept can provide Scania with an opportunity to see the status of each delivery country in terms of transportation flow. The delivery countries are visualized in a scatter chart and it is possible to identify different clusters. In the chatter chart is efficiency plotted on the y-axis and transport time on the x-axis to visualize the relationship between transport time and the efficiency of it. The clusters will make it possible to see if a specific country deviates from the normal situation. When deviations are noticed in the scatter chart is it possible to break down the aggregated value to detailed data and investigate what causes the problem. The concept provides a tool to better visualize different markets against each other through a consideration of efficiency in relation to transport time. It also gives a quick overview too see if a market behaves according to target or not.

The concept can also be extended so that it can measure the total lead time. It is therefore comparable with the two existing concepts *Average Lead time* and *Ideal Flow*, previously developed by Scania. The developed concept still has improvement potential and the thesis authors have provide the company with guidelines how to continue the development journey. The quality of the input data is considered to be the main aspect for improving the performance of the concept.

9.2 *Recommendations*

The authors have, based on the analysis and conclusions, defined recommendations that can help Scania to improve their performance measurement process.

Measures and Indicators

To improve their performance measurement process, Scania need to implement leading indicators in their OTD process. The measures for lead time adaptability and flexibility are suggested by the authors as leading indicators. However, additional leading indicators can also be developed. Development of leading indicators should preferable be performed by experienced employees in workshops. The development process for KPIs presented in this report can be used.

The company should also evaluate the identified measures that are currently not in place to see if they could be of value to implement.

Differentiate KPIs with other indicators

Differentiate between KPIs and PIs by using the correct term to refer to them. The measures linked to the Balanced Scorecard are the critical measures termed KPIs while the team or functional measures are PIs. A differentiation between these can clarify each of the indicators meaning and relevance to employees.

Create "report packages"

Determine which measurement visualization and what KPIs should be presented next to each other. Having standardized ways to present KPIs can help balance and clarify focus areas and intended effects. This can also simplify the interpretation and working with measurements, for those with less knowledge. In order to create a report package should the cause-and-effect relationship between indicators be investigated.

Develop the transport time concept

The authors believe that the developed concept for transport time could be a valuable input to determine the status and increase the control of the flow to each delivery country. It is therefore suggested that the concept should be further developed and tested for the entire lead time.

Improve the quality of input data

In the development process of the new concept for measuring and visualizing transport time, it became apparent that the input data is not completely reliable. The company should look over the quality of the data and continuously work with improving the data reporting process.

Linked to the quality of the data, it was also found that different production units have different procedures for how and when important dates are reported. This will affect all measurements and analysis utilizing the data. A standardized work procedure for how and when dates should be reported can help limit this problem.

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List of interviews

Interview information	Position	Company
Hörting, M. (2018, February 8). Personal Interview.	Regional Inventory and Demand Planner	Sandvik AB
Valtonen, E. (2018, April 9). Personal interview.	Head of Supply Chain Development PA Rock Tools	Sandvik AB
Employee A. (2018, February 27). Personal Interview.	Logistics Planner	Volkswagen AG
Brieke, M. (2018, Mars 19). Personal interview.	Head of Logistics Strategy and Process Projects	MAN Truck & Bus AG
Wesener, A. (2018, Mars 20). Personal interview.	Planner OTD Process	Audi AG
Rottenwaller, G. (2018, Mars 20). Personal interview.	Logistics Planner	Audi AG
Rehm, B. (2018, Mars 20). Personal interview.	Logistics Planner	Audi AG
Norén, J. (2018, April 10). Personal interview.	Manager, Customer CARE, Supply Chain Special Steels	SSAB AB
Kågström, M. (2018, April 10). Personal interview	Manager Inventory Management	SSAB AB
Carman, M. (2018, April 10). Personal interview.	Manager External Logistics	SSAB AB
Kohler-Råd, C. (2018, April 10). Personal interview.	Senior Manager Master Planning	SSAB AB
Rozic, V. (2018, April 10). Personal interview.	Vice President and Head of Supply Chain Special Steels	SSAB AB
Hedlund, P. (2018, April 13). Personal interview.	Head of Order to Delivery development P&L	Scania CV AB
Lundgren, S. (2018, April 13). Personal interview.	Head of Order, Planning and Export	Scania CV AB
Castello, F. (2018, April 19). Personal interview.	Senior Vice President Logistics	Scania CV AB

Appendix 1 – Interview questions

Interview questions

General questions:

- What is your name?
- What is your position within the company?
- What business areas are linked to your department?
- Are there one or more production units linked to your business area?
    - If yes, are they located in different countries?
- Who is the typical customer? I.e. do you sell to distributor, dealer, end customer etc?

General questions regarding the OTD process:

- What are the process steps in the OTD process?
- What different functions within the company are included in the OTD process?
- Is there a department responsible for OTD process development? Or is every function involved responsible for sub-optimizing?

Questions regarding measurements:

- What terminology is used for performance measurements? (KPIs, PIs etc)
- What performance measurements are used to measure the OTD process?
    - How many measurements are you using?
    - Why are they used and what do they show you (i.e. objective)?
- Responsibility:
    - Who is responsible for the measurements? A department? A person?
    - Who develops and updates them?
    - Who reports them to management?
- If lead time and delivery precision are used, how are they measured?
- Are/can the measurements be divided into different functions or geographical areas?
    - Are different production units or geographical areas compared?
- Are average or detailed values used at the company?

Questions regarding follow-up methods/use of the performance measurements:

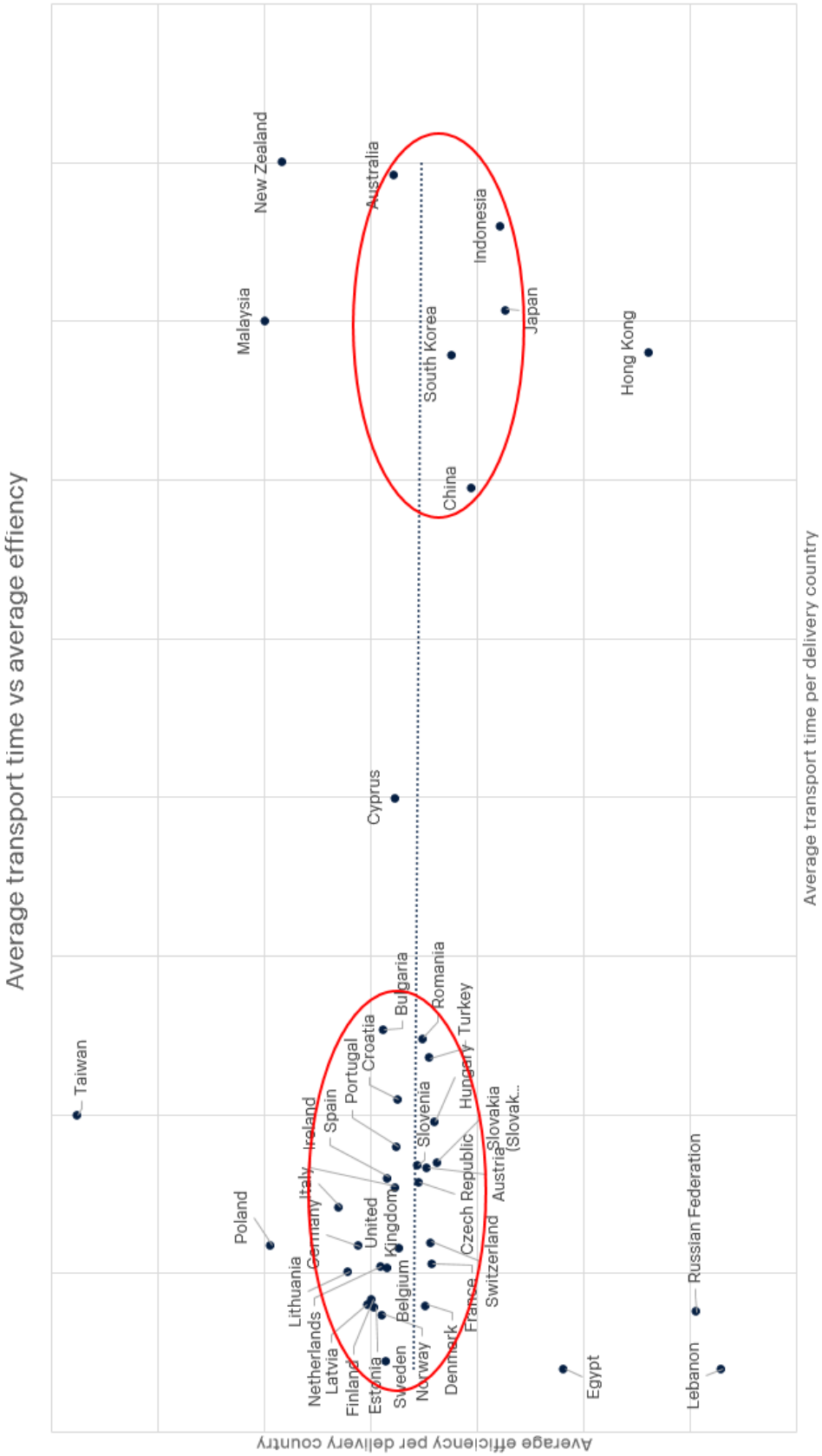
- What tools are used to collect data for measurements?
- How are the measurements visualized or presented?
    - Scorecard/dashboard?
    - Excel sheet/graphs/diagrams/numbers?
    - Other report tool?
- How often are the different measurements updated?
- Are they used:
    - In the daily work?
    - When a deviation occurs?

    - To make improvements?
    - For analysis?
    - Are they forwarded to management? How often?
    - Are they forwarded to relevant departments? (E.g. where a deviation has occurred)
- What happens if the measurements deviate or the targets are not met?
- How do follow-up procedure work?
  - Any formal methods/processes?
    - If yes, what are they?
  - Any informal methods/processes?
    - If yes, what are they?
- How are you working with improving your measurement and follow-up methods?
    - Any current projects or aims?

Other questions

- In your opinion:
    - What is the most critical measurements to track?
    - What is your biggest challenge with performance measurements follow-ups?

Appendix 2 – Identified clusters



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