DEPARTMENT OF ENGINEERING LOGISTICS,
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Developing a Supply Chain Performance Measurement Dashboard

– A Case Study at Axis Communications AB

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Supervisors: Robert Lindroth (Axis Communications AB), Dag Näslund (LTH)

- Acknowledgements -

This master thesis is the finishing part of our Master of Science degree in Industrial Engineering and Management at the Faculty of Engineering, Lund University. The study was written at the Operations department at Axis Communications AB, in cooperation with the department of Engineering Logistics at the Faculty of Engineering, LTH.

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Finally we would like to address our friends and families: Thank you! For supporting, helping and cheering on us, during the work with this thesis as well as at all other times.

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Hanna Pernbert and Kajsa Ryding

- Abstract -

Title	Developing a supply chain performance measurement dashboard – A case study at Axis Communications AB
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Supervisors	Robert Lindroth, Operations Development Manager, Axis Communications AB, Dag Näslund, Associate Professor, Department of Engineering Logistics, Faculty of Engineering, LTH
Background	A central part of Axis Communications AB is the Operations department, which includes all functions related to the supply and distribution of Axis' products. Axis Operations currently measures performance through a number of indicators or goals that are measured for each function. However, the way performance is measured and presented today does not provide a complete picture and therefore has the potential to be developed further. As the company grows, the need for control and overview increases and thereby the need for a dashboard that can provide this, swiftly and frequently.
Purpose	To develop a dashboard by suggesting what metrics to include in it. This dashboard should provide an overview of the performance of the Operations department at Axis Communications AB.
Method	The study is a single case study that uses qualitative data in form of interviews. An analysis model was developed through a literature review where relevant topics for the study was combined. The model comprises a general guide for developing metrics for a dashboard and is not specifically adopted for Axis Operations. For the case specific solution, data was collected at Axis Operations, mainly through interviews, with the aim of understanding the background and context and collect necessary data for suggesting appropriate metrics. The analysis was done by applying the analysis model. A set of metrics suggested from theory as well as the currently used metrics at Axis Operations were analyzed applying requirements identified through theory, both individually and as a group. The outcome of the analysis is a set of metrics for the dashboard.
Conclusion	The result of the study is twofold. One part is a practical contribution in form of a set of metrics for the dashboard for Axis' VP of Operations. The other part is a theoretical contribution in form of an analysis model based on relevant theory from the field, which is used as a guide when creating dashboards. The set of metrics has been selected by applying the analysis model and is adapted to the company's needs and situation. The analysis model is general and can be used to develop dashboards at different levels in a company.
Keywords	Performance Measurement Systems (PMS), measuring, metrics, dashboard, requirements, supply chain management

- Sammanfattning -

Titel Utveckling av en dashboard för prestationsmätning av en försörjningskedja – En fallstudie på Axis Communications AB

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Bakgrund En central del av Axis Communications AB är avdelningen Operations som innefattar de funktioner som arbetar med att tillhandahålla och distribuera Axis produkter. Avdelningen mäter för tillfället prestation genom ett antal indikatorer och mål som mäts för respektive funktion. I dagsläget finns det potential för att utveckla prestationsmätningen då den inte ger någon klar översikt. I takt med att företaget växer så ökar behovet av kontroll och överblick och därigenom behovet av en dashboard som kan bistå med detta snabbt och frekvent.

Syfte Att utveckla en dashboard genom att föreslå de mätetal den ska bestå av. Dashboarden ska ge en överblick över avdelningen Operations, på Axis Communications AB, prestation.

Metod Studien bedrevs som en enfallsstudie som använde kvalitativ data i form av intervjuer. En litteraturstudie genomfördes där relevanta teoretiska områden för studien kombinerades till en analysmodell. Den utvecklade modellen består i en guide för att välja mätetal för en dashboard. Den är inte specifikt anpassad till Axis Operations. För den fallspecfika lösningen samlades data in genom intervjuer på Axis Operations med målet att förstå bakgrund och kontext samt att samla in den data som behövdes för att kunna föreslå mätetal för Operations dashboard. Analysen genomfördes genom att applicera analysmodellen på fallföretaget. En grupp mätetal som föreslagits baserat på teori samt en grupp mätetal som används i nuläget på Axis Operations analyserades individuellt och som grupp mot ett antal kravspecifikationer som tagits fram från teorin. Utfallet av analysen är en rekommenderad grupp mätetal för Axis Operations dashboard.

Slutsatser Studiens resultat består av två delar. Dels ett praktiskt bidrag i form av en grupp mätetal som föreslås till den dashboard som skapas till Axis VP of Operations. Dessutom ett teoretiskt bidrag i form av en analysmodell baserad på relevant teori från området, och som kan användas som guide för att utveckla en dashboard.

Mätetalen har valts genom att applicera analysmodellen och är anpassade till företaget, dess situation och behov. Analysmodellen är generell och kan användas för att utveckla dashboards på olika nivåer i ett företag.

Nyckelord Mätsystem, mätning, mätetal, dashboard, kravspecifikation, logistik i försörjningskedjor

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1 Introduction

1.1 Background

Companies today face several challenges; changing customer patterns, increased demand for transparency and pressure from international competition among others. At the same time, companies must continuously improve to ensure that their products or services meet expectations and that customers remain satisfied. (New, 2015; McKinsey, 2010)

So what can companies do to investigate and control how they are performing? In order to remain competitive and ensure that improvement is occurring, performance is measured. A performance measurement system (PMS) is a systematically chosen collection of metrics used to quantify the efficiency and/or effectiveness of an action, which together gives an overall insight into how the company is performing (Neely, Gregory and Platts, 2005). By using quantifiable metrics, it is possible to see the evolvement over time within the company and assess whether the taken actions give the desired effect, and also to benchmark against others.

However, companies and people within them have different needs regarding information. To meet these needs, the PMS must be adapted to the company and within the company the metric can be more customized to the user by the use of dashboards, which collect the most essential information for the specific user in one place. (Hugos, 2006) The uniqueness of companies and users connects to the existing lack of consensus, in academia as well as in practice, regarding which PMS to use and what metrics to include (Neely, Gregory and Platts, 2005). Still, to make the information available, decisions must be made regarding the PMS, the dashboard and the metrics that are to be included.

1.1.1 Measuring performance at Axis Communications AB

Axis Communications AB (Axis), founded in 1984, is an IT company that offers network video solutions for professional installations at public places and areas. Axis was the first company in the world to launch a network camera and thereby initiated the shift from analog to digital technology. The current product portfolio mainly consists of network cameras, video encoders, accessories and application software, (Axis, 2014a) and the company has a global market leading position within network cameras, security cameras and video encoders (Axis, 2013).

A central part of the company is Axis Operations, which is the department covering all functions that are related to the supply and distribution of Axis' products. This includes demand planning, purchasing, production, orders and logistics, quality, production preparation and systems, reverse logistics, business legal and real estate service. (Lindroth, 2014)

Axis Operations currently measure performance through a number of indicators or goals that are broken down from the company strategy and measured for each function. An overall view of the current state or the progress for relevant key performance indicators (KPIs) and metrics is however not easily obtained. At the moment some of the metrics used are presented at monthly and weekly meetings. Moreover the Vice President of Operations uses a tool containing information that can be used to indicate performance of Axis Operations. However, the way performance is measured and presented today does not provide a complete picture and therefore has the potential to be developed further. As the company grows, the need for control and overview increases and thereby the need for a dashboard that can provide this swiftly and on a daily basis. (Lindroth, 2014; Ädelroth, 2014)

1.2 Purpose and research questions

1.2.1 Purpose

The purpose of this study is to develop a dashboard by suggesting metrics that should be included in it. This dashboard should provide an overview of the performance of the Operations department at Axis.

In order to fulfill this purpose, the current situation regarding measuring at Axis Operations needs to be understood and evaluated according to theoretical findings. It is also necessary to gain insight into important activities and processes at Axis Operations and the department's needs and requirements regarding measuring.

1.2.2 Research questions

- *What defines a supply chain dashboard and the Performance Measurement System that it represents?*
- *What key metrics should be included in a supply chain dashboard for an operations department?*
- *What key requirements should the metrics in the dashboard fulfill?*

1.3 Scope and delimitations

The study is delimited to the measuring at Axis Operations. The evaluation of current metrics and the development of new metrics will therefore be delimited to this part of the company and not include the metrics at other departments. If there are activities and processes within Axis Operations that are affected by other departments, it will be discussed in what ways this may affect the metrics at Axis Operations but the study will not look further into processes at other departments. Individual functions within Operations will not be given specific attention, as the purpose of the study is to create a dashboard for the overall Operations department. Moreover, some of the functions within Axis Operations, such as business legal and real estate services, are excluded from the study since they primarily aim at in-house service.

The Operations department's strategy is derived from Axis overall strategy and this study does not aim at questioning the connection between the two. It is therefore assumed that if a metric connects to the Operations departments' strategy it also connects to the overall company strategy. Similarly, the processes used at Axis Operations today are mapped by the company and this study is delimited to finding appropriate metrics for the existing processes and does therefore not aim at questioning the these processes.

It is possible to have different aims and perspectives when creating a dashboard. This study will explore the development of a dashboard from a business architecture point of view, which focuses on stakeholder, strategies, tactics, semantics and metrics, as defined by Eckerson (2011). An alternative would be to target the technical architecture of the dashboard and thereby put the focus on data sources, data stores, applications and displays. As the two are connected some overlap will occur, but the study does not aim to concentrate on the technical architecture. Therefore the study will not delve deeply into aspects depending on the latter, such as cost structures and prerequisites for application.

The final stage when creating a dashboard is the visual design, which helps the interpretation of data and highlights changes in the metrics. This area will be mentioned in theory, as it is an important part of the final construction of the dashboard, but is outside the scope of the suggestion. The visual design of the dashboard will therefore not be a part of the recommendation to Axis Operations.

1.4 Audience

The audience for this study is primarily Axis Communications AB in particular Axis Operations, but it can also be relevant for other companies interested in how to evaluate and develop a dashboard for an operations department. Finally, individuals with an interest and knowledge within logistics and Performance Measurement, for example from studies within the area, are also part of the potential audience.

1.5 Structure of the study

Chapter 1 – Introduction
The introductory chapter describes the background of the problem, the purpose of the study and the research questions. Moreover, the scope and delimitations of the study are presented.

Chapter 2 – Methodology
This chapter aims to describe how the study has been conducted with regard to research approach and strategy, research design and different aspects of trustworthiness.

Chapter 3 – Theory
The third chapter focuses on the relevant theory related to Performance Measurement Systems, dashboards and metrics as well as requirements for these. The theory is combined into an analysis model which is also presented in the chapter. The aim of the analysis model is to provide a framework for the development of a dashboard by suggesting how to decide what metrics to include.

Chapter 4 – Empirics
Chapter 4 focuses on presenting key activities and processes within Axis Operations that are relevant when measuring, as well as explaining what is measured today and how. Relevant metrics that are currently used at Axis Operations are described using information from interviews with departmental managers based on the requirements introduced in the theory.

Chapter 5 – Analysis
The analysis uses the analysis model from chapter 3 and aims at evaluating how well and in what ways the metrics and current procedures fulfill the requirements presented in theory and the effects of this for Axis Operations. In the analysis it is also examined what solutions are possible within the delimitations of the study.

Chapter 6 – Results and suggestions of the study
In this chapter the conclusions from the analysis are presented and the final solution in form of metrics for a dashboard for Axis Operations is presented.

Chapter 7 – Discussion and evaluation of the study
This chapter mainly aims at demonstrating in what ways the purpose of the study is fulfilled and the research questions are answered. An evaluation of the study and the results is also presented

and the trustworthiness of the study is commented on. Possible areas of future research, which lie outside the scope of this study, are also presented.

2 Methodology

This chapter starts with providing a background to different research approaches, strategies and methods, as well as presenting the choices made for this study. Thereafter the research process and design is presented through a description of how the study has been conducted. Finally it is discussed how different aspects of trustworthiness are attended to in the study.

2.1 Research approach and method

2.1.1 Research approach

According to Creswell (2009) research design involves the intersection of the worldview assumptions the researcher brings to the study, the strategies of inquiry and the specific methods of data collection, analysis and interpretation chosen. He suggest that individuals conducting a study should make explicit the larger philosophical ideas that they adopt since this information will help explain why certain strategies are chosen. (Creswell, 2009)

The worldview assumptions, also referred to as epistemologies, is described by Creswell (2009) as "a general orientation about the world and the nature of research that a researcher holds". Jacobsen (2002) refer to the different worldview assumptions, and why this area is important to attend to, by explaining that there is no real consensus regarding how our world today functions. Consequently there is also a lack of consensus regarding to what extent it is possible to gather data about and investigate different phenomena. (Jacobsen, 2002) Connected to this, Bryman (2008) states that a question of specific concern when conducting a research study is whether the same principles, methods, and view of reality that are used for studies within the natural sciences can be applied to the social reality.

Two main epistemological approaches or worldviews are the positivistic approach and the interpretive approach. The positivistic approach implies that it is important to imitate or follow the rules of natural science also when studying the social reality. The interpretive approach on the other hand builds on a different understanding and interpretation of the reality, which is based on the perception that there is a difference between studying people, as in social sciences, and objects, as in natural sciences. The interpretative approach therefore demands another logic for the research process, which reflects what is typical for people and not objects. (Bryman, 2008)

The philosophical ideas of the authors of this study correspond to that of an interpretive approach as described by Bryman (2008). That is, the emphasis in this study lies on an understanding of the social reality based on how the participants interpret this reality.

2.1.2 Research strategy

Another choice that needs to be made when conducting a study is which research strategy should be used, quantitative or qualitative. Creswell (2009) describes the differences between a qualitative and a quantitative research strategy through the purpose of the study and the approach or the assumptions that the strategy is based on as presented in Table 1.

Qualitative	Quantitative
· Exploring and understanding the meaning individuals or groups ascribe to a social or human problem · Importance of portraying the complexity of a situation	· Testing objective theories and hypothesis by examining the relationship among variables. · Building in protection against bias · Being able to generalize and replicate the findings

Table 1 Qualitative vs. quantitative research strategy, adapted from Creswell (2009)

This study has adopted a qualitative research strategy. This is based on the fact that the study has a greater focus on portraying the complexity of a situation and focusing on the individual meaning of different aspects rather than testing and generalizing theories and hypotheses. According to Bryman (2008) it is also more common to use a qualitative research strategy when adopting an interpretive research approach while the quantitative research strategy is more commonly used when adopting a positivistic research approach.

2.1.3 Research method

Before the study can be conducted there must also be a choice regarding what research method to choose. Höst et al. (2006) describes that different research methods are appropriate depending on the purpose of the study. They present four different research methods that according to them are the most relevant for a thesis research study namely; survey, case study, experiment, and action research.

According to Höst et al. (2006) the survey method is the best choice when aiming to describe a phenomenon by using a representative and randomly selected population sample. The research strategy is mainly quantitative and the data collection should follow a fixed design where questions cannot be changed during the study. The case study method should according to Höst et al. (2006) be used when the aim is to provide an in-depth description of a contemporary phenomenon. It allows a more flexible design where questions can be changed during the course of the study. One main difference between a case study and a survey is that the case study can provide more in-depth knowledge and understanding in comparison to surveys. The case study on the other hand does not provide results that are statistically significant.

An experiment should according to Höst et al. (2006) be used when the study aims at identifying the root causes to different phenomena and describing causal relations. Finally, the action research method is described as appropriate to use for a study that aim at improving something at the same time that it is studied. It is described as an iterative process that involves presenting a solution and evaluating this solution in its context and repeating this cycle until any remaining problems are solved. (Höst et al., 2006)

Yin (2014) also describes different research methods that can be used when examining social science topics, namely the following: experiment, survey, archival analysis, history and case study. Which of these methods to choose depends according to Yin (2014) on three different conditions. These are: "(a) the type of research question posed, (b) the extent of control the researcher has over actual behavioral events, (c) the degree of focus on contemporary as opposed to entirely historical events". Table 2 below presents an overview of how each of the three conditions relates to the described research methods.

Method	Form of research question	Requires control of behavioral events?	Focuses on contemporary events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case study	How, why?	No	Yes

Table 2 Choice of research method, (Yin, 2014)

The research method chosen for this study was the case study method. This since the purpose and conditions of the study, as presented by Höst et al. (2006) and Yin (2014), were assessed as best suited for this specific method (see the discussion below).

The first condition presented by Yin (2014) relates to the research question posed. The three research questions that were answered in this study all ask different forms of "what" questions:

- *What defines a supply chain dashboard and the Performance Measurement System that it represents?*
- *What key metrics should be included in a supply chain dashboard for an operations department?*
- *What key requirements should the metrics in the dashboard fulfill?*

If only looking at the wording of the questions, the appropriate choice of research method would according to Yin (2014) be to do a survey or an archival analysis. The case study method was however assessed as more suitable than a survey since the purpose of the study was rather to provide an in-depth description of one specific case and not to provide a statistically significant description of a phenomenon. The case study method was also assessed as more appropriate than the archival analysis method mainly due to the fact that the study was performed within one specific company with easy access to interview candidates involved in the area. Performing a case study was thus assessed as more likely to provide an in-depth description of the situation than by analyzing archives, also since the documentation within the specific area was assessed as scarce within the company studied.

Moreover, Yin (2014) explains that there are different types of "what" questions. There are for example "what" questions that are described as exploratory for which the case study method can be a suitable choice of research method. The three research questions of this study can be described as exploratory since they together aim at answering the purpose of the study; "how to develop a supply chain performance measurement dashboard". The research method chosen for the study can hence be described as an exploratory case study.

The case study method is also assessed as relevant according to the two other conditions posed by Yin (2014) namely that the study does not require control of behavioral events and that the study does focus on contemporary events.

There are according to Yin (2014) many different types of case studies where the main distinction is made between single and multiple case studies. Yin (2014) describes that when you have the choice and the resources, multiple-case designs may be preferred over single case studies. Performing this study as a multiple case study could have been interesting in order to be able to compare the results between two different companies. However, given the limited time frame of the study it was decided that a single case study was the most appropriate choice.

To conclude, the study was conducted using an interpretive approach, a qualitative research strategy and a single case study research method.

2.2 Research process and design

After deciding on the research approach, strategy and method, the research process and design was formulated. The process follows the steps depicted in Figure 1, which are described in more detail in the following sections.

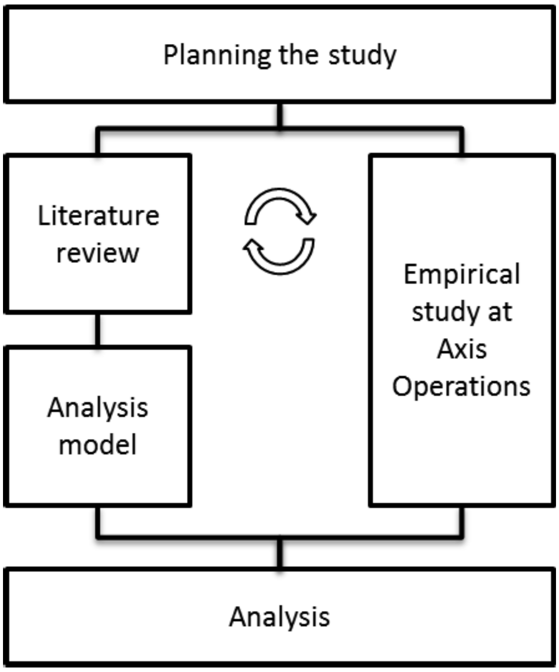

Figure 1 Phases of the study

2.2.1 Planning the study

The research project was initiated based on the researchers having an interest, as well as Axis Operations experiencing an issue, within the area of performance measurement. It was at first not specified what the specific issue was, only that Axis Operations was interested in having an investigating conducted on their performance within the area of measuring. The problem was later narrowed down to concerning what performance measurements should be included in a dashboard that is to be constructed for the VP of Operations at Axis. This was an area that was found to be of interest also academically as there is a lack of consensus of the procedures connected to selecting metrics for a performance measurement dashboard. When an overall understanding of the problem was gained the research approach, strategy and method was decided on as described in section 2.1.

The study aimed at presenting a specific solution in form of a dashboard for Axis Operations. However, in order to do this a more general approach as to how such an issue should be approached first had to be generated. It was therefore decided that a literature review should be performed with the aim of combining relevant theory into an analysis model which later could be used for the specific case at Axis Operations.

2.2.2 Literature review

As illustrated in Figure 1, the literature review and the empirical study at the case company were carried out simultaneously in an iterative process. This to ensure that the information provided by the literature review corresponds to the Operations department's needs.

In order to get acquainted with the research area and get an overview over the literature available in connection to the company's problem, a broad literature search was conducted, which then was narrowed down to the areas considered most relevant for the study. These areas, shown in Figure 2, are Performance measurement systems, dashboards, metrics and requirements for PMSs, dashboards and metrics. The information was discovered through articles, books, and publications by organizations and companies, and websites related to measuring.

Several articles were discovered through LUBsearch, which is the common access point to the resources of the Lund University Libraries. Apart from this, the Web of Knowledge (formerly known as ISI Web of Knowledge) was used. The keywords used at first to focus the search and find relevant articles were; "performance measurement system", "metrics", "performance measures", "performance measurement", "process", "cross-functional integration" and different combinations and variations of these (such as "cross-functional" instead of "cross-functional integration"). The chosen articles were read synoptically at first to get an overview of the field and a preliminary taxonomy of their sources was carried out to discover frequently used literature that could be of relevance. This also gave an insight into which ideas and perspectives are generally accepted and which are developments or adaptions of these. The initial searches thereby lead to further investigation as gaps or particularly relevant areas were discovered.

As stated, the literature study was limited to a few areas regarding measuring. However, as the field is vast it was necessary to limit the theory included even further, so every existing framework, requirement, suggestion of dashboard and metric could not be included. Several sources is however used in order to provide a thorough but also nuanced picture of the existing theory, as well as to decrease the risk of possible errors that could arise due to the researchers' interpretation of the literature.

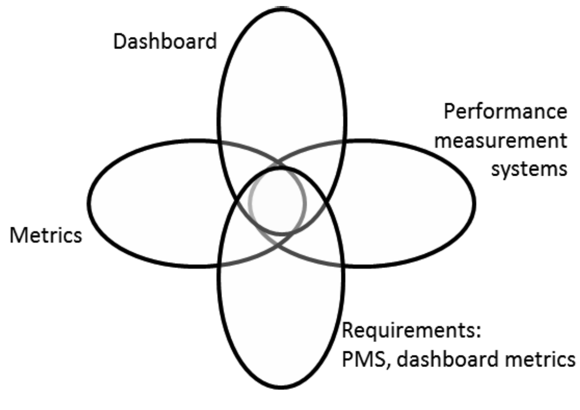

Figure 2 Theoretically relevant areas for the study

Through the greater insight into the existing literature it was found that there is little guidance in current theory regarding the actual procedures for selecting metrics and developing a dashboard for an Operations department. The theory found in the literature review was therefore combined to create an analysis model that guides in the process of selecting metrics for a dashboard.

2.2.3 Empirical study at Axis Operations

2.2.3.1 Qualitative vs. quantitative data collection

When conducting a study it must be decided whether the data collected should be of qualitative or quantitative nature. For a research strategy of qualitative nature it is according to Bryman (2008) more common to use qualitative data, it is however possible to also use quantitative data even though the overall research strategy is of qualitative nature.

The advantages of using quantitative data in a study are according to Jacobsen (2002) that the data is possible to standardize, easy to process, for example through statistical computer programs, and can provide an overview of a big and complex problem. Since fewer resources are needed to collect the data it is also possible to include more respondents and thus use the data for generalizing purposes. The advantages of using qualitative data are on the other hand connected to, amongst other, the flexibility of the study, as the nature and form of the answers that can be given to a specific question are less delimited. Qualitative data is therefore often more nuanced and unique and more likely to provide a real understanding of the situation. (Jacobsen, 2002)

Since the aim of this study was rather to generate a deeper understanding of a specific situation than to find statistical correlations, the data collected in this research project was mainly of qualitative nature and in the form of interviews. Data was however also collected from the company's internal as well as external website as a way of triangulating the data and thus increase the credibility of the study (Bryman, 2008).

2.2.3.2 Preparing and performing interviews at Axis Operations

According to Höst et al. (2006) a commonly used method for data collection when conducting case studies are interviews. There are three main types of interviews; structured, semi-structured and unstructured. According to Bryman, (2008) semi-structured and unstructured interviews are sometimes jointly referred to as qualitative interviews.

The interviews in the study were conducted in a semi-standardized manner (Bryman, 2008), where all interviewees were asked questions based on the same interview protocol, seen in Appendix 1 but not necessarily in the same order, and where the follow-up questions were adapted to the interviewee. The reason to why a semi-structured approach was chosen over a structured approach is that it is more likely to provide in-depth information due to its flexible nature. The reason to why a totally unstructured approach was not chosen is because in these types of interviews it is common to rather let the interviewee decide what should be discussed during the interview. This was not assessed as useful as there were an actual problem formulated and thus actual questions that needed answers. (Bryman, 2008)

The interview protocol, seen in Appendix 1, consists of two parts where the first part is of a more open character and focuses on providing an understanding of the important processes, activities and goals for each department within Operations and how these connect to the overall strategy. In the second part of the interview protocol the currently used metrics at Axis Operations were examined in order to understand what and how the company measures today, why certain metrics are used and how they potentially could be improved in order to be suitable for a performance measurement dashboard. This part of the interview protocol is designed using a Likert scale (Höst et al. 2006) where the respondents were asked to specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements connected to the metrics used at each department. It should be noted that the Likert scale was not used as an attempt to quantify the data for statistical purposes but rather as a way of making the respondents develop their answers connected to the different metrics further.

The interviews were performed with different departmental managers at Axis Operations as well as the Vice President at Axis Operations. The managers that were interviewed were chosen mainly based on two reasons. The first reason was to include the perspective from all different departments within the Operations department in order to ensure that all perspectives that could be of possible interest for the Operations dashboard were represented. Secondly, the candidates interviewed were chosen because they were the individuals that were assessed as having most knowledge about the specific metrics currently used at Axis Operations as well as the important processes of each department.

2.2.4 Analysis and suggestion of metrics

The analysis was performed by applying the analysis model developed to the specific case at Axis Operations and follows the procedure depicted in Figure 3.

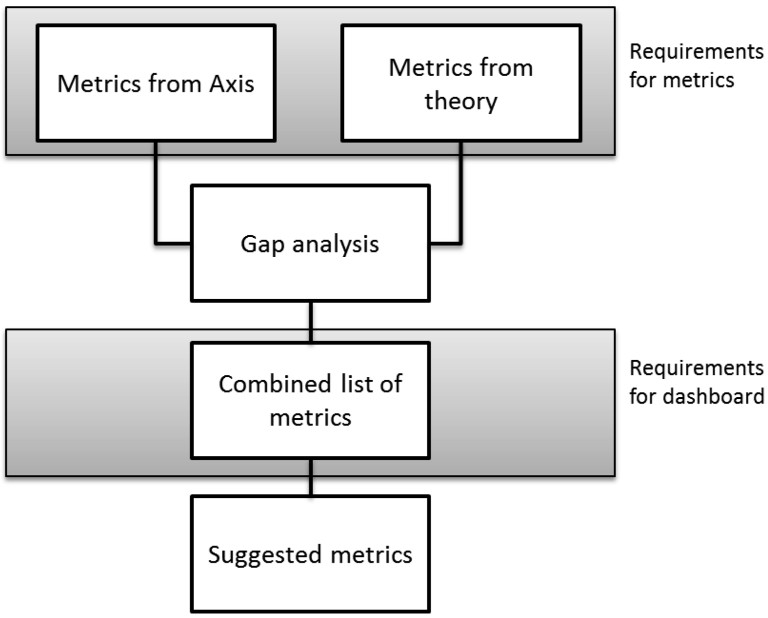

Figure 3 Procedure of the analysis

The metrics currently used at Axis Operations were evaluated based on the respondents' answers to the interview questions regarding how well the metrics fulfill certain requirements presented in theory. The analysis was mainly performed by interpreting the descriptive answers provided to the questions, and comparing this to how the different requirements were described in theory. The ratings performed by the respondents using the Likert scale was, as previously mentioned, not analyzed quantitatively but rather used as a way of providing more descriptive and polarized answers.

When selecting appropriate theoretical metrics to use in the application of the analysis model at the case company, metrics from several areas were investigated to create a long list of relevant metrics. The search included metrics relating to performance measurement systems, best practice reports and articles regarding metrics as well as databases of metrics. In the latter, areas connected to operations and supply chain management were investigated, such as procurement, warehousing, inventory, manufacturing, logistics, order fulfillment, customer service and social responsibility.

Appropriate metrics from this long list were selected by using the requisite that they must be suited to the situation at the case company and be adapted to its processes and what was considered important to measure within each process. Explanation of the latter along with the resulting short list is presented in chapter 5. Then it was assessed to what extent these metrics could fulfill the requirements presented in theory, based on their theoretical descriptions.

When the two sets of metrics, theoretical and currently used where analyzed against the individual requirements a gap analysis was performed with the aim of finding to what extent and in what ways the metrics currently used at Axis Operations and the metrics suggested from theory differed from each other or overlapped. It was also assessed which metrics were most suitable to include in the dashboard and whether any general conclusions could be drawn as to what changes needed to be implemented at Axis Operations.

The outcome of the gap analysis was a combined list of metrics. These metrics were jointly evaluated against the requirements for a dashboard presented in the analysis model, in order to ensure that they together as a group were suited for a dashboard. The set of metrics suggested from theory and the set of metrics currently used at Axis Operations were also analyzed against the requirements for a dashboard. The reason for performing the joint analysis also on these two set of metrics was to be able to compare the final suggestion to the two other possible solutions. This as it would have been possible that the choices made in the performed gap analysis, although assessed as correct on an individual basis, could affect how the metrics perform together as a group. Moreover, the joint analysis of the metrics currently used at Axis Operations provided the case company with valuable information regarding the suitability of the current solution.

The final outcome of the analyses was a set of metrics suggested for the dashboard and presented to the company.

2.3 Trustworthiness

There are several ways of judging the quality of research design. The criteria that form the conventional or traditional view of research quality are according to Halldórsson and Aastrup (2003) internal validity, reliability, external validity and objectivity. These criteria stem from the positivistic paradigm and are based on an ontological realism where "reality exists independently of researchers, and knowledge claims are to be evaluated against their true and objective correspondence with this reality" (Halldórsson and Aastrup, 2003). As previously discussed, qualitative research often adopt a more relative or interpretive view of reality. This makes it complicated to ensure research quality based on the previously mentioned criteria and many qualitative researchers have therefore suggested that there should be alternative criteria for judging qualitative research design (Bryman, 2008). One construct that have won considerable favor is that of Guba, focusing on satisfying four naturalistic quality criteria referred to as criteria of trustworthiness, namely; credibility, transferability, dependability and confirmability (Halldórsson and Aastrup, 2003; Bryman, 2008).

Due to the qualitative nature of this study the criteria presented by Guba are used to judge the quality of the research design. The criteria are briefly introduced below together with the measures taken to increase the trustworthiness, a summary is also provided in Table 3 Trustworthiness of the studyTable 3.

2.3.1 Credibility

According to Halldórsson and Aastrup (2003) there is no single objective reality since the reality is constructed. The credibility of a study therefore depends on whether the description provided by the researcher is acceptable or not. To ensure the credibility of this study two techniques recommended by Bryman (2008) were used; respondent validation and triangulation of sources.

Empirical data was mainly collected through interviews with departmental managers and all interviews were recorded in order to be able to go back and listen to specific parts. Complementary interviews were also conducted when needed to ensure that the same type of information was available for all departments as a base for the analysis. A potential source of error during the interviews is the possibility for the interviewee to misinterpret the questions as well as for the interviewers to misinterpret their answers (Bryman, 2008). To remedy this, the interviewees have been given a copy of the part of the study that is based on their responses as a way of clarifying potential misunderstanding and thereby increasing the credibility of the study.

In addition to the empirical data collected through the interviews, data was also collected from the company webpage; internal as well as external. This data consisted mainly of background information regarding the company, which was used to create a contextual background for the study but was also used to find documents that could complement or triangulate the information attained through the interviews.

2.3.2 Transferability

The extent to which a study is able to make general claims about the world is referred to as the transferability of the study (Halldórsson and Aastrup, 2003). A recommended technique for increasing the transferability is to provide a thick description of the contextual details of the study. This enables the readers to assess whether the study can be applied in another context or not (Bryman, 2008).

The analysis model presented in this study is constructed from theory and aim at providing a general description of how to develop a supply chain performance measurement dashboard. All theory that the analysis model is based on is presented in the study and it is therefore possible for the reader to assess whether the model is transferable to another situation. By describing the details of the current situation at Axis Operations as well as the background, delimitations and boundaries of the study the transferability of the actual suggested solution is also increased. The metrics presented for the dashboard is however specific to the company, which makes it less likely that the exact solution is transferrable.

2.3.3 Dependability

According to the criterion dependability, which concerns the stability of data over time, (Halldórsson and Aastrup, 2003) the researcher should strive to enable a future investigator to repeat the study, however not necessarily gain the same result (Shenton, 2004). In order to increase the dependability of this study, the method chapter aspires to explain in detail the logic behind the method decisions, as well as the processes involved in, and logic behind, the data collection and analysis of the phenomenon.

2.3.4 Confirmability

It is according to Bryman (2008) not possible to reach complete objectivity for research of this type. It is however important to ensure that the findings of the study represent the result of the inquiry and not the researcher's biases, characteristics and preferences. This is referred to as the confirmability of the study. (Bryman, 2008; Halldórsson and Aastrup, 2003) To achieve confirmability the data should be traceable back to its sources and hence demonstrate how the findings can be confirmed through the data itself (Halldórsson and Aastrup, 2003).

In this study all sources used are referred to continuously in the theoretical as well as the empirical chapter and it is thus possible to trace the results of the study back to its sources. As there is a lack of consensus in some parts of the theory with different authors expressing different opinions, several sources have been used in order to provide a more nuanced picture.

In order to confirm that the results are relevant and not based on the researchers' preferences the results were discussed with representatives within the company. An evaluation of the results including a discussion of how the study could have been conducted differently is also provided which adds to the confirmability of the study.

Criteria	Measures taken to increase the trustworthiness of the study
Credibility	· Respondent validation · Triangulation of sources
Transferability	· Thick description of context · General approach of analysis model
Dependability	· Detailed description of how the study was conducted
Confirmability	· Presentation and triangulation of sources · Discussion of results

Table 3 Trustworthiness of the study

3 Theory

This chapter presents theory connected to measuring. It is divided into two main parts; one part focuses mainly on performance measurement systems and the other part focuses on metrics. The PMS part will describe what a PMS is, present some of the most recognized PMS frameworks and identify the requirements for a PMS. There will be a brief introduction to performance measurement in supply chains and the chapter will also present theory connected to dashboards and the development and characteristics of these. In metrics part, different categories of metrics will be presented and requirements for individual metrics are identified. In the end of the chapter an analysis model is presented which provides a guide to developing a performance measurement dashboard.

3.1 Performance Measurement Systems

Performance measurement is, according to Neely et al. (2005), the "process of quantifying action, where measurement is the process of quantification and action leads to performance". Companies measure performance in order to monitor if their goals are met; if they succeed in satisfying their customers with greater efficiency and effectiveness than their competitors. Measuring performance is done through performance metrics, where an individual metric is used to quantify the efficiency and/or effectiveness of an action. (Neely et al., 2005) A company's performance measurement system is the system that measures performance, and it is defined as "the set of metrics used to quantify the efficiency and effectiveness of actions" (Neely et al., 2005). In an interview conducted by Powell (2004), Neely points out the importance of understanding the links between the different measures and to view the PMS from a systems perspective rather than focus on individual measures.

In addition to monitoring if the company's goals are achieved, there are also other benefits connected to measuring performance. According to Neely (Powell, 2004), there are five notable contributions to measuring performance:

- Clarifying objectives
- Communicating the objectives to people
- Influencing behavior to be consistent with the objectives
- Checking whether or not objectives are being delivered
- Challenging theories about how the business works

By deciding what to measure, management is also forced to clarify what is important in the organization and to communicate this to all employees. The measurements then help to influence the behavior within the organization to work towards achieving the objectives. As previously mentioned it also facilitates the follow up, that is to check if the objectives are met. Moreover, if the objectives are followed but no results are achieved, the performance measurement system can help in understanding that the organization's strategy may need to be changed. (Powell, 2004)

3.2 Supply chain measurements

3.2.1 Supply chain and Supply Chain Management

According to Hugos (2006), the term supply chain management was formulated during the 1980s, and became widespread in the 1990s. Since then supply chain management has risen in importance and use within organizations of all types (Hugos, 2006). There are several different definitions of supply chains and supply chain management. According to Chopra and Meindl

(2003) a supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request and includes the manufacturer, supplier, transporters, warehouses, retailers and the customers. Hugos (2006) explains that supply chain management is "the things we do to influence the behavior of the supply chain and get the results we want". He further defines supply chain managements as: "The coordination of production, inventory location, and transportation among the participants in a supply chain to achieve the best mix of responsiveness and efficiency for the market being served."

Hugos (2006) explains that the difference between the concept of supply chain management and the traditional concept of logistics is that logistics typically refer to "activities that occur within the boundaries of a single organization and supply chain refers to networks of companies that work together and coordinate their actions to deliver a product to the market". Supply chain management hence provides a systems approach as the supply chain and the individual organizations are seen as a single entity that manages the activities and coordinates the flow of products and services in order to fulfill the customer requests in the best way possible. (Hugos, 2006)

3.2.2 Supply chain measurement

Since there is an increased focus on supply chain management in today's business environment, this also ought to be reflected in the performance measurement systems. Bechtel and Jayaram (1997) consequently state that the trend in supply chain management is towards using integrated measures that focus on entire processes or series of processes across functional areas. Gunasekaran and Kobu (2007) likewise accentuate that it is essential to develop an integrated performance measurement system that supports an integrated supply chain and the included operations. They further state that the metrics used should "facilitate the integration of various functional areas and also so called extended enterprises or partnering firms along the value chain." (Gunasekaran and Kobu, 2007)

However, some of the measures that companies identify as measures of supply chain management are actually measures of internal logistic operations (Lambert and Pohlen, 2001; Hervani and Helms, 2005; Chan and Qi, 2003; Beamon, 1999). A reason for the deficient use of supply chain measurements is, according to Gunasekaran et al. (2004) that even though there are several conceptual frameworks and discussions of supply chain performance measurement in literature, there is still a limited emphasis on empirical analysis, both in the practitioner and research community. The main problem associated with using metrics more associated with internal logistics than using proper metrics for a supply chain is that it may result in "failure to meet consumer/end user expectations, sub-optimization of departmental or company performance, missed opportunities to outperform the competition and conflict within the supply chain" (Lambert and Pohlen, 2001). In their review of performance measures and metrics in logistics and supply chain management, Gunasekaran and Kobu (2007) note that different authors take different approaches to try to work towards achieving supply chain measuring. Some of the articles reviewed focuses on process-based metrics and others on strategy based measures. Gunasekaran and Kobu (2007) however conclude "both are needed at different levels and should support each other for achieving the goals at their own levels of decision making".

3.3 Dashboard

A dashboard within performance measurement and management information systems is a graphical representation of a company's current status and historical performance, presented as a one-page display, usually on a digital screen. The dashboard should stem from the organizational strategy, so that what needs to be measured is derived from what needs to be accomplished. (Heap, 2004; Hugos, 2006) Consequently it should provide access to the most relevant information that can guide taking action with respect to achieving the company's strategic or operational goals. The data displayed in the dashboard should show a person "at a glance the data that is most important to them" (Hugos, 2006), and the information should be displayed in a way that does not overwhelm the user. (Bremser and Wagner, 2013)

3.3.1 Dashboard development process

According to Bremser and Wagner (2013), the following steps should be followed when developing a dashboard:

- Define dashboard objective
- Define dashboard metrics
- Seek user input
- Build initial dashboard and test
- Publish the dashboard and monitor its use

The first two steps will be briefly explained below.

3.3.1.1 Define dashboard objectives – Types of dashboards

Since the dashboard should be used to guide decision making, the dashboard user's needs and characteristics are important factors in deciding the type of information to include in the dashboard. The dashboard should display different information depending on the department or organizational level it is used for (Bremser and Wagner, 2013; Hugos, 2006). The user of the dashboard should, regardless of at what organizational level or department the dashboard is used, have access to insightful information that is relevant and timely enough to support decisions. (Bremser and Wagner, 2013)

According to Bremser and Wagner (2013) there are three basic types of dashboards: strategic, analytical and operational. Eckerson (2009) and Hugos (2006) classifies the types of dashboards somewhat differently: strategic, tactical and operational. Below follows an explanation of these classifications.

Strategic dashboard

A strategic dashboard is mainly used by senior management and includes high-level key performance measures associated with monitoring strategy implementation. The information presented is often simplified displays showing static and non-interactive information, aiming for an overview of the company's current performance and trends. The focus is to monitor whether the company is on course to achieve its strategic goals. (Bremser and Wagner, 2013; Hugos, 2006; Eckerson, 2009)

Analytical dashboard

An analytical dashboard is mainly used by analysts, and aims to make sense of data and to support executives. The users often employ statistical skills to create predictive models that can be used to, for example, develop "what-if" scenarios. (Bremser and Wagner, 2013)

Tactical dashboard
A tactical dashboard should be designed to help mid-level or departmental managers to manage operations and optimize the performance of the people and processes, in order to achieve the company's performance target (Hugos, 2006; Eckerson, 2009) The dashboard should be used to analyze summarized and detailed data from both outcome and driver metrics that can be either automatically or manually collected. (Eckerson, 2009) According to Eckerson (2009) tactical dashboards should collect data on a daily or weekly basis and Hugos (2006) accentuates the managers' need to quickly see if the operations are on target or not and direct their attention accordingly.

Operational dashboard
An operational dashboard is, according to Bremser and Wagner (2013), mainly used by middle managers to monitor the strategic implementations at different operational responsibility centers, for example a manufacturing plant. Eckerson (2009) and Hugos (2006) describe the users of the operational dashboard somewhat differently, as staff in various departments or front line workers. The use is however described similarly; to monitor and control core processes (Eckerson, 2009) to "track and illuminate the specific business operations that [the users] are responsible for" (Hugos, 2006) and "monitoring strategy implementation at an operational responsibility center" (Bremser and Wagner, 2013). The data in an operational dashboard is often detailed, interactive and possible to continuously update in real-time (Eckerson, 2009; Bremser and Wagner, 2013).

3.3.1.2 Define dashboard metrics – Selection of metrics
A dashboard should provide insight into the business's performance and should focus on the measures that matter. Hence it is important to include the most important measures that can provide this insight. (Bremser and Wagner, 2013) The metrics in the dashboard are a subset of the metrics in a company's Performance Measurement System, and the decision of which metrics to include in the Performance Measurement System will be discussed in more detail later.

An important feature of the dashboard is that it should not include too many metrics. According to Bremser and Wagner (2013), research studies have shown that too many performance metrics result in information overload and difficulties in processing the information and make decisions. Different authors present suggestions regarding the appropriate number of metrics to include in a dashboard. Bremser and Wagner (2003) for example recommend that a strategic dashboard should include only four to eight key performance metrics in order to provide focus. The chosen metrics should represent and provide overview of different important perspectives of the company, and the different perspectives should then be linked to separate dashboards where more detailed information can be provided. (Bremser and Wagner, 2013)

It is suggested by Person (2008) that the number of metrics for a dashboard at a tactical level is limited to three to eight metrics per identified important process. Eckerson (2009) on the other hand, states that since most performance management practitioners argue that a majority of people can focus on a maximum of five to seven items at once it is recommended to limit the number of metrics in a dashboard accordingly. The same author refers in a later publication to research showing that the companies studied on average have 12 metrics on the opening screen of a tactical dashboard (Eckerson, 2011). According to the study this number is also similar to the number of metrics used in strategic level dashboards, 14, and operational level dashboards, 11 (Eckerson, 2011).

3.3.2 Dashboard visual design

The visual design of the dashboard should help the user to interpret the data and provide instant recognition of important changes in the metrics. Different visualization techniques can be used in order to achieve effective communication, such as using different colors, symbols, graphs and positioning data differently. When developing the visual design of the dashboard it is important to adapt it to the user since personality characteristics, cognitive style and previous experience can influence the way data is interpreted and understood. The type of information that should be displayed also affects the choice of visual design since “certain types of problems may also lend themselves to certain kinds of visual display” (Bremser and Wagner, 2013). The presentation can also be used to mitigate bias between metrics. (Bremser and Wagner, 2013)

Below follows a summary of important visual design guidelines according to Bremser and Wagner (2013):

- Use design and visual perception principles
- Use data emphasis techniques
- Use charts that effectively communicate
- Use alerts and markers to highlight problems and opportunities
- Use interactivity to engage the user
- Use art and backgrounds to enhance the user experience

3.4 Performance measurement system frameworks

Several different performance measurement frameworks and tools have been developed, aiming to guide companies in measuring performance. Below, three of the most well-known frameworks are presented: The balanced scorecard, the SCOR model and the performance prism framework.

3.4.1 Balanced scorecard

The balanced scorecard is a performance measurement framework introduced by Kaplan and Norton (1992), and aims at providing a fast but comprehensive view of a business’ performance. During the late 1980’s there was a general concern expressed about traditional performance metrics since these focused solely on financial metrics. The identified risk related to only using financial measures was that it could encourage managers to focus too much on short-term financial results and not enough on continuous improvement and innovation. (Hoque, 2014; Kaplan and Norton, 1992) These concerns led to the development of the balanced scorecard, which introduced a way of combining financial and non-financial metrics in a way that aimed for a more balanced representation of the company’s performance. (Kaplan and Norton, 1992)

3.4.1.1 The four perspectives of the balanced scorecard

The balanced scorecard builds on the notion that no single measure can provide all necessary information and capture the full complexity of an organization’s performance. It is structured in a way that allows managers to look at the business from four different perspectives. (Kaplan and Norton, 1992; Epstein and Manzoni, 1998) When first introduced by Kaplan and Norton (1992) the four different perspectives were: *financial, customer, internal business,* and *innovation and learning perspective*, the two latter were later revised and are now presented as *internal business process perspective* and *learning and growth perspective* (Kaplan and Norton, 1996a). The four perspectives are shown in Figure 4 and are described in more detail below.

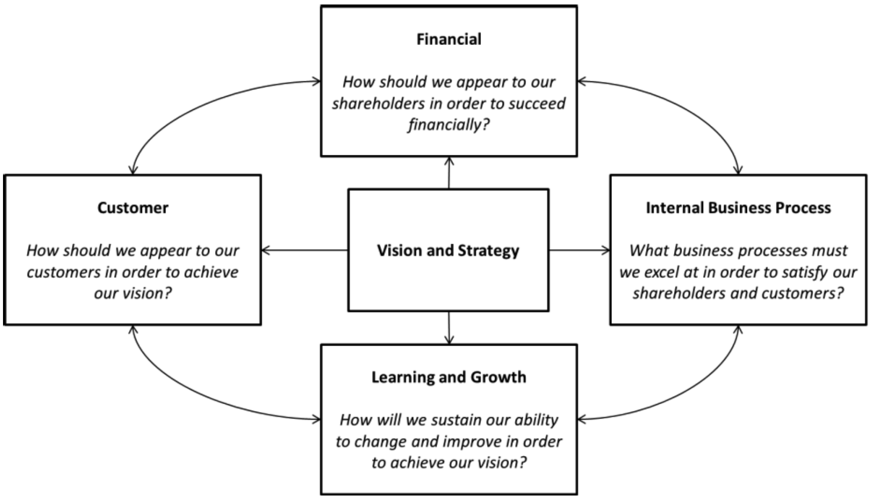

Figure 4 The four perspectives of the balanced scorecard. (Kaplan and Norton, 1996b)

Financial perspective

The role of the financial perspective is to provide information on the results of actions already taken and indicate whether the company's strategy, implementation, and execution are contributing to bottom-line improvement. It aims to answer the question: *How should we appear to our shareholders in order to succeed financially?.* (Kaplan and Norton, 1992; Kaplan and Norton 1996b) The financial perspective is complemented with three non-financial perspectives that focus on drivers of the future financial performance.

Customer perspective

The customer perspective of the balanced scorecard "demands that managers translate their general mission statement on customer service into specific measures that reflect the factors that really matter to customers" (Kaplan and Norton, 1992). This perspective aims to answer the question: *How should we appear to our customers in order to achieve our vision?.* (Kaplan and Norton, 1996b)

Internal business process perspective

The internal business process perspective is used to meet customer's expectations as it aims to answer the question: *What business processes must we excel at in order to satisfy our shareholders and customers?.* Managers should focus on the critical internal operations that enable the satisfaction of customers' needs. All internal measures within this perspective should stem from the business processes that have the greatest impact on customer satisfaction. (Kaplan and Norton 1992; Kaplan and Norton 1996b)

Learning and growth perspective

The learning and growth perspective "identifies the infra-structure that the organization must build to create long-term growth and improvement" and aims to answer the question: *How will we sustain our ability to change and improve in order to achieve our vision?.* (Kaplan and Norton, 1996b) It focuses on how to achieve organizational learning and growth by revealing gaps between existing capabilities of people, system and processes within the organization and identify where investment is needed in order to improve performance. (Kaplan and Norton, 1996b) It can also refer to continuous improvement goals for existing processes. (Kaplan and Norton, 1992)

3.4.1.2 Aims of the balanced scorecard

The balanced scorecard aims to provide an overview of a company's performance by directing managers' and employees' attention to the factors that are most critical and which can lead to competitive breakthrough for the organization. It also aims to minimize information overload, as managers are required to select a limited number of critical indicators within each of the four perspectives, which then will provide a clear overview. The balanced scorecard should not be a replacement for an organization's day-to-day measurement system but rather consist of a selected number of critical indicators that help focus on the strategic vision. (Kaplan and Norton, 1996b; Kaplan and Norton, 1993; Kaplan and Norton, 1992; Epstein and Mazoni, 1998)

The measures of the balanced scorecard can also be cascaded down the organization so that subunits are aligned with the company's overall vision and strategy. This can be done by directly using those indicators that are applicable to the subunit and also by designing other indicators that reflect local needs. (Epstein and Manzoni, 1998; Kaplan and Norton, 1996b) The balanced scorecard was developed to also include a strategy map used to link measures more closely to each other. (Hoque, 2014) According to Kaplan, as cited by Hoque (2014), "the most recent development is about much more than just the balanced scorecard. It embeds the 1992 original Balanced Business Scorecard model as a component within a comprehensive management system that integrates strategy and operations."

3.4.2 SCOR – Supply Chain Operations Reference model

The Supply Chain Operations Reference (SCOR) model is a process reference model that works as a standard diagnostic tool for supply chain management. The model was developed by the Supply Chain Council[1] in 1996 as a grassroots initiative to develop a supply chain process model. (Bolstorff and Rosenbaum, 2003) The SCOR model aims to "facilitate supply chain integration by providing common process and metric definitions applicable across multiple organizations" in order to be able to respond more effectively to market changes and opportunities. (Supply Chain Council, 2010)

The SCOR model consists of four areas; processes, performance, practices and people, which are linked into a unified structure in order to enable its users to address, improve, and communicate supply chain management practices. A brief description of the four areas is presented below: (Supply Chain Council, 2010)

- Processes: Standard descriptions of management processes and a framework of process relationships.
- Performance: Standard metrics to measure process performance.
- Practices: Management practices that produce best-in-class performance.
- People: Training and skills requirements aligned with processes, best practices and metrics.

3.4.2.1 SCOR processes

The business activities associated with satisfying a customer's demand for all phases in the supply chain, from the supplier's supplier to the end customer, are described through six standard integrated processes. These aim to describe: what activities are performed; where they are

[1] The Supply Chain Council is today referred to as APICS Supply Chain Council after a merger in 2014. (APICS, 2014a)

performed; and how they are performed and are all aligned with the company's operational strategy, material flows, work flows and information flows. The six processes of the SCOR model are: Plan, Source, Make, Deliver, Return, and Enable. An overview of the model is shown in Figure 5 and the different processes are briefly described in Table 4. (Supply Chain Council, 2010; Bolstorff and Rosenbaum, 2003)

Figure 5 The SCOR model (Supply Chain Council, 2012)

The SCOR Processes	
Plan	Describes the activities associated with developing plans to operate the supply chain such as gathering of requirements and information on available resources, balancing requirements and resources and identifying corrective actions.
Source	Describes the ordering, receiving, validating and storing of goods and services.
Make	Describes the activities associated with the conversion of materials or creation of the content for services. Make represents all types of material conversions: assembly, chemical processes, maintenance, repair, overhaul, recycling, refurbishment, remanufacturing etc.
Deliver	Describes the activities associated with the creation, maintenance and fulfillment of customer orders. For example receipt, validation and creation of orders, scheduling order delivery, pick, pack, shipment and invoicing.
Return	Describes the activities associated with the reverse flow of goods including identification of the need to return, the disposition decision making, the scheduling of the return, and shipment and receipt of returned goods.
Enable	Describes the activities associated with the management of the supply chain. For example management of business rules, performance management, data management, resource management, facilities management, contract management, supply chain network management, managing regulatory compliance and risk management.

Table 4 The SCOR processes (Supply Chain Council, 2012)

3.4.2.2 SCOR performance

The SCOR performance area consists of two types of elements: the performance attributes and the performance metrics. A performance attribute is a group of metrics that is used to set the strategic direction. It is not the attribute in itself that is being measured, but the ability to achieve the attribute. This ability is assessed through the metrics that the attribute contains. The use of attributes facilitates benchmarking between companies since the focus is not only on the individual metrics but also on the connected strategy. For example, a company with a low cost strategy probably does not perform as well within reliability and agility as a company that focuses on customer satisfaction through high delivery performance. There are five performance attributes in the SCOR model: reliability, responsiveness, agility, costs, and asset management efficiency, these are described briefly in Table 5. (Supply Chain Council, 2010)

The SCOR attributes also facilitate prioritization between different metrics. Bolstorff and Rosenbaum (2003) explain that when introducing SCOR the company should, for each customer or market, determine if each attribute should be performed at superior level, at a level of advantage or at parity. For each customer or market it is only allowed to set one attribute at superior level and one at advantage level, the others should be set at parity compared to other companies. It should be noted that the flexibility and responsiveness attributes are combined in this exercise and regarded as one attribute. (Bolstorff and Rosenbaum, 2003)

The SCOR Performance Attributes	
Reliability	Reliability is a customer-focused attribute that focuses on the predictability of the outcome of a process and addresses the ability to perform tasks as expected.
Responsiveness	Responsiveness is a customer-focused attribute that describes the speed at which tasks are performed.
Agility	Agility is a customer-focused attribute that describes the ability to respond to external influences, and the ability to respond to marketplace changes to gain or maintain competitive advantage.
Cost	Cost is an internally focused attribute that describes the cost of operating the supply chain processes.
Asset management efficiency	Asset management efficiency is an internally focused attribute that describes the ability to efficiently utilize assets.

Table 5 The SCOR performance attributes (Supply Chain Council, 2012)

3.4.2.3 Green SCOR

Sustainable business models and environmental accounting are growing business concerns and there are currently multiple approaches and no agreed upon standards regarding how to measure the total environmental footprint of an organization. The Supply Chain Council has proposed a set of strategic environmental metrics referred to as Green SCOR that can be added to the original SCOR model and used as a framework for environmental accounting. It is suggested that the benefits of adding the Green SCOR metrics is to clearly tie different emissions to processes where they originate, to facilitate the identification of root causes and to identify where action can be taken to improve performance. The Supply Chain Council (2012) recommends using the Green SCOR metrics and argues that these provide an effective tool for environmental supply chain accounting. The Green SCOR approach is however not currently in use and the metrics included are still not seen as fully approved SCOR metrics. (Supply Chain Council, 2012)

3.4.2.4 The SCOR model structure

The overall structure of the SCOR model is hierarchical and interlinked and the SCOR model contains three levels of process detail. The six overall processes previously introduced form the level 1 processes. These are used to describe the scope and high-level configuration of a supply chain. The level 2 processes differentiate the strategies of the level 1 processes and determine the supply chain strategy and the level 3 processes are in turn decomposed from the level 2 processes, and describe the steps performed to execute these. (Supply Chain Council, 2010)

In order to measure the performance of the processes, metrics are assigned to each of the six processes at corresponding levels of detail. The level 1 metrics are also known as the strategic metrics or key performance indicators and are diagnostics for the overall health of the supply chain. These metrics can be used in benchmarking against other companies in order to establish realistic targets that support strategic objectives. The level 2 metrics are used to identify the root causes of the results for the level 1 metrics. Similarly the level 3 metrics serve as diagnostics for the level 2 metrics. In order to ensure balanced decision making and governance it is recommended that the supply chain scorecard contain at least one metric from each of the five performance attributes: reliability, responsiveness, agility, cost, and asset management. (Supply Chain Council, 2010)

3.4.3 The performance prism

The performance prism is a measurement framework that was introduced by Adams and Neely (2000) and is designed to assist performance measurement selection. Neely et al. (2001) argue that although the balanced scorecard was pioneering when it first appeared, it fails to include aspects that are important for functioning in what they refer to as the “New Economy”. Adams and Neely (2000) further argue that the main benefit of the performance prism over the balanced scorecard and other measurement frameworks is the much broader stakeholder view it adopts. The framework does for example not only focus on the organization’s shareholders and customers but also other stakeholders such as employees, suppliers and regulators. The stakeholders are also the main focus in the sense that it is argued that the measurements should not be derived directly from the strategy, but rather from the wants and needs of all stakeholders. Moreover, the performance prism takes into account the reciprocal relationship between the stakeholders and the organization. (Powell, 2004; Adams and Neely, 2000; Neely et al., 2001)

3.4.3.1 The 5 facets

The performance prism aims to provide a holistic view of measurement by including five interrelated facets; stakeholder satisfaction; strategies; processes; capabilities and stakeholder contribution. The outline of the performance prism is shown in Figure 6 and the five facets are explained below. (Neely et al., 2001)

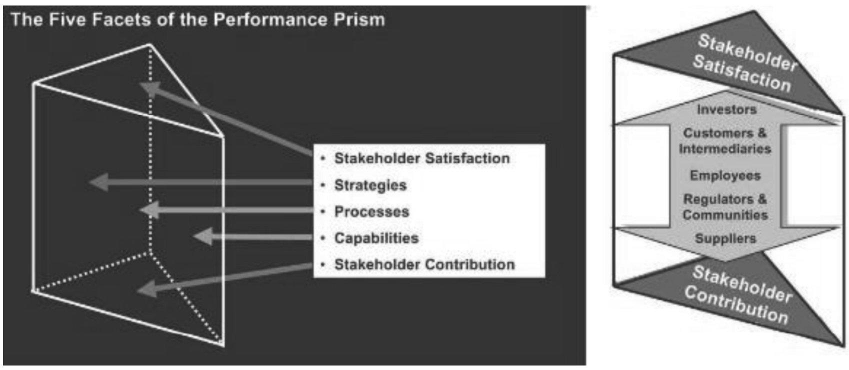

Figure 6 The five facets of the performance prism (Neely et al., 2001)

Stakeholder satisfaction

The first facet of the performance prism aims to answer the question: *Who are the key stakeholders in your organization and what do they want and need?.* As explained above, the view of stakeholders is broader than in other frameworks and can include for example employees, investors, intermediaries, suppliers, regulators and pressure groups. According to Neely et al. (2001) all parties that can have a substantial impact on the company's performance should be considered when selecting the measurements. The type of measures applicable will vary between different companies; some can be direct and others only yield an inference of stakeholder satisfaction. Adams and Neely (2000) argue that even imperfect measurement can be used to provide a basis for what actions to take.

Strategies

Neely et al. (2001) argue that it is wrong to derive performance measurements directly from strategy since "the only reason that an organization has a strategy is to deliver value for some set of stakeholders". Hence the *strategies* facet is placed after the *stakeholder satisfaction* facet in the performance prism and it aims to answer the question: *What strategies are we pursuing in order to satisfy these wants and needs?* (Neely et al., 2001) By grounding a performance measurement system in the strategic objectives it is possible to monitor whether the goals are being met, find potential causes of performance variation and quickly take actions accordingly. (Adams and Neely, 2000)

Processes

When the overall strategies that aim to satisfy the wants and needs of the stakeholders are decided, the third facet: *processes,* aims to answer the question: *What are the processes that we need to put in place in order to allow our strategies to be delivered?.* (Neely et al, 2001) Developing a "strategy map" that outlines how the business works can show what individual business processes are needed to achieve the strategies. These are normally cross-functional processes for which specific measures should be implemented in order to allow management to identify the effectiveness and efficiency of the different processes and their sub-sets. (Neely et al., 2001; Powell, 2004)

Capabilities

The fourth facet aims to answer the question: *What capabilities are necessary to operate and enhance these processes?.* According to Neely et al. (2001), capabilities refer to "the combination of people, practices, technology and infrastructure that together enable execution of the organization's business processes or the "fundamental building blocks of the organization's ability to compete". Performance measures related to the capabilities should be identified and implemented in order to assess whether the required capabilities are in place and if these are being sufficiently nurtured and protected. (Neely et al., 2001)

Stakeholder contribution

The question that the fifth facet aims to answer is: *What do we want and need from the stakeholders in order to maintain and develop the capabilities needed?* (Adams and Neely, 2000) It recognizes that there is a symbiotic relationship between the organization and each stakeholder, where the stakeholder contributes to the organization and not only the other way around. The stakeholder satisfaction is separated from the stakeholder contribution as the two facets have completely different requirements. The latter can for example be loyal customers, employees or suppliers; ideas, suggestions and expertise from employees or suppliers; and profitability stemming from customer buying the products. This perspective is added in order to enhance the connection between what each stakeholder require in connection to what they contribute with. (Powell, 2004; Neely et al., 2001)

3.5 Requirements for a Performance Measurement System

When designing a PMS it is important to take into consideration what requirements should be fulfilled. There are certain features of performance measurement systems that are reoccurring in the different frameworks presented above as well as in other research articles within the area. These features can therefore be considered as particularly important and will be presented below according to the structure used by Caplice and Sheffi (1995).

3.5.1 Six identified requirements

The requirements identified are: c*omprehensive, causally oriented, vertically integrated, horizontally integrated, internally comparable,* and *useful.* These will be presented in more detail below and are also are summarized in Table 6, found in section 3.5.2.

3.5.1.1 Comprehensive

According to Caplice and Sheffi (1995), a performance measurement system is *comprehensive* if it captures all critical areas and the effect that a policy has on each of the relevant stakeholders in the measured process. In order for a PMS to be *comprehensive* it should be ensured that no important perspective is ignored. Connected to this, Caplice and Sheffi (1995) identify three basic performance dimensions that they claim capture the critical areas and stakeholders of most companies. These dimensions are: customer satisfaction, internal process efficiency and financial results. It is suggested that other areas also, e.g. environmental aspects, safety or growth, can be included if considered relevant for the long-term performance. (Caplice and Sheffi, 1995)

The importance of including all critical areas and stakeholders is also highlighted in the balanced scorecard framework. By including metrics connected to the four perspectives, Kaplan and Norton (1992) claim that a *comprehensive* view of the company's performance is provided. There has however been some critique regarding if the four perspectives presented in the balanced scorecard sufficiently cover all critical areas of a company. (Neely et al., 2001; Laitinen 2003; Vaivio, 1999) Neely et al. (2001) claim that the performance prism is *comprehensive,* since it focuses on measuring all areas relating to the important stakeholders of the company, rather than a pre-set number of perspectives.

The SCOR model also aims at creating a *comprehensive* PMS by accentuating the importance of including at least one metric for each of the attributes in order to ensure a balanced decision-making. The model includes all processes connected to supply chain performance but does not include all of a company's business processes or activities. Sales, marketing, research and development, and product development are for example not addressed and the SCOR model moreover "assumes but does not specifically address quality, information technology or administration". (Supply Chain Council, 2010)

In general, many authors point out the importance of a performance measurement system being balanced and focusing on all critical areas of the business. (Alfaro et al. 2007; Caplice and Sheffi; 1995; Kaplan and Norton, 1992; Neely et al., 2001) There is however no clear consensus about what should be included in a PMS for it to be perceived as *comprehensive.*

3.5.1.2 Causally oriented

Caplice and Sheffi (1995) state that a *causally oriented* PMS raises the visibility of long term objectives, and they describe a PMS as *causally oriented* if it "tracks the root causes of performance and not just the end-results". A *causally oriented* PMS can, according to Caplice and Sheffi (1995), be achieved by using non-financial measures since these can indicate future performance while financial metrics are lagging indicators that show the result when it is too late to take action.

Kaplan and Norton (1996) claim along the same lines, that one of the strengths of the balanced scorecard is the use of non-financial measurements in collecting diagnostic information. When these measurements are cascaded down the organization they can be used to change work processes or routines that do not contribute to long-term financial success. Similarly, when developing the performance prism, Neely et al. (2001) acknowledged the balanced scorecard as a pioneer because of the balance between financial and non-financial measures. The performance prism was inspired by this and also focuses strongly on non-financial measures that are cascaded down the organization to achieve *causal orientation.*

The SCOR model focuses mainly on operational measures and consequently has a strong focus on non-financial measures. The measures are also clearly linked together between different organizational levels, which facilitates the identification of root causes to problems. (Supply Chain Council, 2010)

The importance of including non-financial measures and its connection to tracing the underlying causes of performance and not only the final results and effects are often stated in theory (Thakkar et al., 2009; Neely et al., 2005; Caplice and Sheffi, 1995; Supply Chain Council, 2010). Thus, it can be considered that an important requirement for a PMS is that it should be *causally oriented*.

3.5.1.3 Vertically integrated

According to Caplice and Sheffi (1995), a PMS is *vertically integrated* if it "translates the overall strategy of the organization to all decision makers and connects metrics at each level to the appropriate reward system". The aim of *vertical integration* is to design the PMS in such a way that actions taken by people in the company for their own interest are aligned with the company's the best interests. In a *vertically integrated* PMS, the different levels of the organization use different, but still related metrics, and the metrics at each level should be appropriate for taking decisions at that level. (Caplice and Sheffi, 1995)

Kaplan and Norton (1996c) state that the balanced scorecard "gives managers a way of ensuring that all levels of the organization understand the long-term strategy and that both departmental and individual objectives are aligned with it". As previously described, the balanced scorecard's main focus when developing metrics is to start from the company's strategy and cascade the metrics down the organization. Metrics can there either be used directly if they are applicable to the subunit, otherwise different but related metrics can be developed that better reflect local needs. (Epstein and Manzoni, 1998) According to Antonsen (2014) several authors have criticized the balanced scorecard for making organizations top-down controlled and less dynamic, which in practice will make employees less motivated to provide critical reflections or change own practices until new instructions with new indicators and targets are provided. Kaplan (2012) responds to some presented critique of the balanced scorecard by referring to the improvements that have been achieved regarding the connections of metrics, through the inclusion of the strategy map.

As described in section 3.4.3.1 the performance prism is related to the balanced scorecard. Within all the steps that the model consists of, metrics should be developed that can measure the efficiency and effectiveness of the processes, sub-processes and capabilities at different levels in the company (Neely et al., 2001).

The SCOR process starts from the company strategy that is decomposed into sub-processes to which metrics are connected. (Supply Chain Council, 2010) The difference between the SCOR model, the balanced scorecard and the performance prism is that the SCOR model provides a list of metrics, where the connection between the individual metrics for each process and level is clearly presented.

Many authors state the importance of connecting the metrics to the company's strategy (Alfaro et al., 2007; Neely et al., 2005; Kaplan and Norton, 1992; Supply Chain Council, 2010; Grosswiele et al., 2013). Moreover, although there is no clear consensus on how metrics should be cascaded down through the company to be able to use them at different levels, many authors claim that it is important that it can be done. (Alfaro et al., 2007; Grosswiele et al. 2013; Thakkar et al. 2009; Neely et al., 2005; Kaplan and Norton, 1992)

3.5.1.4 Horizontally integrated

Caplice and Sheffi (1995) describe a performance measurement system as *horizontally integrated* if it includes metrics that capture all important activities, functions and departments along the process monitored. The different functions should balance against each other and the PMS should "encourage, or at least not discourage, integrating operations along the entire supply chain". (Caplice and Sheffi, 1995)

Kaplan and Norton (1992) present the balanced scorecard as aiming to pull people toward the same overall vision, and they state that the goals should be established with the assumption that people will adopt necessary behaviors to achieve them. A great focus is also put on understanding the importance of cross-functional integration and interrelationship between different functions. (Kaplan and Norton, 1992) As described in section 3.5.1.3, the balanced scorecard has been critiqued regarding how interactive it is and how well it connects the different areas of measuring. However, Kaplan (2012) explains that it is important to recognize that the balanced scorecard and strategy map should be used to communicate outcomes to be accomplished and through this allow for innovation and collaboration.

Both the performance prism and the SCOR model puts a great focus on the importance of the use of cross-functional processes and how these will be used to achieve the strategies outlined. The performance prism, similarly to the balanced scorecard, uses a strategy map or success map to outline how the business works and what functions and activities should be monitored, and metrics should be chosen accordingly (Neely et al., 2001). The SCOR model identifies the company's supply chain and chooses metrics from all the important cross-functional processes involved in each of the supply chains identified. (Bolstorff and Rosenbaum, 2003)

The importance of aiming for an understanding of the entire process and to avoid sub-optimization through the use of cross-functional metrics is frequently argued for in literature. (Thakkar et al., 2009;, Alfaro et al. 2007; Caplice and Sheffi,1995; Kaplan and Norton, 1992;

Neely et al., 2005) It can therefore be considered that an important requirement for a PMS is that it should be *horizontally integrated*.

3.5.1.5 Internally comparable

According to Caplice and Sheffi (1995) a performance measurement system is *internally comparable* if "trade-offs between the different dimensions of performance can be made". They state that by only using financial metrics it is easier to identify and quantify trade-offs, but the more *comprehensiv*e a PMS becomes, the more difficult it is to make it *internally comparable*. Due to the difficulties associated with achieving *internal comparability,* Caplice and Sheffi (1995) do not provide an example of how this can be achieved. They do however state, "a measurement system should at least try to incorporate some idea of how different performance dimensions can be traded-off between each other". (Caplice and Sheffi, 1995)

Kaplan and Norton (1992) claim that by considering all the important measures together, the scorecard guards against sub-optimization. They mean that the balanced set of measures reveal trade-offs that already have been made and managers are thereby encouraged to try to achieve goals in the future without making trade-offs among key success factors. However, Hoque (2014) states that several authors have "found it difficult to identify the relative importance of and the trade-offs between the balanced scorecard perspectives". Nørreklit (2000) for example argues that there is "not a causal but rather logical relationship among the areas analyzed". She sites Jones and Sasser who claim that ''it is not generic that a high level of satisfaction will lead to greatly increased customer loyalty and that increased customer loyalty is the single most important driver of long term financial performance". She means that Kaplan and Norton cannot claim that the balanced scorecard shows sufficient causal linkage between different trade-offs, she does however agree that there are certain logical relationships present. (Nørreklit, 2000)

The attributes of the SCOR model are used to guide decisions regarding what areas it is most important for the company to succeed within. (Supply Chain Council, 2010) It is however not a quantifiable trade-off but rather gives guidance to what the company should consider most important.

Regarding the performance prism, no literature was found where the framework was claimed to be *internally comparable.*

There are frameworks found in theory that presents ways of weighing trade-offs against each other by using multiple criteria decision making tools such as the analytical hierarchy process (AHP) and fuzzy logics approach (Wibisono and Khan, 2010; Bhagwat and Sharma, 2009; Jakhar and Barua, 2014; Sun, 2010). The AHP model has however been criticized as being defective when used improperly. The AHP model requires critical success factors to be identified and rated against each other and any uncertainties that may exist at this level of design can severely affect the decision making in the future and cause practical problems. (Cheng et al. 2002) Thus, although it is difficult to find a one-best-way of weighing trade-offs against each other, many authors still agree on the importance of at least attempting to consider the trade-offs between different metrics and areas. (Thakkar et al. 2009; Alfaro et al. 2007; Najmi et al. 2012; Kaplan and Norton, 1992; Caplice and Sheffi, 1995)

3.5.1.6 Useful

Caplice and Sheffi (1995) state that if a performance measurement system is difficult to interpret, it will likely not be used to a great extent. One requirement for PMSs is therefore that they should be *useful.* This is defined by Caplice and Sheffi (1995) as "readily understandable by the decision maker and [providing] a guide for action to be taken".

Kaplan and Norton (1992) argue that though providing sufficient information about a company's performance, the scorecard at the same time minimizes information overload. This since it forces managers to limit the number of measures used and focuses on the handful that is most critical (Kaplan and Norton, 1992). Moreover, they state that the balanced scorecard lets managers communicate their strategy up and down the organization and that it helps in translating the strategy into operational terms that provide useful guides to action at the local level. (Kaplan and Norton, 1996c)

The Supply Chain Council claims that the SCOR model makes it easy to quickly determine the performance of a company's supply chain and related operations, and also to compare the performance against other organizations. They further state that the SCOR model make it less time consuming to "drill down to identify contributing factors, and quickly take initiate corrective actions" (Supply Chain Council, 2010) Moreover, the model is claimed to enable its users to communicate their supply chain practices. (APICS, 2014b)

Regarding the performance prism, Neely et al. (2001) state that the framework provides enough information to give an overview of the performance of the process. However, no claims were found in theory regarding the ease of understanding, facilitation of reporting and communication of the result or whether the framework provides a guide for decisions to be taken.

In literature, different suggestions on how to make a PMS *useful* can be found. For example: the information in the PMS should be presented at the correct level and cover the decision makers information requests (Alfaro et al. 2007; Grosswiele et al. 2013), the PMS should facilitate reporting and demonstration of trends (Alfaro et al. 2007), and it should provide management with a set of actions that facilitates performance planning (Thakkar et al. 2009, Alfaro et al. 2007). Although not all authors give the same suggestions it is often claimed that a PMS should be easy to use and apply (Medori and Steeple, 2000; Neely et al., 2005; Alfaro et al. 2007; Thakkar et al. 2009; Kaplan and Norton, 1992; Caplice and Sheffi, 1995).

3.5.2 Summarizing tables

The tables below are used to summarize the requirements for Performance Measurement Systems as presented in sections 3.5.1.1 to 3.5.1.6. Table 6 shows a summary of the descriptions of the requirements for a PMS and Table 7 shows how the different frameworks presented can be connected to the requirements presented.

Requirements for a Performance Measurement System	
Comprehensive	· The PMS includes all critical areas relevant to long term performance
Causally Oriented	· The PMS tracks the root cause of performance and not just the end result.
Vertically Integrated	· The PMS is aligned with the overall strategy and objectives · The different levels of the organization should use different, but still related metrics, and the metrics at each level should be appropriate for taking decisions at that level.
Horizontally Integrated	· The PMS represents all relevant activities, functions and departments within the process and encourages collaboration across functions and divisions. · The logical connections between the metrics within the PMS are clear
Internally Comparable	· The PMS clearly identifies and, if possible, quantifies trade-offs that occur when metrics, processes or activities are counteracting each other or competing for the same resources
Useful	· The PMS is readily understandable and provide a guide for the decisions that should be taken · The PMS facilitates simple reporting and communication of the results · The PMS provides enough information to give an overview of the performance of the process but at the same time minimizes information overload.

Table 6 Requirements for a Performance Measurement System

	Balanced Scorecard	Performance Prism	SCOR
Comprehensive	Include metric within the four balanced scorecard perspectives	Measure all areas related to important stakeholders	Include metrics for all SCOR attributes
Causally Oriented	Includes non-financial measures that are cascaded down the organization	Includes non-financial measures that are cascaded down the organization	Main focus on operational and non-financial measures that are cascaded down the organization
Vertically Integrated	Metrics developed from strategy and cascaded down to all levels of the organization ensuring alignment	Strategy developed from stakeholders' needs. Thereafter metrics cascaded down from strategy and aligned throughout the organization.	Metrics chosen for all processes and levels from list where connection between individual metrics and connection to overall strategy is clear.
Horizontally Integrated	Communicates outcomes that should be accomplished through innovation and cross-functional collaboration	The processes used to achieve the strategies and from which metrics are developed should aim at being cross-functional	The main processes presented are cross-functional and aim to include the entire supply chain
Internally Comparable	A balanced set of measures reveal trade-offs that have already been made and encourage to try to achieve goals in the future without making trade-offs	Not found	Attributes are used to guide decisions regarding within what areas it is most important to succeed
Useful	Provides overview but also minimizes information overload by limiting the number of measures Facilitates communication of the strategy and provide guide to action	Provides overview	Easy to quickly determine performance of supply chain. Easy to compare performance against competitors Less time consuming to find root cause and take corrective actions Enables communication

Table 7 Summary of frameworks in connection to the requirements for a PMS

3.6 Metrics

Individual metrics must also be considered when discussing performance measurement, as having a performance measurement system is not a guarantee that the metrics themselves are flawless. As Caplice and Sheffi (1994) state, there is an abundance of existing metrics within different areas and perspectives. There are moreover several ways to group metrics; some are closely connected to a specific framework whereas others are related to specific activities or functions. This section will present metrics connected to the SCOR and balanced scorecard frameworks but not connected to the performance prism framework since there were no examples on specific metrics connected to the framework found in theory. Apart from presenting metrics connected to specific frameworks this section also presents different categories of metrics related to activities and business functions, requirements that metrics should fulfill and the trade-offs that exists in connection to selecting metrics.

3.6.1 Metrics related to the SCOR framework

The five performance attributes of the SCOR framework were presented in section 3.4.2.2. The following section will present the level 1 metrics related to each attribute as well as some of the level 2 metrics.

3.6.1.1 Reliability

Within reliability there is only one level 1 metric. It is called Perfect order fulfillment and it measures the percentage of orders meeting delivery performance with complete and correct documentation and no delivery damage. It considers both items and quantities, and the order must be delivered on time from the customer's point of view. This metric captures errors at different stages since it covers activities such as order entry, picking, delivery as well as if the order is shipped without damage and invoiced correctly. See Table 8 for description of how to calculate Perfect order fulfillment and which level 2 metrics that connects to it. (Supply Chain Council, 2012)

Metric	Calculation	Associated level 2 metrics
Perfect order fulfillment	$\text{Perfect order fulfillment} = \frac{\text{Total perfect orders}}{\text{Total number of orders}}$	· Percent of orders delivered in full · Delivery performance to customer commit date · Documentation accuracy · Perfect condition

Table 8 SCOR metrics, reliability

3.6.1.2 Responsiveness

Order fulfillment cycle time is the average cycle time to fulfill customer orders and measures the cycle time from when a customer places an order until the order is delivered to customer. The metric includes value-adding time as well as dwell time, so orders placed in advance will increase the average value. The metric can be divided into a "gross" component and a "net" component to separate the order fulfillment process time from the order fulfillment dwell time. See Table 9 for description of how to calculate Order fulfillment cycle time and which level 2 metrics that connect to it. (Supply Chain Council, 2012)

Metric	Calculation	Associated level 2 metrics
Order fulfillment cycle time	$\text{Order fulfillment cycle time} = \frac{\text{Sum actual cycle time for all orders delivered}}{\text{Total number of orders celivered}}$	· Source cycle time · Make cycle time · Deliver cycle time · Delivery retail cycle time

Table 9 SCOR metrics, responsiveness

3.6.1.3 Agility

Agility refers to the ability to respond to marketplace changes in order to gain or maintain competitive advantage. (Supply Chain Council, 2012)

There are four metrics in this attribute; Upside supply chain flexibility, Upside supply chain adaptability, Downside supply chain adaptability, and Overall value at risk (VAR)."Upside" and "downside" refer to the direction of change in demand. Increasing demand is "upside" and decreasing demand is "downside". "Flexibility" measures the number of days it takes to respond to the change in demand, whereas "adaptability" measures the maximum quantity of production change that the company can achieve and sustain in a certain amount of time. (Supply Chain Council, 2012)

The metric Upside supply chain flexibility measures the number of days required to achieve an unplanned sustainable percentage increase in quantities delivered and measure how prepared a company is for a sudden increase in demand. (Supply Chain Council, 2012) According to the Supply Chain Council (2012) "it is evidence that enterprises engaged in appropriate business risk and competitive contingency planning activities will usually be in a better position to optimize overall supply chain performance". Moreover, for a supply chain that lacks flexibility "a seemingly minor increase in production requirement can consume much time and effort as the supply chain struggles to restore its capability to perform" (Supply Chain Council, 2012) It should be noted that some of the activities required occur simultaneously, and the days required for achieving an increase for each process should therefore not necessarily be added. If one part or process requires considerably more time than the other, this will be deciding for the outcome of the metric. (Supply Chain Council, 2012)

Upside supply chain adaptability is defined as the maximum sustainable percentage increase in quantity delivered that can be achieved in a certain amount of time, for example 30 days. How much more can a company produce during a given time than what they regularly do? (Supply Chain Council, 2012)

Downside supply chain adaptability is the reduction in quantities ordered sustainable at 30 days (or other amount of time) prior to delivery with no inventory or cost penalties. How much less can a company produce than what they regularly do, without it leading to inventory and cost penalties? In an agile supply chain, measures can be taken to reduce the damage if demand decreases, for example reducing work hours, order less or stop outsourcing so that the unit cost of the product does not increase. (Supply Chain Council, 2012)

Overall value at risk (VAR) includes the supply chain from the supplier's supplier to the customer's customer as well as the global environment. Any event that can disrupt linkages in the supply chain should be included and considered as a risk event. (Supply Chain Council, 2012)

See Table 10 for description of how to calculate these metrics and which level 2 metrics that connects to them.

Metric	Calculation	Associated level 2 metrics
Upside supply chain flexibility	The minimum time required to achieve the unplanned sustainable increase when considering Source, Make and Deliver components.	· Upside source flexibility · Upside make flexibility · Upside deliver flexibility · Upside source return flexibility · Upside deliver return flexibility
Upside supply chain adaptability	Upside supply chain adaptability = Upside source adaptability + Upside make adaptability + Upside deliver adaptability	· Upside source adaptability · Upside make adaptability · Upside deliver adaptability · Upside source return adaptability · Upside deliver return adaptability
Downside supply chain adaptability	Downside supply chain adaptability = Downside source adaptability + Downside make adaptability + Downside deliver adaptability	· Downside source adaptability · Downside make adaptability · Downside deliver adaptability
Overall value at risk (VaR)	$\text{VaR} = \text{Probability of risk event} \times \text{Monetized impact of risk event}$ $\text{Supply chain Risk VAR} = \text{VAR (Plan)} + \text{VAR(Source)} + \text{VAR (Make)} + \text{VAR (Deliver)} + \text{VAR (Return)}$	· Supplier's/Customer's/Product's risk rating · Value at risk (Plan) · Value at risk (Source) · Value at risk (Make) · Value at risk (Deliver) · Value at risk (Return2)

Table 10 SCOR metrics, agility

3.6.1.4 Cost

Total cost to serve is the sum of the supply chain cost to deliver products and services to customers. It can be measured per event and at the aggregated supply chain level. The metric includes two types of costs, direct and indirect. The former can be directly connected to fulfilling customer orders whereas the later are costs related to operating the supply chain. See Table 11 for description of how to calculate Total cost to serve and which level 2 metrics that connects to it. (Supply Chain Council, 2012)

Metric	Calculation	Associated level 2 metrics
Total cost to serve	$\text{Total cost to serve} = \text{Planning cost} + \text{Sourcing cost} + \text{Material landed cost} + \text{Production cost} + \text{Order management cost} + \text{Fulfillment cost} + \text{Returns cost}$	· Planning cost · Sourcing cost · Material landed cost · Production cost · Order management cost · Fulfillment cost · Returns cost · Cost of goods sold

Table 11 SCOR metrics, cost

3.6.1.5 Asset management efficiency

The metric Cash-to-cash cycle time measures “the time it takes for an investment made to flow back into a company after it has been spent for raw materials” (Supply Chain Council, 2012). The longer the Cash-to-cash cycle time, the more net working capital is needed. The metric is accepted and used to benchmark supply chain asset management performance within many industries. (Supply Chain Council, 2012) According to Forbes (2012) it is a “great way to analyze the efficiency of the organization in managing cash to generate more sales” and that firms that efficiently manage their cash flow also tend to generate better stock returns.

- Days sales outstanding measures the time from when a sale is completed until the payment is received from the customers. The metric is expressed in days and is calculated as a 5 point rolling average of gross accounts receivable divided by the total gross annual sales, which is divided by 365 (days). (Supply Chain Council, 2012)
- Inventory days of supply measures the amount of inventory expressed in days of sales. (Supply Chain Council, 2012) The metric connects to the management of inventory levels and the balance between ensuring sufficient inventory on hand and minimizing inventory. (PWC, 2012) Inventory often represents a large component of a company’s working capital and can be difficult to liquidate quickly. (Bragg, 2012) Inventory days of supply helps to maximize the working capital efficiency and minimize the risk of obsolescence. (PWC, 2012) It is calculated as a 5 point rolling average of gross value of inventory at standard cost divided by the annual cost of goods sold, which is divided by 365 (days). (Supply Chain Council, 2012)
- Days payable outstanding measures the length of time from purchasing materials until cash payments must be made expressed in days. (Supply Chain Council, 2012) PWC (2012) explains that the metric can be used to minimize working capital requirements by delaying payments to suppliers, but it should be balanced against the risks of damaging the relationship. In order for a company to be capital efficient they should aim at reaching as long payment terms as possible. The metric is calculated as a 5 point rolling average of gross value of inventory at standard cost divided by the total gross annual material purchases, which is divided by 365 (days). (Supply Chain Council, 2012)

Return on Supply chain fixed assets measures the return an organization receives on its invested capital in supply chain fixed assets. This includes the fixed assets used in Plan, Source, Make, Deliver and Return. (Supply Chain Council, 2012)

Return on working capital is a metric that assesses the magnitude of investment relative to a company’s working capital position compared to the revenue generated from a supply chain. (Supply Chain Council, 2012)

See Table 12 for description of how to calculate these metrics and which level 2 metrics that connect to them.

Metric	Calculation	Associated level 2 metrics
Cash-to-cash cycle time	$\text{Cash} - \text{to} - \text{cash cycle time} = \text{Inventory days of supply} + \text{Days sales outstanding} - \text{Days payable outstanding}$	· Days sales Outstanding · Inventory days of supply · Days payable outstanding
Return on supply chain fixed assets	$\text{Return on supply chain fixed assets} = \frac{\text{Supply chain revenue} - \text{COGS} - \text{Supply chain management cost}}{\text{Supply chain fixed assets}}$	· Supply chain revenue · Supply chain fixed assets
Return on working capital	$\text{Return on working capital} = \frac{\text{Supply chain revenue} - \text{Total cost to serve}}{\text{Inventory} + \text{Accounts receivable} - \text{Accounts payable}}$	· Accounts payable (payables outstanding) · Accounts receivable (sales outstanding) · Inventory

Table 12 SCOR metrics, asset management efficiency

3.6.1.6 Green SCOR metrics

Sustainability is a possible complement for companies who are interested in the environmental footprint and want to reduce their environmental impact. The only level 1 metric within Green SCOR is Total supply chain carbon footprint, seen in Table 13, which measures the sum of the carbon equivalent emissions. Since companies in a supply chain frequently share resources such as facilities, the emissions must be divided between the involved parties. The calculations generally use emission factors based on energy consumption, fuel type and consumption or the throughput of processes. (Supply chain council, 2012)

Metric	Calculation	Associated level 2 metrics
Total supply chain carbon footprint	Total supply chain carbon footprint = Plan carbon emissions + Source carbon emissions + Make carbon emissions + Deliver carbon emissions + Return carbon emissions	· Plan carbon emissions · Source carbon emissions · Make carbon emissions · Deliver carbon emissions · Return carbon emissions

Table 13 Green SCOR metrics

3.6.2 Metrics relating to the balanced scorecard framework

As presented in section 3.4.1.1, the balanced scorecard achieves its balance through the four perspectives: customer, internal business processes, financial and learning and growth. Unlike the SCOR framework, the balanced scorecard does not suggest a clear set of metrics that should be used along with the framework. However, some examples and suggestions of metrics relating to each perspective can be found and are presented in this section. There are several different dimensions that can be measured; some of the most common are cost, time, quality and flexibility. (Neely, Gregory and Platts, 2005; Kaplan and Norton, 1992)

The customer perspective covers customer satisfaction and focus, which are leading indicators since unhappy customers will not remain loyal with the company but find another supplier. It indicates future changes even though the financial situation looks good today. Aspects that can be measured within this perspective are time, quality, cost and performance and service, since these are common concerns from customers. Some metrics relating to these aspects are Lead time, Defect level of incoming goods, On-time delivery and Customer satisfaction. (Kaplan and Norton, 1992)

The internal business processes shows the efficiency of the business and what the company must do internally to meet customers' expectations. The metrics should stem from the processes that have a great impact on the satisfaction of the customers, for example factors concerning cycle time, quality, employee skills and productivity. Companies should also try to measure their core competencies and critical technologies. (Kaplan and Norton, 1992) For example, the metric yield measured quality, and Actual introduction schedule vs plan shows the accuracy when introducing new products. (Kaplan and Norton, 1992)

Metrics relating to learning and growth can help to distribute resources to the training that is most needed. How good a company is at innovating, improving and learning connects to the company's value, since it must continue to launch new products, create value for the customers and improve operating efficiencies. By measuring for example Percentage of sales from new products, Time to develop next generation and New product introduction vs. competition these aspects can be captured. (Kaplan and Norton, 1992)

Previously a lot of focus has been placed on financial metric, causing an unbalanced situation. Financial metrics can also be seen as reactive and looking backwards instead of to the future. However, financial metrics are still important since they indicate if the strategy, implementation and execution are going well. Typically metrics within this perspective relate to profitability, growth and shareholder value, for example Return of equity, Operating income and Quarterly sales growth. (Kaplan and Norton, 1992)

3.6.3 Metrics relating to activities and business functions

The processes within a company or supply chain can be broken down to sub-processes and activities from which suitable metrics can be developed. Metrics can also be related to a specific function. One advantage of sorting metrics according to where in the supply chain they are located is that it is easy to apply and understand the context. (Gunasekaran and Kobu, 2007) In addition to the frameworks mentioned earlier, this section will present metrics within different business activities and functions.

3.6.3.1 General metrics

Some metrics are not specific for a function or activity, since they are influenced by several functions but not owned by a specific department. They can be used to assess the performance on a higher level or connect to several different functions. Other metrics measure factors that influence or are influenced by several activities. For example, backlog of orders, forecast accuracy, cost and quality are typical measures that cover a business end-to-end as they affect and are affected by decisions made in different parts of the company. (Davis, 2014) Examples of metrics and their definitions are presented in Table 14 and the metrics are further described below.

Metric	Description
Forecast accuracy	· Accuracy of forecasting method as compared to actual sales for a given period of time. (Hyndman and Koehler, 2005)
New product forecast accuracy	· Mean absolute percent error of new products from launch through planned volume hurdle. (Hoover, 2009)
First pass yield	· Number of units coming out of a process divided by number of units going into a process. (Davis, 2014)
Sales backlog ratio	· The ratio between the current backlog of orders and the sales for a given period; indicates the ability for a business to maintain its current level of production. (Bragg, 2002)

Table 14 General metrics

Forecast accuracy measures the percentage error of the prognosis. It can be calculated for products or families in relation to markets or distribution channels and the changes in the result can be used to determine the success rate. There are many different ways of computing the accuracy; metrics can be dependent on the scale that the data has, be based on percentage errors or relative errors, or use relative measures instead of relative errors. A commonly used metrics is Mean absolute percentage error, MAPE, which is calculated as the difference between the actual value and the forecasted value divided by the actual value. (Hyndman and Koehler, 2005)

New product forecast accuracy is similar to the regular prognosis, but without the established pattern that can exist for products already on the market. The prognosis is a foundation for some of the work done in a company, for example the amount of goods kept in inventory. By knowing how accurate the prognosis is, it is possible to see if errors occur because of the prognosis or despite it as well as how trustworthy it is. (Hoover, 2009)

First pass yield, also known as Throughput yield, indicates the percentage of items passing through a process or activity without any problems or need for rework or corrective activity. It shows the quality and production performance of a process. (Davis, 2014)

The metric Sales backlog ratio measures the ratio between the current backlog of orders compared to the sales for a given period. The metric shows the ability for a business to maintain its current level of production. A decrease implies that the company is starting to lose sales, which can lead to over-capacity in production and hence financial losses. An increase on the other hand implies that the company is not able to keep up with customer demand which can result in customer relations problem due to delayed orders as well as increased costs associated with additional capacity needs. The metric is calculated by dividing the most current total backlog of orders by the sales. The period used in the denominator should preferably be less than annual, for example quarterly, since sales may vary during the year due to seasonality. The metric can also be used to determine the number of days of sales contained within the backlog by comparing the backlog to the average daily sales volume that a company typically produces. (Bragg, 2002)

3.6.3.2 Production ramp up

Production ramp up covers the activities between product development and full capacity production. The involved activities can be different as they are customized to fit specific production requirements. During production ramp up the focus lies on achieving the wanted production volume to enter the market and maximize the profit, while at the same time achieving the wanted quality. Metrics frequently relate to time and cost, but can also concern the quality of the output and productivity by measuring equipment functionality. (Doltsinis, Ratchev and Lohse, 2013) Examples of metrics that measure the production ramp up activities and their definitions are presented in Table 15.

Metric	Description
Percentage of new product developments launched on time	Measures the amount of products out of the total that are launched at the market within the prognosticated time frame. (KPI library, 2014a)
Percentage of new product developments launched on budget	Measures the amount of product development projects that manage to hold the assigned budget. (KPI library, 2014a)
Output quality	Measures whether or not each product meet the set quality objectives. The sum shows how far a system is from reaching its quality targets. (Doltsinis, Ratchev and Lohse, 2013)

Table 15 Production ramp up metrics

3.6.3.3 Order

The time of the order process can be measured by different metrics, e.g. Order fulfillment lead time or Order cycle from order entry to shipment, where the latter measures the average time from order placement until customer receipt. The order cycle can also be measured between other activities, e.g. from when an order is released to be manufactured until it is ready for shipping. (KPI Library, 2014f) The activities within the function can be measured by the average handling cost and handling time per order and the average number of orders per handler. The associated costs for managing the orders can be measured as well as the costs for fulfilling the order. (KPI Library, 2014f) Metrics that capture mistakes are percentage of incorrectly assigned orders issued, percentage of orders without correct documents and percentage of products that do not live up to set criteria. (KPI Library, 2014f)

3.6.3.4 Warehouse

There are several metrics related to a warehouse and its core processes; receiving, put-away, storage, picking, packing and shipment. (Bartholdi and Hackman, 2010) Metrics relating to receiving are for example Total inbound volume received and Ratio of receiving errors and damaged goods. (KPI Library, 2014k) Once goods have been received they should be put away, common metrics related to this activity measure: the average time from dock to stock, the average time from receiving to inventory and the volume put away per time period. For picking, the amount can be measured, either as order lines or complete orders. (KPI Library, 2014k) Metrics can also relate to the completeness and correctness of picked boxes and pallets as well as the percentage of correctly picked order lines along with the total amount of picks per hour. (KPI Library, 2014k)

Accuracy of goods in storage can be measured for location in warehouse and as a comparison to the records. Total value of the inventory and inventory holding cost are common cost-related metrics, as well as inventory turnover. (Bartholdi and Hackman, 2010) Other aspects that can be measured are the safety stock and obsolete inventory, which are goods that no longer will be used or sold. (KPI Library, 2014d)

The total volume can be measured when packing and shipping goods, errors made in picking may get caught in controls before shipping, so the correctness can be measured. The utilization of a warehouse can be calculated as percentage of used floor space or filled warehouse locations. (KPI Library, 2014k)

3.6.3.5 Logistics and shipment

When transporting goods from a warehouse to a retailer the transit time can be measured. The accuracy of the lead time and the percentage of deliveries and pickups that are on time makes it possible to confirm arrival dates with customers. (KPI Library, 2014f) A more overall view of this is On Time in Full (OTIF), which shows the percentage of orders that arrive on time and contains the correct goods in the right amount. (KPI Library, 2014f; KPI Library, 2014h) Another area within logistics concern damages and errors, examples of measured areas are percentage of orders delivered with damaged items and ratio of correct freight bills of total orders shipped. (KPI Library, 2014e; KPI Library, 2014h)

There are different types of costs associated with transportation; the cost for a shipment depends on the transport mode, distance, amount and type of goods as well as if there are costs for imports or exports. The costs can be calculated per unit, weight, route, transportation mode or type of cost. (KPI Library, 2014e; KPI Library, 2014h)

3.6.3.6 Procurement and purchasing

Financial metrics are frequently appearing in procurement and purchasing. (van Weele 2010) The spend of the function can be calculated per supplier, per purchaser and as a percentage of sales. (KPI Library, 2014g) There are also costs associated with tendering processes and when purchasing. The average total cost of processing a purchase can be measured, as well as procurement's operating expense as a percentage of the sales. (KPI Library, 2014j) Potential issues can also be seen by measuring invoices without matching purchase order or number of stock-outs that depend on lack of raw material. Measuring the percentage of purchase orders with line item, pricing, supplier data, quantity or delivery date and address errors also relates to potential issues. (KPI Library, 2014g)

3.6.3.7 Customer support

Customer support and follow-up are relevant for many companies. One of the main areas relate to complaints from customers, some aspects to measure are number or ratio of complaints, the cause for the complaint, number of problems that are solved and the percentage of customers that are satisfied with the way their issue was handled. Apart from this the time to respond and solve the issue can be measured as well as the cost per resolution and customer. (KPI Library, 2014b; KPI Library, 2014c)

Connected to complaint is customer satisfaction, which can be measured as an index or a percentage of the whole. The information can be gathered by satisfaction surveys and feedback. (KPI Library, 2014b; KPI Library, 2014c) By using the metric Returns percentage, the value of returned product versus net revenue sales of that product is measured. This rate of returns shows the quality of the products and makes it possible to find potential sources of damage in the supply chain as well as see the amount of faulty products not captured by the testing systems. (Davis, 2014) Customer support can also investigate the customer base to see how high the percentage of sales placed to new customers is compared to those placed to the existing base.

Changes in the customer base can be monitored and comparisons made from year to year. (KPI Library, 2014b; KPI Library, 2014c)

3.6.3.8 Sustainability

Apart from the metrics relating to Green SCOR, there are other metrics within environmental aspects. Sustainability is a relatively new area to measure. It is a vast area that covers aspects such as emissions, energy and resource consumption and recycling as well as social contribution, codes of conduct etc. (Caniato, Luzzini and Ronchi, 2014; Dey and Cheffi, 2013). Philanthropy and other social contributions can be measured as percentages of profit or operating income. Another metric relating to corporate social responsibility is amount of suppliers that affirmed the business code of conduct. (KPI Library, 2014i)

3.7 Requirements for metrics

Performance measurement systems and frameworks can be constructed differently and have various aims and focuses as described earlier. Although the metrics included in a PMS can measure completely different areas, specifications exist that the metrics can be evaluated against. As with the metrics themselves, there are several different ways to structure the requirements that individual metrics should fulfill. This section presents requirements that a metric should fulfill based on a suggestion of Caplice and Sheffi (1994) and adapted using additional references.

3.7.1 Nine identified requirements

The requirements identified are: *validity, robustness, usefulness, integration, economy, compatibility, reliability, level of detail*, and *behavioral soundness*, presented below. A summary of the requirements can be found in Table 16 in section 0.

3.7.1.1 Validity

Caplice and Sheffi (1994) define a metric as *valid* if it "reflects the actual activity being performed and controls for any exogenous factors that are out of the process manager's control". It is also said that the more situation specific aspects that are included in a metric the more *valid* it is. (Caplice and Sheffi, 1994) That the metric should reflect the essence of the activity in question is stated as important by several authors (Akyuz and Erkan, 2010; Caplice and Sheffi, 1994; Kennerley and Neely, 2003) as well as the importance of controlling for exogenous factors. A metric should for example measure what it is meant to measure and only that, so that no other activity or undesired data is included (Neely et al. 1997; Kennerley and Neely; 2003). A metric should also only take into account those factors that can be affected or controlled by the person or department that is using the metric or being assessed by its result (Neely et al., 1997; Akyuz and Erkan, 2010).

3.7.1.2 Robustness

Apart from being valid, a metric should also be *robust*, which according to Caplice and Sheffi (1994) mean that it is generally accepted and interpreted in the same way by all users and thus is possible to use for benchmarking so that performance can be compared between companies and industries. (Caplice and Sheffi, 1994) Akyuz and Erkan (2010) agree that metrics should be possible to compare to metrics used by similar organizations. It is moreover stated by several authors that it is important that a metric is easy to understand and that the purpose of each metric as well as procedures connected to data collection, calculation methods and other related procedures are clearly defined. (Akyuz and Erkan, 2010; Neely et al. 1997; Caplice and Sheffi, 1994; Kennerley and Neely, 2003) This connects back to the requirement of *robustness* since for a metric to be interpreted similarly by all users and thus possible to compare it must also be understood, interpreted and defined in the same way. (Caplice and Sheffi; 1994)

3.7.1.3 Usefulness

Another important aspect is the *usefulness* of the metric which implies that the metric is easy to understand by the decision maker and that the metric supports decisions or gives suggestions about actions or which direction to move in order to improve the result. Therefore a metric concerning a single factor is more useful than a combined one, since the latter is more difficult to interpret because it depends on several factors. (Caplice and Sheffi, 1994) The requirement *usefulness* can also be connected to if the metric provides fast feedback, which by several authors is stated as beneficial. This since if the result of the metric is provided quickly it means that the information can be reviewed and action taken directly. (Akyuz and Erkan, 2010; Thakkar et al., 2009; Kennerley and Neely, 2003) Moreover, if targets can be set for the metric it can be continuously updated and new challenges introduced as the performance improves. (Akyuz and Erkan, 2010; Neely et al., 1997)

3.7.1.4 Integration

To get a clearer overview and be able to view the company as an entity it is important to consider the level of integration of the metrics. Caplice and Sheffi (1994) refer to a metric as *integrated* if it measures a process and includes all major components and aspects of that process. An *integrated* metric also aims toward coordination and collaboration across functions within a company or with suppliers, customers or other partners. (Caplice and Sheffi, 1994) This leads to a focus on process orientation instead of a functional orientation, which is stated as important by several authors since it aims at ensuring that the entire company strives towards the same overall goal. (Akyuz and Erkan, 2010; Thakkar et al., 2009; Neely et al., 1997)

3.7.1.5 Economy

The act of measuring can mean a considerable cost for a company since it includes data collection, calculation, monitoring and other procedures and not just reviewing the results at specified intervals. Therefore it is necessary to consider how much each metric costs, so it can be investigated whether or not the metric is worth including in the performance measurement system. (Caplice and Sheffi, 1994; Akyuz and Erkan, 2010; Kennerley and Neely, 2003; Grosswiele et al., 2013) It is preferable to minimize the costs, but a metric is according to Caplice and Sheffi (1994) considered *economical* as long as the benefit it gives outweighs the cost of using it. This can be difficult to assess since some costs may be shared among several metrics and the perceived benefit can be difficult to express in monetary value. For those reasons this requirement should be seen more as a guideline to be considered than a strict cost-benefit comparison. (Caplice and Sheffi, 1994)

3.7.1.6 Compatibility

A metric is according to Caplice and Sheffi (1994) *compatible* with the existing performance measurements system if no significant additional work is necessary to implement it and start using it. This requirement is connected to the requirement regarding *economy* and at times these two overlap since any metric can be seen as compatible with a system given that time and money are not issue. However, to be compatible the metric must be in line with the existing routines regarding data collection, information systems and flows of information in the organization. If a metric does not share routines regarding measuring, for example if it is necessary with additional contact with a supplier to gather specific information for the metric, it cannot be considered compatible. (Caplice and Sheffi, 1994) Grosswiele et al. (2013) discusses the same area and highlight the importance of reviewing the existing metrics in connection to introducing new ones.

3.7.1.7 Reliability

A metric is said to be *reliable* if it controls for inherent errors in data collection and is repeatable (Caplice and Sheffi, 1994). This can be connected to the importance of clearly defining the purpose, data collection and calculation methods, as well as related procedures, which is stated as important by several authors. (Akyuz and Erkan, 2010; Neely et al. 1997; Caplice and Sheffi, 1994; Kennerley and Neely, 2003) Moreover, it is said that a metric should be objective, and not based on opinion (Neely et al. 1997) and that a metric should produce similar results, i.e. be consistent whoever measures the metric and whenever it is measured (Kennerley and Neely, 2003). To be able to rely on the result the metric should also be simple to understand (Neely et al. 1997) so that the results are not possible to misinterpret (Kennerley and Neely, 2003).

3.7.1.8 Level of detail

Decisions are made on different levels in an organization and therefore different metrics are appropriate for each level. (Akyuz and Erkan, 2010) Since the wanted level of detail of the metric depends on the person that is going to use it, it is necessary to adapt a metric accordingly in order to be able to use as a base for decisions. In connection to this Caplice and Sheffi (1994) refer to the granularity and aggregation of the metric, which should be adapted to the context in which the metric should be used. A metric can for example be measured with different scope, such as locally, regionally or nationally, or different frequency, for example: hourly, daily or weekly. What is considered an appropriate level of detail however depend on the user. (Caplice and Sheffi, 1994)

3.7.1.9 Behavioral soundness

Performance measurement can be used to assess, motivate and award employees, both individually and as a group. (Thakkar et al., 2009; Bourne et al., 2003) It can be a good tool for evaluating performance, but it will also impact the working environment. Since many metrics are based on activities performed by employees, their behavior can be influenced and this can in turn lead to a normative effect if a certain action leads to a better result. (Franceschini et al., 2014) It is therefore necessary to carefully consider the consequences that each metric can have on behavior, with regard to what is measured, how it is measured, how targets are set and how the results are presented. (Bourne et al., 2003) A metric that is *behaviorally sound* is constructed in a way that discourages counter-productive actions, so that the company also benefits when an individual performs better. Essentially, the idea is to avoid local optimization at the expense of the entire organization. (Bourne et al., 2003; Caplice and Sheffi, 1994; Franceschini et al., 2014; Kennerley and Neely, 2003; Thakkar et al., 2009)

3.7.2 Summarizing table

Table 16 shows a summary of the requirements for metrics that have been described above.

Summary of Requirements for Metrics	
Validity	· The metric is based solely on factors that can be controlled by the person or department responsible for taking decisions or acting on the results · The metric measures "what it is supposed to" (i.e. completely reflects the actual activity/process being performed) · The metric is customized to situation specific aspects of the process/activity being measured.
Robustness	· The metric is not customized to any situation specific aspect of the process or activity being measured. · The metric is general enough to be able to use for benchmarking · The metric is widely recognized, used and accepted in the industry or by similar functions across industries.
Usefulness	· The metric provides guidance for what specific action to take based on the result · The metric focuses on a single activity or function · The metric can be analyzed soon enough for action to be taken
Integration	· The metric measures a process and includes all relevant activities for that process. · The metric encourages collaboration across functions and divisions.
Economy	· The benefits of using the metric outweigh the costs related to the metric (data collection, analysis, report).
Compatibility	· The metric shares routines connected to data collection with other metric or metrics.
Reliability	· The metric clearly defines purpose, data collection, calculation, time span and surrounding procedures. · The results of the metric are not possible to misinterpret · The human factor (subjective assessment, errors in data collection and calculation) cannot affect the result of the metric
Level of detail	· The metric presents the results in a level of detail that is adapted to the person responsible for taking action or making decisions.
Behavioral soundness	· The metric does not encourage behavior that is counter-productive for the company. · The metric can be used as a foundation for giving feedback to the employees about their performance.

Table 16 Summary of requirements for metrics

3.7.3 Trade-offs

According to Caplice and Sheffi (1994) it is not possible for a metric to be superior within every criterion since the criteria can counteract each other. This mainly refers to the criteria *validity, robustness, usefulness and integration*. As illustrated in Figure 7 this leads to several different trade-offs that must be considered to adapt the PMS and metrics to the needs of a company. The primary trade-offs are:

- *Integration* versus *usefulness*: there is a clear contrast between integration and usefulness, since a cross-functional metric will provide less support for a specific function than a metric that focuses solely on it.
- *Robustness* versus *validity*: a metric that aims to be comparable to other situations must be rather general to be applicable, but a customized metric makes it more precise for the individual case. Therefore one metric cannot satisfy both needs.

These two trade-offs both describe distinct separate perspectives that can be difficult to settle. There are other compromises that must be made as well, but these are more compatible; *usefulness* versus *validity*, *usefulness* versus *robustness* and *integration* versus *validity*. By resolving these trade-offs the aim of the performance measurement is specified further. (Caplice and Sheffi, 1994)

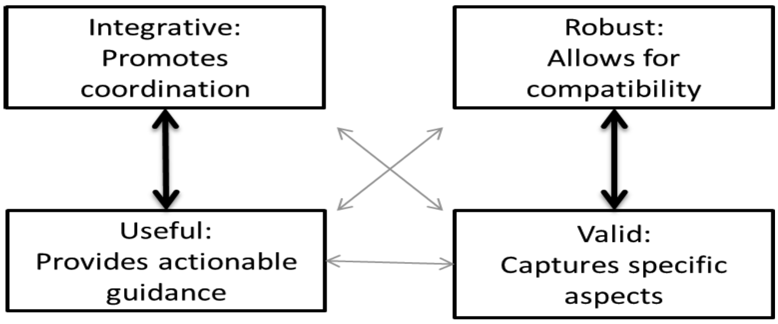

Figure 7 Schematic of criteria trade-offs (Caplice and Sheffi, 1994)

3.8 Analysis model

In the previous sections, general theory related to different areas of measuring is presented. In this section, these different areas will be combined to form an analysis model, which aims to provide guidance for the design of a supply chain dashboard for an operations department. By following the steps described in the analysis model, a dashboard can thus be designed. The analysis model is general in nature and allows for the design of supply chain dashboards aimed at different users and uses.

The first step of the analysis model aims to define the user of the dashboard since that affects the selection of metrics and design of the dashboard. The model then suggests a method for selecting metrics and ensuring that the chosen metrics are adequate by analyzing them individually and as a group using identified requirements. In the theory a set of requirements for a PMS was introduced. By combining these requirements with the theory presented regarding dashboards, a set of requirements for a dashboard was developed and used for the analysis of the metrics as a group. The requirements for a dashboard are presented further below. The final step of the model consists of presenting data through the visual design of the dashboard, the details of this step is however outside the scope of this report. A schematic figure of the analysis model is shown in Figure 8.

Figure 8 Analysis model

3.8.1 The analysis model; step-by-step

Below follows a step-by-step description of the analysis model

1. Define the user of the dashboard; CEO, VP, manager or individual employee
2. Select metrics by following the steps described below:
    a. Identify the stakeholders that the dashboard should consider.
    b. Identify the strategy that satisfies the needs of the stakeholders
    c. Identify and map the processes connected to the strategy that the dashboard should cover.
    d. Select and design metrics according to the processes and their important sub-processes and activities
    e. Ensure that the individual metrics meet the requirements for metrics with consideration to the user (see Table 17 and Table 19)
    f. Ensure that the group of selected metrics together meets the requirements for a dashboard. (See Table 18)
3. Visual design of the dashboard

3.8.2 The analysis model; description

3.8.2.1 Define the user

The first step is to select whom the dashboard is aimed for, to ensure that the selection of metrics will be adapted to that user. Four levels are suggested: CEO, VP, manager or individual employee. These hierarchical levels can naturally differ between companies since they can be structured differently. This analysis model will however refer to the four levels as defined below:

- CEO is responsible for the entire company
- Vice President, VP, has a responsibility for several departments within one area of the company
- Manager is in charge of one department or function
- Employee is not responsible for other staff.

The selected user indicates where in a company the dashboard will be used and what scope it should have, which is developed further in the second step.

3.8.2.2 Select the metrics

It is suggested that the selection of metrics is done in accordance with the method described by Adams and Neely (2000) in the Performance Prism framework. This means starting with the concerned stakeholders for the dashboard and identifying their needs, continuing with identifying what strategy to adopt in order to fulfill these needs. After that, the processes that meet the strategy and stakeholder needs should be identified and finally the necessary capabilities or activities that are needed to operate these processes should be identified. The processes and activities are then used as a base for selecting performance measures for the dashboard. This is referred to in the analysis model as steps 2a-2d. All selected metrics should meet the individual requirements for metrics as presented in theory and discussed in section 3.8.2.3. The metrics should also as a group fulfill the requirements of a dashboard as presented in section 3.8.2.4 below.

3.8.2.3 Requirements for metrics

As mentioned, all selected metrics should meet the requirements for metrics presented in theory to ensure that they are well constructed on an individual basis. The majority of these requirements should be fulfilled regardless of who is the user of the dashboard. This applies to the requirements referred to as *economy, compatibility, reliability,* and *behavioral soundness*.

The requirement for metrics referred to as *level of detail* is dependent on the user of the dashboard as well as the context and purpose of each metric. One part of the requirement refers to which decision level is considered appropriate for each of the four types of user identified in step 1 of the analysis model. This part of the requirement is discussed in more detail further below in connection to the requirement of a dashboard referred to as *useful.* The other part of the requirement *level of detail* refer to more situation and context specific aspects of the metric, which also depends on the user but not specifically connected to the four types of users identified. It rather depends on the purpose of measuring for the specific user of the metric. Examples of such context specific aspects are frequency and scope of measuring.

Another important aspect is the trade-offs that occur between the requirements *integration* and *usefulness* as well as *validity* and *robustness* when selecting and designing the metrics. As can be seen in Table 17, metrics designed according to the requirement *integration* are more important at higher levels in an organization since those mainly focus on the processes, coordination and the overall picture. At lower organizational levels it is more important to include metrics that are designed according to the requirement *usefulness* since those focus more on what actions to take connected to single specified activities.

Similarly, the higher the organizational level of the user, the more important it is to include metrics designed according the requirement *robustness* in the dashboard. This since it allows for comparison and benchmarking to a greater extent than the metrics designed according to the requirement *validity.* At lower organizational level it is however more important to design metrics according to the requirement *validity* since these metrics should be customized to specific activities and based mainly on factors that can be controlled by the person responsible for making decisions.

User **Requirements for metrics**	**CEO**	**VP**	**Manager**	**Individual Employee**
Robustness vs. Validity	Main focus on *robustness*	More focus on *robustness* than *validity*	More focus on *validity* than *robustness*	Main focus on *validity*
Integration vs. Usefulness	Main focus on *integration*	More focus on *integration* than *usefulness*	More focus on *usefulness* than *integration*	Main focus on *usefulness*

Table 17 Trade-offs between requirements for metrics

3.8.2.4 Requirements for a dashboard

As previously mentioned, the metrics selected should be analyzed as a group to ensure that the requirements for a dashboard are met. The requirements for a dashboard were developed using the requirements of a PMS and theory connected to dashboards. Therefore the requirements for a dashboard are to a great extent similar to the requirements for a PMS. The requirements for a dashboard are presented in Table 18.

Requirements for a dashboard	
Useful	The dashboard should provide information in a way that is useful for the user regarding: type of information (see Table 19), amount of information (12-15 metrics where 5-7 metrics are considered critical), and the way it is presented.
Causally Oriented	Non-financial metrics should be included in order to be able to find the root cause of the identified problems.
Vertically Integrated	The metrics in the dashboard should be connected to the overall company strategy and be possible to aggregate or disaggregate to other levels in the organization.
Horizontally Integrated	The metrics in the dashboard should be developed based on processes
Internally Comparable	The metrics in the dashboard should be presented in a way that allows for internal comparability and prioritization. For example using the SCOR attributes.
Comprehensive	All areas critical areas should be included. (See Table 19)

Table 18 Requirements for a dashboard

To fulfill the requirements identified for a dashboard, the included metrics should as previously mentioned be adapted to the user's needs. Table 19 below presents suggestions of how some of the requirements should be fulfilled, with regard to the user. These suggestions are further explained below in connection to each requirement.

User	**CEO**	**VP**	**Manager**	**Individual Employee**
Critical areas to include: ***(comprehensive)***	BSC perspectives	BSC perspectives (if relevant to department) SCOR attributes	Critical areas inherited from higher levels.	Critical areas inherited from higher levels.
Delimiting Scope ***(comprehensive)***	Processes and activities that are critical to the entire company	Processes and activities that are critical to the department	Processes and activities that are critical to the department	Focus on individually performed activities
Decision level ***(useful)***	Strategic	Strategic/ Tactical SCOR level 1-2	Tactical/ Operational SCOR level 2-3	Operational SCOR level 3 or lower

Table 19 Selection of metrics adapted to user

Useful
A dashboard is considered to fulfill the requirement *useful* if it provides information in a way that is relevant for the user regarding the type of information, the amount of information, and the way it is presented. The foundation is therefore to have identified he user, as explained in Step 1 of the analysis model.

Including the right type of information refers to identifying the purpose of the dashboard and choosing metrics that provides useful information from that perspective. It also connects to the decision level of the metric, which can be seen in Table 19. As discussed in theory, dashboards used by senior management should mainly include strategic level metrics. When referring to a dashboard for a VP of a department, the metrics included in the dashboard should be mainly of strategic or tactical level. Metrics of more operational character can however be included if they are assessed as especially important based on the purpose. Particularly for the VP of an Operations department, the metrics could be chosen from the SCOR model and the decision level should then mainly be that of SCOR level 1-2. The decision level of the metrics included in a dashboard at manager level should be at tactical or operational level, which can be compared to metrics at SCOR level 2-3. A dashboard at individual level can include SCOR level 3 metrics, or metrics at an even lower level, that are adapted to the specific activities performed by the individual.

The right amount of information in the dashboard refers to only including a limited number of metrics in order to provide an overview of the important information without causing information overload. As discussed in theory there is no real consensus as to what number of metrics is considered appropriate. Based on what is presented there, the analysis model suggests that the amount of metrics should be limited to 12-15 metrics among which of 5-7 metrics are the most critical metrics.

Causally oriented
In order for a dashboard to fulfill the requirement of *causal orientation* the metrics included should be possible to decompose so that the root cause of the problem can be identified. As suggested by Caplice and Sheffi (2005) this can be achieved by including non-financial metrics.

Vertical and horizontal integration
Regarding the requirement *vertical integration*, the metrics used should be connected to strategy and possible to cascade down through the organization. It should also be possible to connect metrics and thus also dashboards used at different levels in the company by aggregating and disaggregating the metrics included.

For the dashboard to fulfill the requirement *horizontal integration*, the metrics should be developed from important processes and encourage collaboration across functions and divisions. The method of designing metrics described in section 3.8.2.2 aims to fulfill the requirements *horizontal* and *vertical integration* since it advocates that metrics should be developed based on processes and activities, then cascaded down through the organization.

Internal comparability
In order to fulfill the requirement *internal comparability* the metrics in the dashboard should be presented in a way that allows for prioritization between them in cases where trade-offs may occur. This is in theory described as difficult to achieve, but a way of prioritizing is mentioned in

relation to the SCOR model where the attributes can be used as a way of prioritizing between metrics.

Comprehensive
To fulfill the requirement *comprehensive,* all areas that are considered critical for the user should be included. In Table 19, the suggested critical areas specified with regard to user-type are presented as well as a suggestion of the delimiting scope of each dashboard.

The dashboard for a CEO can include parts and perspectives representing the entire company. For that user, it is suggested that the balanced scorecard can guide which areas to include, thereby covering its four perspectives.

For a VP, the dashboard can also represent the different perspectives of the balanced scorecard but it should be contemplated if all of the perspectives are relevant for the processes or activities of that particular department. For a VP of an Operations department the SCOR model is as a way of including all critical areas. The scope of the dashboard at a Vice President's level should be delimited to processes and activities that are critical to the department in question.

As previously explained, the dashboard at manager level should include metrics that represent the activities or processes performed by the particular department. The critical areas to include are mainly inherited from higher organizational levels and the scope should be delimited to the critical processes and activities of the department. The same applies to the dashboard at individual level where the critical areas to include are mainly inherited from higher organizational levels and should be delimited to the activities performed by the individual.

3.8.2.5 Visual design of the dashboard
The final step is to visually design the dashboard, the details of that is outside the scope of this project. It is however important to consider that the way the metrics are presented can make the dashboard easier to use and the results easier to interpret. The layout and design can also help make comparisons and prioritize between the metrics and thus aid in fulfilling the requirement *useful* for the dashboard.

3.8.3 The analysis model; summarizing figure
Figure 9 summarizes the analysis model and the steps included.

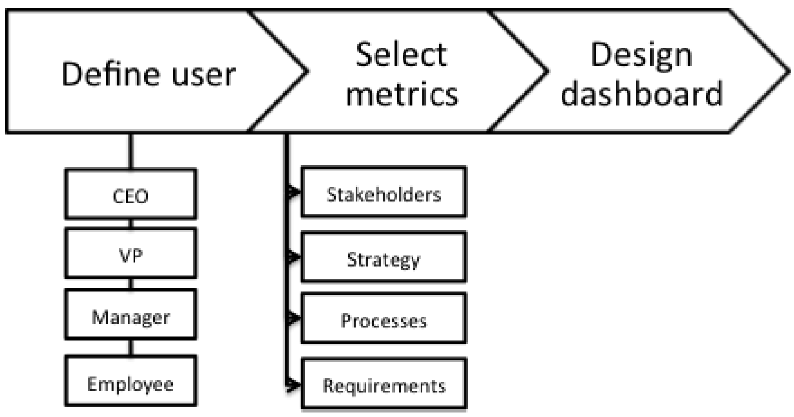

Figure 9 Summary of the analysis model

4 Empirics chapter

In this chapter the empirical findings regarding measuring at Axis Operations will be presented. It introduces the company's strategy and thereafter information regarding internal processes and procedures for selecting metrics. Thereafter the individual metrics are presented in connection to the requirements for metrics presented in theory. The metrics that are presented are primarily the key operations goals, but also some of the functional goals that were suggested as valuable to use in the dashboard by the different departmental managers as well as the Vice President of Operations.

4.1 Background Axis

4.1.1 Axis' strategy

Axis operates in an expanding market and aims to grow faster or in line with the market in the long term. The company's overall goal is to strengthen the market leading position and to achieve a total average annual growth of 20%. Axis aims to achieve these goals through a clear focus on organic growth, and the company's strategic plan is based on global market leadership, loyal partnership and long-term cooperation, and the continued release of new and innovative products and solutions. (Axis, 2013)

Product quality and delivery security are central factors in Axis' business. In the company's annual report it is stated that Axis' "partners and end customers should be able to depend on the right products being delivered on time, in the promised condition and that meet or exceed expectations in terms of reliability, use and functionality" (Axis, 2013). This is also reflected in Axis Operation's mission, which is to "maximize Axis' growth opportunity through a scalable and flexible supply chain, and to achieve this in a capital and cost-efficient way". (Axis, 2014c) Axis aims to achieve this through a flexible production structure, long-term commitment from partners and through establishing configuration centers close to the end customers. The relationship to the partners is developed through continuous evaluation and quality assurance of the partners as well as a shared ambition to improve. Moreover, it is stated in the annual report that the company "considers sustainability through the entire value chain and thus strives to minimize its climate impact, work for good working conditions and fight corruption and violations of human rights." (Axis, 2013)

4.1.2 Axis' supply chain

Axis' role in the supply chain, from a product flow perspective, is that of final assembler at the configuration and logistics centers (CLCs). Axis' upstream and downstream supply chain is explained below and depicted in Figure 10.

The company's downstream supply chain makes up a comprehensive partner network that consists of distributors that sell on to system integrators or resellers that in turn meet the end users. The distributors, also referred to as partners, stock the products and through continual dialogue Axis attains a good understanding of the partners' view of market trends, forecast inventory levels and what channels need to be supplemented or developed. The system integrators and resellers "meet the end customers and handle installation, integration and service of Axis' security solutions. Axis' own sales organization works very closely with partner companies and provides continual support, specialist knowledge and skills transfer." (Axis, 2013)

The manufacturing of Axis' products takes place at contract manufacturers, also referred to as electronics manufacturing services (EMS). The EMSs together with the component suppliers, which supply the EMSs with components, make up Axis' upstream supply chain. (Axis, 2013; Axis, 2014b)

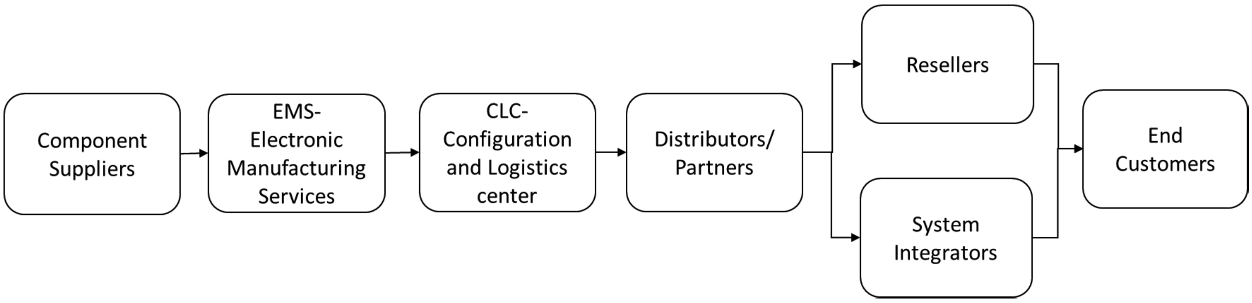

Figure 10 Axis' supply chain from a product flow perspective (own figure based on Axis, 2013)

4.1.3 Departments within Axis Operation

The main role of Axis Operations is to run Axis' supply chain. The departments included in Axis Operations are shown in Figure 11. (Axis, 2014c)

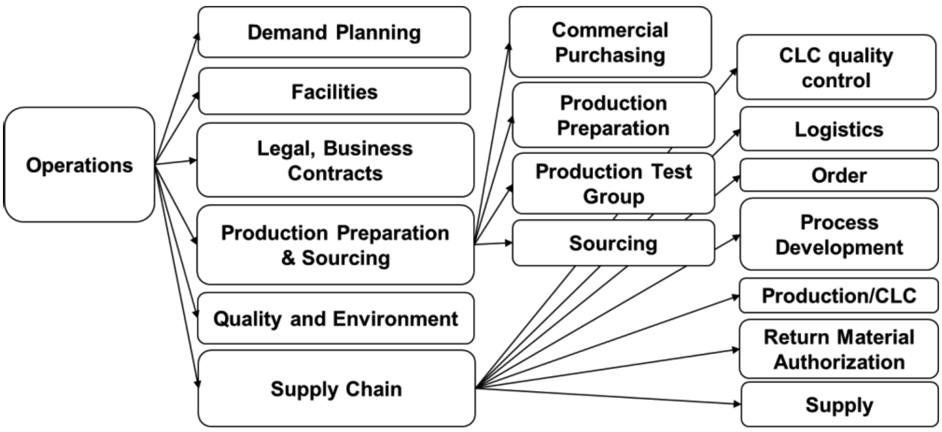

Figure 11 Axis Operations' departments (own figure based on Axis 2014c)

The two main parts of Axis Operations are the Supply Chain unit and the Production Preparation and Sourcing unit. The Supply Chain unit runs the supply chain for all products in volume production and also works closely with the Sales department. (Axis, 2014c) The different departments within the Supply Chain unit are briefly presented in appendix 3.

The Production Preparation and Sourcing unit prepares volume production and also prepares the supplier base for products under development and future products. Production Preparation and Sourcing works in close cooperation with Research and Development and Product Management. (Axis, 2014c) The different departments included in the Production Preparation and Sourcing unit are briefly described in appendix 3.

The departments Demand Planning and Quality and Environment are also part of Operations and are described briefly in appendix 3.

4.1.4 Main processes within Axis Operations

The main processes associated with the Operations department are the Industrialization process, the Product supply process and the RMA process. A simplified overview of Axis Operations main processes is shown in Figure 12 and the processes along with its sub processes are described below.

Figure 12 Overview of Axis Operations' processes (own figure)

1.1.1.1 Product supply process

The Product Supply process includes the following sub processes: Order process, Fulfillment process and Material Supply process which are briefly described below. The Product Supply process also uses input from the support process referred to as the Demand Planning process, which is also described below. An overview of the Product Supply process is provided in Figure 13. (Axis, 2014q)

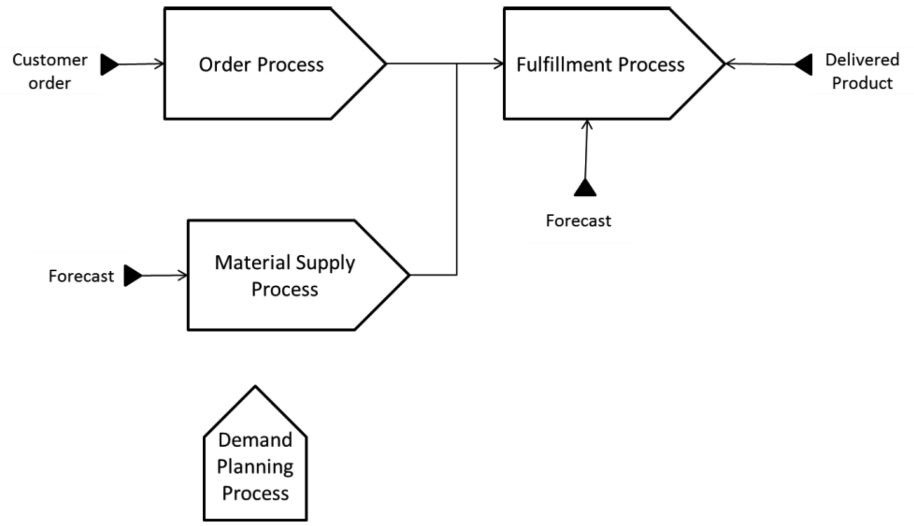

Figure 13 Product supply process modified from figure at Axis' internal webpage (Axis, 2014q)

The order process aims to process customer orders, confirm delivery schedules to the customers, and to inform the customers of product availability. It involves activities such as entering the order into the business system, planning for the production, and confirming the order with the customer. The purpose of the Order process is to secure a rapid and efficient workflow internally, so that customer orders enter the production within as short time as possible. Externally the purpose is to fulfill customer expectations by providing professional and rapid service regarding order processing and confirmation. (Axis, 2014r)

The fulfillment process aims to "deliver customer orders according to the terms set by the order process" (Axis, 2014s). It involves all activities at the CLCs such as checking that material is available, picking the right material, producing the units, and finally packing and shipping the units. (Axis, 2014s)

The material supply process aims to ensure "that the correct material is available in order to satisfy the customer needs" (Axis, 2014l). Based on the prognoses made in the demand planning process the material supply process involves entering orders, surveying the deliveries, receiving the material and checking its quality. (Axis, 2014l)

The demand planning process is the process in which Axis forecasts the future demand in order to prepare inventory, capacity planning and component planning. (Axis, 2014m)

4.1.4.1 Industrialization process

The industrialization process aims to "design and verify the supply chain in terms of quality and capacity" (Axis, 2014n). The process links product development with full scale volume production and involves activities such as sourcing and negotiation with suppliers, development and improvement of test systems for the products, as well as the actual testing of the products. (Nilsson, S., 2014; Axis, 2014n)

4.1.4.2 Return Material Authorization Process

The RMA process aims to ensure quick repair and return service with high quality to the customers. It involves activities such as contact with customer when they report faulty units, receive faulty units at RMA partners who performs the repairs, and shipping the repaired or replaced unit back to customer. (Axis, 2014o)

4.2 Measuring at Axis

Axis Operations currently measures performance using a collection of metrics connected to the Operation's goals. This section will describe how these goals are developed and used within the company.

Per Ädelroth, VP of Operations, (2014) explains in an interview that Axis Operations aims to have a performance measurement system that covers all the important parts of the Operations department and that encourages collaboration between the different functions. To achieve this, all goals and metrics are developed from two main focus areas that are connected to the company strategy, and from the main processes of the Operations department. (Ädelroth, 2014)

In addition to the goals described above, Ädelroth (2014) describes that he uses a tool which presents data related to the current backlog, entered order lines, shipped order lines and invoiced order lines. The data is shown on a daily, monthly and yearly basis and is possible to update in real time. The tool is currently not used in connection to any explicitly defined goals or metrics. However, Per Ädelroth uses the data on a daily basis to monitor for example the balance between the incoming and outgoing order lines and the current backlog level. (Ädelroth, 2014)

4.2.1 Focus areas

The Operations department has decided the two focus areas. They are not directly decomposed from any specific metrics on corporate level but do connect to the company strategy and Operation's mission. All goals at Operations are classified according to the two focus areas as defined below: (Ädelroth, 2014)

- Growth goals, aim to maximize Axis growth opportunity
- Efficiency goals, aim to grow in a capital, cost and environmentally efficient way.

Per Ädelroth explains that the two focus areas are used to facilitate the overview and keep the purpose of the different goals in mind. Although the aim is to not include too many metrics in the

PMS, Ädelroth (2014) explains that it is difficult to keep the total number of metrics for all departments down. Hence, the focus areas aid in categorizing the goals and connecting them to the overall company strategy in order to keep the big picture in mind. (Ädelroth, 2014)

The focus areas can also be used to prioritize between different goals. In case of conflict between a growth goal and an efficiency goal, the growth goal should be prioritized. The efficiency goals are however stated to be vital for the long-term growth and should also be considered important. (Axis, 2014p; Ädelroth, 2014)

Brief explanations of the type of goals that can be found in connection to the different focus areas are presented below in Table 20. (Axis, 2014p) An overview of all key Operations metrics and their definitions will be presented in section 4.3.1.

Focus Area	Goals connected to:
Growth goals	· Delivery and product quality · Flexibility · Shortening of ramp up time of new products
Efficiency goals	· Cost efficiency · Inventory levels · Environment

Table 20 Focus areas and example of goals

4.2.2 Development and use of metrics at Axis Operations

Ädelroth (2014) describes the process of developing metrics as going through the entire business, originating from the company strategy and cascaded down to the individual employees. The starting point is the key operations goals, which are based on the two focus areas and are decided on once a year in the Operations' management team. During these meetings it is discussed if the current goals are still relevant to use for the next year or if some goals should be replaced or new should be added. (Ädelroth, 2014) Based on the overall goals, the goals for each main process are developed and each department is responsible for setting the functional goals for their area and work towards these. (Ädelroth, 2014) The last step involves developing goals for individual employees based on the functional goals.

The process goals are set before the functional goals since the former are supposed to connect the different department and in that way stimulate collaboration between the departments. (Ädelroth, 2014) Moreover, he explains that the reason for using the two focus areas as a base for the development of all metrics is that it is important to primarily focus on the overall goal areas and not too much on individual metrics. However, it is important that there is an ongoing discussion between the different functions about the challenges and what to achieve on a higher organizational level. (Ädelroth, 2014)

Ädelroth (2014) explains that the discussion about the results of the metrics is done through different forums. Two to four times a month the Supply Chain team meets to discuss the goals, what caused the results and what corrective actions can be taken. Once a month there are also meetings with the whole Operations management team, also aiming to find root causes and together decide on improving actions. In between these, the different functions discuss their respective functional goals and what can be improved at each department to improve the results of the overall goals. (Ädelroth, 2014)

4.3 Metrics

In this section Axis Operation's metrics will be presented. The key Operations goals will be presented, first as an overview, and thereafter each individual metric will be presented in connection to the requirements for metrics presented in theory. Thereafter a section that briefly presents the suggested functional goals for a dashboard follows.

4.3.1 Key Operations goals 2014

The key operations goals for 2014 are listed in Table 21, and below follows a presentation of all key operation goals, later analyzed on an individual level. The descriptions of the metrics are based on interviews with departmental managers at Axis. They responded to the questions found in appendix 1 and their answers, in the form of ratings of the metrics based on the requirements, are presented in appendix 2.

Goal	Definition	Focus Area
Delivery precision	Percentage of order lines delivered at agreed point of delivery and exact date agreed on in the first order confirmation. -Not before, not after the confirmed date. (Loftorp, 2014)	Growth
Service level (10days, 20 days)	Percentage of deliveries to agreed point of delivery within 10 respective 20 business days from their order. (Loftorp, 2014)	Growth
Supply chain quality	Perfect order fulfillment without regard to time; right delivery location, right quantity, right article, not damaged, no missed parts. (Qvarfordh, 2014)	Growth
Dead on arrival (DOA) quality	Percentage of articles that do not function when arriving at customer or stops functioning within 3 months. (Loftorp, 2014)	Growth
Time from first article approval to 90% first pass yield	Percentage of projects that achieves to reach a 90% first pass yield within 90 days counted from the approval of the first article. (Nilsson, S., 2014)	Growth
Capacity flexibility	Percentage of suppliers (EMS and strategic and preferred suppliers) that can handle a 30% increased output with 1 month's notice. (Nilsson, S., 2014)	Growth
Return material authorization turnaround time	Percentage of units returned to customers from RMA partners within 5 business days. (Aiyar Panchmatia, 2014)	Growth
Operations costs	Total cost of running operations including production, transport, customs, RMA, and inventory obsolescence. Expressed as percentage of Axis revenue (Loftorp, 2014)	Efficiency
Inventory turnover	Number of inventory turns per year, calculated as the sales divided by the inventory purchasing cost. (Haag, 2014)	Efficiency
Purchase cost	Right price from start and percentage yearly price reduction. (Dzinovic, 2014)	Efficiency
Decrease CO_2/ton km emissions from transport	Percentage reduction of CO_2/ton km emissions from transport. (De Wiengren & Torstensson, 2014)	Efficiency
Payment terms	Number of new suppliers with agreed on payment terms of 60 days or more. (Lindkvist, 2014)	Efficiency

Table 21 Key Operations goals 2014

4.3.1.1 Delivery precision

The metric Delivery precision aims to measure the percentage of order lines delivered at the agreed point of delivery at the exact date agreed on in the first order confirmation. In order to fulfill the requirements of delivery precision, the order lines should neither be delivered after nor before the confirmed date. Delivery precision is measuring an output of the material supply and fulfillment processes, and measures mainly if Axis Operations is keeping its promises to the customers. (Loftorp, 2014)

The departments affecting the result of the metrics are mainly Supply, the CLCs, Logistics and the Quality and Environment department. (Loftorp, 2014; Trotzig, 2014) The Supply department is measured on shortage of available material at the CLCs at the time of production. The delivery precision metric measures the percentage of order lines not delivered on the confirmed date due to shortage of material. (Haag, 2014) The configuration and logistic centers are measured on the percentage of order lines that are sent at the exact planned shipment date, achieved by producing according to plan and ensuring there is enough capacity and personnel available. (Nilsson, T., 2014) Currently, the logistics and transportation part of the delivery precision metric is not measured in real time. Instead a pre-negotiated lead time is added in order to calculate the time of arrival. The goal is to not have any transportation lead times that are longer than five days. (de Wiengren and Torstensson, 2014)

Quality and Environment are measured on the percentage of order lines not delivered to customers at the agreed date due to quality related misses, for example a production stop. This can be caused by for example issues in the design such as wrong specifications or that components delivered by suppliers do not meet the specifications. When a production stop occurs this directly affects the lead time and the issue must be solved as fast as possible to reduce the effect on the delivery precision. (Trotzig, 2014)

Validity and robustness
Delivery precision is a general metric on an overall level, for the different departments the decomposed metrics are more specific. Delivery precision is measured against what the customers have been promised and not a specific time frame, which makes it easier to affect and control. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014, Nilsson, T., 2014; Trotzig, 2014) However, on a departmental level there are still aspects that cannot be controlled, for example the Quality and Environment department measures stops in production that can depend on suppliers or errors in the design. (Trotzig, 2014)

To meet the Delivery precision target, as it is measured today, the order lines must be shipped at the exact scheduled date. Since the real time of transport is not included in the metric, an order line that is not shipped on its exact planned date can never meet the target. In order to investigate whether the transport suppliers deliver as agreed on and to make sure that the pre-negotiated lead times are reliable, the real lead times are measured and analyzed by the logistics department, but this is not included in the delivery precision metric. The way the metric is measured today is therefore perceived as not entirely measuring what it is intended to since it can be said to rather show the shipment precision than the delivery precision. (de Wiengren and Torstensson, 2014)

Integration and usefulness
Delivery precision for the entire Operations department does not give a clear guide as to what to do when changes occur since there are multiple possible sources. (Loftorp, 2014) At departmental level it is easier to know what can be done based on the results. (de Wiengren and Torstensson, 2014; Haag, 2014, Nilsson, T., 2014; Trotzig, 2014). As the metric is broken down per department, the lower levels of the metric are more focused on activities. (de Wiengren and Torstensson, 2014; Nilsson, T., 2014; Trotzig, 2014) Delivery precision is, on a higher level, process oriented and covers most of the Operations department. (Loftorp, 2014) A lot of different functions are involved when going through the results, but for some departments the outcome is reactive and available too late to correct the errors. (de Wiengren and Torstensson, 2014; Loftorp, 2014; Nilsson, T., 2014)

Economy

The general opinion is that the benefits of using the metric outweigh the cost and efforts needed, since it shows the performance of the department. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014; Nilsson, T., 2014; Trotzig, 2014)

Compatibility

The data for the metric is reported into the business system when the order is confirmed and when it is shipped. (Loftorp, 2014) Moreover, the data is shared between the departments and used for other metrics as well. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014; Nilsson, T., 2014; Trotzig, 2014)

Reliability

The metric is considered to be well defined and quite self-explanatory but may need a little clarification to be understood. Throughout most of Operations the metric does not require manual handling when calculating, only when interpreting and acting on the result, but at the Logistics department a risk of errors due to human factor exists as the metric is calculated manually. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014; Nilsson, T., 2014; Trotzig, 2014)

Level of detail

On an overall level the metric gives an indication of the trends in the results, but the underlying causes to changes in the result can only be seen on the departmental level and there it is used as a foundation for decisions. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014; Nilsson, T., 2014; Trotzig, 2014)

Behavioral soundness

The metric reflects the reality and there is little that can be done to make the situation seem better than it is. However, (Loftorp, 2014) explains that by prioritizing new orders over orders that are already late the result would look better although it would cause some customers to receive their products very late. Production could theoretically also be contacted unofficially instead of through the system and thus the lead times would be perceived shorter than they really are. Loftorp (2014) does however not perceive this as a risk or something that actually occurs at Axis today. Delivery precision can be used to give feedback on both overall and department level, but it is necessary to consider the factors that are outside of the departments' control. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014; Nilsson, T., 2014; Trotzig, 2014)

4.3.1.2 Service level

The service level is measured through two metrics. The first one aims to measure the percentage of order lines delivered to the agreed point of delivery within 10 business days from the order confirmation date. The second metric is used to pick up the order lines that miss the goal of 10 business days, and aims to measure the percentage of orders that are delivered within 20 business days from order confirmation. Similarly to Delivery precision, Service level measures the output of the material supply and fulfillment processes. (Loftorp, 2014)

The responsibilities of the different departments are very similar for Service level and Delivery precision. The Supply department is measured on the percentage of order lines that are not delivered to the customer within the time span due to material unavailability. (Haag, 2014) The CLCs are for the 10 days service level metric, measured on the percentage of order lines that are sent within 4 days from order confirmation. This is based on the pre-negotiated lead times of transport of five days mentioned above. (Nilsson, T., 2014) Logistics is, similarly as for Delivery precision, not measuring the transport lead times in real time but are assessed based on the pre-negotiated lead times. (de Wiengren and Torstensson, 2014)

Validity and robustness
Service level is more dependent on the prognosis than Delivery precision is, since it measures against specific time frames. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014, Nilsson, T., 2014) Therefore it is more sensitive to unexpected orders and low inventory levels. The goal is to always deliver to customer within 10 respectively 20 days, and the metric is therefore measured even in circumstances when it is known that it will not be possible to meet the goal. In such a case, the confirmed date to customer may be set to more than 10 or 20 days in order to meet the delivery precision target, but the Service level target will in that case be missed. (Loftorp, 2014)

The metric assumes fixed transportation lead time based on the pre-negotiated lead times mentioned before. This means that if shipments are sent within 4 days from order confirmation and the pre-negotiated lead time is equal to or less than 5 days, the target will be seen as fulfilled. To a small number of customers the pre-negotiated lead time is however longer than five business days, so to these customers the target will always be considered as not being fulfilled when the order is not shipped within 4 days from order. As the metric does not include the actual transportation lead time it can be questioned if it to a full extent measures what is intended. (de Wiengren and Torstensson, 2014)

Integration and usefulness
On an overall level the metric can indicate that effort is needed, but it does not specify what or where, which is easier to see on a departmental level. The metric is an aggregation of metrics from different departments that together show the results of the overall process. The result of the metric is generally available too late for discovered errors to be corrected, but the metric can be used to learn for the future. (de Wiengren and Torstensson, 2014;, 2014; Loftorp, 2014, Nilsson, T., 2014)

Economy
The metric consists of several measures that are combined and is not thought to be particularly difficult to measure, but important to use in order to show Operations' performance. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014, Nilsson, T., 2014)

Compatibility
The information required to calculate Service level is readily available and shared between the involved departments. The data is collected in the same way as for Delivery precision and the two metrics are discussed and reviewed with the same frequency and at the same meetings. (de Wiengren and Torstensson, 2014; Loftorp, 2014, Nilsson, T., 2014)

Reliability
Service level is a general metric that is clearly defined, the exact time frames makes it a bit more specific and can require some explanation. (Loftorp, 2014)

Level of detail
Service level gives an indication of to what extent there is a need to put an effort into improving the results of the metric, but it does not give thorough guidance as to what must be done. On

departmental level it can guide the necessary actions to a greater extent since the potential issues are not as aggregated. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014, Nilsson, T., 2014)

Behavioral soundness
Service level can be used for giving feedback on different levels, some departments can completely control their area of responsibility whereas others are dependent on suppliers and freight forwarders and therefore the metric does not give a correct picture of their performance. (de Wiengren and Torstensson, 2014; Haag, 2014; Loftorp, 2014, Nilsson, T., 2014) Operations as a whole is dependent on the prognosis and changes in the market and should be able to handle regular fluctuations, but it makes it difficult to assess the performance since the conditions can affect the metric a lot. (Loftorp, 2014)

4.3.1.3 Supply chain quality
The supply chain quality metric measures perfect order fulfillment without regard to time. That is, the percentage of order lines delivered according to the following requirements: right address, right quantity, right article shipped, not short shipped, units not damaged, no missing parts, no transportation damages. It is the Supply Chain CLC quality control function that is responsible for measuring this metric and the departments affecting it are mainly the CLCs, the Logistics department and the Order department. (Qvarfordh, 2014)

The Order department is responsible for correctly registering the orders in the business system. The CLCs then pick, pack and ship the right articles, in the right quantity, to the right address, according to what is registered in the business system. At the CLCs the products also pass through testing systems in order to ensure that the units are undamaged and functioning. (Qvarfordh, 2014) The Logistics department is responsible for the products during transport. In order to avoid transport damages, the logistics department keeps a dialogue and a good relation with the transport suppliers and, if it is necessary, changes suppliers. (de Wiengren and Torstensson, 2014) When defects are reported they are classified so that the responsibility can be assigned to different departments. (Qvarfordh, 2014; Loftorp, 2014)

Validity and robustness
The metric consists of several different factors and many of them can be controlled by the different functions of the Operations department. Aspects like transportation however involve the performance of the suppliers. According to the involved departments Supply chain quality measures what it is intended to and is on an overall level general, as it is quite similar to the metric perfect order fulfillment, but on a departmental level it is more specific. (de Wiengren and Torstensson, 2014; Loftorp, 2014; Qvarfordh, 2014) A perceived problem is that the data is reported manually and the categorizing of problem is subjectively made, which may cause inconsistencies in the results. (Qvarfordh, 2014; Loftorp, 2014)

Integration and usefulness
Supply chain quality is perceived as a metric that focuses on processes on a higher level, but is more functional on a departmental level. Supply chain quality includes several parts of Operations, which makes cooperation essential. On an Operations level the metric can indicate that some action must be taken, but since there can be several reasons for a damage to occur it is necessary to investigate further. (de Wiengren and Torstensson, 2014; Loftorp, 2014; Qvarfordh,

2014) For a specific department it is easier to know what to focus on since there are fewer reasons as to what may have gone wrong. (de Wiengren and Torstensson, 2014)

Economy
There are many benefits with measuring Supply chain quality, it is for example needed to be able to continue discussions with suppliers about possible improvements. Still, the metric is considered to be time consuming and requires manual work. (de Wiengren and Torstensson, 2014; Loftorp, 2014; Qvarfordh, 2014)

Compatibility
The routines for collecting data are unique since the information is gathered within many different areas and from different sources. (de Wiengren and Torstensson, 2014; Loftorp, 2014; Qvarfordh, 2014)

Reliability
Supply chain quality is acknowledged as easy to understand and it is similar to the metric Perfect order fulfillment, but without the aspect of time. The purpose and calculation are well defined, but the data gathering could be clarified since it requires manual handling and the classification of damages differ between customers so that some report everything whereas others tend to fix it themselves instead of reporting. (de Wiengren and Torstensson, 2014; Loftorp, 2014; Qvarfordh, 2014)

Level of detail
For a specific department, such as Logistics, the data is on the right level for the employees and for communication with suppliers. (de Wiengren and Torstensson, 2014) On an overall level for Operations the data is on varying levels of detail, making it more difficult to find patterns and make decisions. (Loftorp, 2014; Qvarfordh, 2014)

Behavioral soundness
The department representatives state that as long as errors are reported, the results of the metric represent the actual situation and can be used to give feedback on different levels. (de Wiengren and Torstensson, 2014; Loftorp, 2014; Qvarfordh, 2014)

4.3.1.4 Dead on Arrival Quality
The metric Dead on arrival (DOA) quality measures the percentage of articles that do not function when arriving at customers or that stop functioning within three months from delivery. This is a metric that mainly has a monitoring purpose at Axis Operations since the Operations department normally does not do anything causing malfunction on arrival. In most cases the reason is faults in design or construction. However, Operations can to some extent affect the results of the metric by ensuring that the product is not damaged during transport or after testing it at the CLCs. Moreover, by improving the test systems at the CLCs, fewer defective products are sent to customers. However, it is not a metric that is discussed frequently as long as the levels are within a normal range. (Loftorp, 2014)

Validity and robustness
The metric is not completely controlled by the Supply chain department since damages on a product can depend on faults in design or construction as well as factors that are not within Operations' direct control such as transportation damages. The metric is considered to be general, possible to compare to similar ones and it measures what it is intended to. One identified

problem is that some products are returned as RMA instead of DOA even though they should be classified as the latter. (Loftorp, 2014)

Integration and usefulness
It is an overall measure that involves several departments. Supply chain monitors the metric and when changes occur the reason is not obvious so R&D, support and test functions are involved. Since the Supply chain department does not take action on the metric, the data can be said to be possible to analyze in time. (Loftorp, 2014)

Economy
Since the metric mainly monitors it does not require a lot of resources but it is not as prioritized and important as other metrics. (Loftorp, 2014)

Compatibility
The routines for gathering data are shared with the RMA and products returning for repairs. (Loftorp, 2014)

Reliability
According to Loftorp (2014) the metric is clearly defined and quite self-explanatory, but it may have to be specified that the limit is 30 days. Dead on arrival quality can be misguiding if customers report products as RMA instead of DOA and the support function accepts them, since the metric will not be representative of the actual distribution. (Loftorp, 2014)

Level of detail
Dead on arrival quality is not thought to be on the right level for the users, it is necessary to investigate more to find the wanted information. (Loftorp, 2014)

Behavioral soundness
The reason for the damage can be communicated as feedback to the concerned department. Damaged goods are returned as either DOA or RMA and registered as such, but there is no identified incentive to register DOA as RMA or the other way around. (Loftorp, 2014)

4.3.1.5 Time from First Article Approval to 90% First Pass Yield

This metric measures the amount of projects that manage to go from First Article Approval (FAA) to a 90% First Pass Yield (FPY) at the EMS within 90 days. (Nilsson, S., 2014) The time from the production start (FAA) until 90% FPY is a part of the ramp-up time, which should be kept short. The metric also affects the service level, since a low yield will lead to the CLCs not getting material and components when needed from the EMSs. (Trotzig, 2014) Time from FAA to 90% FPY is primarily measured by the Quality and Environment department and for each of the development projects it is measured whether they manage to reach the 90% FPY target on time or not. (Trotzig, 2014)

Validity and robustness
Time from FAA to 90% FPY measures what it is intended to, according to the involved departments. The involved departments explain that it is intended to measure the part of the product development process that the Operations department can influence. However, the Operations department cannot control parts of the metric since R&D are involved in product development projects and the yield is measured at the suppliers'. As the metric is created specifically for Axis' process it can only be used for benchmarking if it is adapted to be more

general. Similar metrics in other companies tend to be different depending on the product and industry. (Nilsson, S., 2014; Trotzig, 2014)

Integration and usefulness
Nilsson, S. (2014) and Trotzig (2014) comment that the metric covers a part of a larger process that several departments are involved in. Therefore it requires cooperation over many functions within Operations and R&D to reach the goal. The departments working with the metric know how to interpret the results and what to do to reach the goal. If the result of one project is not good, it is possible to learn from this and put in extra efforts where needed. (Nilsson, S., 2014; Trotzig, 2014)

Economy
Time from FAA to 90% FPY is seen as an important metric to measure and at the same time not very complex to measure. (Nilsson, S., 2014; Trotzig, 2014)

Compatibility
The routines for collecting data for the metric are special and require participation from the suppliers. Parts of the data are used in other metrics. (Nilsson, S., 2014; Trotzig, 2014)

Reliability
Nilsson, S. (2014) and Trotzig (2014) state that the metric is easy to understand and clearly defined, but the interpretation of it can be complicated. Assessing the outcome of the metric is subjective since the metric may have reached the goal but then fluctuated with every project. (Nilsson, S., 2014; Trotzig, 2014)

Level of detail
According to the involved departments, there can be underlying conditions that affect the outcome of a project and the aggregated level of the metric, and the fact that it is measured on a yearly basis, makes it very volatile in the beginning of the year. This makes the metric more difficult to use. (Nilsson, S., 2014; Trotzig, 2014)

Behavioral soundness
Nilsson, S. (2014) and Trotzig (2014) comment that the metric is to some degree suitable to give feedback and encourage efforts, but that it is hard to discern who is responsible for what. The subjective assessment of the outcome can make the metric seem better than it really is, and it is also possible to correct errors in production instead of reporting them, thereby increasing the yield. However, a new system will be implemented that logs all activities. (Nilsson, S., 2014; Trotzig, 2014)

4.3.1.6 Capacity Flexibility
Capacity flexibility measures the percentage of suppliers (EMSs, strategic and preferred suppliers) that can handle a 30% increased output when given 1 months' notice. The increase in output can only be requested once per 6 months. (Nilsson, S., 2014) Capacity flexibility is not negotiated along with payment terms, price and lead times since Axis does not reward it extra, but it is a request and an ongoing project to support suppliers and help them achieve it. (Lindkvist, 2014)

The metric is measured manually at the involved departments; Supply, Sourcing and Commercial Purchasing. The departments all measure the same way, the only difference is which suppliers they are responsible for. (Haag, 2014; Lindkvist, 2014) Capacity flexibility is calculated at least once per year and at times up to every quarter, and the departments have regular contact with the suppliers. (Lindkvist, 2014)

Validity and robustness
Nilsson, S. (2014) and Lindkvist (2014) agree that the metric can be affected but not controlled, since it is very dependent on the suppliers and the data that they provide, but Nilsson, S. (2014) considers the departments within Axis to have slightly higher impact on the supplier than what is experienced by Lindkvist (2014). Currently the data is gathered by requesting the suppliers to assess their flexibility. The content and magnitude of the responses differ between the suppliers, making it difficult to assess the situation. Even if the contact is continuous, the capacity flexibility can change over time and this makes it difficult to assess if the metric measures what it is intended to. Capacity flexibility is created to fit to Axis' development process, but can be used for benchmarking with some adaptions. (Nilsson, S., 2014; Lindkvist, 2014)

Integration and usefulness
The metric does not show exactly how to proceed according to Nilsson, S. (2014) and Lindkvist (2014), but the information from the suppliers indicates what to focus on. Since this information can be of varying quality and detail it can be difficult to assess the capacity flexibility, and it cannot be entirely known if a supplier meets it until Axis needs extra capacity. (Nilsson, S., 2014; Lindkvist, 2014) The metric requires a lot of contact with the suppliers, since the prognosis is shared with them and their response is used to plan production and orders. (Nilsson, S., 2014; Lindkvist, 2014)

Economy
The metric is within Axis seen as important to measure and it is not particularly difficult to measure, since the people in charge of the contact with each supplier know if they meet the goal or not. (Nilsson, S., 2014; Lindkvist, 2014)

Compatibility
Capacity flexibility requires continuous contact with the suppliers to maintain the dialogue and ensure that they have the extra capacity. (Nilsson, S., 2014; Lindkvist, 2014)

Reliability
Nilsson, S. (2014) considers the metric to be quite easy to understand, but some explanation is needed, whereas Lindkvist (2014) believes that it takes more explanation for the metric to be understood. The purpose of the metric is clear but how it is calculated is less clear, which connects to that the information the metric is based on is varied and comes from the suppliers and can therefore be subjective. (Nilsson, S., 2014; Lindkvist, 2014)

Level of detail
Nilsson, S. (2014) and Lindkvist (2014) comment that the metric can show the people working with it that something must be done, but since it does not give a clear picture of the situation and the ingoing data is varying, a lot of work is required to follow up and investigate. (Nilsson, S., 2014; Lindkvist, 2014)

Behavioral soundness
Nilsson, S. (2014) states that the metric can be used to give feedback on a departmental level since that is where the responsibility lies, but the lack of clear definitions can lead to differences

in assessment of what is an acceptable level from the suppliers. (Nilsson, S., 2014) Lindkvist (2014) explains that the metric is mainly dependent on information from the suppliers and is not related to the amount of work put in or other conditions that can affect whether a supplier is considered to have the required capacity flexibility. (Lindkvist, 2014)

4.3.1.7 Return Material Authorization turnaround time

The Return material authorization (RMA) turnaround time measures the percentage of working units returned to the customer from the RMA partner within 5 business days, excluding shipment. The metric aims to improve customer satisfaction by reducing the time a customer is without its product due to it being defect. (Aiyar Panchmatia, 2014) The department within Axis Operations that is able to affect this measurement is the RMA department, which is responsible for managing the RMA partners who performs the reparations or replacements of malfunctioning units. In the monthly meetings with the RMA partners the performance is reviewed and the possible reasons to the results are discussed. (Aiyar Panchmatia, 2014)

Validity and robustness

The metric is considered as generic metric by the involved departments and it is considered to measure what is intended. It is however commented on that it would be beneficial to be able to measure in more detail. The metric does not show whether the unit sent back to the customer is the same unit that was sent from the customer to the RMA partner. This is however in most cases not important to know since the customers are mainly requesting to get a unit as soon as possible, not necessarily the same unit. (Nilsson, T., 2014) The departments working with the metric can affect it by cooperating with the RMA partners, but it cannot be completely controlled since some aspects depend entirely on the customers or RMA partners. (Aiyar Panchmatia, 2014; Nilsson, T., 2014)

Integration and usefulness

The result of the metric indicates the performance of the RMA partners, but a lower performance can have different reasons, so it cannot show exactly what a decrease or increase depends on. Therefore it is used to discuss together with the RMA partners what actions can be taken in order to improve results. (Nilsson,T., 2014) Since there are several RMA partners spread out over the world that should work in the same way, cooperation between them and Axis is necessary. It is stated that the metric focuses on this since it shows when extra effort is needed to help the partners improve, but it does not consider internal cooperation within Axis. (Aiyar Panchmatia, 2014) RMA turnaround time can both be seen as measuring a part of a process, as it shows some of the chain when returning products, but it can also be seen as a function that repairs or replaces damaged products. It is possible to look at the data for the metric continuously, but it can require some work and the quality of it can differ. (Aiyar Panchmatia, 2014; Nilsson, T., 2014)

Economy

RMA turnaround time is necessary to measure in order to see if any intervention or extra effort is needed, without the metric the feedback would have to come from the customers. (Aiyar Panchmatia, 2014; Nilsson, T., 2014) Aiyar Panchmatia (2014) states that even though the metric is important, the measuring could be improved to require less effort.

Compatibility
Data related to the metric is gathered in a database when it is collected. (Aiyar Panchmatia, 2014; Nilsson, T., 2014) Aiyar Panchmatia (2014) explains that it is a separate tool and not connected to the same database as many other metrics.

Reliability
The purpose and method of measuring RMA turnaround time is considered to be well defined and those working with the metric understand it intuitively, but minor explanation may be needed. The calculation of the metric requires some manual work, which can affect the quality of the data and be a source of faults. (Aiyar Panchmatia, 2014; Nilsson, T., 2014)

Level of detail
RMA turnaround time can be used as a long-term indicator but it is not possible to base decisions on it without investigating further. Since the metric does not report why the result changes, it is necessary to discuss possible improvements with the RMA partners. (Aiyar Panchmatia, 2014; Nilsson, T., 2014)

Behavioral soundness
The metric can be used to give feed back to the RMA partners through communication and follow up of the results. However, the results have a theoretical potential of being inaccurate if products are not registered as received directly when arriving but rather when the RMA partner already knows that the damage can be fixed, thereby shortening the shown lead time. (Aiyar Panchmatia, 2014; Nilsson, T., 2014)

4.3.1.8 Operations Cost
Operations cost is measured as a total of all the costs related to running the Operations department. (Axis, 2014p) This is presented as a percentage of Axis' total revenue to show the connection to the overall business. It is considered beneficial to display Operations cost this way, since the cost itself is not as relevant as is its relationship to the revenue. By showing the cost as a percentage of revenue, the cost needed to support the sales is indicated. (Ädelroth, 2014) Operations cost is measured quarterly, as that is when the revenue is made public. (Loftorp, 2014)

Examples of the costs measured are transport, customs, RMA, inventory obsolescence and the costs connected to the production at the CLCs. Logistics department measures the world wide freight cost and its reduction; i.e. the total reduction in freight cost for inbound and outbound freight in relation to sales price. Supply is measured on inventory obsolescence, which is the value of the inventory that is scrapped when for example products are no longer sold due to changes in design, or when there are quality issues with the material. RMA measures the RMA cost per unit and its reduction, which includes the monthly fee to RMA partners, cost of materials for repair, cost of shipment and the RMA advance repairs costs.

Validity and robustness
The company can affect all of the cost components the metric consists of. The concept Operations cost may be general, but Axis selects which costs to include and that makes it more specific. Since this selection is done within the company the metric measures what it is supposed to. (Loftorp, 2014)

Integration and usefulness
The metric can only be measured quarterly since it is calculated as a ratio of the revenue, and Loftorp (2014) comments that it would be interesting to be able to see trends earlier. The entire Operations department is included in the metric, but the focus of each department is on their own budget more than on the common goal. Since Operations cost includes several components the reason for changes in the result is not obvious. (Loftorp, 2014)

Economy
The metric is seen as rather easy to calculate since the different cost components already are available and calculated. It is a metric that is necessary to measure to know how much the Operations department costs. (Loftorp, 2014)

Compatibility
The information from each department needed to calculate the metric is available in the ERP system every quarter when it is time to calculate Operations cost. (Loftorp, 2014)

Reliability
Loftorp (2014) states that Operations cost is quite self-explanatory as a concept, but it is not intuitively understood which costs are included and which are excluded. It is well defined and measures the costs that the Supply chain department wishes to include. The majority of the employees at Operations know what the metric means and a few know exactly how to measure it, which is always done in the same way. (Loftorp, 2014)

Level of detail
Operations cost is on the right level of detail for comparing to overall goals but it is necessary to break it down to find details about departments. For that reason it may be missing some information that could be useful. (Loftorp, 2014)

Behavioral soundness
According to Loftorp (2014) the metric can be used to give feedback to Operations as a whole since it is measured on a high level and is cross-functional, but it should not be used individually or per department. Since all costs that are included are documented and registered the metric shows what is intended and an increase in costs is normal if the amount of products sold also increases. (Loftorp, 2014)

4.3.1.9 Inventory Turnover
Inventory turnover (ITO) is measured as Axis' revenue divided by the inventory value and there is a span set as a goal for the measure. (Haag, 2014) There is a balance between Inventory turnover on one hand and Service level and Delivery precision on the other, since high inventory levels will make it easier to fulfill customers' orders but will be very costly and decrease the turnover rate. (Ädelroth, 2014) ITO relates to Operations' overall goal of achieving growth in a cost efficient, capital efficient and environmentally efficient way. The Supply department is solely responsible for measuring Inventory turnover and it is calculated every quarter when the revenue is made available for the public. (Haag, 2014)

Validity and robustness
According to Haag (2014) Inventory turnover is constructed to measure what it is supposed to. The metric is general and depends to some extent on the forecast made by Demand Planning, since that determines the predicted sales and indicates how much to keep in stock. (Haag, 2014)

Integration and usefulness
Inventory turnover is measured quarterly; it is however possible to control it in between by calculating using COGS. It is considered to be a process oriented metric and the result can give an indication and an overview of what action must be taken, but it does not show exactly what has to be done. (Haag, 2014)

Economy
Inventory turnover is seen as easy to measure since the data needed for the calculations are readily available when the metric is to be calculated and the calculations are easy. At the same time the metric and the results that it presents are valuable to see if the goals are met and that the inventory is balanced. (Haag, 2014)

Compatibility
When it is time to calculate the metric, all the data components needed are available from the finance department. No extra effort is needed to gather the information. (Haag, 2014)

Reliability
According to Haag (2014), the people working with the metric understand it. Calculation of Inventory turnover at Axis is clearly defined and data is always gathered the same way. Since the calculations are simple and the data is available, there is little room for human error and the result of the metric is practically always correct. (Haag, 2014)

Level of detail
Haag (2014) perceives the metric to be on the right level of detail for what it is used for. However, it could be beneficial to break it down more for a more detailed level of study since it is possible to analyze the inventory further. (Haag, 2014)

Behavioral soundness
The set goal of Inventory turnover ensures that the metric is not optimized at the expense of Service level, but kept balanced. The metric can be used to give feedback to the department since it is only the Supply department that is responsible. (Haag, 2014)

4.3.1.10 Purchase cost

Purchase cost measures the percentage reduction in purchasing cost compared to the previous year. It also includes having the right price on new products from the start in order to avoid unnecessary costs. (Dzinovic, 2014; Axis, 2014p) The reduction is measured against a baseline, which is the price during the last quarter of the previous year. A change will be implemented where the goal for the metric will be set on a rolling 12 months basis instead of only setting the goals based on previous years last quarter. (Dzinovic, 2014)

Purchase cost is calculated for the products where Commercial purchasing is responsible for the negotiations. These are the components bought from the EMSs, which constitute of the majority of products purchased. The reduction is presented at an aggregate level, but it is possible to investigate the reduction per product or supplier in the tool. Commercial purchasing calculates the metric, but both Supply and Sourcing are involved since they are in contact with different suppliers. (Dzinovic, 2014)

Validity and robustness
Purchase cost is possible to control and affect to some extent but not completely, it is more difficult with single source products and sometimes it is necessary to purchase more expensive components. (Dzinovic, 2014; Nilsson, S., 2014) Both Dzinovic (2014) and Nilsson, S. (2014) agree that the metric is general, but where the latter considers Purchase cost to be measuring what it is intended to, Dzinovic states that it measures most of what is possible, but not everything since not all purchased products are included. (Dzinovic, 2014; Nilsson, S., 2014)

Integration and usefulness
Dzinovic (2014) states that the result of the metric indicates that something must be done but there is no indication of what, whereas Nilsson, S. (2014) claims that there can be some significance when looking at the different suppliers. (Dzinovic, 2014; Nilsson, S., 2014) The metric is dependent on several functions since it is affected by decisions made in the product development phase. According to Dzinovic (2014) and Nilsson (2014) the result of Purchase cost is difficult to affect towards the end of the year even if the current result can be seen continuously, but it is possible to analyze the information and see what potentially can be improved. (Dzinovic, 2014; Nilsson, S., 2014)

Economy
It is perceived as an important metric for Axis to measure to be able to further reduce the purchasing price and continue negotiations with suppliers, it is not difficult to measure but it takes some work. (Dzinovic, 2014; Nilsson, S., 2014)

Compatibility
Purchase cost is considered to be a unique metric in the sense that it does not share data with other metrics and the information must be gathered from several different sources. (Dzinovic, 2014; Nilsson, S., 2014)

Reliability
The metric, including what is measured and why, is perceived as well defined and clear for the people working with it. (Dzinovic, 2014; Nilsson, S., 2014) Nilsson, S. (2014) states that the human factor cannot affect the metric when computing it, while Dzinovic (2014) means that since data input for the metric is done manually, this may cause errors in the results.

Level of detail
The metric is adapted to the people working with it, it shows what has been achieved and gives information about what to focus on in the future. (Dzinovic, 2014; Nilsson, S., 2014)

Behavioral soundness
There is a possibility of misinterpretation when viewing the metric since price reductions may not show properly and it is not clearly defined. However, the metric has a clear goal and a balance between Purchase cost and other factors that are negotiated, for example payment terms and lead time. The change in presentation of the results, to having a moving baseline and goal instead of per calendar year, will reduce the risk of efforts not being made because it would not impact the result. (Dzinovic, 2014; Nilsson, S., 2014)

4.3.1.11 Decrease CO_2/ton km emissions from transport
Decrease in CO_2 emissions per ton km of transportation is an environmental goal and is measured as the percentage difference in emissions originating from freight compared to the

previous year (Axis, 2014p) Since Axis buys the service of transporting for both inbound and outbound goods, the freight forwarders provide the data regarding emissions. (de Wiengren and Torstensson, 2014)

The two departments that are connected to this metric are Logistics and Supply. The Logistics department gathers and consolidates the data from the freight forwarders since they all measure and present their results in different ways. The data from the suppliers is a foundation for negotiations and the department only works with freight forwarders that are certified or have an environmental program. However, the expected outbound lead times is a limitation on which modes of transportation that can be used. (de Wiengren and Torstensson, 2014) Supply measures the increase of ocean and road transport in relation to air transport. The department is responsible for ordering inbound transportation of material to the CLCs, the aim is to use ocean and road transport but urgent orders or delays may lead to the use of airfreight. (Haag, 2014)

Validity and robustness

The metric is perceived as very dependent on the suppliers since all the data is provided by them and they measure and present results differently. According to de Wiengren and Torstensson (2014) Decrease in CO_2/ton km emissions from transport is a general metric that is possible to benchmark, and the aggregation of the suppliers' data means that the metric measures what it is intended to. (de Wiengren and Torstensson, 2014)

Integration and usefulness

The metric is seen as activity oriented and the results from the Logistics department are distributed to other departments. The result of the metric is used as a foundation for further discussions together with the suppliers, but it can only be used for future improvements since the data arrives too late for direct action. (de Wiengren and Torstensson, 2014)

Economy

De Wiengren and Torstensson (2014) consider that it is necessary to measure Decrease in CO_2/ton km emissions from transports to be able to continue improving it together with the freight forwarders. However, the metric requires a lot of manual work to be computed and it is time consuming. (de Wiengren and Torstensson, 2014)

Compatibility

The procedures for gathering and calculating data are considered to be unique and the information is not used for any other metric. (de Wiengren and Torstensson, 2014)

Reliability

Since all suppliers measure differently the metric is not clearly defined and it requires clarification to understand the first time it is seen. The difference in measuring also leads to a higher risk of human error since a lot of manual work is needed to compile the information and calculate. However, new EU regulations will come into place, with guidelines for calculating emissions. (de Wiengren and Torstensson, 2014)

Level of detail

The metric is on the right level of detail for the employees in the department and can according to de Wiengren and Torstensson (2014) be used to maintain discussions with suppliers.

Behavioral soundness

Decrease in CO_2/ton km emissions from transport is a considered a transparent metric but it cannot be used to give feedback about performance since there are several factors that can influence the emissions. (de Wiengren and Torstensson, 2014)

4.3.1.12 Payment terms

Payment terms measures the amount of suppliers out of the total that have agreed to extend the payment terms to at least 60 days. Extended payments terms are beneficial for Axis from a financial point of view. (Haag, 2014; Lindkvist, 2014; Nilsson, S., 2014) This metric is shared between Sourcing and Supply since they are responsible for the contact with different suppliers, but the measuring by the two departments is similar. However, it is Sourcing that is mainly in charge of the negotiations. (Haag, 2014; Lindkvist, 2014)

Validity and robustness

The departments working with the metric, particularly with new suppliers since it is one of the negotiated aspects, can affect Payment terms. However, it may not be possible to achieve from the start and it is more difficult with suppliers of single source components. The metric is considered to be general and measures what it is intended to. (Nilsson, S., 2014; Lindkvist, 2014)

Integration and usefulness

Nilsson, S. (2014) and Lindkvist (2014) state that since the metric only measures one aspect, it shows clearly what should be done if the set goals are not reached. Few departments are involved in the metric, and the metric focuses on activities within those departments. It is possible to act directly on the metric since the negotiations are ongoing, if the goal is not reached the discussions continue and it is a trade-off with aspects such as purchase cost and lead time. (Nilsson, S., 2014; Lindkvist, 2014)

Economy

Payment terms is within Axis seen as an important metric to investigate and it is not difficult to measure since the information about the current payment terms to suppliers is available. Either the goal for each supplier has been met or not. (Nilsson, S., 2014; Lindkvist, 2014)

Compatibility

The information that the metric is based on is not used for any other measuring. (Nilsson, S., 2014; Lindkvist, 2014)

Reliability

The metric is perceived as easy to understand and the human factor cannot unintentionally affect the outcome since it is a binary measure, either the goal has been met or not. (Nilsson, S., 2014; Lindkvist, 2014) Lindkvist (2014) considers payment terms to be a clearly defined metric, whereas Nilsson, S. (2014) somewhat agrees but claims that the purpose has not been common knowledge and the awareness could be improved.

Level of detail

The department representatives say that the metric is on the right level of detail for those using it, since they can interpret the results and continue with the necessary efforts. (Nilsson, S., 2014; Lindkvist, 2014)

Behavioral soundness
The trade-off between purchase cost and payment terms must be kept in mind to avoid sub-optimization when working with the metric. The metric can be used for giving feedback, but the trade-offs must be considered, since there are several aspects that can affect the outcome. (Nilsson, S., 2014; Lindkvist, 2014)

4.3.2 Functional goals

The functional goals that were assessed as interesting to include in the dashboard by the departmental managers at Axis Operations and the VP of Operations are listed in Table 22 and presented in more detail below.

Goal	Definition	Growth/ Efficiency
Forecast accuracy and bias	Measures the percentage accuracy and bias of the forecasted prognosis. (Hjelmström, 2014)	Growth
Ramp up accuracy	Measures the accuracy of the forecasts during the ramp-up of a product. Measured as the percentage of projects for which the actual sales ends up within the span of a low and a high forecasted scenario. (Hjelmström, 2014)	Growth
First article approval lead time	The percentage of new components for which the lead time from receiving a FAS (first article sample) request for a component until first article approval is sent out is less than 4 days. (Trotzig, 2014)	Growth

Table 22 Functional goals that are possible candidates for a dashboard

4.3.2.1 Forecast accuracy and bias

Forecast accuracy and bias are two metrics that are used to assess the precision of demand planning activities. The forecast accuracy expresses the difference between the actual sales each month and the prognosis that was made earlier. A prognosis that is too high will lead to higher inventory levels and lower Inventory turnover, a prognosis that is too low will affect the Service level due to for example shortages in material. (Hjelmström, 2014)

Forecast accuracy is accompanied by bias. Each product is given a weight by multiplying its cost of goods sold (COGS) with its number of sales. The higher the volume value, the more important the product is. The bias is then calculated as the error in prognosis, times the weight of the product and this is presented as a minimum and maximum bias, average and median for the products. The two metrics are displayed for the entire prognosis as well as divided per product classes – A, B and C. (Hjelmström, 2014)

Validity and robustness
Since the metric is measuring how well the prognosis corresponds to the future it is difficult to assess whether or not it is possible to control. It is Demand planning that is responsible for planning the expected forecasts but the actual result of the forecast accuracy depends on other departments such as the sales department. However, Demand planning does have methods and knowledge to do the forecasts and as expressed by Hjelmström (2014): “If we were not able to affect it at all it would be meaningless to measure”. The metric shows what it is supposed to show with regard to how the forecasting goals are defined. It could according to Hjelmström, (2014) be interesting to include the actual sales margin when calculating the bias, since only

weighting according to the volume value does not show the whole truth. However, the current way of measuring works well. (Hjelmström, 2014)

The metric is to some extent general and possible to use for benchmarking. The time frames of measuring can differ between companies and the way that some products are grouped together make it less comparable to other companies. However, it is still possible to compare how the prognoses are in comparison to other companies. (Hjelmström, 2014)

Integration and usefulness
The metric shows the results of decisions made earlier and it is therefore not much that can be done to take corrective actions. The results are rather used as a way of understanding reasons to, for example, current availability problems. It is also used as a way of understanding the reasons to why the prognosis made was not correct and to learn from the mistakes in order to improve future forecasts. For example if it is identified that there is a tendency of unfounded optimism in a specific quarter, this can be taken into account when doing future forecasts for the same period. (Hjelmström, 2014)

Hjelmström (2014) explains that the collaboration around the metric consists mainly in Demand planning explaining to other departments, for example the purchasing department how the forecast accuracy may have affected the inventory levels. Meetings are held with other departments and actors such as sales, product managers and distributors, providing important input to the planning activity. Hjelmström (2014) describes the forecast accuracy as the output of a relatively big process since there are a lot of factors included, for example if the regional sales departments perform projects as planned or if all orders are reported as they are supposed to. (Hjelmström, 2014)

Economy
Hjelmström (2014) expresses that the metric is important and valuable to follow up but she feels that too much time is spent on the calculations. Especially since the department in many cases already know what the result will be, but still have to perform the calculations. She does however believe that the benefits of using the metric still outweigh the costs and efforts connected to it. (Hjelmström, 2014)

Compatibility
The data for the metric is available in the business system and used for other purposes as well. There is however a specific file that needs to be filled in in order to extract the data for the metric. (Hjelmström, 2014)

Reliability
According to Hjelmström (2014) the result of the forecast accuracy part of the metric can be quite intuitively understood while the bias part is much more difficult to understand as it is more abstract. The metric therefore needs a lot of explanation and it is based on many formulas and calculations. There is also a risk of the result of the metric being incorrect due to the calculations being performed manually in Excel. The purpose of the metric is rather clear to all involved although the exact procedures regarding how to perform the specific activities connected to the metric are not always defined. (Hjelmström, 2014)

Level of detail
The metric is used by Demand planning in order to identify the reasons for differences between actual and forecasted demand, and to learn from that. It is also used for communicating reasons for Axis' behavior towards other actors, e.g. to suppliers that are affected by Axis suddenly increasing or decreasing the number of orders. The level of detail is according to Hjelmström (2014) appropriate for how Demand planning works today.

Behavioral soundness
Hjelmström (2014) believes that the metric is not encouraging any counterproductive behavior and that it can be used to give feedback about performance. As it is considered worse when a prognosis is below actual sales than when it is too high it could lead to the prognosis in general being too high. There is an upper limit for the prognosis as well, and the department aims to do the prognoses as accurately as possible. The goal is cascaded down to the individual performance goals and helps keeping a focus on what is important. Since the result of the metric depends on factors that cannot entirely be controlled Hjelmström (2014) explains that it is possible to feel that the outcome was not Demand planning's fault, but it is a good way of creating a feeling of responsibility. The metric is also used in order to understand why other departments may not have reached their goals, for example the material availability goal for Purchasing and the Service level goal that affects the entire Operations department. (Hjelmström, 2014)

4.3.2.2 Ramp up accuracy
Ramp-up accuracy measures the accuracy of the ramp-up plan of a new product. When launching a new product, Demand planning and product analysts cooperate to create 3 scenarios for the expected sales within the coming 6 months. One scenario shows the expected prognosis, one shows the lowest expected outcome and the last scenario shows the highest expected outcome. The worst and best case scenarios are used as upper and lower limits for a span, and the metric measures the percentage of projects for which the actual sales are within that span. (Hjelmström, 2014)

Validity and robustness
The factors that affect the outcome of the metric are quite similar to those for Forecast accuracy. It is not possible to know exactly what will happen in the future but Demand planning has methods for how to do forecasts and can thus affect the outcome. The outcome of Ramp up accuracy can to be controlled to a greater extent than Forecast accuracy, since the span between the highest and lowest expected scenario is decided by Demand planning. However, there are more factors that can affect the outcome of the metric compared to Forecast accuracy since Ramp up accuracy forecasts the demand of new products and the input data to the forecast is less reliable. (Hjelmström, 2014)

The metric measures what it is supposed to according to its definition. Hjelmström (2014) contemplates the value of measuring the metric in some other way, for example by comparing the actual sales to the expected outcome. A problem with the way the metric is measured today is that a project that ends up just outside of the span is considered as bad as a project that is far outside the span. This since the metric considers only if the expected sales are within the span or not. (Hjelmström, 2014)

Hjelmström (2014) assesses the metric to be quite comparable, but each ramp up project is unique and implies different conditions. Some products are entirely new which makes it more difficult to predict and some new products are just new versions of already existing products, which makes the forecasting easier. (Hjelmström, 2014)

Integration and usefulness
The outcome of the metric is based on several different aspects and the metric does not provide any clear guidance as to what actions to take in regard to the result. The analyzed results are historical and cannot be used to correct current projects, but can be used to identify trends in the accuracy of the forecasts. (Hjelmström, 2014) There are quite many departments that affect the result of the ramp up accuracy metric but it is Demand planning that is responsible for doing the actual forecast and the metric is mainly used within the department. (Hjelmström, 2014)

Economy
The metric is not difficult to measure and is in general considered valuable. The benefits of measuring the metric outweigh the costs although there is some critique regarding the way the metric is measured, as explained above. (Hjelmström 2014)

Compatibility
The data used is readily available and not unique for the metric. (Hjelmström, 2014)

Reliability
The metric only needs a brief description to be understood. What could be a possible source of confusion is according to Hjelmström (2014) that Ramp up accuracy is very different from Forecast accuracy. If comparing the two it could cause confusion that Ramp up accuracy, which involve more insecure forecasting, have a higher goal than Forecast accuracy. Hjelmström (2014) however does not believe that this causes any problems. The purpose of why the metric should be used is clear although the procedures connected to forecasting involve many assumptions. The descriptions of the calculations are clear but there is a risk of human errors affecting the result. (Hjelmström, 2014)

Level of detail
The metric gives a good overview of the total number of projects for which Ramp up accuracy was satisfactorily met. However, it does not provide any information about the reasons to the results, for example what products that affected the result. In order for the information to be useful it is necessary to investigate the root causes. (Hjelmström, 2014)

Behavioral soundness
Since the metric measures the percentage of projects for which the actual sales ends up within the span, Demand planning could theoretically set the scenario limits extremely high respectively low to create a larger span and increase the chances of the actual demand ending up within the span. Hjelmström (2014) however considers this to as unlikely. Partly because there are other actors involved in the meetings when the scenarios are decided who would question too extreme limits, but primarily because Demand planning has no interest in deliberately setting the limits incorrectly.

4.3.2.3 First article approval lead time
First article approval lead time measures the percentage of the new components that are approved by the Quality and Environment department within 4 days of arrival. The metric is one of the final steps of industrialization process and relates to getting products to market as quickly as possible. (Trotzig, 2014)

Validity and robustness
The metric is to a great extent based on factors that can be controlled. It measures the lead time from the moment the Quality and Environment (Q&E) department receives a First Article Sample (FAS) request from a design engineer until the component is approved by the Q&E department. The role of the Q&E department is mainly to review and ensure that all necessary tests are already performed; e.g. the designer should have made sure that all measurements are correct and that the component is cosmetically and functionally approved, the electronic parts should function, and the quality engineers ensure that the supplier and their processes are verified and approved. If any of those steps are not performed correctly, the Q&E department should make sure that it is done as soon as possible. (Trotzig, 2014)

The metric measures what it is supposed to according to its definition. However, Trotzig (2014) explains that this activity is only a small part of the bigger approval process, and what really should be measured is the whole process from when the FAS is built at the EMS until volume availability is reached at the CLCs. This is a process that includes not only the approval of the FAA but also that all verifications are ready at the CLCs regarding pre-production and pre-volume. It also includes the transportation of the first volume batch. This process has been mapped and improvements to the process have been identified but it is still not implemented. In order to start measuring this process, a method of how it should be measured first needs to be identified. (Trotzig, 2014)

Integration and usefulness
The way in which the metric is defined today it measures a specific activity and provides clear guidance to what needs to be done in order for the activity to be fulfilled. It does not encourage collaboration between different departments to a great extent since it is mainly Q&E's activity. Other departments are however contacted by Q&E and thus involved when the different tasks from the checklist are not satisfactorily fulfilled. Trotzig (2014) explains that each single case should be handled as fast as possible and it is easy to notice when the lead time will not be met. Corrective actions can then be taken directly. (Trotzig, 2014)

Economy
The metric was previously logged and calculated in Excel. Now all data has to be available in the intranet where there is no functionality for doing calculations. Hence it is today more cumbersome to perform the calculations. With regard to this, as well as that it can be questioned if the metric really measures what it is supposed to; Trotzig (2014) expresses concerns regarding if the benefits of this metric outweighs the costs. (Trotzig, 2014)

Compatibility
The data needed for the metric are unique and need to be collected only for this metric. (Trotzig, 2014)

Reliability
The metric is according to Trotzig (2014) easy to understand and the purpose of measuring it is clear. There is however no clear definition of when to start calculating the lead time; e.g. if it should start when the FAA is created or when it is left at the Q&E department. There can also be discussions with the design engineer regarding if the FAA is ready to be handed over, which affects when to start calculating the lead time. (Trotzig, 2014)

Level of detail
The level of detail is currently correct for the actions that should be taken by the Q&E department. (Trotzig, 2014)

Behavioral soundness
The metric in itself does not encourage counterproductive behavior. However, the target level is set low in comparison to other goals at Axis, which to some extent creates less of a sense of urgency. (Trotzig, 2014)

5 Analysis

In this section the analysis model is applied, with an aim of suggesting a set of metrics for Axis Operations' dashboard. The section initially goes through the first steps of the analysis model in order to identify the user of the dashboard, the stakeholders, the strategies and the processes at Axis Operations. Thereafter a set of metrics for Axis Operations' dashboard is selected based on theory and these metrics are individually analyzed according to the requirements for metrics. The metrics in the current PMS at Axis Operations are also individually analyzed using the requirements of metrics. The two lists of metrics are then compared in a gap analysis resulting in one combined set of metrics. Finally, the combined set of metrics is analyzed using the requirements of a dashboard in order to ensure that the final group of metrics suggested meets the requirements presented in theory. The set of metrics suggested from theory and the set of metrics currently used at Axis Operations are also analyzed against the requirements for a dashboard in order to be able to compare the final suggestion of metrics to the two alternative solutions.

5.1 User of dashboard

The user of the dashboard is in the mission statement of this project defined as the VP of Operations at Axis. As previously explained, who the user of the dashboard is affects what type of metrics to include in it.

Table 23 shows the type of metrics that, according to the analysis model, should be included in the dashboard for Axis Operations. This considers level of detail, critical areas to include and the trade-offs between certain requirements for individual metrics. It is used as a base for the analysis of the current metrics at Axis Operations as well as for the metrics suggested from theory.

User	**VP of Operations**
Critical areas to include: ***(Comprehensive)***	· BSC perspectives (if relevant to the Operations department) · SCOR attributes
Delimitation of scope	· Processes and activities that are critical to the Operations department.
Level of detail:	· Strategic/tactical · SCOR level 1-2
Robustness* vs. *validity	· More focus on *robustness* than *validity*
Integration* vs. *usefulness	· More focus on *integration* than *usefulness*

Table 23 Type of metrics to include in a dashboard for a VP of Operations

5.2 Suggestion of metrics from theory

According to the first steps of the analysis model, the selection of metrics should be based on processes connected to the stakeholders' needs and the strategies identified to fulfill these. The information regarding Axis Operations' stakeholders, strategies and processes, which was used as a base for selecting the suggested metrics from theory, is summarized in Table 24.

Key stakeholders for Axis Operations	· CEO/board of Axis · Partners · End customers
Stakeholders' wants and needs	· The CEO/board wants to strengthen the company's position as market leaders and achieve an annual growth of 20%. · Partners should be able to depend on the right products being delivered on time, in the promised condition and meet or exceed expectations in terms of reliability, use and functionality. · End customers are from Axis Operations' perspective mainly interested in the aspects related to the product such as quality and functionality. This since the end customers buy products or solutions from the partners and are therefore not to the same extent directly affected by the delivery performance of Axis Operations.
Strategies pursued in order to satisfy stakeholders' wants and needs	· Loyal partnership and long-term cooperation with partners · Continual evaluation and quality assurance of partners and a shared ambition to continuously improve · A scalable and flexible supply chain managed in a capital and cost efficient way

Processes put in place in order to allow the strategies to be delivered	· Product Supply Process
	    · Order process
	    · Fulfillment process
	    · Material Supply process
	    · Demand planning process
	· Industrialization process
	· Return Material Authorization (RMA) process

Table 24 Stakeholders' needs and processes at Axis Operations

Below follows a section where the metrics suggested from theory are evaluated based on the requirements for metrics as specified in the analysis model. However, as the metrics analyzed are not currently in place, the assessment of some of the requirements are more hypothetical than others. The requirements *economy*, *compatibility, reliability* and *behavioral soundness* are dependent on how a metric is incorporated into the company, as they are evaluated based on routines and procedures for using the metric. In the analysis below, these four requirements will therefore be analyzed from a more general point of view focusing on what to consider if the metrics should be implemented. Thereafter follows a section where the metrics are analyzed according to the other individual requirements and the metrics are then assessed as appropriate to include when the requirements of *robustness* and *integration* are fulfilled to a greater extent than the requirements of *validity* and *usefulness.* The assessment of the appropriateness of a metric is however also based on the purpose of the metric and the type of information that it provides.

Economy

The extent to which a metric is considered to fulfill the requirement *economical* depends on to what extent the Operations department perceive that the metric provides valuable information as well as how much effort is needed for measuring it. As this cannot be entirely known in advance, it is difficult to assess the requirement *economy* for the metrics suggested in theory. A more detailed and technical investigation, which is outside the scope of this study, would be needed in order to grasp the width of all possible benefits as well as all the potential costs of implementing a specific metric.

The input data is most likely already available for some metrics, others may depend on the current activities in the company or exist to some degree but not completely. Other metrics can require activities that have not been done before. For some of the metrics originating from the SCOR model it is stated that the data needed tends to be available in most companies' ERP systems. However, this only gives an indication of whether the data is easy to find or not and does not consider the amount of processing needed or what kind of system support that is possible and available.

Compatibility
As with the requirement *economy*, the requirement *compatibility* is dependent on existing routines and procedures in the company. Aspects that affect the *compatibility* are both the needs of the metric and the tools and procedures already in place. Without more examination it is not possible to determine the degree of overlap and congruence. A metric that is similar to those already in use, or that combines two results, may be possible to introduce in a company without considerable effort, while another may require completely unique data gathering and calculation procedures. The requirement also depends on if there are any ERP systems or business systems and the scope of them.

Reliability
In order to meet the requirement *reliability* it is necessary to have explicit routines that are solid in the sense that the outcome is trustworthy, that it is not subjective and has not been intentionally or unintentionally tampered with. For metrics that have a clear definition and way of measuring from the start the requirements are easier fulfilled, but it all depends on the implementation. Without a thorough understanding of the metric, regarding both the purpose and the origin of the data, misunderstandings may arise from wrongful interpretations.

Behavioral soundness
The definitions and procedures influence the daily use of the metric and thereby also influences the extent to which the requirement *behavioral soundness* is fulfilled. This is important to be aware of and work towards avoiding when implementing a new metric as well as when setting goals and creating bonus systems. This since incentives can lead to unexpected and unwanted actions. It may for example be possible to tamper with metrics by incorrect registrations so that results look better than they actually are. The risks of this happening can however be reduced by sound incentives and a culture of discussing the causes of the results rather than assessing individual or departmental performance only based on the actual result.

5.2.1 Metrics for the Product supply process

As presented in the empirical chapter, the Product supply process at Axis is the overall process that aims at supplying the market with products, based on the customer orders and sales. Since Axis Operations' strategy is to grow by fulfilling the customers' demands regarding quality and reliability, the metrics for the Product supply process should reflect this. Metrics that measure the capital efficiency of the process should also be included, since Axis Operations' mission states that growth should be achieved in a capital efficient way. Based on this, the following metrics are suggested for the Product supply process. They are presented as an overview in Figure 14, with definitions in Table 25, and they are analyzed individually below. Some of the metrics presented as belonging to the Product supply process are, according to Davis (2014), so called end-to-end metrics. These metrics are still considered to belong to the Product supply process since the Operations department can affect the suggested metrics to a great extent, although other departments influence some parts of the metrics. This is discussed in more detail in connection to the individual requirements for each metrics.

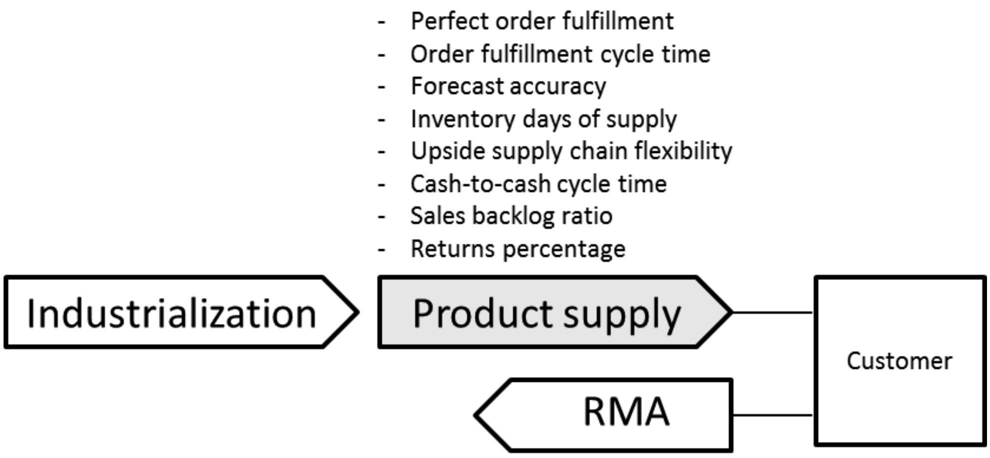

Figure 14 Overview metrics Product supply process

Metric	Definition
Perfect order fulfillment	The percentage of orders meeting delivery performance with complete and accurate documentation and no delivery damage. Components include all items and quantities on-time using the customer's definition of on-time, and documentation – packing slips, bills of lading, invoices, etc.
Order fulfillment cycle time	The average actual cycle time consistently achieved to fulfill customer orders. For each individual order, this cycle time starts from the order receipt and ends with customer acceptance of the order.
Forecast accuracy	Forecast accuracy is calculated for products and/or families for markets/distribution channels, in unit measurement. Common calculation: (Sum Actuals – Sum of Variance)/(Sum Actuals) to determine percentage error. Monitoring the delta of Forecast Accuracy over measured time periods can determine success rates.
Inventory days of supply	The amount of inventory (stock) expressed in days of sales.
Upside supply chain flexibility	The number of days required to achieve an unplanned sustainable percentage increase in quantities delivered.
Cash-to-cash cycle time	The time it takes for an investment made to flow back into a company after it has been spent for raw materials.
Sales backlog ratio	The ratio between the current backlog of orders that a company have compared to the sales for a given period.
Returns percentage	Value of returns versus net revenue sales of an item

Table 25 Metrics suggested for the Product supply process

5.2.1.1 Perfect order fulfillment

Validity and Robustness
Perfect order fulfillment is a metric from SCOR level 1, therefore it is general, well established and possible to use for comparison to other companies or industries. The metric is based on the level 2 metrics Percentage of orders delivered in full, Delivery performance to customer commit date, Document accuracy and Perfect condition. As these level 2 metrics involve the work of several different departments it is not possible to completely control them on an aggregate level, even if the separate departments can do it. For those reasons, Perfect order fulfillment is considered more *robust* than *valid* according to the requirements.

Integration and Usefulness
The metric focuses on a process and the performance of the supply chain and not an individual activity. It includes several departments whose joint effort is shown in the outcome of the metric. Even if not all departments affect each other, some issues that arise early in the supply chain, such as delays, can be counteracted by those downstream. In that sense the metric encourages cooperation, as problems may be corrected instead of amplified. The metric does not show clearly where problems arise or what to do about them, but the level 2 metrics can provide further indications. According to the definitions of the requirements, Perfect order fulfillment is assessed to be more *integrated* than *useful*.

Level of detail
The metric is a SCOR level 1 metric and gives an overall view of the supply chain's performance and connects to customer satisfaction, therefore it is regarded as the *right level of detail* based on the requirements.

Conclusion
The requirements are fulfilled and the metric is assessed as appropriate as it provides information connected to customer satisfaction, which is an important part of the company´s strategy.

5.2.1.2 Order fulfillment cycle time

Validity and Robustness
Being a level 1 SCOR metric, Order fulfillment cycle time is general and can potentially be used for benchmarking. The metric consists of the level 2 metrics Source cycle time, Make cycle time, Deliver cycle time and Delivery retail cycle time. As these metrics relate to different parts of the process and is based on four components, it is not just one responsible department that controls it. Based on this, Order fulfillment cycle time is assessed as more *robust* than *valid* according to the requirements.

Integration and Usefulness
The metric is a combination of several cycle times that jointly capture the process from sourcing to making and delivering the order. As different functions and departments are involved and the activities follow upon each other, the metric encourages collaboration and communication in order to get the goods to the customers on time. No explicit guidance is given that can explain changes in the outcome, but by using the level 2 metrics it is possible to gain more clarity and identify where problems occur. As this is the case, Order fulfillment cycle time is regarded as meeting the requirement *integration* to a higher degree than the requirement *usefulness.*

Level of detail
Order fulfillment cycle time is a SCOR level 1 metric and measures the time of the full process; therefore it is assessed to be on the right *level of detail* based on the requirement.

Conclusion
The metric fulfills the requirements and is assessed as beneficial to measure since without knowing the approximate speed of the supply chain it is difficult to set delivery dates to the customers.

5.2.1.3 Forecast accuracy

Validity and Robustness
The metric is not constructed from other metrics, but it measures the outcome of all the work that is put in to the work of making the prognosis. All aspects of the work may be possible to control by the departments responsible for them, but not by the one measuring Forecast accuracy. The metric is possible to compare against other companies, a scale-less metric presented as a percentage even more so. Thereby the metric meets the requirement *robustness* to a greater extent than the requirement *validity*.

Integration and Usefulness
Forecast accuracy covers the activities needed to create a prognosis and the outcome of the sales. The prognosis is a base for other functions within the Operations department and part of the Order fulfillment process as it sets conditions for and gives guidelines to for example the departments working with purchasing; in that way it encourages communication. Forecast accuracy does not give any guidance and it is not possible to correct the prognosis based on the result, as it is only available after the time period in question. Based on this, Forecast accuracy is assessed as more *integrated* than *useful*.

Level of detail
Forecast accuracy is a level 3 metric, so the information it provides must be considered as relevant to be at the right *level of detail* according to the requirements.

Conclusion
The metric fulfills the requirements and is assessed as appropriate to include despite the fact that the metric is a SCOR level 3 metric. This since it provides relevant information that is used by several departments and gives indications of the performance of the entire product supply process.

5.2.1.4 Inventory days of supply

Validity and Robustness
The metric is a SCOR level 2 metric and can be used when benchmarking. The different factors affecting the metric are the rate of purchasing of material and the rate of sales, where the rate of purchasing should be adapted to the rate of sales. These factors are to some extent possible to control at a disaggregate level. The outcome of the metric can however not be controlled by one single department since, for example, the purchasing department will depend on the forecasts when purchasing the material. The metric is therefore considered to be more *robust* than *valid* according to the requirements.

Integration and Usefulness
By only looking at the result of the metric it is not entirely clear what needs to be done although it does give indications of where to look for the problem. The result of the metric can be improved through either better forecasts or by purchasing material more in accordance with the existing forecasts. The metric shows the result of the combination of several processes and it encourages collaboration between the departments since it is important for the purchasing department and the demand-planning department to communicate to improve the results. Based on the description above the metric is assessed to fulfill the requirement *integration* more than the requirement *usefulness*.

Level of detail
The level of detail of information is considered to be correct for the dashboard for Axis Operations since it is a SCOR level 2 metric and fulfills the requirements *robustness* and *integration* more than the requirements *validity* and *usefulness*.

Conclusion
The metric fulfills the requirements and is assessed to be valuable for Axis since it helps in improving the capital efficiency of the Product supply process.

5.2.1.5 Upside supply chain flexibility

Validity and Robustness
The metric is a SCOR level 1 metric, which enables benchmarking. However, the extent to which the metric is possible to benchmark is affected by the percentage increase that is decided on. It must therefore be considered whether the chosen percentage should be at the levels that Axis actually needs to achieve and thus make the metric adapted towards a situation that is specific for Axis, or if it should be chosen according to what the competitors use. It can also be argued to what extent it is possible to benchmark since the result of the metric is based on planning activities and therefore is hypothetical.

Some of the different factors affecting the metric are possible to control at disaggregated level, for example capacity flexibility at the CLCs. Other factors are possible to affect but to a lesser extent, for example the capacity at the suppliers. However, since the metric is shown at an aggregate level each person or department that can affect the result of the metric cannot control all different parts of the metric. The metric is therefore regarded as fulfilling the requirement *robustness* to a higher degree than the requirement *validity*.

Integration and Usefulness
The metric does not provide guidance to what specific action to take since it is measured on an aggregate level and shows the flexibility for the entire supply chain. It does however give an indication of when something needs to be done and metrics at more disaggregate levels can be used in order to show where in the supply chain improvements are needed. The metric provides an overview of the flexibility of the supply chain and encourages collaboration between different departments since increased demand can only be reached if all different parts involved are sufficiently flexible. Communication between the different parts is therefore needed. Based on the above discussion the metric is assessed as more *integrated* than *useful* according to the requirements.

Level of detail
The level of detail of information is considered to be correct for the dashboard for Axis Operations since the metric is a SCOR level 1 metric and is fulfilling the requirements *robustness* and *integration* to a higher degree than the requirements *validity* and *usefulness*.

Conclusion
The metric is considered to fulfill the requirements for a dashboard and is assessed to be valuable for Axis since it can help in optimizing the overall supply chain performance and the outcome of the Product supply process. This since it helps Axis Operations to be prepared to respond to sudden demand increases, which is important to be able to do in order to achieve a sustained growth.

5.2.1.6 Cash-to-cash cycle time

Validity and Robustness
The metric is a SCOR level 1 metric and is therefore considered general and possible to use when benchmarking. The metric measures the combined outcome of the SCOR level 2 metrics: Days payable outstanding, Days sales outstanding, and Inventory days of supply. The factors affecting the metric are possible to control to some extent at a disaggregate level, but each person or department that can affect the result cannot control all different factors of the aggregate metric. The metric is therefore considered to fulfill the requirement of *robustness* more than the requirement of *validity.*

Integration and Usefulness
The metric does not focus on a single activity but shows the combination of the results of several processes or activities; negotiating payment terms with customers and suppliers as well as keeping appropriate inventory levels. The metric encourages collaboration across functions since the different parts may affect each other. For example, a better payment term for purchasing may be reached if orders are larger, this may however affect inventory levels negatively. Hence collaboration between different departments is important to improve the result. The metric itself does not provide clear guidance as to what action to take based on the result since it is shown at such an aggregate level, it is however possible to look at the components and from that see what needs to be done. The metric is considered to fulfill the requirement *integration* to a greater extent than the requirement *usefulness*.

Level of detail
As the metric is a SCOR level 1 metric, showing the output of several activities and processes within the Operations department, the metric is considered to be at the right level for a VP of Operations. It moreover fulfills the requirements *robustness* and *integration* to a higher degree than the requirements *validity* and *usefulness*.

Conclusion
The metric is assessed to fulfill the requirements for a dashboard and is assessed as appropriate since it provides information regarding how lean the company is operating its Product supply process with regard to operating capital. This information is assessed as valuable to Axis Operations since their mission is to achieve growth in a cost and capital efficient way.

5.2.1.7 Sales backlog ratio

Validity and Robustness
There are many different factors affecting the metric since it shows the ability of delivering the entered orders, which is connected to Axis' entire Product supply process. Moreover, the metric does not only show the performance when delivering entered orders but also the performance of the sales department and the rate at which they enter orders. The different factors affecting the result of the metric can be controlled on a disaggregate level but the outcome of the metric cannot be controlled by one single department.

The metric is general and possible to use for benchmarking since it is not specific for Axis Operations. However, since the value of the metric can differ according to the strategy of the business this needs to be taken into account if using the metric for benchmarking purposes.

Based on the discussion above, the metric is considered to be more *robust* than *valid* according to the requirements.

Integration and Usefulness
The metric shows the result of the performance of the entire supply chain. By only looking at the result of the metric it is not entirely clear what needs to be done, but it can provide an indication if something is wrong. The problem can either be declining sales which means that the Operations department needs to be prepared to scale down capacity, or it can be a problem associated with delivering orders to customers due to a bottleneck somewhere in the supply chain. In order to find the root cause of the problem it is necessary for the departments to communicate, and in that way the metric encourages collaboration. Based on these reasons, Sales backlog ratio is assessed as fulfilling the requirement *integration* more than the requirement *usefulness*.

Level of detail
The level of detail of information is considered to be correct for the dashboard for Axis Operations, since the metric meets the requirements *robustness* and *integration* instead of the requirements *validity* and *usefulness*.

Conclusion
The metric fulfills the requirements and is assessed as valuable for Axis Operations since it measures the outcome of the entire Product supply process and aims at, in a proactive manner, identifying problems that can lead to either over-capacity or delayed customer orders with financial losses as a consequence.

5.2.1.8 Returns percentage

Validity and Robustness
There are similar metrics to Returns percentage, that measure for example amount of products returned or sorted per type of damage instead of product so the metric is considered as general and can be used for benchmarks. The metric does not cover an entire process per se, but shows the outcome of the fulfillment process and connects to after sales service. There are several aspects affecting the result of the metric as it depends on the work of different functions, such as manufacturing for the assembly, logistics for transport and purchasing for the raw material, and

all these sources of error cannot be controlled by the one metric Returns percentage. Based on these reasons, the metric is assessed to be more *robust* than *valid* according to the requirements.

Integration and Usefulness

The metric shows the outcome of different activities in the process, and communicating this information to the concerned departments makes it possible to discover and address problems and issues. For example, if several products are returned with the same type of defect originating in sub-quality raw material, the departments responsible for purchasing can be notified and pass this on to the suppliers. Collaboration will thereby improve the result of the metric. The cause of the return is not specified in this metric, so it is necessary to investigate further. Based on these factors, Returns percentage is considered to be more *integrated* than *useful* when comparing to the requirements.

Level of detail

In order to be at the right *level of detail* according to the requirement, the information provided by the metric must be considered as relevant for a VP of Operations. As the metric gives an indication of the quality of the products and the testing systems of the company, it is considered as suitable.

Conclusion

The metric fulfills the requirements and is assessed as suitable since it shows the outcome of several activities that are a part of the RMA process. The metric also connects to the customer satisfaction and after sales service, where the former is central for the Operations department.

5.2.2 Metrics for the Industrialization process

As stated previously, the Industrialization process aims to design and verify the supply chain for the product that is to be ramped up to volume production, and ensure that the quality and capacity is as expected. Time and quality are essential and the metrics adapted to the process should consider this. The process also involves activities connected to sourcing and negotiation with suppliers. Connected to these activities, cost and capital efficiency are important aspects. The suggested metrics are presented as an overview in Figure 15, with definition in Table 26 and analyzed individually below.

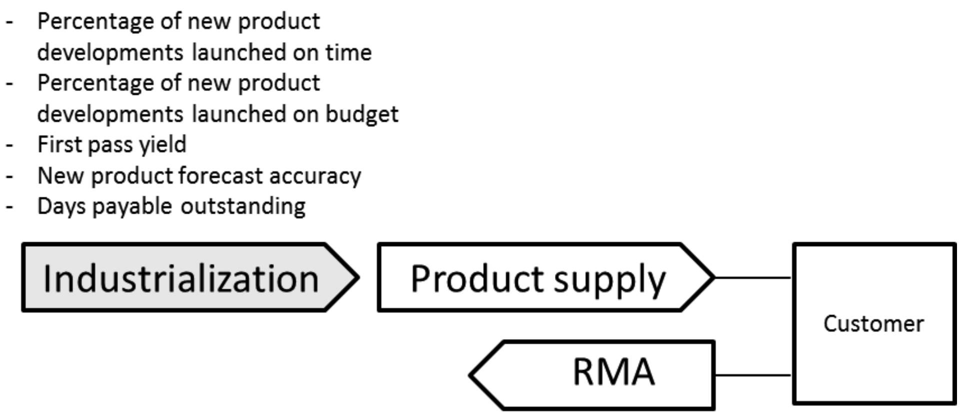

Figure 15 Overview metrics industrialization process

Metric	Definition
Percentage of new product developments launched on time	The amount of product out of the total that are launched at the market within the prognosticated time frame.
Percentage of new product developments launched on budget	The amount of product development projects that manage to hold the assigned budget.
First pass yield	Number of units coming out of a process divided by number of units going into a process.
New product forecast accuracy	Mean absolute percent error of new products from launch through planned volume hurdle.
Days payable outstanding	The length of time from purchasing materials, labor and/or conversion of resources until cash payments must be made expressed in days.

Table 26 Metrics suggested for the Industrialization process

5.2.2.1 Percentage of new product developments launched on time

Validity and Robustness

The metric covers the Industrialization process and measures how well the projects meet the set time frame. It is general and not specified to any company, so therefore it can be used to benchmark. The process includes several activities and Percentage of new product developments launched on time compares their combined lead times with what was budgeted. As it includes all projects and the individual projects can be affected by different factors, it is not possible for one person or department to completely control the metric. For example, mistakes in production depending on the design or problems with finding suitable raw material can cause a need for additional time. Based on these reasons, the metric fulfills the requirement *robustness* to a greater extent than the metric *validity*.

Integration and Usefulness

The metric does not focus on a single activity, but measures the outcome of a process. To ensure that projects are finished within the schedule, it is important to communicate between the functions so that a delay in the beginning can be attended to by speeding up downstream instead of affecting the overall result. The only indication that the metric can provide is the overall performance with regard to how well the projects in general stick to the schedule. It does not show explicitly what to do apart from putting more effort into planning. Therefore, the metric is assessed as more *integrated* than *useful* when analyzing against the requirements.

Level of detail

The metric is assessed as being on the right *level of detail*, as it gives an aggregate view of the projects going through a process and the aspect of time gives a foundation for planning.

Conclusion

The metric fulfills the requirements and provides relevant information about the organization's ability to both estimate time and follow plans in the industrialization process, which is important since the schedule forms the prognosis for when products reach the market and delays can be costly. The metric is therefore valuable for Axis as it makes it possible to learn from mistakes and also investigate if estimations are reasonable.

5.2.2.2 Percentage of new product developments launched on budget

Validity and Robustness
Percentage of new product developments launched on budget measures at an aggregate level how well the projects going through the industrialization process hold their budgets. As the metric is general and only shows a percentage, it is possible to use for comparison with other companies. It is not possible to control the entire metric because of the aggregate level and the fact that the cost of the projects can be affected through all the activities that the process consists of. Therefore the metric is considered to be more *robust* than *valid* according to the requirements.

Integration and Usefulness
The metric measures the outcome of an entire process for several projects. It encourages cooperation in the sense that additional costs in one activity must be balanced somewhere else to maintain the budget. Percentage of new product developments launched on budget does not give clear guidance of how to act if the result declines, since it only reflects the outcome of the assembled projects. It can indicate that for the result to improve, more projects must meet their budget, which could be done by more carefully set budgets or more restrictions on spending. Based on this, the metric is regarded as meeting the requirement *integration* to a higher degree than the requirement *usefulness*.

Level of detail
As the metric gives an overview of the projects' performance with regard to budget it is assessed as being on the right *level of detail* for a VP of Operations.

Conclusion
The metric fulfills the requirements and is assessed as relevant as it shows the conformity with budget which is relevant since it gives insight into how the industrialization process goes and can indicate possible problems. It is also relevant for Operations to know the costs for introducing a product to the market and where discrepancies with the budget originate.

5.2.2.3 First pass yield

Validity and Robustness
The metric is designed for covering a process and is a well-established metric that can be used for benchmarking although there may be some differences as to what is considered a reasonable goal between industries. As it does cover an entire process it is in most cases not possible for one function or department to influence the outcome completely as other departments are responsible for some activities. For a product to reach quality level aimed for, several aspects must usually be met, which also makes it improbable that an individual department could influence the entire process. Therefore, the metric meets the requirement *robustness* to a higher degree than the requirement *validity*.

Integration and Usefulness
First pass yield measures a process and shows its performance by displaying the amount of products that pass through the process without needing additional work. Depending on the scope of the process, several departments or functions may be involved and cooperate along it. The metric shows their joint performance since it captures all faults or defects. However, it does not explicitly state what to improve as it shows that a certain amount of products need rework, but

not always the cause for the rework needed. Based on this, First pass yield is assessed as more *integrated* than *useful*.

Level of detail
Depending on the importance of the process, First pass yield can be suitable to include in the dashboard as it shows the process's performance. However, the metric can also be used to measure an activity, and is then less relevant. It is assessed as a SCOR level 3 metric.

Conclusion
The metric fulfills the requirements and provides relevant information regarding performance given that the measured process is considered important. By applying it to the Industrialization process, the metric can show the quality of production by setting a first pass yield for the testing systems and can also be used to discover potential issues. However, the metric should be included only if it provides relevant information since it corresponds to a level 3 metric in SCOR.

5.2.2.4 New product forecast accuracy

Validity and Robustness
New product forecast accuracy is used to show discrepancies between the forecast of the new products and how much was actually sold. When making a prognosis, several functions with knowledge of the new product and the market provide their input. This in combination with that the result is dependent on sales, makes it difficult to control the metric. New product forecast accuracy could, just as the regular Forecast accuracy, be used to benchmark if it is not connected to a specific scale at the company. As a result, the metric is seen as more *robust* than *valid* when assessed by the requirements.

Integration and Usefulness
Some of the work in the Operations department is dependent on the prognosis since it makes it possible to plan in advance, set stock levels and contact suppliers for example. It is therefore relevant to investigate how correct the prognosis is. There will always be incidents that can occur which are difficult to predict, but it still gives an indication of if the prognosis can be trusted and if the department is providing trustworthy prognoses. As the result is reactive and shows the outcome of previous actions it is only possible to learn from those aspects that it has in common with later projects. Therefore, the metric is more in accordance with the requirement *integration* than the requirement *usefulness*.

Level of detail
For the metric to be at the right *level of detail* according to the requirement, the result of the metric must be considered as relevant for a VP of Operations. The metric is assessed as corresponding to level 3 metrics in SCOR. As the metric gives an indication of how well the prognosis for new products has been done it is relevant to include in a dashboard.

Conclusion
The metric fulfills the requirements but may be considered to correspond to a level that is too low for a VP of Operations. It is however assessed as important to measure since it shows how well the company predicts future sales of new products and since it connects to the ramp up of new products in the Industrialization process.

5.2.2.5 Days Payable Outstanding

Validity and Robustness
The metric is a SCOR level 2 metric. It is possible to use for benchmarking is not customized to a situation specific aspect at Axis Operations. The factors affecting the metric can be controlled to some extent through negotiating better payment terms with suppliers. Days payable outstanding can however not be fully controlled since payment terms is not an isolated aspect but rather one part of the negotiation process in which other aspects also are negotiated. Hence, the metric is assessed to fulfill the requirement *validity* to some extent but the requirement *robustness* is however fulfilled to a greater extent.

Integration and Usefulness
The metric can to some degree provide guidance for what actions to take based on its result, that is, if the days payable outstanding are too long, the payment terms to suppliers need to be re-negotiated. However, as the payment terms is just one of several factors negotiated in the negotiation process it is not always clear exactly what actions to take in order to improve the result. The metric shows the output of the negotiation process and cannot be argued to encourage collaboration between the different departments to a great extent; it does however not discourage collaboration. Based on the discussion above the metric is assessed to be somewhat *useful* and somewhat *integrated* according to the requirements, but it does not meet either of the requirements completely.

Level of detail
The metric is a SCOR level 2 metric and fulfills the requirement *robustness* more than the requirement *validity*. However, neither the requirement *usefulness* nor the requirement *integration* are dominant, both are met to some degree. The level of detail of information is therefore assessed to be somewhat at the right level for a dashboard for Axis Operations.

Conclusion
The metric is assessed to fulfill most of the requirements for a dashboard for a VP of Operations. It is also assessed to be valuable for Axis Operations since it aims at measuring how capital efficient Axis' Product supply process is.

5.2.3 Metrics for the RMA process
The RMA process concerns after sales service and covers the repair and return service of damaged products. An important aspect of the process is to return the products to the customers quickly as it is inconvenient for the customers to be without the products. Consequently it is important to measure the time for this process. The suggested metric is presented in Figure 16 and Table 27 and analyzed below.

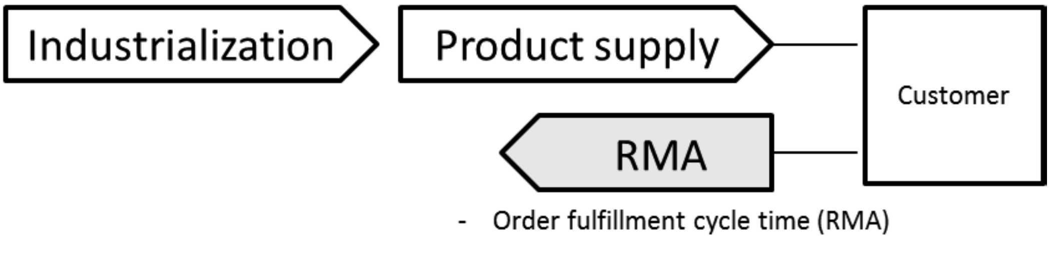

Figure 16 Overview metrics suggested for the RMA process

Metric	Definition
Order fulfillment cycle time (RMA)	The average actual cycle time consistently achieved to fulfill customer orders. For each individual order, this cycle time starts from the order receipt and ends with customer acceptance of the order.

Table 27 Metrics suggested for the RMA process

5.2.3.1 Order fulfillment cycle time (RMA)

Order fulfillment cycle time has been described and analyzed further above. Apart from being used in the product supply process; it can be applied to the RMA process at Axis. The metric is assessed as meeting the requirements in the same way as above, with the exception that it is assessed as corresponding to SCOR level 2. This since the scope for the metric is narrower when applied to the RMA process than when applied to the product supply process. Instead of measuring the time from an order being placed until it reaches the customer, it measures the time from when a customer reports a damaged product until the product is repaired or replaced and returned to customer. It is relevant to include in a dashboard since it measures how long the customers must wait, which relates to the customers' satisfaction with after sales service.

5.2.4 End-to-end metrics

As presented by Davis (2014), some metrics are influenced by everyone but not specifically owned by one specific function. It was previously explained that some of the metrics presented by Davis (2014) as End-to-end metrics here belong to the Product supply process since they are mainly connected to that process. The metrics presented in this section can however not be connected to only one of the presented processes and will therefore be referred to as End-to-end metrics. The End-to-end metrics that are suggested for Axis Operations are connected to cost and environmental efficiency which both are important parts of Axis Operations' mission. The metrics suggested are presented as an overview in Figure 17 and with definition in Table 28, they are also individually analyzed below.

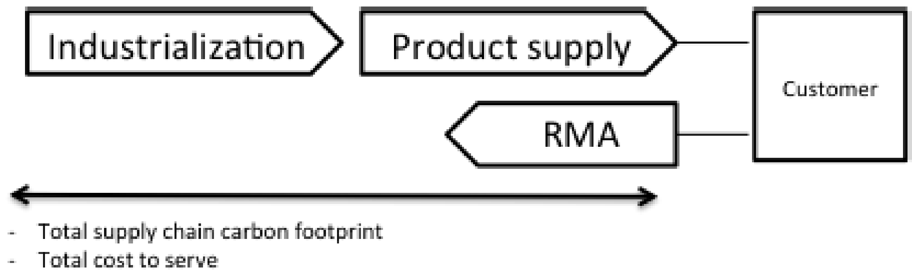

Figure 17 Overview overall metrics for Axis Operations

Metric	Definition
Total supply chain carbon footprint	The sum of the carbon equivalent emissions associated with the SCOR level 2 processes Plan, Source, Make, Deliver and Return. Total supply chain carbon footprint is the sum of emissions from energy and fuel consumption and process related emissions
Total cost to serve	The sum of the supply chain cost to deliver products and services to customers. Total cost to serve includes the cost to plan the supply chain, cost to source materials, products, goods, merchandize and services, cost to produce, manufacture, remanufacture, refurbish, repair and maintain goods and services if applicable, cost to manage orders, customer inquiries and returns and cost to deliver products and services at the agreed location (point of revenue).

Table 28 Overall metrics suggested

5.2.4.1 Total supply chain carbon footprint

Validity and Robustness
The metric is a SCOR level 1 metric based on the following level 2 metrics; Plan carbon emissions, Source carbon emissions, Make carbon emissions, Deliver carbon emissions and Return carbon emissions. As the metric spans over several processes and activities it is not possible for one specific function to control and affect all aspects that affect the metric as the metric is presented on an aggregated level. Based on this, Total supply chain carbon footprint is considered to be more *robust* than *valid.*

Integration and Usefulness
Total supply chain carbon footprint focuses on the performance of the supply chain. It involves all departments and shows their joint efforts and the emissions that they cause. It is necessary to cooperate to achieve the best overall solution to reduce the carbon footprint for the entire supply chain instead of sub-optimizing and focusing on only one aspect. As the metric is aggregated and gathers the output of the whole supply chain it cannot indicate which activity that can improve or what the result and changes to it depends on. Therefore Total supply chain carbon footprint is assessed as meeting the requirement *integration* to a higher degree than the requirement *usefulness.*

Level of detail
The metric is a SCOR level 1 metric, so it gives an aggregated view and is relevant to use to investigate the influence that the company has on the environment

Conclusion
The metric fulfills the requirements and is assessed as relevant since it measures Axis Operations' environmental efficiency which is in line with the mission to grow sustainably.

5.2.4.2 Total cost to serve

Validity and Robustness
Total cost to serve is constructed by Planning cost, Sourcing cost, Material landed cost, Production cost, Order management cost, Fulfillment cost, Returns cost and Cost of goods sold. As the metric is a SCOR level 1 metric it is possible to benchmark and compare between companies. However, the metric is based on several cost components related to different parts of the business and controlled by different departments. As the metric is presented on an aggregate level, the department or function responsible for measuring cannot control all different components. Therefore, Total cost to serve is assessed to fulfill the requirement *robustness* to a greater extent than the requirement *validity*.

Integration and Usefulness
The metric does not focus on one single activity, but investigates the costs throughout the entire Operations department. All functions and activities are reflected in the metric, and all efforts to reduce costs will affect it. Therefore some collaboration is necessary between the departments to avoid counter-productive savings, since lowering costs in one activity may result in increases somewhere else. As the metric shows the accumulated costs, it cannot explicitly state which components have increased or decreased or what can be done about it without further investigation. For these reasons, the metric is considered as more *integrated* than *useful* according to the requirements.

Level of detail
Total cost to serve is a SCOR level 1 metric and it gives an overview of all costs associated with the Operations department. Therefore it is assessed to be at the right *level of detail* for the dashboard.

Conclusion
The metric fulfills the requirements and provides an overview of all the costs associated with the department and connects to all processes and activities. This is assessed as relevant since Axis aims for efficiency in combination with growth and it is therefore necessary to track the costs in combination with the performance.

5.3 Analysis of Axis Operations current metrics

This section presents the analysis of the metrics presented in the empirics' chapter and the extent to which they meet the requirements for metrics described in the theory chapter. The analysis is based on the respondents' descriptions of the metrics and their responses to the questions. A summary of the findings for each metric is presented in a table below each individual analysis.

For each metric their respective decision level is presented. The classification of the decision levels is done using the SCOR model. The metrics were classified according to the different SCOR levels by comparing the definition of the metrics used at Axis Operations with the definition of the metrics presented in the SCOR model. For the metrics where no corresponding definition was found, the metric was compared to other SCOR metrics in order to assess its level. Some metrics were also classified according to whether the metric was considered as more strategic, tactical or operational, where strategic metrics were considered SCOR level 1 metrics, tactical metrics were considered SCOR level 2 metrics and operational level metrics were considered SCOR level 3 metrics. In appendix 4 it is presented how the classification of each metric was done.

5.3.1 Product Supply Process

Figure 18 presents an overview of the analyzed metrics currently used at Axis Operations that correspond to the Product supply process. The metrics are individually analyzed below.

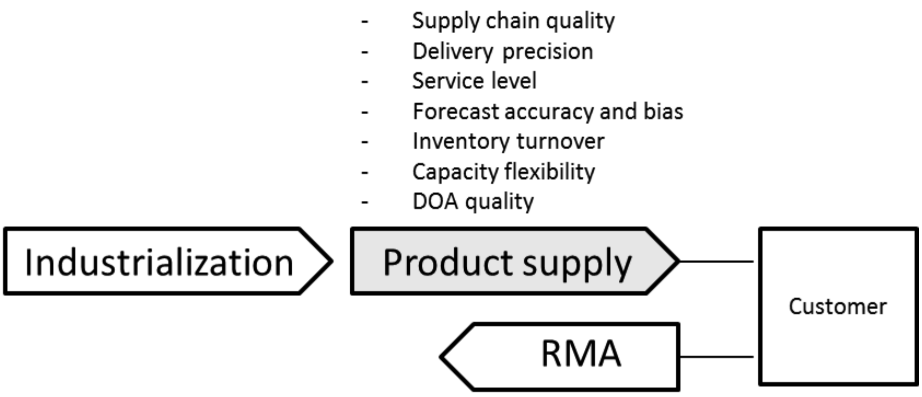

Figure 18 Axis Operations' Product supply process metrics

5.3.1.1 Supply chain quality

Supply chain quality is considered an aggregate metric and the Supply chain department cannot control all aspects of the metric since many departments affect the outcome of the metric. The process of measuring the metric is dependent on the customers since it is designed to measure the faults that are discovered with them. A similar metric can be found within the SCOR model; SCOR RL 1.1 Perfect order fulfillment. Where the main difference between the two is that Perfect order fulfillment considers the time aspect. By excluding this, the currently used metric is not as easy to benchmark as it otherwise would be, but it still to some extent possible. Based on this, Supply chain quality is considered to be *robust* to a larger extent than *valid*.

Supply chain quality is constructed to be aggregate and measures several types of mistakes and defects. Discerning where faults occur therefore needs some additional work and it is not explicitly shown by the metric what exact actions to take. The metric covers a large part of the fulfillment process and includes many of the involved departments. Therefore the metric fulfills the requirement *integration* to a larger extent than the requirement *usefulness*.

One of the main problems connected to the metric currently is the input data, since the level of faults reported differs and some issues are not even reported. A more even level of the input data can improve the *reliability* of the metric and the possibilities to detect actual problems. A more homogenous classification of the detected defects will also aid in creating a solid basis for analysis and improvement. However, Supply chain quality is assessed as relevant to include in a dashboard since it includes a large part of the process and gives an overall view of the quality and the customer satisfaction.

Requirement	**Comments**
Validity and Robustness	The metric is more *robust* than *valid*
Integration and Usefulness	The metric is more *integrated* than *useful*
Economy	The metric is *economical*
Compatibility	Supply chain quality is not *compatible*
Reliability	The metric is somewhat *reliable*
Level of detail	The metric is on the right *level of detail*, assessed as SCOR level 1
Behavioral soundness	The metric is somewhat *behaviorally sound*

Table 29 Fulfillment of requirements – Supply chain quality

5.3.1.2 Delivery precision

Delivery precision is comparable to the SCOR metrics RL 2.2 Delivery performance to customer commit date as both aim at measuring the delivery performance to customer with regard to time. Both metrics are also designed to show results at a higher, aggregate level. However, Delivery precision measures the percentage of orders shipped on time and then adds the carrier performance reliability, whereas Delivery performance to customer commit date covers the process until the customer has received the order. The assumption used regarding transportation means that the metric does not measure what it is supposed to since the entire process is not included. But in all, the metric is general, not specifically adapted to Axis and similar to a metric in the SCOR model and is therefore assessed to be more *robust* than *valid* according to the requirements.

The metric focuses on a process and its outcome, which can depend on many different aspects since the work of several departments is involved. As Delivery precision shows the success or failure of a delivery only when it is sent, it is difficult to affect the orders that are currently in the process. However, it is possible to learn from previous mistakes and improve the process for the future. In all, Delivery precision meets the requirement *integration* to a higher extent than the requirement *usefulness*.

Without clear definitions and explanations, the exclusion of the transportation part can influence the perception, and thereby the *reliability*, of the metric as it is believed to cover more than it actually does. To make the metric more *valid* and *reliable* it is suggested that the actual transportation time is included in the metric. If this is not possible, the carrier performance reliability could be used as a complement to Delivery precision, but it is then important to clearly point out and be aware of what is actually measured.

As Delivery precision is connected to customer satisfaction it is relevant to include in a dashboard for VP of Operations.

Requirement	Comments
Validity and Robustness	Delivery precision is more *robust* than *valid*
Integration and Usefulness	Delivery precision is more *integrated* than *useful*
Economy	Delivery precision is *economical*
Compatibility	The metric is *compatible*
Reliability	The metric is somewhat *reliable*
Level of detail	The metric is on the right *level of detail* since it gives an overview. Assessed as SCOR level 2
Behavioral soundness	The metric is somewhat *behaviorally sound*

Table 30 Fulfillment of requirements – Delivery precision

5.3.1.3 Service level

Service level is related to SCOR RS 1.1 Order fulfillment cycle time, but Axis does not measure average days but individual orders and as with Delivery precision, the transportation part is not included. This means that the metric only show with certainty the amount of days until an order is shipped and not the entire lead time to the customer. Consequently, the metric is slightly less reliable to use for benchmarking, but it can be done. The metric is measured at an aggregate level, which means that all parts of the process cannot be controlled by one single department within Operations. The metric is regarded as more *robust* than *valid* when applying the requirements.

The metric is constructed to show an overall picture over the Operations department's performance and depict a process instead of a single activity and the joint efforts of several departments within Operations. The metric measures already delivered orders and thus arrive too late to be able to take proactive action, it is however possible to discover general problems that can be addressed. Based on this, Service level fulfills the requirement *integration* to a higher degree than the requirement *usefulness*.

The exception of transportation time in the metric also requires that the metric is clearly defined and explained when used in order to avoid confusion and improve the *reliability* of the metric. One solution is to include proof of delivery in the measuring or else to clarify that it concerns Service level until shipped and combine it with carrier performance reliability for view of the entire process.

Service level is considered relevant to include in a dashboard as it covers several departments' work and the time to delivery is a relevant part of customer satisfaction.

Requirement	Comments
Validity and Robustness	The metric is more *robust* than *valid*
Integration and Usefulness	Service level is more *integrated* than *useful*
Economy	Service level is *economical*
Compatibility	The metric is *compatible*
Reliability	The metric is somewhat *reliable*
Level of detail	The metric is on the right *level of detail*, SCOR level 1
Behavioral soundness	The metric is *behaviorally sound*

Table 31 Fulfillment of requirements – Service level

5.3.1.4 Forecast accuracy and bias

Forecast accuracy and bias are dependent on the prognosis and can therefore only be controlled to the extent that Demand planning does their best in predicting the sales. Other functions and departments are also involved in making the prognosis and the amount actually sold depends on the customer demand. However, both metrics are often used to control the outcome when prognoses are made. Both Forecast accuracy and bias can therefore be used for benchmarking. The metrics are both regarded as more *robust* than *valid* according to the requirements.

As the prognosis is aggregated over all products or product classes and differences in the sales can be due to different reasons, the metrics cannot give any explicit answers to changes in the result, only indications. The scope of both metrics is beyond a single activity, and the work that Demand planning does will affect several other departments in the fulfillment process as they plan based on the prognosis. Therefore the metrics are more *integrated* than *useful* when using the definitions from the requirements.

Since both metrics require some explanation it is important to have clear definitions available to avoid misinterpretation. The requirement *reliability* is also dependent on the amount of manual input of data, and the *reliability* would improve if this was reduced, as it would lessen the risk for mistakes. It is beneficial that the metrics indicate problems, but their importance within that area can be questioned if Demand planning catches most errors before the results are seen. Still, the department's performance with the prognosis will affect the other departments involved in the Material supply process as the prognosis lays the foundation for the departments that are purchasing goods and planning transportation. Shortages can originate in a low prognosis or despite of a good prognosis, so the comparison of the predicted situation and the actual can be an indication of where within Operations it is necessary to improve performance.

The metrics can be presented as a trend over time as the majority of products remain the same even if some are added and others phased out.

Requirement	Comments
Validity and Robustness	The metrics are more *robust* than *valid*
Integration and Usefulness	The metrics are more *integrated* than *useful*
Economy	Forecast accuracy and bias are *economical*
Compatibility	The metrics are somewhat *compatible*
Reliability	The metrics are somewhat *reliable*
Level of detail	The metrics are assessed as SCOR level 3 but is still assessed as being on the right *level of detail*, as they indicate problems that can affect the entire Operations department.
Behavioral soundness	Forecast accuracy and bias are *behaviorally sound*

Table 32 Fulfillment of requirements – Forecast accuracy and bias

5.3.1.5 Inventory turnover

Inventory turnover is assessed to measure what is wanted, which is how quickly the company uses its supply of goods within a specific time frame. The metric is based on factors that can be influenced by others than the Operations department, such as the Sales department. The Operations department can however affect the metric to a great extent. There are several common ways of measuring Inventory turnover, which increases the need for definitions and clarity to avoid confusion. The metric is similar to SCOR AM 2.2 Inventory days of supply and can be used for benchmarking given that the calculation is similar. The metric is not completely in accordance with the requirement *robustness*, but more so than with *validity*.

The metric is based on processes concerning both purchasing, prognosis and sales and shows a ratio of the outcome of all these processes. It is therefore not clear by looking at the result of the metric exactly what action should be taken, it only indicates that something needs to be done. Based on above discussion, Inventory turnover is regarded as more *integrated* than *useful*, using the definitions of the requirements.

In order to make the metric easier to benchmark the way of calculating the metric should be changed to using COGS instead of revenue. It is however an interesting metric to include since it provides information on the capital efficiency of the department by aiming at keeping appropriate stock levels.

Requirement	Comments
Validity and Robustness	The metric is more *robust* than *valid*
Integration and Usefulness	The metric is more *integrated* than *useful*
Economy	The metric is *economical*
Compatibility	The metric is *compatible*
Reliability	The metric is *reliable*
Level of detail	The metric is on the right *level of detail* and assessed as SCOR level 2
Behavioral soundness	The metric is *behaviorally sound*

Table 33 Fulfillment of requirements – Inventory turnover

5.3.1.6 Capacity flexibility

Capacity flexibility aims to measure the suppliers' performance and preparedness for an increase in demand, which lies outside Operations' control. The metric mainly measures what it is supposed to do since it aims to measure the capacity flexibility at the suppliers and this is also what is measured. The metric measures the possible outcome of all suppliers' make processes and does therefore not concern a specific activity. As the definition of flexibility for the suppliers can differ between companies, it may not be particularly beneficial to compare the metric to other companies, as their levels may not carry the same meaning. However, the metric can be compared to the SCOR metric AG2.2 Upside make flexibility, and if the procedures described in the SCOR model is used the data would be more comparable and it would be possible to benchmark the metric. The metric is based on the discussion more in accordance with the requirement *robustness* than *validity*, but it is not completely *robust*.

The result of the metric does not provide guidance to what specific action to take but can provide an indication of that something needs to be done. The metric does not encourage collaboration between the different departments at Axis Operations to a great extent since the metric is mainly the responsibility of the sourcing and supply departments which are responsible for different suppliers. It does however encourage collaboration between Axis Operation and its suppliers and thus encourages collaboration within the supply chain. The metric could be even more integrated if the flexibility for more parts of the supply chain was included, for example by measuring the flexibility at the CLCs or for delivery. The metric is however based on the discussion assessed as more *integrated* than *useful.*

The *reliability* of the metric is affected by the fact that the suppliers provide the input data that the metric is based on and that this data is subjective and built on suppliers' plans and hypothesis. Clearer definitions of what data should be provided and how the assessment should be made, for example using the SCOR model definition, would make the metric more *reliable.*

Despite the fact that the metric can be inaccurate and provides more estimation than an exact value, the suppliers' preparedness for an increase in demand is still assessed as valuable knowledge in a dashboard. This since if the suppliers are not at all prepared for an increase in demand, that could severely affect the possibility to deliver orders to customer.

Requirement	Comments
Validity and Robustness	The metric is more *robust* than *valid*
Integration and Usefulness	The metric is more *integrated* than *useful*
Economy	The metric is *economical*
Compatibility	The metric is not *compatible*
Reliability	Capacity flexibility is not *reliable*
Level of detail	The metric is somewhat on the right *level of detail*, it corresponds to SCOR level 2.
Behavioral soundness	Capacity flexibility is *behaviorally sound*

Table 34 Fulfillment of requirements – Capacity flexibility

5.3.1.7 Dead on arrival quality

Dead on arrival quality is assessed as possible to use when comparing to other companies as long as it is clear how the type of return is defined. As every type of source for damages is to be included and the metric shows products assessed at an accumulated level, the department measuring DOA quality cannot control or affect all the underlying reasons for the result. Therefore the metric is regarded as fulfilling the requirements *robustness* to a greater extent than *validity*.

The Supply chain department monitors DOA quality, and contacts other departments when it is time to act on changes in the result, since the action needed is not obvious. The metric shows the outcome of the production and assembly done at other departments as well as the accuracy of the testing system and for that reason DOA quality is more *integrated* than *useful* according to the definitions of the requirements.

There are some uncertainties regarding the input data, as some products are reported as RMA instead of DOA and decreasing that amount by clear classifications will make the metric meeting the requirement *reliability* to a higher degree.

DOA quality is valuable to measure as it can be seen as a complement to the metrics related to RMA and Supply chain quality to give a fuller picture of returned and damaged goods, so despite the fact that it corresponds to a metric from SCOR's level 3 it is valuable to look at in a dashboard. It is also an indication of how well Axis' testing systems are working, since it shows the amount of faulty products not caught.

Requirement	Comments
Validity and Robustness	The metric is more *robust* than *valid*
Integration and Usefulness	The metric is more integrated than *useful*
Economy	Dead on arrival quality is *economical*
Compatibility	The metric is somewhat *compatible*
Reliability	The metric is *reliable*
Level of detail	The metric meets the requirement *level of detail*, it corresponds to metrics on SCOR's level 3 and can be used to monitor
Behavioral soundness	Dead on arrival quality is *behaviorally sound*

Table 35 Fulfillment of requirements – Dead on arrival quality

5.3.2 Industrialization Process

Figure 19 presents an overview of the analyzed metrics currently used at Axis Operations that correspond to the Industrialization process. The metrics are individually analyzed below.

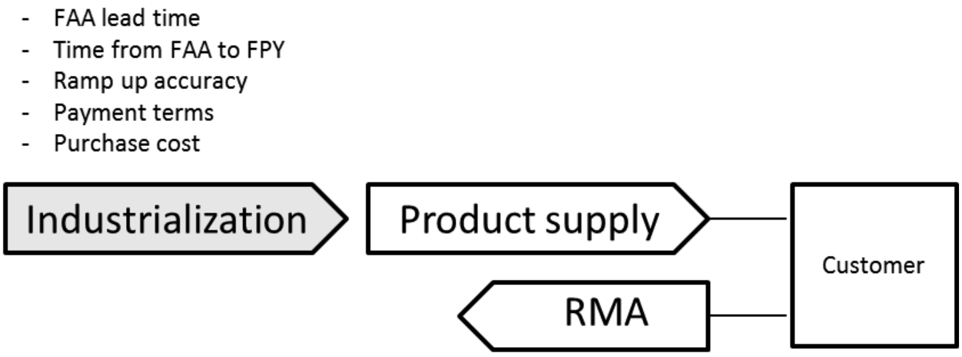

Figure 19 Axis Operations' Industrialization process metrics

5.3.2.1 FAA lead time

FAA lead time is dependent on other departments fulfilling their duties since some aspects lie outside the Operations department's control. The metric measures what it is supposed to according to its definition but it is questioned whether this is what should be measured. It is adapted to fit Axis' development process so comparison with other companies may require some rework if that should be possible. It is assessed to correspond to a SCOR level 3 metric since it currently measures a small part of the process. FAA lead time is neither completely *robust* nor completely *valid*, according to the requirements since it is specific for the situation but not completely within the control of the Operations department.

The metric is not currently constructed to cover a process since it focuses on one activity. Within that activity, FAA lead time provides guidance to those working with it and it is easy to realize when a product will not meet the lead time, so that extra effort can be put in. Based on this, the metric is regarded as more *useful* than *integrated* according to the requirements.

It is one of the few metrics where the result is not valuable enough to call the metric *economical*, according to the definition of the requirement. The metric could be extended or complemented with other metrics to cover the entire process from the building of the FAS until volume availability, as suggested in section 4.3.2.3. This would give a better overview and more holistic view of the situation. Including a larger part of the process in the metric would also place it on a better *level of detail*, as defined by the requirement.

Although the metric does not currently fulfill all of the requirements, it is suggested to be included in the dashboard on the premises that it is changed according to the suggestions. This since if measuring a larger part of the development process it would provide important information regarding the industrialization process and the time needed for new products to reach volume production, which is a crucial part in getting the products to the market.

Moreover, the changes presented would make the metric assessed as SCOR level 2 instead of SCOR level 3 metric.

Requirement	Comments
Validity and Robustness	FAA lead time is neither *robust* nor *valid*
Integration and Usefulness	The metric is more *useful* than *integrated*
Economy	The metric is somewhat *economical*
Compatibility	FAA lead time is not *compatible*
Reliability	The metric is somewhat *reliable*
Level of detail	FAA lead time is not on the right *level of detail* for the Operations department, it is assessed as SCOR level 3
Behavioral soundness	The metric is *behaviorally sound*

Table 36 Fulfillment of requirements – FAA lead time

5.3.2.2 Time from FAA to 90% FPY

Time from FAA to 90% FPY is an aggregated metric including all development projects reaching this specific phase in the Industrialization process within a year. It is not possible for the Operations department to control all phases of this process and the metric is not adapted to one specific activity. If other companies' industrialization processes are similar, the metric is possible to benchmark, but this may be unlikely. As the SCOR model does not cover product development no corresponding metric can be found there, but the metric is assessed as on level 2 since it is tactical. Based on the above discussion it is concluded that Time from FAA to 90% FPY is considered as meeting the requirement *robustness* to a greater extent than *validity*.

Time from FAA to 90% FPY shows the combined outcome of several different projects, and the underlying cause to a result is therefore not obvious. It is not always certain what to do to act on the metric, but it is possible to learn from the previous projects even if the ones that already are completed cannot be changed. In all, Time from FAA to 90% FPY is regarded as more *integrated* than *useful* when using the definitions of the requirements.

Since the period of measuring is one calendar year, the result will be fluctuating a lot during the first months before it stabilizes. By adopting a moving baseline of measuring that show the performance of the last 12 months instead of based on calendar year the metric will show a more stable and reliable outcome. It would lessen the volatility and instead show the trend. By adopting these adjustments the metric is therefore better constructed for use in a dashboard.

Requirement	Comments
Validity and Robustness	The metric is more robust than *valid*
Integration and Usefulness	The metric is more *integrated* than *useful*
Economy	The metric is *economical*
Compatibility	The metric is not *compatible*
Reliability	The metric is *reliable*
Level of detail	The metric is on the right *level of detail*, assessed as SCOR level 2
Behavioral soundness	The metric is *behaviorally sound*

Table 37 Fulfillment of requirements – Time from FAA to 90% FPY

5.3.2.3 Ramp up accuracy

All aspects of Ramp up accuracy are not possible to control as the metric forecasts the demand of new products and parts of it lies outside of Demand planning's control. The metric is not unique for Axis and can be used for benchmarking since it shows the outcome of a prognosis for new products. Ramp up accuracy includes different projects each month and each project faces different conditions, some being more difficult to forecast than others. For that reason comparisons between different months will not give conclusive answers, neither regarding Demand planning's competence in forecasting nor the success of the projects. Based on the discussion above, Ramp up accuracy is considered more in accordance with the requirement *robustness* than the requirement *validity*.

As the metric measures the outcome of projects, the result cannot be used to take action on the projects measured. It can only indicate how well the prognosis was made. However, Demand planning's precision with the prognosis will affect other departments such as Supply and the amount purchased and kept in inventory. The metric also considers the process of ramp up, and based on these reasons the metric is regarded as meeting the requirement *integration* to a larger extent than the requirement *usefulness*.

The underlying assumptions may be difficult to take into consideration when measuring as it would make the metric very complex, but reducing the need for manual calculations will improve the *reliability*, as described in the requirement. The requirement *level of detail* of Ramp up accuracy on Operations level can be debated, as an aggregate metric only gives an indication, but a detailed display including every project individually may provide too much information for a VP of Operations given that there is a responsible department who works with the metric continuously.

The result of the metric can be showed either as an aggregation of total sales compared to the total expected, total lower and total higher limit of expected demand, or it can be measured as the percentage of projects that were within the span. The disadvantage of measuring in the first way described is that individual projects that are above the upper limit and those that are below the lower limit may cancel each other out, so that two wrongs become a right. A disadvantage of the second alternative is that it does not show how close the real demand is to the limits, only if they were inside or outside of the span.

To get a balanced view of the actual outcome, both ways of showing the result can be interesting to measure in a dashboard. A suggestion is to show the percentage of projects within the span as the aggregate measure to include in a dashboard. The individual projects can then be investigated further by using drill down capabilities where it can be shown how close or far they are from the actual limits.

Demand Planning's work with the prognosis, and its impact on other departments, makes the metric interesting at an overall level for Operations and therefore it is relevant to include in a dashboard.

Requirement	Comments
Validity and Robustness	The metric is more *robust* than *valid*
Integration and Usefulness	Ramp up accuracy is more *integrated* than *useful*
Economy	The metric is *economical*
Compatibility	Ramp up accuracy is *compatible*
Reliability	Ramp up accuracy is somewhat *reliable*
Level of detail	The metric is at the right *level of detail*, assessed as SCOR level 3
Behavioral soundness	Ramp up accuracy is somewhat *behaviorally sound*

Table 38 Fulfillment of requirements – Ramp up accuracy

5.3.2.4 Payment terms

The metric is balanced against other factors in the negotiations with suppliers and can therefore not be completely controlled, as it may have to be sacrificed to achieve other goals. Payment terms is similar to the SCOR metric AM 2.3 Days payable outstanding, but the latter is measured as time from purchasing materials until cash payments must be made, expressed in days. The way in which the metric is measured today it is not very interesting to use for benchmarking purposes as it shows number of successful negotiations. If however measuring the metric using Days payable outstanding it would be possible to use for benchmarking. The way in which the metric is measured today Payment terms is considered as more *valid* than *robust* when using the requirements.

Payment terms focuses on one part of the negotiations with suppliers, when looking at the metric alone it is specific and shows which of the suppliers that perform as wanted and which that do not. It aims at improving the cash flow of the company but measures the negotiation activity and not the actual cash flow level. The way the metric is measured today, it is considered to be more *useful* than *integrated* when assessed by the requirements.

A benefit with measuring as suggested in the SCOR model is that it is possible to display the average number of outstanding days, and see the trend of continuous development instead of whether or not suppliers meet the goal. It also connects more clearly to the cash flow as the amount of days is known. The purpose of Payment terms, to improve the capital efficiency of the company, makes it an interesting metric for the dashboard despite the fact that it does not fulfill all requirements. It is therefore suggested that the metric is measured according to the definition provided in the SCOR model.

Requirement	Comments
Validity and Robustness	Payment terms is more *valid* than *robust*
Integration and Usefulness	The metric is more *useful* than *integrated*
Economy	The metric is *economical*
Compatibility	Payment terms is *compatible*
Reliability	The metric is *reliable*
Level of detail	Payment terms is on the right *level of detail* and considered as SCOR level 2
Behavioral soundness	The metric is somewhat *behaviorally sound*

Table 39 Fulfillment of requirements – Payment terms

5.3.2.5 Purchase cost

There is a clear trade-off between Purchase cost, Payment terms and lead time from suppliers as all aspects must be considered in a negotiation and one may be fulfilled at the expense of the others. Purchase cost is related to the SCOR metric 3.009 Purchase materials cost, but where the latter measures the total amount spent, Purchase cost also considers the reduction. The metric can be benchmarked, but the development of cost may differ a lot between industries and companies so it may not give answers that are completely helpful. Several departments are involved in purchasing at Axis and even if they can affect the reduction in price, the previously mentioned trade-offs and the suppliers also influence the outcome. Based on that, Purchase cost is seen as fulfilling the requirement *robustness* to a greater extent than *validity*, but it is not completely *robust.*

The metric involves both suppliers and different departments within Axis, but it focuses on one aspect in the negotiation process and is rather specific. However, the complexity of the metric, as it is shown on an accumulated level, makes it difficult to know exactly where changes occur. Therefore Purchase cost is considered to fulfill the requirement *usefulness* more than the requirement *integration*, even though it is not completely *useful*.

It is suggested that the metric is measured using not only a moving target, as is about to be implemented, but also a moving baseline. Using a moving baseline and target will give a fairer representation of the work and achievements throughout the year, improving the metric's consistency with the requirement *behavioral soundness*. A more automatic tool for data input would reduce the risk of errors due to human interference and thereby improve the requirement *reliability*.

Purchase cost is valuable to include in the dashboard, despite being more *useful* than *integrated*, since it shows the continuous improvement in reducing the cost.

Requirement	Comments
Validity and Robustness	The metric is more *robust* than *valid*
Integration and Usefulness	Purchase cost is more *useful* than *integrated*
Economy	The metric is *economical*
Compatibility	Purchase cost is not *compatible*
Reliability	The metric is somewhat *reliable*
Level of detail	Purchase cost is on the right *level of detail* regarding the information it provides, but is on SCOR level 3
Behavioral soundness	The metric is somewhat *behaviorally sound*

Table 40 Fulfillment of requirements – Purchase cost

5.3.3 RMA process

Figure 20 presents an overview of the analyzed metrics currently used at Axis Operations that correspond to the RMA process. The presented metric is analyzed below.

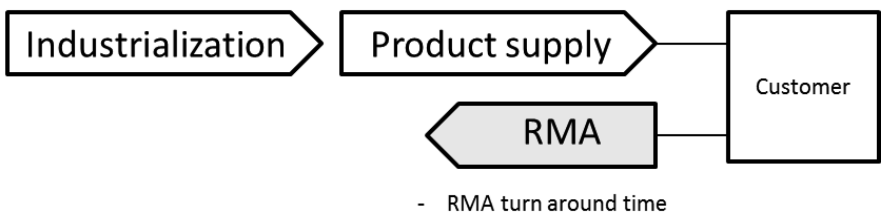

Figure 20 Axis Operations' RMA process metrics

5.3.3.1 RMA turnaround time

RMA turnaround time is comparable to SCOR RS 2.2 Make cycle time, since the return process in SCOR does not correspond to the actual maintenance and repair activities as these are generally related to the make processes. Similarly to the other metrics that measure the performance of different types of suppliers; RMA turnaround time cannot be completely controlled, only affected. The metric is regarded as more *robust* than *valid*, based on the requirements, as it is a general metric, possible to benchmark and that does not focus on a specific activity and also lies outside the control of the department measuring it.

For the use in a dashboard for VP of Operations the main focus on the metric should be on if the actual lead time meets the target or not since that affects customer satisfaction. The reason to why it happen is interesting to know in order to be able to improve the result but it should not be shown in an Operations' dashboard. RMA turnaround time is measuring a part of a process and includes both Axis and the RMA partners. The entire process is not covered as the transportation is excluded, and therefore the metric does not completely live up to the requirement *integration*, it is however assessed as more *integrated* than *useful.*

The dependency on suppliers also affects the requirement *reliability* as the RMA partners provide the data and know that they will be assessed by it. A more transparent data gathering would therefore be beneficial. That would also improve the metric's *behavioral soundness*, related to the requirement, as it can reduce the risk for unwanted behavior. As RMA turnaround time relates to after-sales service, and thereby customer satisfaction, it is relevant to include in a dashboard.

Requirement	Comments
Validity and Robustness	RMA turnaround time is more *robust* than *valid*
Integration and Usefulness	RMA turnaround time is more *integrated* than *useful*
Economy	The metric is *economical*
Compatibility	The metric is not *compatible*
Reliability	The metric is somewhat *reliable*
Level of detail	The metric is on the right *level of detail* if the purpose is overview, it is assessed as SCOR level 2
Behavioral soundness	The metric is *behaviorally sound*

Table 41 Fulfillment of requirements – RMA turnaround time

5.3.4 End-to-end metrics

Figure 21 presents an overview of the analyzed metrics currently used at Axis Operations that are referred to as End-to-end metrics according to previous definitions. The metrics are individually analyzed below.

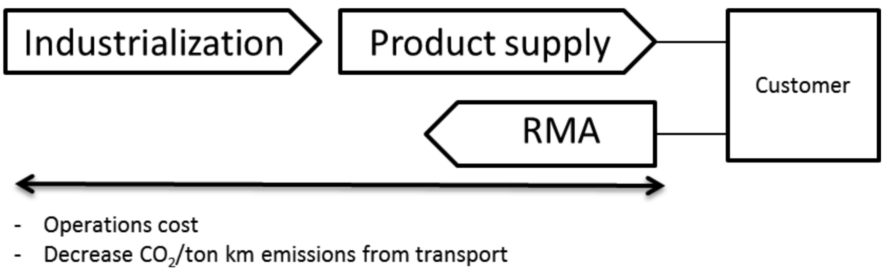

Figure 21 Overall process metrics at Axis Operations

5.3.4.1 Operations cost

Operations cost is related to the SCOR model's Total cost to serve, but Operations cost is shown as a percentage of revenue thereby showing the efficiency instead of simply cost. As the metric is on an aggregate level and consists of many already available components and is calculated by using the revenue it represents a larger scope than only the Operations department. As long as the cost components are similar the metric can be used for benchmarking. Operations cost is considered as more *robust* than *valid* when assessed by the requirements.

The extensive scope of the metric makes it difficult to discern details or underlying reasons for the changes in the result. The scope does give an overview of the Operations department and the costs it incurs in relation to the company's sales. The way that the metric is calculated using the revenue also makes it difficult to take proactive action on the result due to the infrequent availability of the revenue. Based on above discussion, Operations cost is regarded as more *integrated* than *useful*.

One consideration is that the cost of a supply chain is not dependent on the value of the goods sold, but rather the complexity and the amount of products. For that reason the metric does not entirely meet the requirement *reliability* as Axis may have sold more but cheaper products, which could leave the revenue on the same level but increase the costs for Operations. Measuring using the revenue also implies that Operations cost only can be calculated every quarter since the absolute terms of the cost alone does not provide perspective. It could be investigated if it is possible to measure the cost in connection to something else than revenue, for example connected to the complexity or amount of products. However, the relation between the obtained costs and the revenue still provides an indication of the department's efficiency, and the metric is considered valuable to include in a dashboard.

Requirement	Comments
Validity and Robustness	The metric is more *robust* than *valid*
Integration and Usefulness	Operations cost is more *integrated* than *useful*
Economy	The metric is *economical*
Compatibility	Operations cost is *compatible*
Reliability	The metric is *reliable*
Level of detail	The metric is on the right *level of detail*, assessed as SCOR level 2
Behavioral soundness	The metric is *behaviorally sound*

Table 42 Fulfillment of requirements – Operations cost

5.3.4.2 Decrease CO_2/ton km emissions from transport

The metric Decrease CO_2/ton km emissions from transport can be compared to 2.004 Deliver carbon emissions within Green SCOR. However, the latter is more inclusive and covers other aspects than transportation. As it is possible to compare different freight forwarders emissions, it is also possible to compare the company's performance to others. When using Decrease CO_2/ton km emissions from transport there are counteracting aspects that sometimes are prioritized higher than the environmental goal, such as lead time and cost. This in combination with the dependency on the suppliers, who are the ones measuring the emissions, means that it is not possible to completely control the elements affecting the metric. Therefore it is considered to be more *robust* than *valid* according to the requirements.

As the metric shows the aggregate reduction in emissions and not per supplier or route it gives an overview of the situation but no explicit guidelines or explanations of the outcome. The metric makes it necessary to communicate between the departments responsible for booking transportation and the freight forwarders. Based on this the metric is more *integrated* than *useful* according to the requirements.

Currently the input data when calculating the metric is very varied, which means that a lot of manual handling is needed to get a result. However, this will hopefully be addressed by the new EU requirements, which will ensure that freight forwarders measure and present results more alike, and this will also improve the requirement *validity*.

The metric is assessed to provide relevant information for the Operations department since the company aims at sustainable growth and can therefore be included in a dashboard. However, a wider scope of the metric would be relevant, so that the environmental impact of more of the daily business is included.

Requirement	Comments
Validity vs. Robustness	The metric is more *robust* than *valid*
Integration vs. Usefulness	The metric is more *integrated* than *useful*
Economy	Decrease CO_2/ton km emissions from transport is *economical*
Compatibility	The metric is not *compatible*
Reliability	Decrease in CO_2/ton km emissions from transport is somewhat *reliable*
Level of detail	The metric is somewhat on the right *level of detail,* assessed as SCOR level 3.
Behavioral soundness	The metric is somewhat *behaviorally sound*

Table 43 Fulfillment of requirements – Decrease CO_2/ton km emissions from transport

5.4 Gap analysis: Theoretic metrics vs. Axis' metrics

A gap analysis was performed where the metrics suggested from theory and the metrics currently used at Axis Operations were individually compared to each other. Differences and overlaps between the two subsets of metrics were identified leading to the identification of four different types of scenarios as presented below:

- *Scenario 1* – The metric presented in theory does not have a counterpart currently measured at Axis Operations.
- *Scenario 2* – The metric currently used at Axis does not have a counterpart suggested from theory.
- *Scenario 3* – The metric presented in theory and the metric currently used at Axis are assessed as identical or very similar.
- *Scenario 4* – The metric presented in theory and the metric currently used at Axis are related but not identical.

This section is structured as follows. Section 5.4.1 presents the findings related to the four scenarios. Thereafter, in section 5.4.2, the detailed gap analysis for the metrics of each process is presented. Finally, section 5.4.3 presents an overview of the remaining metrics.

5.4.1 Scenario analysis

5.4.1.1 Scenario 1 – Theoretical metric has no counterpart currently measured

When comparing the two subsets of metrics, there were three metrics identified among those suggested from theory that did not have an exact counterpart currently measured at Axis Operations. These three measure different processes and there is no specific connection between them. Cash-to-cash cycle time provides an aggregate perspective of the cash flow. Sales backlog ratio is proactive and connects to fulfillment of customer orders and capacity planning. Percentage of new product developments launched on budget relates to costs in the industrialization process. As they are so different, there is no general issue identified at Axis, e.g. specific areas or aspects that are not being measured today. The three metrics are however assessed as valuable and therefore suggested for the dashboard.

5.4.1.2 Scenario 2 – Metric currently used has no theoretically suggested counterpart

Two metrics at Axis do not have exact theoretical counterparts among the metrics suggested from theory; Delivery precision and Purchase cost. These metrics do however correspond to lower level metrics that to some extent form part of some of the metrics suggested from theory. Delivery precision corresponds to the SCOR level 2 Delivery to customer commit date, and is included as it is especially valuable for Axis to measure. Purchase cost relates somewhat to the theoretical Total cost to serve, but since the former focuses on price reduction the overlap is incomplete and Purchase cost is therefore suggested for the dashboard.

5.4.1.3 Scenario 3 – Theoretically suggested metrics and currently used metrics are similar

Two of the theoretical metrics; Forecast accuracy and New product forecast accuracy are very similar to their counterparts at Axis since the way of measuring and scope of the metrics are alike or mostly so. Because of this, it is suggested that the currently used metrics are included in the dashboard since these are already familiar to the company.

5.4.1.4 Scenario 4 – Suggested and currently used metrics are related but not identical

The majority of the metrics found in theory have a counterpart at Axis and vice versa. Some of the metrics do, although measuring the same areas, differ in way of calculation and scope. In the cases where the metric from Axis is suggested, the reason tends to be that it is perceived as more adapted to the needs and situation of Axis Operations or by having a more fitting scope. In the cases where the theoretical metric was suggested the reason for this was one of the following or a combination:

- The metric provides an overview of the effect of a process rather than depicting activities performed by individual departments
- The metric provides an overview of the entire supply chain rather than only parts
- The metric is easier to benchmark

Some of the currently used metrics at Axis Operations tend to depict activities rather than the effect of processes, which may depend on that the Operations department has not had a dashboard before. The measuring has therefore largely taken place by using goals for the different departments, which although aiming for the same result as the metrics suggested are less process oriented.

In general it is found that the current metrics at Axis Operations measure more or less the same areas as the metrics suggested from theory, the difference lies mainly in the way of calculating the metrics and the scope of measuring. The choice between the metrics from theory and the currently used metrics in case of overlap was based on:

- The specific needs of the Operations department
- The way of measuring that is most appropriate for a dashboard
- The possibility to benchmark the metric

5.4.2 Gap analysis for each process

In Table 44, Table 45, Table 46 and Table 47 below, the gap analysis for each process is presented. The tables specify which of the four scenarios it is and comments on the choice. For some metrics a longer discussion is provided below the table to explain the choice.

The suggested metrics are presented in bold in the tables. If the metric used at Axis is suggested on the premises that changes are made to improve the metric, the metric will retain its current name followed by an asterisk (*).

5.4.2.1 Product supply process

Metrics from theory	Axis' metrics	Scenario	Comment
Perfect order fulfillment	Supply chain quality	4	Related but Perfect order fulfillment includes the aspect of delivery on time to customer. Select Perfect order fulfillment since it is a SCOR metric and fulfills the requirement of *robustness* to a greater extent.
-	**Delivery precision***	2	No exact counterpart in theory. The metric corresponds to part of the SCOR metric Perfect order fulfillment (Delivery performance to customer commit date). The difference is that although the metric at Axis aims to measure delivery performance, actual transport time is not measured. Include Delivery Precision since reliability of order deliveries is important to Axis. However, change to measure actual transportation time.
Order fulfillment cycle time	**Service level***	4	Related but somewhat differently defined. Moreover, current Service level does not measure actual transportation time. Include Service level since the way of measuring better matches the needs of Axis Operations, see discussion below. However, change to measure actual transportation time.
Forecast accuracy	**Forecast accuracy and bias**	3	Very similar. Metric currently used at Axis also includes bias. Select Forecast accuracy and bias.
Inventory days of supply	Inventory turnover	4	Related but different way of measuring. Select Inventory days of supply since it is easier to benchmark.
Upside supply chain flexibility	**Capacity flexibility***	4	Related but not similar since the scope is different. Chose capacity flexibility since more adapted to Axis needs. See discussion below.
Cash-to-cash cycle time	-	1	No exact counterpart at Axis, the metric is however constructed by the lower level metrics Days sales outstanding, Days payable outstanding and Inventory days of supply. There is therefore to some extent an overlap since the two latter metrics are included in the dashboard. Cash-to-cash cycle time is however included for further analysis as it provides an integrated perspective and an overview of the entire cycle time.
Sales backlog ratio	-	1	No corresponding metric at Axis, therefore included.
Returns percentage	**DOA quality**	4	Related but different way of measuring. Returns percentage is defined as measuring value and DOA quality measures numbers of returns. Select DOA quality. See discussion below.

Table 44 Gap analysis – Product supply process

Service level and Order fulfillment cycle time

Service level and Order fulfillment cycle time both aim at measuring the cycle time from order to delivery to customer. They are somewhat differently defined since Service level measures for how many of the orders the target cycle time is met while Order fulfillment cycle time shows the actual average cycle time of all orders. It is suggested that the metric should be calculated according to the definition of Service level rather than the definition for Order fulfillment cycle time since that better matches Operations' needs.

A disadvantage of measuring it in the suggested way is that it does not provide information regarding how late the orders are that do not meet the 20 days deadline. This is not easily detected using Order fulfillment cycle time either, since using an average number may hide variation. An advantage of using Order fulfillment cycle time is the ease of benchmarking since it is a SCOR metric. Service level is considered to provide information that is easier for Axis Operations to analyze and act upon in comparison to the information provided by Order fulfillment cycle time, which provides a very general result. The metric suggested for the dashboard is therefore Service level. It is also suggested that it is changed to measure the actual transportation time and not just add a fixed transportation time to the lead time at point of shipment.

Returns percentage and DOA quality
The metrics are similar in definition although Returns percentage is more general than DOA quality, as it may refer to any return while DOA is specified as only measuring the products returned as dead on arrival. The main difference between the metrics is that Returns percentage is defined as measuring the value of the returns while DOA measures the amount. It is possible to define in any way, but it is suggested that number of returns rather than value is measured since it can be valuable information for handling returns in the supply chain. The advantage of showing the value of returns is that it can be valuable to know the financial consequences of malfunctioning products. If only one should be chosen for the dashboard the current way of measuring, using the number of products is suggested based on it providing valuable information for different parts of the supply chain.

Capacity flexibility and Upside supply chain flexibility
The metric Capacity flexibility is comparable to the SCOR level 2 metric Upside make flexibility which is part of the metric Upside supply chain flexibility. The purpose of the two metrics is the same, to prepare for a sudden increase in demand so that delivery to customers is not affected. What differs between the metric is however the scope of measuring, where Upside supply chain flexibility focuses on the entire supply chain while Capacity flexibility only focuses on the preparedness of Axis' suppliers. It can therefore be argued that the metric Upside supply chain flexibility should be chosen since it would provide a more holistic view. However, as previously explained, the two metrics are based on plans and assumptions and are not assessed as fully reliable. A more aggregate measure thus also implies more possible errors. Moreover, the result of the metric Upside supply chain flexibility is decided by the part of the supply chain that would take the longest time to respond to the change. The way that Axis' supply chain is built, the most critical part from a flexibility perspective is the suppliers. Measuring Capacity flexibility would therefore provide basically the same result as measuring Upside supply chain flexibility but would require less resources, Capacity flexibility is therefore suggested. It should be noted that more standardized routines for data collection are suggested. It should also be kept in mind that the metric does not provide information on the entire supply chain and the flexibility of the other parts of the supply chain must also be monitored in other ways.

5.4.2.2 Industrialization process

Metrics from theory	Axis' metrics	Scenario	Comment
Percentage of new product developments launched on time	**FAA lead time***	4	Related but FAA lead time measures a more limited scope. Moreover, Percentage of new product developments launched on time measures all the way to market. Select FAA lead time provided that the metric is changed to measure a greater part of the development process. See discussion below.
Percentage of new product developments launched on budget	-	1	No corresponding metric at Axis, therefore included.
First pass yield	**Time from FAA to 90% FPY**	4	Related but Time from FAA to 90% FPY is rather a combination of First pass yield and Percentage of new product developments launched on time. Select Time from FAA to 90% FPY since more integrated and shows the overview of a larger process.
New product forecast accuracy	**Ramp up accuracy**	3	Very similar. Continue with Ramp up accuracy
Days payable outstanding	Payment terms	4	Related but Days payable outstanding focus more on effect of process rather than depicting a departmental activity. Days payable outstanding is also a SCOR metric and thus fulfills *Robustness* to a greater extent. Select Days payable outstanding
-	**Purchase cost**	2	Since the metric shows the continual decrease in purchasing costs there is no corresponding metric suggested from theory. Include in dashboard.

Table 45 Gap analysis – Industrialization process

FAA lead time and Percentage of new product developments launched on time

The two metrics both measure the industrialization process, but their scopes are very different. FAA lead time is assessed as too narrow as it only measures an activity and is in need of improvement to be included in a dashboard. Percentage of new product developments launched on time has a wider scope as it covers the process until the product is launched on the market. This means that it will partly cover the same time span as Time from FAA to 90% FPY does, and this is considered unnecessary. Therefore it is suggested that FAA lead time is expanded in accordance with the suggestions in the analysis in section 5.3.2.1 so it covers the process from the building of the FAS until volume availability. This will, as stated previously, result in that the metric is assessed as matching SCOR level 2 instead of SCOR level 3.

5.4.2.3 RMA process

Metrics from theory	Axis' metrics	Scenario	Comment
Order fulfillment cycle time (RMA)	**RMA turnaround time***	4	Related but somewhat differently defined. Include RMA turnaround time since the way of measuring better matches Axis Operations' needs, see discussion below. However, change to include actual transportation time.

Table 46 Gap analysis – RMA process

RMA turnaround time and Order fulfillment cycle time (RMA)

The main differences between the metric currently used and the metric suggested from theory are similar to the differences between Service level and Order fulfillment cycle time as previously discussed. That is, the metric currently used at Axis does not include the transportation cycle time and the metric currently used at Axis shows the number of times the target is met and not the average actual cycle time. Similarly to the metric Service level, it is recommended that the RMA turnaround time is measured using the number of times the target is met rather than the average actual cycle time since this information is assessed as more valuable for the user.

5.4.2.4 End-to-end metrics

Metrics from theory	**Axis' metrics**	**Scenario**	**Comment**
Total cost to serve	**Operations cost**	4	Total cost to serve is related but not identical to the combination of Operations cost and Purchase cost. Select Operations cost since more related to the needs of Axis Operations, see discussion below.
Total supply chain carbon footprint	Decrease CO2/ton km emissions from transport	4	Related, but Total supply chain carbon footprint has a wider scope, which is preferable. Total supply chain carbon footprint is selected.

Table 47 Gap analysis for End-to-end metrics

Total cost to serve, Operations cost and Purchase cost

The metrics Total cost to serve, Operations cost and Purchase cost all measure the costs connected to the operations department but are defined somewhat differently. The metric Total cost to serve includes all costs, indirect as well as direct while Operations cost and Purchase cost can be used together to provide a picture of the direct and indirect costs. The advantage of using Total cost to serve is that it is a SCOR level 1 metric, which fulfills the requirement of *robustness* to a greater extent. However, the way in which the costs at Axis Operations are measured today, using the metrics Operations cost and Purchase cost, is assessed as valuable since it separates the direct material costs from the other costs. The metric Purchase cost is also monitored as a continuous improvement metric, which is assessed as valuable for the department. The fact that the metric Operations cost and the metric Purchase cost are used in combination also makes the metric Purchase cost valuable to include despite the fact that it is assessed as being at the same level as a SCOR level 3 metric. Based on this, the metric Operations cost in combination with the metric Purchase cost are suggested, despite the fact that the metric Total cost to serve is assessed as fulfilling the requirement of *robustness* to a greater extent.

5.4.3 Metrics suggested after performed gap-analysis

Figure 22 below presents an overview of the metrics suggested for the dashboard after the gap-analysis presented above was performed. These metrics are used as input for the following analyses that are made in section 5.5 according to the requirements for a dashboard. The group of metrics suggested here are in the following analyses referred to as the combined list of metrics.

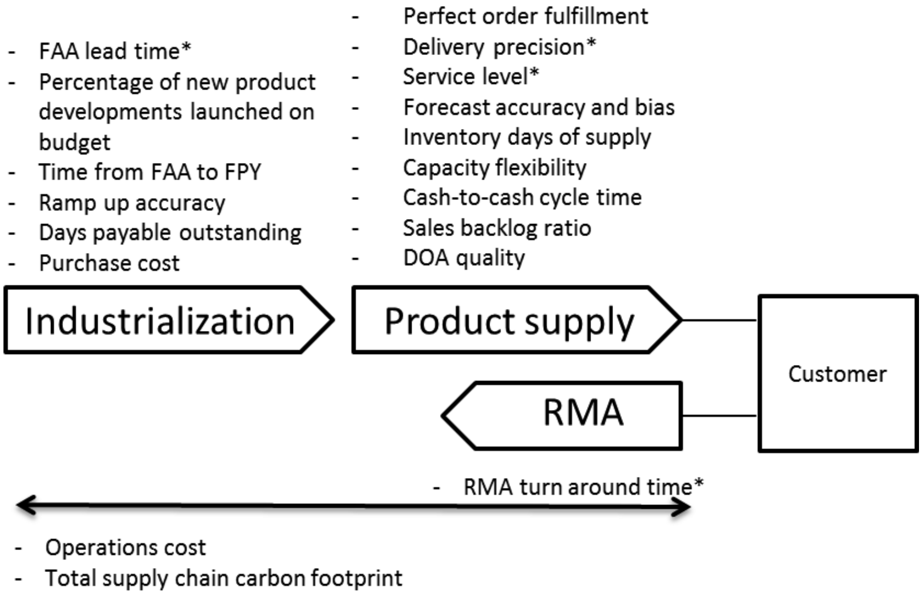

Figure 22 Suggested metrics after performed gap-analysis

5.5 Analysis of requirements for dashboard

For each requirement three analyses will be made; one analysis on the list of metrics provided based on theory, one analysis on the current metrics at Axis Operations, and one analysis on the combined list of metrics.

5.5.1 Usefulness

According to the analysis model, the dashboard should provide information that is adapted to the user thereby fulfilling the requirement *usefulness* for a dashboard. This refers to the purpose of including the metric i.e. how valuable the information is for the user, the decision level of the metric, the number of metrics included and the way the metrics are presented in the dashboard. The visual presentation in the dashboard is outside the scope of this project and this part of the requirement will therefore not be analyzed.

The part of the requirement regarding the type of information to include in the dashboard is partly covered in the analysis of the individual metrics since a description of the purpose of including each metric is provided. Only metrics that are regarded as providing valuable information for a VP of Operations are thus included this far in the analysis. This section will mainly focus on whether the amount of metrics is appropriate according to what is suggested in the analysis model. In case the number of metrics is abundant, there will be a discussion and a suggestion of which metrics are assessed as least valuable to include. These metrics will however be analyzed for all of the requirements in order to identify how the exclusion of these metrics may affect the requirement referred to as *comprehensiveness.*

5.5.1.1 Usefulness of metrics suggested from theory

In Table 48 below the metrics suggested from theory are presented according to the SCOR levels. The metrics that are not selected from the SCOR model are assessed as corresponding to the different SCOR levels in the same way as is described in section 5.3.

SCOR Level 1	SCOR Level 2	SCOR Level 3
Perfect order fulfillment	Days payable outstanding	Forecast accuracy
Order fulfillment cycle time	Inventory days of supply	Returns percentage
Upside supply chain flexibility	Sales backlog ratio	First pass yield
Cash-to-cash cycle time	Percentage of new product developments launched on time	New product forecast accuracy
Total cost to serve	Percentage of new product developments launched on budget	
Total supply chain carbon footprint	Order fulfillment cycle time (RMA)	

Table 48 Metrics from theory presented according to SCOR levels

Regarding the amount of information included in the dashboard, the total number of suggested metrics from theory is 16 and thus just above the limit in the analysis model.

Four of the suggested metrics are SCOR level 3 metrics and thus, according to the analysis model, represents a decision level that is considered as too low for a dashboard for a VP of Operations. These metrics are still suggested for the dashboard since the information provided by them is considered valuable for the VP of Operations, and the decision level is only one factor in deciding what metrics to include. For a deeper explanation as to why these metrics are assessed as valuable see the individual analyses in section 5.2

5.5.1.2 Usefulness of current metrics at Axis Operations

Table 49 shows the metrics currently used at Axis Operations presented according to the SCOR levels. The metrics that does not correspond directly to a SCOR metric are assessed as corresponding to the different SCOR levels in the same way as is described in section 5.3.

SCOR Level 1	SCOR Level 2	SCOR Level 3
Supply chain quality	Delivery Precision *	Forecast accuracy and bias
Service level*	Payment terms	DOA quality
	Inventory turnover	Purchase cost
	Capacity flexibility	Ramp up accuracy
	FAA lead time*	Decrease CO_2/ton km emissions from transportation
	Time from FAA to 90% FPY	
	RMA turnaround time*	
	Operations cost	

Table 49 Current metrics at Axis Operations presented according to SCOR level

It was found that five of the current metrics analyzed are SCOR level 3 metrics and thus, according to the analysis model, represents a decision level that is considered to be too low for a dashboard designed for the VP of Operations. All of the metrics are however still considered to provide valuable information for the user. See the individual analyses in section 5.3 for deeper explanation.

5.5.1.3 Usefulness of combined list of metrics

Table 50 below presents, according to the SCOR levels, the combined list of metrics that was suggested after the comparison of the metrics suggested from theory and the current metrics at Axis Operations had been made. The total number of metrics suggested in the combined list of metrics is 18 which according to the analysis model is considered as too many metrics to include in a dashboard. In order for the requirement *usefulness* to be fulfilled, three metrics were therefore selected as being the least valuable for the user and were suggested for exclusion; these are presented in italics in the table. As suggested by the analysis model, seven metrics were selected as the most critical. These are presented in bold in the table. The discussion regarding how the metrics were assessed as critical respectively less valuable to include follows below.

SCOR Level 1	SCOR Level 2	SCOR Level 3
Perfect Order Fulfillment	**Delivery Precision***	Forecast accuracy and bias
Service level*	**Days Payable Outstanding**	DOA quality
Cash-to-Cash cycle time	**Inventory days of supply**	Purchase cost
Total supply chain carbon footprint	Capacity flexibility*	Ramp up accuracy
	Sales backlog ratio	
	FAA lead time*	
	Percentage of new product developments launched on budget	
	Time from FAA to 90% FPY	
	RMA turnaround time*	
	Operations cost	

Table 50 Combined list of metrics presented according to SCOR levels showing most and least critical metrics

As shown in Table 50, four of the analyzed metrics are SCOR level 3 metrics and thus represent a decision level considered to be too low for a dashboard for the VP of Operations. This is however only one decision factor and the purpose of measuring the metrics is also an important factor and as previously discussed, all metrics suggested so far are assessed as being valuable to measure for some reason. The purposes of the metrics are used as a basis for discussion of what metrics to exclude and also to decide what metrics to suggest as most critical.

Exclusion of metrics

The metrics suggested as least valuable to include in the dashboard are Cash-to-cash cycle time, Percentage of new products developments launched on budget, and Total supply chain carbon footprint. The reasons to these choices are presented below.

Cash-to-cash cycle time

The metric Cash-to-cash cycle time aims at improving the capital efficiency of Axis Operations' processes. The metric is built up by three SCOR level 2 metrics; Days payable outstanding, Inventory days of supply and Days sales outstanding. The former two are already suggested for the dashboard, but the latter is not suggested since it refers to activities that cannot be controlled by the Operations department. An advantage of including the metric in the dashboard is that since it is a SCOR level 1 metric it fulfills the requirement *integration* to a greater extent than the metrics Days payable outstanding and Inventory days of supply. Cash-to-cash cycle time can also be used in benchmarking purposes in order to compare how efficiently the company uses all its working capital. Since it is possible to benchmark Days payable outstanding and Inventory days of supply it is suggested that only these metrics are included. Cash-to-cash cycle time is refused despite providing valuable information, as it is not possible to fully control by the department.

Percentage of new products developed on budget
According to Axis Operations' strategy, focus should primarily be on delivering products on time in the promised condition. This should be reflected in the metrics in the dashboard, which should focus on measuring quality and reliability towards customers. Since there are already metrics included in the dashboard that measure costs, Percentage of new products developed on budget is assessed as less valuable to include in comparison with the other suggested metrics. The metric was also compared to the metrics that were identified as being SCOR level 3, where all of the others were assessed as more valuable to include.

DOA quality is more valuable since it provides information on the percentage of non-functioning products that reach customers. It is important from a customer perspective, and shows the quality of the products as well as Axis Operations' test processes. The metrics related to forecasts are assessed as more valuable since they can help understanding if failure in delivering orders to customers depends on problems in the supply chain or if it is due to poor forecasting. These are hence also more customer-oriented and the result affects the entire Order fulfillment process.

Total supply chain carbon footprint
The environmental effect that the company has is important to measure, particularly since Axis aims to continue growing in a sustainable way. However, in order for a metric to be included in the suggestions, it must both fulfill the requirements and be considered as among the most important ones for running the business. As Axis supply chain is constructed the way it is, with functions as construction of components, repair of damages and transportation outsourced, Total supply chain carbon footprint becomes very dependent on aspects that lie outside the Operations department's control. This also leads to that the data is less available as it must be requested from suppliers, which affects the frequency of measuring. If the period of measuring is set to a year, infrequent updates may not be an issue, but a slow-moving metric does not have a given place in the dashboard. Based on these reasons, despite measuring an important aspect Total supply chain carbon footprint is considered as one of the least important metrics from the combined list.

Critical metrics
The metrics selected as most critical for the dashboard were suggested because they together aim at meeting the stakeholders' needs, which were identified as being able to depend on the right products being delivered on time in the promised condition. Some of the metrics do this by measuring the actual performance towards customers, for example Perfect order fulfillment and Delivery precision. Sales backlog ratio is more proactive and aims to identify problems with delivery before customers are affected. Moreover, there are metrics suggested that measure cost and capital efficiency, such as Operations cost and Inventory days of supply, which is important since Axis Operations' mission is to achieve growth in a capital and cost efficient way. Moreover, the metric Time from FAA to 90% FPY is suggested since it means that both the Product supply process as well as the Industrialization processes is included among the most critical metrics.

5.5.2 Vertical and Horizontal integration
In order for a dashboard to fulfill the requirement *vertical integration* the metrics in the dashboard should be connected to the overall company strategy and possible to aggregate or disaggregate to other levels in the organization. In order for the dashboard to fulfill the requirement *horizontal integration* the metrics in the dashboard should be developed based on processes.

5.5.2.1 Vertical and Horizontal integration of metrics suggested from theory

The metrics suggested from theory are selected based on Axis Operations' processes and connect to the strategies of Axis Operations as presented in section 5.25.2. The strategies presented are connected to the overall company strategy and the metrics suggested are therefore also connected to it. The majority of the metrics suggested are SCOR metrics and thus easy to disaggregate to lower organizational levels. Based on this, the requirements *vertical* and *horizontal integration* are assessed as fulfilled.

5.5.2.2 Vertical and Horizontal integration of current metrics at Axis Operations

The current metrics used at Axis Operations are, as explained in section 4.2.2, developed from the main processes and cascaded down through the different organizational levels. They are also connected to the overall company strategy, e.g. through the focus areas. The requirements *vertical* and *horizontal integration* are thus assessed as fulfilled.

5.5.2.3 Vertical and Horizontal integration of combined list of metrics

Since the two lists of metrics separately fulfill the requirements *vertical* and *horizontal integration*, the combined list is for logical reasons also assessed to fulfill the requirements.

5.5.3 Causal orientation

In order for the dashboard to fulfill the requirement *causal orientation*, non-financial metrics should be included in order to make it possible to find the root cause of the identified problems.

The majority of the metrics suggested from theory as well as those currently used at Axis Operations are non-financial metrics. The requirement *causal orientation* is therefore assessed as fulfilled for all three lists of metrics; the one suggested from theory, the one currently used at Axis Operations and the combined list of metrics.

5.5.4 Internally comparable

The analysis model encourages that the metrics in the dashboard should be presented in a way that allows for internal comparison and prioritization.

5.5.4.1 Internal comparability of metrics suggested from theory

According to the analysis model, the SCOR attributes can be used for internal comparison between metrics. Table 51 presents the metrics suggested from theory, classified according to the SCOR attributes. For the metrics that are not SCOR metrics the definition of the attributes as presented in theory was used to classify the metrics. See appendix 4.

SCOR attribute	Metrics from theory
Reliability	Perfect Order fulfillment Forecast Accuracy Returns Percentage Percentage of new product developments launched on time First Pass Yield New product forecast accuracy
Responsiveness	Order fulfillment cycle time Sales Backlog Ratio Order fulfillment cycle time (RMA)
Agility	Upside Supply chain flexibility
Cost	Percentage of new product developments launched on budget Total cost to serve
Asset management efficiency	Days payable outstanding Inventory Days of supply Cash to cash cycle time
Green SCOR	Total supply chain carbon footprint

Table 51 Metrics from theory presented according to SCOR attributes

5.5.4.2 Internal comparability of current metrics at Axis Operations

Axis Operations is currently using two focus areas to prioritize between the different metrics, where growth is ranked higher than efficiency. Since the analysis model suggests that internal comparison can be achieved by using the SCOR attributes, the metrics at Axis Operations are presented in Table 52 with their focus areas as well as classification according to the SCOR attributes. For the metrics that are not corresponding to SCOR metrics, the definition of the attributes was used for the classification. See Appendix 4.

SCOR attribute	Metrics from Axis Operations	Focus Area
Reliability	· Supply chain quality · Delivery precision* · Forecast accuracy and bias · DOA quality · Time from FAA to 90% FPY · Ramp up accuracy	Growth Growth Growth Growth Growth Growth
Responsiveness	· Service level* · FAA lead time* · RMA turnaround time*	Growth Growth Growth
Agility	· Capacity flexibility	Growth
Cost	· Purchase cost · Operations cost	Efficiency Efficiency
Asset Management Efficiency	· Payment terms · Inventory turnover	Efficiency Efficiency
Green SCOR	· Decrease CO_2/ton km emissions from transport	Efficiency

Table 52 Current metrics – SCOR attributes and Focus areas

The majority of the metrics referred to as growth goals at Axis Operations are classified as corresponding to the three customer-focused SCOR attributes Reliability, Responsiveness and Agility. On the other hand, most of the efficiency goals correspond to the internally focused SCOR attributes Cost and Asset management efficiency. Prioritizing the metrics in the PMS at Axis Operations according to the SCOR attributes in addition to the focus areas would imply more levels of comparison than is currently possible. The SCOR attributes would allow comparison also between different growth and efficiency goals and could thus help in decision-making. A risk with more hierarchy is that the rankings are followed too rigorously, which leads to less critical thinking in the decisions. However, as long as the attributes are used as a guide to selection rather than a rule, using the SCOR attributes could help internal comparability between metrics.

5.5.4.3 Internal comparability of combined list of metrics

The list of combined metrics, presented in Table 53, is classified according to the SCOR attributes and the focus areas of Axis Operations, where the latter can be seen as a simplified way of prioritizing between the metrics. It is suggested that the metrics that are classified as belonging to the attributes Reliability, Responsiveness or Agility below should be classified as growth metrics. The attributes Cost, Asset management efficiency or Green SCOR are considered as corresponding to the focus area efficiency. This classification is based on Axis' description of the focus areas as well as comparison with existing metrics.

SCOR attribute	Metrics combined list	Focus Area
Reliability	Perfect order fulfillment	Growth
	Delivery precision*	Growth
	Forecast accuracy and bias	Growth
	DOA quality	Growth
	Time from FAA to 90% FPY	Growth
	Ramp up accuracy	Growth
Responsiveness	Service level*	Growth
	Sales backlog ratio	Growth
	FAA lead time*	Growth
	RMA turnaround time*	Growth
Agility	Capacity flexibility*	Growth
Cost	Purchase cost	Efficiency
	Percentage of new product developments launched on budget	Efficiency
	Operations cost	Efficiency
Asset management efficiency	Days payable outstanding	Efficiency
	Inventory days of supply	Efficiency
	Cash-to-cash cycle time	Efficiency
Green SCOR	*Total supply chain carbon footprint*	Efficiency

Table 53 Combined list of metrics – SCOR attributes and Focus areas

5.5.5 Comprehensiveness

In order for a dashboard to fulfill the requirement *comprehensiveness*, all critical areas should be included. The analysis model suggests that the dashboard should be analyzed from the perspectives of the balanced scorecard and the SCOR attributes in order to identify whether any critical areas are missing.

5.5.5.1 Comprehensiveness – Balanced Scorecard

When analyzing c*omprehensiveness* with regard to the balanced scorecard, the metrics were classified according to the four different perspectives. In the classification, the metrics were compared to metrics suggested by Kaplan and Norton (1992) as well as to the definitions of the different perspectives. In Table 54, Table 55 and Table 56 the metrics suggested from theory, the metrics currently used at Axis Operations as well as the combined list of metrics are respectively classified according to the balanced scorecard perspectives. The metrics written in italics in Table 56 are the metrics that were suggested for exclusion when analyzing the requirement *usefulness*. These are presented in order to show how the exclusion would affect the fulfillment of the requirement *comprehensiveness*.

Comprehensiveness of metrics suggested from theory – BSC

BSC perspective	Metrics should aim at answering the question:	Metrics from theory
Financial perspective	*How should we appear to our shareholders in order to succeed financially?*	Days payable outstanding Cash-to-cash cycle time Total cost to serve
Customer perspective	*How should we appear to our customers?*	Perfect order fulfillment Returns percentage
Learning and growth	*How will we sustain our ability to change and improve in order to achieve our vision?*	Percentage of new product developments launched on time
Internal business processes	*What business processes must we excel at in order to satisfy our shareholders and customers?*	Order fulfillment cycle time Forecast accuracy Inventory days of supply Upside supply chain flexibility Sales backlog ratio Percentage of new product developments launched on budget First pass yield New product forecast accuracy Order fulfillment cycle time (RMA) Total supply chain carbon footprint

Table 54 Metrics suggested from theory classified according to balanced scorecard perspectives

There are metrics representing all perspectives in the balanced scorecard. What is found is that the representation is somewhat unbalanced with a majority of the metrics belonging to the internal business process perspective. An explanation is that the metrics are adapted to an Operations department, where the mission is to run the supply chain as efficiently as possible. Moreover, classifying the metrics according to the balanced scorecard perspectives is complex and it is not always clear what perspective a metric should belong to. The internal business process perspective for example focus on the critical internal operations that enable the company to satisfy customer needs, whereas the customer perspective demands that "managers translate their general mission statement on customer service into specific measures that really matter to customers" (Kaplan and Norton, 1992). Hence both these perspectives aim at customer satisfaction and it can be argued that some of the metrics presented as belonging to the internal process perspective could as well belong to the customer perspective.

The learning and growth perspective only has one metric representing the area. However, if the part of the description suggesting that metrics aiming at continuous improvement should belong to this perspective were used, a majority of the metrics would be included.

It can be concluded that classifying the metrics according to the different perspectives can be done in different ways, there are however metrics suggested from theory that represent all the different perspectives of the balanced scorecard and the requirement of *comprehensiveness* can be regarded as fulfilled from the balance scorecard perspective.

Comprehensiveness of current metrics at Axis Operations – BSC

BSC perspective	Metrics should aim at answering the question:	Metrics at Axis Operations
Financial perspective	*How should we appear to our shareholders in order to succeed financially?*	Payment terms Purchase cost Operations cost
Customer perspective	*How should we appear to our customers?*	Supply chain quality Delivery precision* DOA quality RMA turnaround time*
Learning and growth	*How will we sustain our ability to change and improve in order to achieve our vision?*	Time from FAA to 90% FPY Purchase cost FAA lead time*
Internal business processes	*What business processes must we excel at in order to satisfy our shareholders and customers?*	Service level* Forecast accuracy and bias Inventory turnover Capacity flexibility Ramp up accuracy Decrease CO_2/ton km emissions from transport

Table 55 Metrics at Axis Operations classified according to balanced scorecard perspectives

The analysis of the current metrics at Axis Operations shows that there are metrics representing all perspectives from the balanced scorecard and the requirement of *comprehensiveness* is therefore assessed as fulfilled.

Comprehensiveness of combined list of metrics – BSC

BSC perspective	Metrics should aim at answering the question:	Metrics combined list
Financial perspective	*How should we appear to our shareholders in order to succeed financially?*	Days payable outstanding *Cash-to-cash cycle time* Purchase cost Operations cost
Customer perspective	*How should we appear to our customers?*	Perfect order fulfillment Delivery precision* DOA quality
Learning and growth	*How will we sustain our ability to change and improve in order to achieve our vision?*	Purchase cost FAA lead time* Time from FAA to 90% FPY
Internal business processes	*What business processes must we excel at in order to satisfy our shareholders and customers?*	Service level* Forecast accuracy and bias Inventory days of supply Capacity flexibility* Sales backlog ratio *Percentage of new product developments launched on budget* Ramp up accuracy RMA turnaround time* *Total supply chain carbon footprint*

Table 56 Metrics from combined list classified according to balanced scorecard perspectives

The analysis of the combined list of metrics shows that all perspectives from the balanced scorecard are represented, even when excluding the earlier mentioned metrics. The different perspectives are also in this case somewhat unbalanced. However, following the logics of the previous discussions, the collection of metrics is assessed to fulfill the requirement *comprehensiveness* from the perspective of the balanced scorecard.

5.5.5.2 Comprehensiveness – SCOR

The analysis of *comprehensiveness* with regard to the SCOR attributes was done by classifying the metrics in accordance to the definitions of the SCOR attributes. In Table 57, Table 58 and Table 59 the metrics suggested from theory, the metrics currently used at Axis Operations as well as the combined list of metrics are respectively classified according to the SCOR attributes. Similarly as for the analysis of *comprehensiveness* with regard to the balanced scorecard, the metrics that were suggested for exclusion in the analysis of the requirement *usefulness* are presented in italics in Table 59. This shows how the exclusion of these metrics would affect the fulfillment of the requirement *comprehensiveness*.

Comprehensiveness of metrics suggested from theory – SCOR

SCOR attribute	Metrics from theory
Reliability	· Perfect order fulfillment · Forecast accuracy · Returns percentage · Percentage of new product developments launched on time · First pass yield · New product forecast accuracy
Responsiveness	· Order fulfillment cycle time · Sales backlog ratio · Order fulfillment cycle time (RMA)
Agility	· Upside supply chain flexibility
Cost	· Percentage of new product developments launched on budget · Total cost to serve
Asset management efficiency	· Days payable outstanding · Inventory days of supply · Cash to cash cycle time
Green SCOR	· Total supply chain carbon footprint

Table 57 Metrics suggested from theory classified according to SCOR attributes

The analysis of the metrics suggested from theory shows that there are metrics representing all SCOR attributes and the requirement *comprehensiveness* with respect to the SCOR attributes can thus be considered as fulfilled.

Comprehensiveness of metrics at Axis Operations – SCOR

SCOR attribute	Metrics at Axis Operations
Reliability	· Supply chain quality · Delivery precision* · Forecast accuracy and bias · DOA quality · Time from FAA to 90% FPY · Ramp up accuracy
Responsiveness	· Service level* · FAA lead time* · RMA turnaround time*
Agility	· Capacity flexibility
Cost	· Purchase cost · Operations cost
Asset Management Efficiency	· Payment terms · Inventory turnover
Green SCOR	· Decrease CO_2/ton km emissions from transport

Table 58 Metrics at Axis Operations classified according to SCOR attributes

The analysis of the current metrics at Axis Operations shows that there are metrics representing all of the SCOR attributes and the requirement *comprehensiveness* with respect to the SCOR attributes can thus be considered as fulfilled.

Comprehensiveness of combined list of metrics – SCOR

SCOR attribute	Metrics from theory
Reliability	· Perfect order fulfillment · Delivery precision* · Time from FAA to 90% FPY · Ramp up accuracy · Forecast accuracy and bias · DOA quality
Responsiveness	· Service level* · Sales backlog ratio · FAA lead time* · RMA turnaround time
Agility	· Capacity flexibility*
Cost	· Operations cost · Purchase cost · *Percentage of new product developments launched on budget*
Asset management efficiency	· Days payable outstanding · Inventory days of supply · *Cash to cash cycle time*
Green SCOR	· *Total supply chain carbon footprint*

Table 59 Metrics from combined list classified according to SCOR attributes

The analysis of the current metrics at Axis Operations shows that there are metrics representing the majority of the SCOR attributes. The only attribute that would not be represented if excluding these metrics is the Green SCOR attribute. It can be discussed if Total supply chain carbon footprint then must be included to fulfill the requirement *comprehensiveness*. However, the Green SCOR attribute is not one of the original SCOR attributes, and when stating that at least one metric for each performance attribute should be used to ensure balanced decision making (Supply Chain Council, 2012), the Supply Chain Council does not refer to the Green SCOR attribute. The requirement *comprehensiveness* is thus assessed as fulfilled even if Total supply chain carbon footprint is excluded.

6 Results and suggestions

In this chapter the findings from the study are summarized and presented. The result of the study is also presented in form of a suggestion of which metrics to include in the dashboard for the VP of Operations.

6.1 Findings from the analysis of individual metrics

In chapter 5, all metrics currently used at Axis Operations as well as the metrics suggested from theory were individually analyzed against the requirements for metrics presented in theory. The analysis of the individual metrics currently used at Axis Operations showed that the metrics in general fulfilled the requirements, a summary of the findings is presented in the sections below.

6.1.1 Fulfillment of requirements robustness, integration and level of detail

According to the analysis model, the metrics should be more robust than valid, and more integrated than useful. The metrics should also be at the right level of detail for a VP of Operations. Almost all of the currently used metrics analyzed were found to meet these requirements, with the exception of the three metrics presented in Table 60 below.

	Validity vs. robustness	Integration vs. Usefulness	Level of detail
FAA lead time	Neither robust nor valid	More useful than integrated	Not right
Payment terms	More valid than robust	More useful than integrated	Right
Purchase cost	More robust than valid	More useful than integrated	Right

Table 60 Fulfillment of requirements; validity, robustness, integration, usefulness and level of detail

As shown in the table, the metric FAA lead time did not meet any of the above mentioned requirements and it was consequently recommended that the metric needed to be redesigned if it should be possible to include in the dashboard. It was however assessed as providing valuable information connected to the Industrialization process and was therefore not discarded. The metric Payment terms was assessed as being both more *valid* than *robust* as well as more *useful* than *integrated* but it was still considered an important metric due to its connection to Axis Operations' mission of achieving growth in a capital efficient way and was therefore not discarded. The metric Purchase cost was assessed as being more *useful* than *integrated* due to its focus being delimited only to the cost of purchased material. However, as that is an area where the Operations department work hard to achieve cost reductions it is considered a relevant metric to include.

6.1.2 Fulfillment of requirements economy and compatibility

All metrics analyzed except FAA lead time were assessed as being *economical.* That means that the benefits of measuring are perceived as outweighing the costs for the majority of the metrics currently used at Axis Operations today. They are assessed as this, despite the fact that many of the metrics were considered as not, or only to some extent, *compatible* according to the requirement, see Table 61. A metric is assessed as not *compatible* when the data collection is unique for the metric. This implies that more resources are needed for measuring in comparison to if all metrics would be compatible with each other, especially when much of the work is done manually, as is the case at Axis Operations today. The fact that many of the metrics are assessed as not, or only to some extent, *compatible* does not imply that they should be discarded, especially since the majority of the metrics were assessed as *economical*. It is however relevant to investigate how much resources could be saved if more of the measuring could be done automatically.

Compatible	To some extent compatible	Not compatible
Delivery precision	Forecast accuracy and bias	Supply chain quality
Service level	DOA quality	Capacity flexibility
Inventory turnover		FAA lead time
Service level		Time from FAA to 90% FPY
Ramp up accuracy		Purchase cost
Operations cost		RMA turnaround time
		Decrease CO2/ton km emissions from transport

Table 61 Fulfillment of the requirement compatibility

6.1.3 Fulfillment of the requirement reliability

The majority of the metrics were found to be only somewhat *reliable*. This was attributed to the fact that the calculations for the majority of the metrics are processed in Excel, implying a risk of errors due to the manual input of data. More automated data collection for the metrics would hence increase the *reliability*. For many of the metrics it was however explained that bigger errors are often detected since the individuals in charge of measuring recognizes discrepancies and know what could have caused it.

Some metrics were also assessed as only being somewhat *reliable* due to the sources or methods of collecting input data not being to a full extent *reliable.* For example for Supply chain quality where the input data depend on to what extent customers report issues, or RMA turnaround time where the suppliers provide the data and know that they will be assessed on it.

The only metric that was assessed as not being *reliable* was Capacity flexibility. This was due to the fact that not only is the metric based on assumptions and hypothesis, but also these are provided by suppliers and it is not clearly defined what data should be provided.

In general, the interviewees did not assess the fact that the metrics were not to a full extent *reliable* as critical for the use of the metrics. It can however be investigated whether more measuring could be performed automatically and whether it is possible to improve the methods of collecting input data.

6.1.4 Fulfillment of the requirement behavioral soundness

The majority of the metrics were assessed as being *behaviorally sound* and no metric was assessed as being not at all *behaviorally sound.* For some of the metrics it was however considered possible that there could exist a risk of the metric being used in a way that is not entirely *behaviorally sound,* for example for Delivery precision, Payment terms and Purchase cost. It was however clearly stated by all interviewees that the *behavioral soundness* of the metrics was not assessed as an issue due to the way in which the metrics are followed up. It was in general described that metrics are followed up by discussions and a culture of jointly aiming at finding the root cause of the problem and solve this rather than blaming individuals or departments. There were therefore no perceived incentives for using the metrics in a way that would not be *behaviorally sound.*

6.2 Findings from gap analysis

After analyzing all metrics individually, a gap analysis was performed which aimed at finding overlaps or differences between the metrics currently used at Axis Operations and the metrics suggested from theory. The gap analysis showed that the metrics currently used in general measures the same areas as the metrics suggested from theory and there were no greater gaps identified as to areas that should be measured but was not currently measured. In total there were only two of the metrics suggested from theory that did not have a counterpart among the currently used metrics at Axis Operations and which thus were suggested; Cash to cash cycle time and Sales backlog ratio.

The majority of the metrics suggested from theory were consequently found to have a counterpart among the metrics currently used at Axis Operations. Some of these metrics were found to be very similar and in these cases it was suggested that the metrics currently used at Axis Operations were kept. This since no reason was found to change metrics if the already existing metrics were assessed as appropriate. For some metrics there was however a more distinct difference between the metric suggested from theory and the metrics currently used at Axis Operations. Among these metrics there were some of the current as well as some of the metrics from theory that were finally suggested to the dashboard.

A discovered general trend was that although the metrics currently used measured the most important areas, they were not to the same extent adapted to being used in a dashboard. The focus of many of the metrics was rather towards measuring activities performed by individual departments than to focus on the overview and effect of the processes. In those cases the theoretical metric was suggested. An example of such a metric is Days payable outstanding which was chosen over the currently used metric Payment terms since Payment terms rather depicts the activity of negotiation than the actual results that the activity aim for, namely to improve the cash flow. A reason to why some of the currently used metrics at Axis Operations tend to depict activities rather than the effect of processes can be since the Operations department has not had a dashboard before. The measuring has therefore largely taken place using goals within the different departments which, although aiming for the same result as the metrics suggested from theory, are less process oriented.

In the cases where the metrics were quite similar but the theoretical metric was assessed as being easier to benchmark, the theoretical metric was suggested. In some cases the currently used metric was suggested over the theoretical. This happened mainly when the metric was assessed as being more adapted to the specific needs and situation of Axis Operations.

6.3 Suggestion of metrics for the dashboard

Based on the findings from the individual analysis of metrics as well as the gap analysis, a combined list of metrics was presented as a suggestion of what metrics to include in the dashboard, see Table 62. As the combined list of metrics consisted of more metrics than was recommended according to the requirement of a dashboard referred to as *usefulness,* some of the metrics had to be excluded. As suggested by the analysis model, some metrics were also assessed as being more critical than the others.

Critical metrics (included)	Included in dashboard	Not included
Perfect order fulfillment	Capacity flexibility	Cash-to-cash cycle time
Service level*	Days payable outstanding	Total supply chain carbon footprint
Delivery precision*	FAA lead time*	Percentage of new product developments launched on budget
Inventory days of supply	RMA turnaround time*	
Sales backlog ratio	Ramp up accuracy	
Operations cost	Forecast accuracy and bias	
Time from FAA to 90% FPY	DOA quality	
	Purchase cost	

Table 62 Final suggestion of metrics to include in the dashboard

6.3.1 Suggested metrics

All suggested metrics are based on Axis Operations' stakeholders' needs and the strategies and processes currently in place for meeting these needs. Axis Operations' main goals are aimed at growth by providing the right products on time in the promised condition. The suggested metrics Perfect order fulfillment, Delivery precision, Service level, FAA lead time, Sales backlog ratio, Time from FAA to 90% FPY, RMA turnaround time, Ramp up accuracy, Forecast accuracy and bias, and DOA quality relate to the goal as they are connected to quality and reliability. In Axis Operations' mission it is also stated that growth should be achieved in a cost- and capital efficient way. The suggested metrics that measure this aspect are: Inventory days of supply, Operations cost, Days payable outstanding, and Purchase cost. Since Axis aims at growing it is also important to be able to respond to a sudden increase in demand, which the metric Capacity flexibility provides.

6.3.2 Critical metrics

The metrics assessed as being most critical were suggested because they together aim at meeting the stakeholders' needs and Axis Operations' mission. Both through measuring actual performance towards customers or proactively identifying problems before customers are affected.

6.3.3 Excluded metrics

The metrics Cash-to-cash cycle time, Total supply chain carbon footprint and Percentage of new product developments launched on time were excluded of varying reason. Among other due to: not being possible to fully control by the department, not being possible to measure very frequently, data being less available, and the metric measuring an aspect that was considered less important in comparison to other aspects included.

6.3.4 Overview of final suggestion of metrics and definition

An overview of the suggested metrics and their connection to the different processes is presented in Figure 23. Moreover, Table 63 below provides a summary of how the metrics suggested for the dashboard should be defined. It also provides suggestions for some of the metrics that are currently used at Axis Operations that need to be improved.

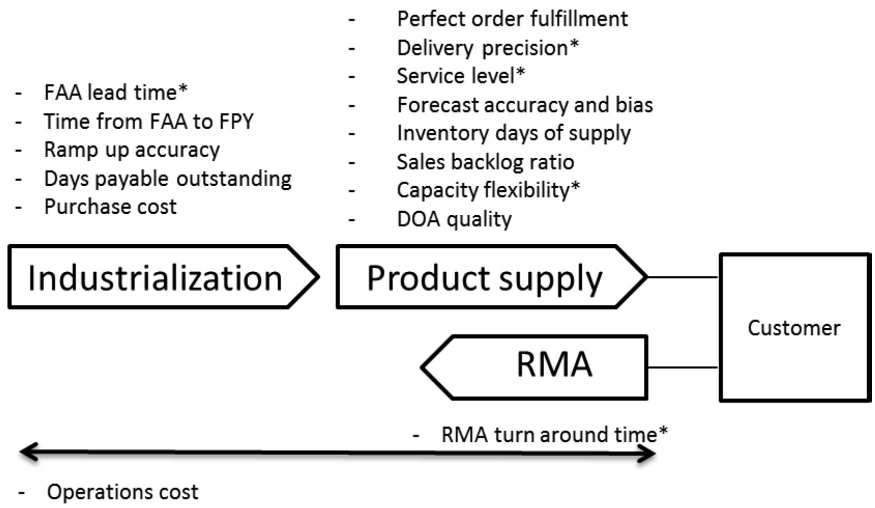

Figure 23 Overview over the final suggestion of metrics for the dashboard

Metric	Definition
Perfect Order fulfillment	Measure in similar way as the currently used metric Supply chain quality but use definition from SCOR and include shipment time to make it easier to benchmark. Also aim at improving the quality of input data.
Service level*	Use current definition but include actual transportation time in the metric or take into consideration carrier performance reliability.
Delivery precision*	Use current definition but include actual transportation time or take into consideration carrier performance reliability.
Inventory days of supply	Similar to currently used Inventory turnover but calculate according to SCOR definition using COGS to increase possibility to benchmark.
Sales backlog ratio	Measure as defined in theory as a ratio between the backlog of orders and the sales for a given period.
Operations cost	Use current definition.
Time from FAA to 90% FPY	Use current definition but change to a moving baseline instead of calendar year.
Capacity flexibility	Improve reliability of data by more clearly defining what should be measured. SCOR definitions can be used as a guide.
Days payable outstanding	Use definition from SCOR.
FAA lead time*	Extend the metric to cover more of the development process.
RMA turnaround time	Extend the metric to cover the entire process, including actual transportation time.
Ramp-up accuracy	Use current definition and display as percentage of projects within the forecasted limits.
Forecast accuracy and bias	Use current definition.
DOA quality	Use current definition but aim at ensuring correct input data with regard to the classification of returning products.
Purchase cost	Use current definition but with a moving baseline.

Table 63 Definition of suggested metrics

6.4 Findings from the analysis of requirements for a dashboard

After identifying the suggested group of metrics these were jointly analyzed in order to ensure that the requirements for a dashboard were fulfilled. The analysis was performed in three parallel sections analyzing the currently used metrics at Axis Operations, the metrics suggested from theory, and finally the combined list of metrics suggested.

The analyses showed that the requirements of a dashboard were fulfilled for all three lists of metrics. Table 64 below summarizes in what ways the requirements are considered as being fulfilled for the combined list of metrics presented as the final suggestion of what metrics to include in the dashboard.

Requirement	Fulfillment of the requirements of the dashboard
Comprehensive	The suggested dashboard contains metrics for all the Balanced Scorecard perspectives as well as all SCOR attributes and is therefore assessed as fulfilling the requirement *comprehensive.*
Causally oriented	The suggested dashboard includes several non-financial metrics and is therefore considered to fulfill the requirement regarding being *causally oriented.*
Vertically integrated	The metrics suggested are connected to the overall company strategy and are possible to aggregate and disaggregate between different levels in the organization. The disaggregation of metrics is especially facilitated through the use of SCOR metrics. The dashboard is therefore assessed as fulfilling the requirement of being *vertically integrated.*
Horizontally integrated	The metrics in the current PMS are developed based on processes and encourages collaboration between different departments. It is therefore assessed as being *horizontally integrated.*
Internally comparable	The metrics suggested for the dashboard can be internally compared in two ways. Either using the focus areas; growth and efficiency, which is currently done at Axis Operations, or by using the SCOR attributes which would make it possible also to prioritize between different growth metrics. The dashboard is based on this assessed to fulfill the requirement *internally comparable.*
Useful	The metrics suggested for the dashboard are assessed as providing valuable information for the user, which is shown through the purpose of measuring each metric. Moreover, 15 metrics are suggested in total of which 7 metrics are suggested as the most critical which corresponds to the suggested appropriate number of metrics to include in a dashboard. The requirement *useful* is therefore assessed as being fulfilled.

Table 64 Fulfillment of requirements of the suggested dashboard

7 Discussion and evaluation of the study

This chapter connects to the purpose and research questions of the study and presents how these have been attended to. A discussion of the result is also provided which addresses possible weaknesses of the result as well as the trustworthiness of the study. Finally a suggestion of further research within the area is presented.

7.1 Fulfilling purpose and research questions

7.1.1 Fulfilling the purpose

As stated in the introduction, the purpose of this study is to suggest metrics for a dashboard that gives an overview of the performance of Axis' Operations department. In Chapter 6 the result of the study is presented, in the form of a set of metrics suggested for inclusion in a dashboard aimed for the Operations department at Axis. The suggested metrics have also been assessed by the intended user of the dashboard as relevant and possible to use for the Operations department. Through this, the purpose of the study is considered as fulfilled.

7.1.2 Answering the research questions

Below follows a discussion of how each of the three research questions of this study have been answered.

- *What defines a supply chain dashboard and the Performance Measurement System that it represents?*

Theory regarding dashboards and PMSs is presented in chapter 3, including definitions of the two to provide the reader with a solid foundation and understanding of the solutions that are presented in the study. Thereby the first research question has been answered.

- *What key metrics should be included in a supply chain dashboard for an operations department?*

The metrics are selected by using the theory, which has been concentrated in the analysis model. The model contains requirements for evaluation of individual metrics and groups of metrics as well as recommendations for how to find suitable metrics that should be included in a dashboard. An example of how the selection is done is shown in chapter 5, where the model is applied on Axis' Operations department. The outcome of this application is the suggestion of metrics for a dashboard. Hence, this answers the question of what metrics should be included in a supply chain dashboard for an operations department. It should however be noted that there is no "one best" set of metrics available and the suggestion presented is just one of several possible solutions, although a relevant one as it meets the user's needs. The research question is however also answered at a more general level through the analysis model. This will be discussed further in section 7.2 below.

- *What key requirements should the metrics in the dashboard fulfill?*

In Chapter 3 requirements for individual metrics as well as for a joint set of metrics are presented. The requirements are designed based on combined theory for metrics, performance measurement systems and dashboards and answers the last research question of what requirements the metrics in a dashboard should fulfill.

7.2 Discussion of results

7.2.1 Discussion of the suggested metrics for Axis Operations' dashboard

According to the developed analysis model, the needs of the user and the company's situation are central aspects when creating the dashboard. The specific suggestion of metrics can therefore not be directly applied to another company. When analyzing the metrics suggested for the dashboard, there is also no absolute answer regarding how well the requirements are fulfilled. It is therefore possible that someone else could achieve a different outcome that is also adapted to the needs of the user and therefore considered as possible to use. However, the inclusion of different departmental managers in the assessment of the metrics increases the confirmability of the study by ensuring that the result is not based solely by the values and opinions of the authors. Moreover, the final suggestion has been presented to the user and is assessed as relevant for the operations department, which speaks to the quality of the suggestion and its trustworthiness.

As stated in the delimitations of the study, the study does not remap the processes at Axis Operations and moreover does not question the connection between the Operations department's strategy and the overall company strategy. It is thus possible that a study that starts with questioning how the strategies connect and whether the processes are correctly mapped could reach another conclusion.

Potential sources of errors, as well as the balance between benefits and costs, regarding the suggested metrics depend on the ability of the company to collect the correct data and use it appropriately. As stated in the delimitations of the study the details of these aspects lie outside the scope of the study as it relates to what Eckerson (2011) describes as the technical architecture.

7.2.2 Discussion of the developed analysis model

One of the weaknesses of the analysis model is that the suggestion provided can never be exhaustive in the sense that it provides the one best solution. It can however be questioned if it is even possible to provide such an analysis model due to the multiplicity of metrics existing in the field. By ensuring that the metrics fulfill the requirements, at least to a certain degree, the analysis model ensures that metrics that are not adequate are excluded from the dashboard. Moreover the analysis model stresses that the metrics are adapted to the company's needs and assessed as eligible by the user. Hence, the analysis model is argued to provide a set of metrics for a dashboard that are adequate and appropriate for the situation.

As for individual components of the analysis models, there are some aspects that can be discussed and improved. The requirement *comprehensive* is partly assessed by using the four perspectives of the Balanced Scorecard to analyze the collection of metrics. However, as mentioned in chapter 5, this grouping of metrics according to which perspective they belong to is subjective and it is possible to categorize metrics differently depending on the point of view or reasoning. Therefore it can be discussed whether or not it is suitable to use the method to assess the metrics. The requirement *comprehensive* also considers the attributes from SCOR, which is appropriate to use for a dashboard relating to operations, but does not cover all areas needed for a CEO. Therefore, depending on the user that the dashboard is adapted to, the Balanced Scorecard is more or less important and may be used as a complement to SCOR. However, when using BSC within the requirement *comprehensive* it is important to consider that the assessment is based on subjective reasoning.

Within the requirement *level of detail* the metrics are compared to existing metrics within the SCOR framework to assess if they are on the desired and appropriate level. The corresponding SCOR-level should not be seen as an absolute decision factor regarding if metrics should be included in the dashboard or not, it rather provides an indication. There can be several reasons for suggesting a metric not corresponding to the decision level suggested in the analysis model, for example if it is seen as particularly important within that specific type of business. As companies differ from each other it is not possible to state that a level 3 metric never is appropriate for a CEO. Therefore the SCOR-levels are not a strict foundation for making decisions, but a guideline where exceptions are allowed.

7.2.3 Contributions

The contributions of this study are two-fold, one part is practical and one is theoretical. Each of them will be described more fully below.

The theoretical contribution consists of an analysis model, which combines existing areas from theory to create a guide for developing dashboards at different levels in an organization. The theoretical pieces themselves are not new and no new theory is developed or presented, but the linking and combination of performance measurement systems, dashboards, metrics and different requirements form the study's contribution. The outcome is a comprehensive guide, instructing the user on how to select metrics and ensure that the chosen set is adequate and fulfills the intended purpose. It has a solid foundation and ties together the strategy, stakeholders and processes, and from there gives directions for how to proceed with selection and evaluation. As the analysis model is not specified to create one type of dashboard in one kind of scenario, the contribution is quite general. At the same time, it is connected to reality and possible to use and apply.

The practical contribution of the study is the suggested metrics for Axis Operations' dashboard, which fulfills the assignment posed by the company. Consequently, the practical contribution of the study is mainly directed towards the case company, but other companies or organizations can also use the set of metrics chosen for Axis Operations given that the context and situation are assessed as similar. The practical contribution of the study is tightly linked to the theoretical one, as the suggested dashboard is developed by applying the analysis model. This connection shows that the model has a practical use and is not a solely a conceptual idea.

7.2.4 Trustworthiness

Chapter 2 describes how the study is carried out and the measures that were taken in order to ensure the trustworthiness of the study. These measures were explained through the criteria credibility, dependability, transferability and confirmability. Below follows a short summary how these criteria were attended to through the study.

7.2.4.1 Credibility

In order to ensure the credibility of the study, triangulation of sources was used both in the literature review and when conducting the empirical study. A weakness regarding the credibility may lie in the fact that for some metrics there is only one respondent assessing the metric, this is partly due to the fact that the interviews were rather time consuming and it was therefore necessary to limit the number of respondents. Using more respondents for each metric could have increased the credibility, however, the persons interviewed were the ones assessed to have most knowledge of the metric in question. Hence, it can be discussed if asking more people about the metric would have made the study more trustworthy if those people have less knowledge about the metric in question.

As previously explained, the respondents were also offered to view the parts of the empirical description that was based on their responses in order to reduce errors based on misunderstandings and thus improve the credibility of the study.

7.2.4.2 Dependability

The method chapter aims at describing all phases of the study in a thorough way in order to make it possible for others to assess the dependability of the study. Bryman (2008) explains that a way of ensuring the dependability even further is to provide a transcript of all interviews and all decisions taken during the study so that these can be examined by other researchers, which in this case could be the supervisor of the project. This validation technique is however described as very demanding by the person doing the validations (Bryman, 2008). The description of the study provided in the method chapter in combination with continuous meetings with the supervisor is therefore assessed as sufficient to justify the dependability of the study.

7.2.4.3 Transferability

The practical result of the study, the suggested metrics for Axis Operations, does not aim at being directly transferable as it is specifically adapted to the company and department in question. The study however aims at providing a solid description of the context in order for the reader to assess whether the result is possible to transfer to a similar company or not.

The theoretical part of the study is assessed as being transferrable to other companies as it provides a general approach to developing metrics. However, more applications of the study including evaluations of the actual solutions are needed in order to ensure the transferability of the study.

7.2.4.4 Confirmability

It is, as previously explained, possible for other researchers to come to another conclusion as to which is the appropriate set of metrics. This since it is to some extent possible to interpret the requirements somewhat differently when assessing the metrics. By including departmental managers in assessing the metrics at Axis Operations, the risk of the result being colored by the authors' opinions is however reduced which increases the confirmability of the study. Triangulation of sources is also used in both the theoretical and empirical part of the study to further improve the confirmability. Moreover, this chapter openly discusses potential sources of errors or misinterpretations in order to improve the confirmability of the study.

7.3 Suggestions for future research

The analysis model needs further testing and development to make it more general and applicable, particularly using the model to implement a dashboard for other levels than VP as this has not been done in the study. Performing an evaluation of the implementation of the dashboard would also be beneficial, as it would provide feedback of how the analysis model could be improved. It would also be beneficial to perform studies that evaluate the metrics selected through the analysis model by exploring if these in fact were the most appropriate metrics to include in the dashboard. The selection of metrics greatly influences the final suggestion and, as earlier mentioned, an abundance of metrics exists. By choosing a set metrics for the initial evaluation, many are excluded and the impact of different metrics could be investigated.

In the study performed, the Operations department already measures performance to some extent. This, in combination with the limited time frame for this study, meant that not all parts of the analysis model where carried out to the same extent in practice. Applying the model to an organization that does not have any measuring in place, and where the processes are not mapped, would provide a more thorough practical application of the model.

The final step in the analysis model, visual design, lies outside the scope of this study. It is however of interest to perform studies that focuses to a greater extent also on how the metrics will actually be presented visually. This since the visual design of the dashboard can affect the outcome and usefulness of the dashboard. Moreover, including the visual aspect earlier in the study may aid in the analysis of metrics, as issues with measuring are made more apparent.

The technical architecture of the dashboard is also an interesting area that is tightly knit to the development of a dashboard. Exploring the connections between that area and the analysis model can complement the existing analysis as it can provide a more thorough solution that also addresses more practical issues. Such a study would provide a more “hands-on” solution, which may be easier to apply for companies and organizations.

During the literature search, several articles were discovered relating to control styles, and the culture within an organization connected to measuring such as the purpose of measuring, the way metrics are followed up, and the way information connected to measuring is shared. This is an interesting aspect as the control style in a company can affect the construction of a PMS, and thereby a dashboard, as well as the selection of metrics and reward systems. Including this in the analysis model would add another dimension and could help to adapt the dashboard further to a company’s needs.

Connected to information sharing and strategies for distributing information it would also be interesting to investigate to what extent the information provided in the dashboard is shared within the company and whether the dashboard aid in increasing the level of awareness of the current situation, goals and progress within the company. This is of particular interest for expanding companies, as communication often becomes more challenging during fast growth.

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Appendix

1. Interview guide

Introduction of the department

- Describe the purpose of the department
- Describe the core activities performed at the department.

Goals and Metrics

- According to you, what are the requirements of a metric?

The goals and the metrics connected to these are reviewed together. For each goal:

- Describe the goal
    - What is the purpose of the goal?
    - How is it connected to Axis Operations' strategy?
    - Is the goal a growth goal, efficiency goal or activity goal?

For all metrics connected to efficiency and growth goals; go through the requirements and:

- Indicate to what degree the metric complies with the description of the requirements.
- Motivate the rating of each metric

Operations Dashboard

The aim of this project is to provide Axis Operations with a dashboard that shows the performance of the department.

- According to you, what are the requirements for a dashboard?
- What metrics do you think should be included in the dashboard in order to provide a holistic view of the Operations department?
- Do you have suggestions on metrics that could be valuable to include in the dashboard, that are not measured at any department today.

Validity and robustness	
The metric is based on factors that:	
1. Cannot be controlled or affected	7. Can be both controlled and affected
The metric:	
1. Doesn't measure what it is supposed to	7. Measures what it is supposed to
The metric is:	
1. Customized to situation specific aspects	7. General and possible to use when benchmarking
Usefulness and Integration	
The metric itself clearly provides guidance for what specific action to take based on the result.	
1. Not at all	7. Completely
The metric encourages collaboration across functions and divisions.	
1. Not at all	7. Completely
The metric:	
1. Focuses on a single activity or function	7. Provides overview of the performance of a process
The input data for the metric can be analyzed soon enough for action to be taken.	
1. Not at all	7. Completely
Level of detail	
The result of the metric is presented at the right level of detail for the person making decisions based on it.	
1. Not at all	7. Completely
Behavioral soundness	
The metric encourages counter-productive behavior.	
1. Not at all	7. To a great extent
The metric can be used for giving feedback about performance.	
1. Not at all	7. Completely
Reliability	
The metric:	
1. Needs explanation to be understood	7. Is intuitively understood
The human factor (subjective assessment, errors in data collection and calculation) can affect the result of the metric.	
1. Not at all	7. To a great extent
The purpose, data collection, calculation, and surrounding procedures are:	
1. Not defined	7. Clearly defined
Economy	
The benefits of using the metric outweigh the cost of measuring:	
1. Not at all	7. Completely
Compatibility	
The routines for collecting data are:	
1. Unique for the metric	7. Shared with other metric(s)

2. Respondents answers to questionnaire, regarding metrics

This appendix contains the ratings for each metric that were done by the respondents based on the questions presented in the interview guide in Appendix 1. It should be noted that the names of the requirements (validity, robustness etc.,) were not shown to the respondents as this could have affected the answers if the respondents already have a perception of the meaning of the name which did not correspond to the definition used in the study

Delivery precision

Requirement	Loftorp	Nilsson, T	De Wiengren, Torstensson	Haag	Trotzig	Interpretation
Validity vs. Robustness	7	6	2	7	4	1. Not valid. 7. Very valid
	5	7	1	6	6	1. Not valid. 7. Very valid
	7	4	1	7	7	1. Valid. 7. Robust
Integration vs. Usefulness	1	5	1	7	1	1. Not useful. 7. Very useful.
	6	6	6	7	5	1. Not integrated. 7. Very integrated.
	7	3	1	7	7	1. Not integrated. 7. Very integrated.
	3	7	1	6	1	1. Not useful. 7. Very useful.
Economy	6	7	7	6	7	1. Not economical. 7. Economical
Compatibility	7	7	7	5	7	1. Not compatible. 7. Compatible.
Reliability	6	4	7	5	6	1. Reliable. 7 Not reliable.
	1	5	7	2	1	1. Reliable. 7 Not reliable.
	7	7	7	6	1	1. Not reliable. 7. Reliable
Level of detail	4	5	7	7	5	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	3	2	1	1	1	1. Behaviorally sound. 7. Not behaviorally sound.
	6	6	2	7	5	1. Not behaviorally sound. 7. Behaviorally sound.

Service level

Requirement	Loftorp	Nilsson, T.	De Wiengren, Torstensson	Haag	Interpretation
Validity vs. Robustness	5	4	6	7	1. Not valid. 7. Very valid
	5	5	1	6	1. Not valid. 7. Very valid
	6	4	1	7	1. Valid. 7. Robust
Integration vs. Usefulness	1	5	1	7	1. Not useful. 7. Very useful.
	5	5	6	7	1. Not integrated. 7. Very integrated.
	7	7	1	7	1. Not integrated. 7. Very integrated.
	3	7	1	6	1. Not useful. 7. Very useful.
Economy	6	7	7	6	1. Not economical. 7. Economical
Compatibility	7	7	7	3	1. Not compatible. 7. Compatible.
Reliability	5	4	7	5	1. Reliable. 7 Not reliable.
	1	4	7	2	1. Reliable. 7 Not reliable.
	7	7	7	6	1. Not reliable. 7. Reliable
Level of detail	4	5	7	7	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	3	2	1	2	1. Behaviorally sound. 7. Not behaviorally sound.
	5	6	2	7	1. Not behaviorally sound. 7. Behaviorally sound.

Supply Chain quality

Requirement	Qvarfordh	Loftorp	De Wiengren, Torstensson	Interpretation
Validity vs. Robustness	5	7	1	1. Not valid. 7. Very valid
	5	6	6	1. Not valid. 7. Very valid
	1	6	1	1. Valid. 7. Robust
Integration vs. Usefulness	5	1	1	1. Not useful. 7. Very useful.
	6	6	6	1. Not integrated. 7. Very integrated.
	6	6	1	1. Not integrated. 7. Very integrated.
	6	6	1	1. Not useful. 7. Very useful.
Economy	5	6	7	1. Not economical. 7. Economical
Compatibility	2	1	1	1. Not compatible. 7. Compatible.
Reliability	6	6	7	1. Reliable. 7 Not reliable.
	6	6	7	1. Reliable. 7 Not reliable.
	5	5	7	1. Not reliable. 7. Reliable
Level of detail	5	5	7	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	4	1	1	1. Behaviorally sound. 7. Not behaviorally sound.
	5	4	2	1. Not behaviorally sound. 7. Behaviorally sound.

DOA quality

Requirement	Loftorp	Interpretation
Validity vs. Robustness	3	1. Not valid. 7. Very valid
	6	1. Not valid. 7. Very valid
	7	1. Valid. 7. Robust
Integration vs. Usefulness	1	1. Not useful. 7. Very useful.
	2	1. Not integrated. 7. Very integrated.
	7	1. Not integrated. 7. Very integrated.
	6	1. Not useful. 7. Very useful.
Economy	5	1. Not economical. 7. Economical
Compatibility	6	1. Not compatible. 7. Compatible.
Reliability	6	1. Reliable. 7 Not reliable.
	3	1. Reliable. 7 Not reliable.
	7	1. Not reliable. 7. Reliable
Level of detail	2	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	1	1. Behaviorally sound. 7. Not behaviorally sound.
	6	1. Not behaviorally sound. 7. Behaviorally sound.

Time from FAA to 90% FPY

Requirement	Nilsson, S.	Trotzig	Interpretation
Validity vs. Robustness	6	3	1. Not valid. 7. Very valid
	5	7	1. Not valid. 7. Very valid
	3	1	1. Valid. 7. Robust
Integration vs. Usefulness	6	6	1. Not useful. 7. Very useful.
	7	7	1. Not integrated. 7. Very integrated.
	6	7	1. Not integrated. 7. Very integrated.
	5	7	1. Not useful. 7. Very useful.
Economy	7	7	1. Not economical. 7. Economical
Compatibility	3	2	1. Not compatible. 7. Compatible.
Reliability	6	7	1. Reliable. 7 Not reliable.
	2	5	1. Reliable. 7 Not reliable.
	6	6	1. Not reliable. 7. Reliable
Level of detail	6	7	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	2	1	1. Behaviorally sound. 7. Not behaviorally sound.
	4	5	1. Not behaviorally sound. 7. Behaviorally sound.

Capacity flexibility

Requirement	Nilsson, S.	Lindkvist	Interpretation
Validity vs. Robustness	5	3	1. Not valid. 7. Very valid
	5	4	1. Not valid. 7. Very valid
	4	5	1. Valid. 7. Robust
Integration vs. Usefulness	4	7	1. Not useful. 7. Very useful.
	3	3	1. Not integrated. 7. Very integrated.
	4	7	1. Not integrated. 7. Very integrated.
	4	7	1. Not useful. 7. Very useful.
Economy	7	7	1. Not economical. 7. Economical
Compatibility	1	1	1. Not compatible. 7. Compatible.
Reliability	5	1	1. Reliable. 7 Not reliable.
	5	7	1. Reliable. 7 Not reliable.
	4	6	1. Not reliable. 7. Reliable
Level of detail	6	3	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	3	5	1. Behaviorally sound. 7. Not behaviorally sound.
	6	4	1. Not behaviorally sound. 7. Behaviorally sound.

RMA turnaround time

Requirement	Nilsson, T.	Aiyar Panchmatia	Interpretation
Validity vs. Robustness	4	5	1. Not valid. 7. Very valid
	7	6	1. Not valid. 7. Very valid
	7	7	1. Valid. 7. Robust
Integration vs. Usefulness	5	5	1. Not useful. 7. Very useful.
	6	6	1. Not integrated. 7. Very integrated.
	7	4	1. Not integrated. 7. Very integrated.
	7	2	1. Not useful. 7. Very useful.
Economy	7	4	1. Not economical. 7. Economical
Compatibility	7	1	1. Not compatible. 7. Compatible.
Reliability	4	5	1. Reliable. 7 Not reliable.
	6	5	1. Reliable. 7 Not reliable.
	6	6	1. Not reliable. 7. Reliable
Level of detail	5	2	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	5	5	1. Behaviorally sound. 7. Not behaviorally sound.
	6	6	1. Not behaviorally sound. 7. Behaviorally sound.

Operations cost

Requirement	Loftorp	Interpretation
Validity vs. Robustness	7	1. Not valid. 7. Very valid
	7	1. Not valid. 7. Very valid
	4	1. Valid. 7. Robust
Integration vs. Usefulness	1	1. Not useful. 7. Very useful.
	6	1. Not integrated. 7. Very integrated.
	7	1. Not integrated. 7. Very integrated.
	5	1. Not useful. 7. Very useful.
Economy	7	1. Not economical. 7. Economical
Compatibility	7	1. Not compatible. 7. Compatible.
Reliability	7	1. Reliable. 7 Not reliable.
	1	1. Reliable. 7 Not reliable.
	7	1. Not reliable. 7. Reliable
Level of detail	6	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	1	1. Behaviorally sound. 7. Not behaviorally sound.
	7	1. Not behaviorally sound. 7. Behaviorally sound.

Inventory turnover

Requirement	Haag	Interpretation
Validity vs. Robustness	6	1. Not valid. 7. Very valid
	7	1. Not valid. 7. Very valid
	7	1. Valid. 7. Robust
Integration vs. Usefulness	6	1. Not useful. 7. Very useful.
	5	1. Not integrated. 7. Very integrated.
	7	1. Not integrated. 7. Very integrated.
	7	1. Not useful. 7. Very useful.
Economy	7	1. Not economical. 7. Economical
Compatibility	7	1. Not compatible. 7. Compatible.
Reliability	7	1. Reliable. 7 Not reliable.
	1	1. Reliable. 7 Not reliable.
	7	1. Not reliable. 7. Reliable
Level of detail	6	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	3	1. Behaviorally sound. 7. Not behaviorally sound.
	7	1. Not behaviorally sound. 7. Behaviorally sound.

Purchase cost

Requirement	Dzinovic	Nilsson, S	Interpretation
Validity vs. Robustness	5	7	1. Not valid. 7. Very valid
	4	7	1. Not valid. 7. Very valid
	7	6	1. Valid. 7. Robust
Integration vs. Usefulness	3	6	1. Not useful. 7. Very useful.
	6	6	1. Not integrated. 7. Very integrated.
	5	6	1. Not integrated. 7. Very integrated.
	7	5	1. Not useful. 7. Very useful.
Economy	6	7	1. Not economical. 7. Economical
Compatibility	1	1	1. Not compatible. 7. Compatible.
Reliability	4	6	1. Reliable. 7 Not reliable.
	6	1	1. Reliable. 7 Not reliable.
	6	6	1. Not reliable. 7. Reliable
Level of detail	7	7	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	5	3	1. Behaviorally sound. 7. Not behaviorally sound.
	5	6	1. Not behaviorally sound. 7. Behaviorally sound.

Decrease CO2/ton km emissions from transport

Requirement	De Wiengren, Torstensson	Interpretation
Validity vs. Robustness	2	1. Not valid. 7. Very valid
	6	1. Not valid. 7. Very valid
	6	1. Valid. 7. Robust
Integration vs. Usefulness	4	1. Not useful. 7. Very useful.
	5	1. Not integrated. 7. Very integrated.
	1	1. Not integrated. 7. Very integrated.
	1	1. Not useful. 7. Very useful.
Economy	7	1. Not economical. 7. Economical
Compatibility	1	1. Not compatible. 7. Compatible.
Reliability	6	1. Reliable. 7 Not reliable.
	7	1. Reliable. 7 Not reliable.
	7	1. Not reliable. 7. Reliable
Level of detail	7	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	1	1. Behaviorally sound. 7. Not behaviorally sound.
	1	1. Not behaviorally sound. 7. Behaviorally sound.

Payment terms

Requirement	Nilsson, S	Lindkvist	Interpretation
Validity vs. Robustness	6	6	1. Not valid. 7. Very valid
	7	7	1. Not valid. 7. Very valid
	7	7	1. Valid. 7. Robust
Integration vs. Usefulness	6	7	1. Not useful. 7. Very useful.
	3	2	1. Not integrated. 7. Very integrated.
	2	2	1. Not integrated. 7. Very integrated.
	7	7	1. Not useful. 7. Very useful.
Economy	7	7	1. Not economical. 7. Economical
Compatibility	1	1	1. Not compatible. 7. Compatible.
Reliability	7	7	1. Reliable. 7 Not reliable.
	1	1	1. Reliable. 7 Not reliable.
	5	7	1. Not reliable. 7. Reliable
Level of detail	7	7	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	4	3	1. Behaviorally sound. 7. Not behaviorally sound.
	6	6	1. Not behaviorally sound. 7. Behaviorally sound.

Forecast accuracy and bias

Requirement	Hjelmström	Interpretation
Validity vs. Robustness	5	1. Not valid. 7. Very valid
	6	1. Not valid. 7. Very valid
	5	1. Valid. 7. Robust
Integration vs. Usefulness	4	1. Not useful. 7. Very useful.
	5	1. Not integrated. 7. Very integrated.
	7	1. Not integrated. 7. Very integrated.
	4	1. Not useful. 7. Very useful.
Economy	6	1. Not economical. 7. Economical
Compatibility	5	1. Not compatible. 7. Compatible.
Reliability	2	1. Reliable. 7 Not reliable.
	5	1. Reliable. 7 Not reliable.
	5	1. Not reliable. 7. Reliable
Level of detail	5	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	2	1. Behaviorally sound. 7. Not behaviorally sound.
	6	1. Not behaviorally sound. 7. Behaviorally sound.

Ramp-up accuracy

Requirement	Hjelmström	Interpretation
Validity vs. Robustness	5	1. Not valid. 7. Very valid
	5	1. Not valid. 7. Very valid
	5	1. Valid. 7. Robust
Integration vs. Usefulness	3	1. Not useful. 7. Very useful.
	4	1. Not integrated. 7. Very integrated.
	5	1. Not integrated. 7. Very integrated.
	4	1. Not useful. 7. Very useful.
Economy	5	1. Not economical. 7. Economical
Compatibility	6	1. Not compatible. 7. Compatible.
Reliability	4	1. Reliable. 7 Not reliable.
	4	1. Reliable. 7 Not reliable.
	5	1. Not reliable. 7. Reliable
Level of detail	4	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	5	1. Behaviorally sound. 7. Not behaviorally sound.
	5	1. Not behaviorally sound. 7. Behaviorally sound.

FAA lead time

Requirement	Trotzig	Interpretation
Validity vs. Robustness	6	1. Not valid. 7. Very valid
	6	1. Not valid. 7. Very valid
	6	1. Valid. 7. Robust
Integration vs. Usefulness	6	1. Not useful. 7. Very useful.
	2	1. Not integrated. 7. Very integrated.
	1	1. Not integrated. 7. Very integrated.
	6	1. Not useful. 7. Very useful.
Economy	4	1. Not economical. 7. Economical
Compatibility	1	1. Not compatible. 7. Compatible.
Reliability	7	1. Reliable. 7 Not reliable.
	5	1. Reliable. 7 Not reliable.
	2	1. Not reliable. 7. Reliable
Level of detail	6	1. Not right level of detail. 7. Right level of detail
Behavioral soundness	1	1. Behaviorally sound. 7. Not behaviorally sound.
	6	1. Not behaviorally sound. 7. Behaviorally sound.

3. Departments within Axis Operations

Departments within the Supply chain unit

Department	Main responsibility
CLC quality control	Work towards creating clear processes of how to work with quality at all CLCs, develop quality measurements that can be used to control the business and handle returns to and from CLCs worldwide. (Axis, 2014d)
Logistics	Responsible for transportation including, among others, selection of transport suppliers and freight negotiation and transport forecasts to suppliers for space reservation. (Axis, 2014e)
Order	The main point of contact towards customers regarding orders, deliveries and other order related queries. (Axis, 2014f)
Process development	Work with all CLCs to support planning issues and problems that can occur in, or in connection to, production. (Axis, 2014g)
Production and CLC:s	The main responsibilities are warehousing, manufacturing and distribution of products to subsidiaries and customers through the CLCs. (Axis, 2014h)
Return Material Authorization	Responsible for ensuring that the RMA service channels provide quick and quality repairs/return service to customers. (Axis, 2014i)
Supply	Responsible for all manufacturing purchases to the CLCs and ensuring that there is material available for manufacturing. (Axis, 2014j)

Departments within the Production Preparation and Sourcing unit

Department	Main responsibility
Commercial Purchasing	Responsible for securing the right price and other terms and condition through negotiation with suppliers. (Axis, 2014k)
Production Preparation	Consist of the subunits: Product Data Group, Design for Manufacturing and Industrial lead. Responsible for driving production related areas within product projects to secure a stable and fast ramp-up in production. (Axis, 2014t)
Production test group	Responsible for developing and maintaining high performing and cost efficient production tests that secure quality of the products. (Axis, 2014u)
Sourcing	Responsible for sourcing, evaluating and selecting new suppliers and effectively manage suppliers, factories and agents relations. (Axis, 2014v)

Description of the Demand planning and Quality and Environment departments

Department	Main responsibility
Demand Planning	Responsible for forecasting future demands of Axis' products. (Axis, 2014w)
Quality and Environment	Responsible for ensuring that Axis' products meet the specifications, and to drive quality assurance and improvement activities at EMS partners and CLCs to ensure that the supply chain is capable of achieving the specified quality. Moreover, they are responsible for coordinating the environmental activities at Axis. (Axis, 2014y)

4. Decision levels and SCOR attributes

Decision level- Metrics at Axis

Metrics at Axis	Corresponding metric in SCOR (deciding level of detail)	Level
Supply Chain quality	RL 1.1- Perfect order fulfillment	1
Service level	RS 1.1- Order fulfillment cycle time	1
Operations cost	Part of CO 1.001- Total cost to serve	2
Delivery Precision	RL 2.2- Delivery Performance to customer commit date	2
RMA turnaround time	RS 2.2- Make cycle time	2
Capacity flexibility	AG 2.2- Upside make flexibility	2
Inventory turnover	AM 2.2- Inventory days of supply	2
Payment terms	AM 2.3- Days payable outstanding	2
Time from FAA to 90% FPY	No direct corresponding SCOR metric but assessed to be at tactical level and hence correspond to SCOR level 2	2
Dead On Arrival quality	Not exact but similar to RL 3.24- Orders delivered damaged free or RL 3.55 Number of returns within warranty period	3
Forecast accuracy	RL 3.37- Forecast accuracy	3
Ramp up accuracy	Not found but assessed as same level as forecast accuracy- level 3	3
Response to enquiries	Not found but assessed as corresponding to the same level as for example RS 3.8- The average time associated with authorizing payment to suppliers which is a level 3 metric.	3
Process orders to status "Released" or "Blocked" within given timeframe	Not found but assessed as being same level as "Response to enquiries" -level 3.	3
Purchase cost	Similar to CO 3.009- Purchased materials cost	3
RMA repair rate	Not exact but similar to AM 3.39- Percentage unserviceable MRO inventory in disposition	3
P-returns	AM 3.28-Percentage of defective inventory	3
Decrease CO2	Part of GS 2.004- Deliver carbon emissions (assessed as level 3 since only considering transport and not other aspects of deliver)	3
FAA lead time	Not found but assessed as corresponding to the same level as for example RS 3.101 -Produce and test cycle time which is a level 3 metric.	3

Decision level- Metrics from theory

Metrics from Theory	**Corresponding metric in SCOR (deciding level of detail)**	**Level**
Sales backlog ratio	No direct corresponding SCOR metric but assessed to be at tactical level and hence correspond to SCOR level 2	2
New product forecast accuracy	RL 3.37- Forecast accuracy	3
Percentage of new product developments launched on time	No direct corresponding SCOR metric but assessed to be at tactical level and hence correspond to SCOR level 2	2
Percentage of new product developments launched on budget	No direct corresponding SCOR metric but assessed to be at tactical level and hence correspond to SCOR level 2	2
First pass yield	RL. 3.58- Yield	3
Returns percentage	Not exact but similar to RL 3.24- Orders delivered damaged free or RL 3.55 Number of returns within warranty period	3

SCOR attributes

Reliability =RL, Responsiveness=RS, Agility=AG, Cost= CO, Asset Management Efficiency=AM

SCOR attributes- Metrics from theory

Metrics from Theory	SCOR Attribute	Explanation
Perfect Order fulfillment	RL	RL. 1.1
Returns Percentage	RL	Not exact but similar to RL 3.24- Orders delivered damaged free or RL 3.55 Number of returns within warranty period
Forecast accuracy	RL	RL 3.37- Forecast accuracy
First Pass Yield	RL	RL. 3.58- Yield
New product Forecast Accuracy	RL	Similar to RL 3.37 Forecast accuracy
Percentage of new product developments launched on time	RL	Measures the predictability of launching the products on time
Order fulfillment cycle time	RS	RS.1.1
Sales Backlog Ratio	RS	Aim at ensuring the cycle time of the product supply process is not too long.
Upside Supply chain flexibility	AG	AG.1.1
Total cost to serve	CO	CO.1.001
Percentage of new product developments launched on budget	CO	Measures a type of cost
Cash to cash cycle time	AM	AM.1.1
Days payable outstanding	AM	AM.2.3
Inventory Days of supply	AM	AM.2.2
Total supply chain carbon footprint	Green SCOR	GS.1.001

SCOR attributes- Metrics from Axis

Metrics at Axis	**SCOR Attribute**	**Explanation**
Supply Chain quality	RL	RL 1.1- Perfect order fulfillment
Service level	RS	RS 1.1- Order fulfillment cycle time
Operations cost	CO	Part of CO 1.001- Total cost to serve
Delivery Precision	RL	RL 2.2- Delivery Performance to customer commit date
RMA turnaround time	RS	RS 2.2- Make cycle time
Capacity flexibility	AG	AG 2.2- Upside make flexibility
Inventory turnover	AM	AM 2.2- Inventory days of supply
Payment terms	AM	AM 2.3- Days payable outstanding
Time from FAA to 90% FPY	RL	Measures the predictability of launching the products on time to the right quality
Dead On Arrival quality	RL	Not exact but similar to RL 3.24- Orders delivered damaged free or RL 3.55 Number of returns within warranty period
Forecast accuracy	RL	RL 3.37- Forecast accuracy
Ramp up accuracy	RL	Not found but assessed as same level as forecast accuracy-level 3
Purchase cost	CO	Similar to CO 3.009- Purchased materials cost
Decrease CO_2/ton km emissions from transport	Green SCOR	Part of GS 2.004- Deliver carbon emissions (assessed as level 3 since only considering transport and not other aspects of deliver)
FAA lead time	RS	Measures the cycle time of introducing new products.