Increased Supply Chain Flexibility by Changes in Information Sharing with Suppliers – The FAIS Roadmap

The case of Axis Communications AB

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Abstract

Title: Increased Supply Chain Flexibility by Changes in Information Sharing with Suppliers – The FAIS Roadmap
The case of Axis Communications AB

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Background: Due to a shifting competitive landscape, companies have realized that in order to meet the new market trends, they need to be flexible not only within their own link but throughout their supply chain. One factor that has proved to have great impact on supply chain flexibility is information sharing.

Purpose: The purpose of this thesis is to add to the knowledge on how organizations can increase their supply chain flexibility by changes in information sharing with suppliers.

Objectives: The objective of this thesis is twofold:

- To develop a roadmap for analyzing the need and possibilities to increase supply chain flexibility by changes in information sharing with suppliers.

- With support of this roadmap, present recommendations aiming at increasing the flexibility in Axis's supply chain by changes in information sharing with suppliers.

Method: This study has been conducted using a systems approach. Through combining theories about supply chain flexibility, information sharing in supply chains and an empirical investigation in an abductive manner, the FAIS Roadmap has been developed. The preliminary FAIS Roadmap was tested using a case study on Axis Communications AB.

Conclusions: The developed FAIS Roadmap is a tool that can be used in order to specify what changes that should be made regarding information sharing with suppliers in order to increase the supply chain flexibility. After testing the developed roadmap, some refinements were done, resulting in a final version of the FAIS Roadmap. Furthermore, the test resulted in five recommendations for Axis: *understand suppliers' real need for information*, *simplify and synchronize internal information processes*, *make sure that high quality information is passed on further up the chain*, *benefit from extensive information sharing in early stages of product development*, and *share additional information in order to decrease lead times.*

Key words: Supply chain, supply chain management, supply chain flexibility, supply chain flexibility dimensions, information sharing, FAIS Roadmap, Axis Communications AB.

Acknowledgements

This thesis has been written during the spring of 2009 and is a concluding part of our Masters in Technology Management at Lund University. Writing this thesis has given us understanding and knowledge in a very complex but interesting subject that is highly relevant for today's organizations.

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We would also like to give a very special thanks to our tutors at Lund University, Carina Johnsson and Ulf Paulsson that have given us valuable support and helped us reach academic heights. We would also like to thank our reference group, Emma Jönsson and Emilie Persson, for providing us with helpful feedback and criticism to our thesis.

Finally, we want to thank everyone who has contributed to this thesis by being flexible during conducted interviews and for sharing high quality information with us.

Lund, June 2009

Simon Quick Louice Rosdahl

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1 Introduction

This chapter will give an introduction to the thesis including background, purpose and objectives. Thereafter, delimitations as well as the target audience for this thesis will be discussed. Finally, a general outline and disposition will be presented.

1.1 Background

The competitive landscape has been shifting due to increased globalization as well as the technological revolution. Information Technology has driven the technological revolution and has made information more transparent and customers more aware of different products and services on the market. The customers demand higher quality and service, lower prices, shorter lead times, and more variety of products and services[1,2,3]. This has led to shorter product life cycles and thereby technological developments occurring at a faster pace and reductions in time to market for new products[4,5], see Figure 1.

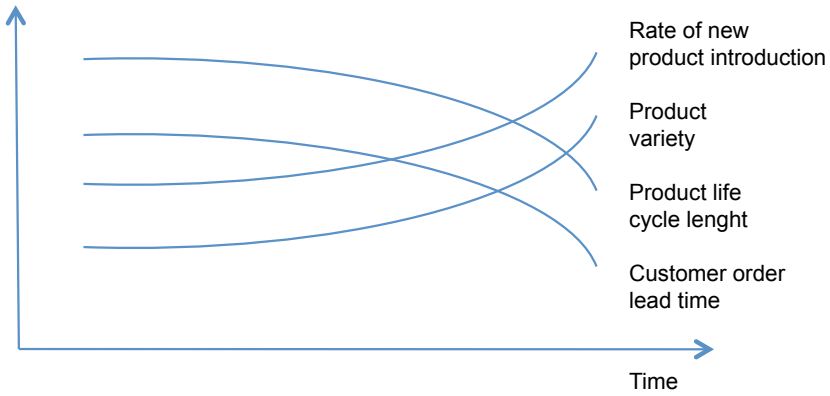

Figure 1: Current trends in the marketplace (Mattsson (2000) p. 184)

As a result of the globalization and the new technology, an organization cannot only focus on strategies regarding low cost or high quality; it must also have a strategy for high responsiveness.[6] In the 1990's, many companies realized that in order to meet the new market demands, they needed to be flexible not only within their own link but throughout their chain. They therefore begun to look more intensively beyond their borders and tried to accomplish flexibility throughout their entire supply chain.[7,8,9]

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[1] Hitt et al. (1998), p. 23
[2] Lummus et al. (2003), p. 447
[3] Simatupang & Sridharan (2002), p. 15
[4] Hitt et al. (1998), p. 23
[5] Mattsson (2000), p. 184
[6] Lummus et al. (2003), p. 447
[7] Ibid.

"As supply chains compete with supply chains in the future, companies must understand that flexible supply chains will outperform those that are less agile."[10]

One factor that has proven to have great impact on supply chain flexibility and supply chain performance is information sharing[11,12,13]. Managing information is essential in order to manage, plan and control processes in a supply chain[14]. Lack of information sharing results in uncertainties about supply chain trading partners, and when uncertainties arise, they result in higher costs because of errors in forecasting, demand processing and order batching[15]. In order to achieve effective information sharing, an organization must analyze what data that is preferable, how to obtain that data at the right time to the right receiver and in the right format.[16]

One company that has realized the need for being able to quickly adjust the supply after changes in demand is the Swedish-based IT company Axis Communications AB, hereafter called Axis. Axis is the global market leader in network videos, driving the ongoing shift from analog to digital video surveillance.[17] Axis market is characterized by a high rate of new product introductions, short lead times, high product variety and relatively short product life cycle lengths. Therefore, Axis must tackle these new market trends in order to retain the position as the global market leader. Axis has thereby realized the need for increased supply chain flexibility.

1.2 Purpose

The purpose of this thesis is to add to the knowledge on how organizations can increase their supply chain flexibility by changes in information sharing with suppliers.

1.3 Objectives

The objective of this thesis is twofold:

- To develop a roadmap for analyzing the need and possibilities to increase supply chain flexibility by changes in information sharing with suppliers.
- With support of this roadmap, present recommendations aiming at increasing the flexibility in Axis's supply chain by changes in information sharing with suppliers.

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[8] Schmenner & Tatikonda (2005), p. 1184
[9] Slack (2005)
[10] Lummus et al. (2003), p. 455
[11] Agrawal et al. (2009), p. 590
[12] Mason-Jones & Towill (1997), p. 147
[13] Chu & Lee (2006), p. 1568
[14] Skjott-Larsen et al. (2007), p. 99
[15] Yu et al. (2001), p. 115
[16] Barratt & Oke (2007), p. 1218
[17] Axis webpage (2009-01-15)

1.4 Focus and Delimitations

This thesis does not aim at changing information systems or information infrastructure, neither to change information sharing with distributors or other customers. This thesis focus on the upstream supply chain and how changes in information sharing can affect supply chain flexibility. Hence, no recommendations regarding systems for handling information or how to ensure that correct information is received from downstream trading partners will be developed.

Sine changes in information systems or information infrastructure is not taken into consideration in this study, additional information regarding preferable systems needs to be investigated. Furthermore, the potential costs associated with an implementation of the results produced by the use of the presented roadmap are not investigated. Hence, to successfully implement any changes found through the use of the roadmap, a thorough cost analysis has to be performed. Moreover, since no recommendations will be developed regarding how to ensure that correct information is received from downstream trading partners, it is important that this is evaluated additionally in order to ensure that information sent upstream the chain is based on high quality information.

Additionally, the limited time frame of four months, results in limitations for the test of the developed roadmap, due to this only one case study, at Axis, will be conducted. This affects the external validity of the developed roadmap and, until additional tests have been performed, the roadmap ought to be seen as an inspiration, rather than a completely plenary way for how to increase supply chain flexibility.

1.5 Target Audience

The primary target audience for this thesis is scholars or students with an interest in issues regarding supply chain management in fast growing companies, supply chain flexibility or supply chain information sharing. Furthermore, the target group is employees at Axis working with, or having an interest in, questions regarding the supply chain. In addition, other organizations, scholars or students may find this thesis interesting and inspiring for further investigations.

The persons within this target group are assumed to have basic knowledge about the subjects of supply chain and supply chain management.

1.6 Outline and Disposition

Chapter 1: Introduction

This chapter will give an introduction to the thesis including background, purpose and objectives. Thereafter, focus and delimitations as well as the target audience for this thesis will be discussed. Finally, a general outline and disposition will be presented.

Chapter 2: Methodology

This chapter will describe methodological issues as well as the methodology used in this thesis. As conclusion, an overview of the working method and how the authors

have strived towards achieving a high credibility of the conducted study will also be presented.

Chapter 3: Theory

This chapter lays the theoretical foundation upon which this thesis is based. Relevant terms will be defined, and theories regarding different aspects of the term supply chain, supply chain management, supply chain flexibility and information sharing will be presented. The chapter concludes with a sum up and commenting.

Chapter 4: Axis Communications AB and its Supply Chain

In this chapter a general description of Axis, as well as Axis's supply chain, will be made where two suppliers are evaluated. The chapter ends with a sum up of the current flexibility and information sharing situation in Axis supply chain.

Chapter 5: The Preliminary Flexibility and Information Sharing (FAIS) Roadmap

In this chapter, the developed roadmap for analysis of how supply chain flexibility can be increased by changes in information sharing with suppliers will be presented.

Chapter 6: Testing and Refining the Preliminary FAIS Roadmap at Axis

In this chapter the preliminary FAIS Roadmap will be tested on Axis. Thereafter, refinements to the roadmap will be presented, as well as the final FAIS Roadmap. Furthermore, recommendations for how to increase the supply chain flexibility at Axis will be presented.

Chapter 7: Reflections and Conclusions

In this chapter the chosen theories, the developed roadmap, and the fulfillment of the purpose and objectives will be reflected upon. Furthermore, the generalizability of the results will be discussed.

2 Methodology

In order to attain a sufficient level of credibility and objectivity in a scientific study it is imperative to address issues of research methodology. This chapter will describe methodological issues as well as the methodology used in this thesis. As conclusion, an overview of the working method and how the authors have strived towards achieving a high credibility of the conducted study is presented.

There is a difference between methodology and method. Methodology refers to the principles of logical and philosophical art on which methods on lower levels are based. The method generally describes the practical scientific work procedure and the more principle choices regarding tools for data collection and analysis.[18]

2.1 Methodological Issues

In this section, methodological issues that a researcher has to consider when conducting a study will be presented. The purpose of presenting the methodological approach used is to make it possible for other authors to replicate the study and evaluate the work procedure.[19]

2.1.1 Research Paradigms

Every researcher has basic assumptions, *paradigms*, regarding the reality, how new knowledge is created, how information should be gathered and analyzed etcetera. The paradigm of *interpretivism* considers that different people view reality in different ways based on for instance personal emotions and different backgrounds. Taking the paradigm of interpretivism into account is important when analyzing gathered empirics or generating recommendations.[20] Researchers with a *positivistic* paradigm believe that observable phenomena can lead to the production of credible empirics, and that the facts can provide basis for theory[21]. These basic assumptions can have great impact on the methodology, the available methods and techniques for collection and study of information, as well as on how conclusions are drawn. Therefore, it is of importance that the authors have a clear view of their basic assumptions before the initiation of the study, since these assumptions affect the choice of methodology, method and practical procedure.[22] Basic assumptions cannot be tested empirically or logically. As a result it is impossible to choose the best way to solve a scientific problem in advance. For that reason, one should strive towards a fit between problem, solution techniques and the author's basic assumptions; the three nodes of research, see Figure 2.[23]

[18] Paulsson (1999), pp. 49-50
[19] Backman (2008), p. 41
[20] Saunders et al. (2007), pp. 106-107
[21] Ibid. (2007), p. 103
[22] Björklund & Paulsson (2003), p. 64
[23] Bjerke (1981), p. 3

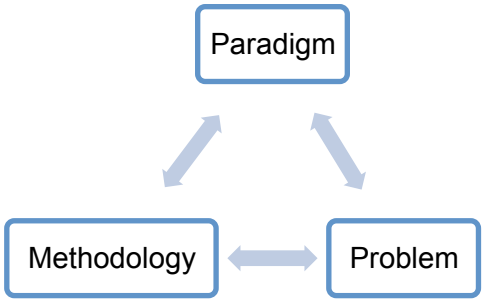

Figure 2: Three nodes of research, inspired by Bjerke (1981), p. 2

2.1.2 Methodological Perspective

There are mainly three different methodological approaches used in management research to cope with the fit between the three nodes of research: the *analytical*-, the *systems*- and the *actor's approach*.[24] The systems approach is based on an objective view of reality and that the whole is often more than the sum of the parts[25]. In the systems approach, there is a focus on synergies between different parts, and the relation between these parts is as important as the parts themselves[26].

Research can be related to either the empirical or the theoretical world. *Induction* means that the researcher constructs theories using factual knowledge, which is developing theories from empirical observations. *Deduction* has its starting point in theory, where predictions about the empirical world are developed. These predictions are then brought back in the empirical world, in order to test the developed theories relevance.[27] *Abduction* is a combination of the inductive and deductive methods. It is a method where the researchers move back and forth between the theoretical and the empirical worlds.[28]

2.1.3 Different Research Methods

Literature study

Literature studies provide secondary data in form of written material. The material has often been completed in another purpose than that of the current study. Therefore, it is important to be aware of the fact that the information can be partial or not comprehensive. Due to the secondary nature of the information, it is important to always question the information as well as the usage of the material. However, the strength of literature studies is that the researcher during a limited time can assimilate large amount of information. Furthermore, literature studies are often suitable to map existing knowledge within the field of study in order to build a theoretical frame of reference.[29]

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[24] Bjerke (1981), p. 3
[25] Arbnor & Bjerke (1997), p. 65
[26] Björklund & Paulsson (2003), p. 59
[27] Arbnor & Bjerke (1997), p. 93
[28] Björklund & Paulsson (2003), p. 62
[29] Ibid, pp. 67-70

Interviews

Interviews enable for the researcher to collect information that is directly relevant to the purpose of the study. Hence, interviews are a way of collecting primary data. Interviews give a deep understanding since questions can be individually adjusted to specific respondents. However, interviews are often a very time consuming research method.[30]

Survey

The purpose of *survey studies* is primarily to gather information that can be analyzed to find patterns and perform evaluations[31].

"Surveys can provide answers to the questions What? Where? When? And How?, but it is not so easy to find out Why? Causal relationships can rarely, if ever, be proved by survey method."[32]

The risk for misunderstandings or misinterpretations is often bigger than in interviews, where the respondent easier can ask for clarifications. Furthermore, the level of detail in the answers given can be significantly lower than those provided during an interview.[33]

Case study

Case studies can be used for exploratory, descriptive, or explanatory purposes and allows the researcher to retain a holistic view over real-life events[34]. In particular, case studies are suitable when the timeframe for the study is limited. Furthermore, case studies enable the researcher to concentrate on specific events or phenomenon for the identification of unique features affecting the phenomenon in question.[35]

"In general, case studies are the preferred strategy when "how" and "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context."[36]

2.1.4 Data Collection and Analysis

Primary and secondary data

There are two different data types; primary and secondary data. Primary data consists of new information that has not yet been documented and is collected with the purpose of being used in a specific project. Secondary data is data collected from information already available, e.g. printed material.[37]

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[30] Björklund & Paulsson (2003), pp. 68-70
[31] Bell (2005), p. 14
[32] Ibid.
[33] Björklund & Paulsson (2003), p. 70
[34] Yin R. K. (1984), p. 14-15
[35] Bell, (2005), p. 10
[36] Yin R. K., (1984), p. 13
[37] Bell (2005), p. 125

During the gathering process of primary data, by for instance interviews, it is important that the person being interviewed is understood with the purpose of the interview and how the gathered data can contribute to the study[38]. When conducting quantitative interviews it is also important that the interviewee is not affected by the person conducting the interview, since then the gathered data might not represent the interviewee's true opinion[39]. Secondary sources, such as articles and books, always need to be analyzed critically by asking questions such as who the originator is, and for what purpose the material was created[40].

Qualitative and quantitative data

There are two different methods for collecting data; quantitative and qualitative. Simplified, quantitative studies are based on information that can be measured or valued in a numerical or statistical matter[41], and qualitative studies are used when the intention is to gain a deeper understanding for a specific subject or situation[42]. The major difference between these two approaches is how the study is conducted. While a high level of structure characterizes quantitative studies, the qualitative studies are more flexible and are used to create a deeper knowledge than the knowledge often obtained by quantitative methods. For instance, when conducting interviews in a qualitative manner, the interviewees could to some extent have the ability to control the development of the interview. This is supported by for example Holme & Krohn Solvang (1997), since new aspects may arise during interviews that have to be considered. Furthermore, qualitative studies have its strength in providing a more holistic view of the situation, and therefore this type of study fits well with the systems approach.[43]

When following the qualitative approach, the collected data can be analyzed using a qualitative analysis where data is analyzed continuously during the gathering process, for instance directly after the conducted interviews. In contrary, when doing a quantitative analysis, it is more common to gather all data before the analysis. The advantage with a qualitative analysis is that the researcher can get ideas of possible directions. Often, it is also better to initiate the analysis when data is fresh in mind. However, in the final stage of a qualitative analysis, one should go through all the collected data in a cohesive way in order to be able to draw more general conclusions.[44]

2.1.5 Validity, Reliability and Objectivity

Internal validity refers to whether the methodology used actually examines what one intends to examine. *External validity* concerns whether the research findings can be

[38] Patel & Davidson (2003), p.70
[39] Ibid., p.102
[40] Ibid., p.64
[41] Backman (2008), p. 33
[42] Björklund & Paulsson (2003), p. 63
[43] Holme & Krohn Solvang (1997), pp. 79-80
[44] Patel & Davidson (2003), pp.119-120

generalized beyond the immediate case study.[45,46] *Reliability* stands for the degree of trustworthiness of the measurement; that is to what degree the result is replicable when the same method for measuring is used. *Objectivity* states to what extent individual opinions and values affect the result.[47]

It is important to be aware of the fact that studying peoples' opinions, knowledge, and other abstract phenomena, is combined with difficulties since there are no clear ways of how to conduct such studies or interpret the results. Furthermore, when conducting for example interviews, the reliability of the collected data can often be affected by misinterpretations by the interviewers. It is important to be aware of these issues in order to be able to work with preventing them as far as possible[48]

2.2 Design of This Study

In the previous sections, some methodological issues where presented. In the following section, the chosen methodology will be discussed, as well as why the methodology is suitable for this study, and how the authors have dealt with the presented methodological issues.

2.2.1 Research Paradigms

There are two opposing paradigms that describe some of the basic assumptions in this thesis. The paradigm of *interpretivism* is an important assumption since many of the underlying aspects of the issue of study is highly affected by personal beliefs. The *positivistic* paradigm is also considered since the authors believe that by observations, credible empirics can be produced, and that the facts can provide basis for theory. The authors therefore believe that the result of the study in this thesis possibly will be relevant for other organizations under similar circumstances. According to the reasoning above, the paradigm describing the basic assumptions in this thesis is a combination of the positivistic and interpretivistic paradigms.

2.2.2 Methodological Perspective and Research Method

The purpose of this thesis is to add to the knowledge on how organizations can increase their supply chain flexibility by changes in information sharing with suppliers. In order to fulfill this purpose, the authors will use a systems approach, where internal and external processes, the relations and forms of collaboration between different actors in a supply chain, as well as the information shared between these different actors will be studied in order to get a holistic view of the supply chain.

Since the purpose of this thesis regards *how* organizations can increase their supply chain flexibility by changes in information sharing with suppliers, a case study is seen as most appropriate for a thesis of this nature. The case study is performed at Axis

[45] Ejvegård (1996)
[46] Holme & Krohn Solvang (1997)
[47] Björklund & Paulsson (2003), p. 59
[48] Patel & Davidson (2003), p.98-101

and parts of the company's supply chain by, interviews, formal and informal meetings with personnel at Axis and the members within their supply chain.

Additionally, this thesis was initiated on behalf of Axis, with the objective of finding areas of improvement regarding changes in information sharing in their supply chain in order to increase their supply chain flexibility. To achieve this, the thesis takes its standpoint in the deductive approach where a literature study regarding supply chain management, information sharing and supply chain flexibility will be conducted. The initial theoretical study will be followed by a more inductive approach where general interviews and observations at both Axis and some of their suppliers will be performed in order to get a better understanding of the real-life context of the issue of study.

The authors will use the theoretical and empirical findings as inspiration when developing a roadmap for analysis of the need and possibilities to increase supply chain flexibility through changes in information sharing with suppliers. In order to fully develop the roadmap, the authors will go back to theory to get a deeper understanding of how information sharing and supply chain flexibility is related and how changes in information sharing can be performed. A more extensive literature study will be performed to get a comprehensive picture of existing theories and documented case studies. The initial theoretical and empirical study as well as the comprehensive theoretical study will be the foundation for the creation of the roadmap. The roadmap will then be tested on Axis in order to give recommendations for improvements. Hence, the overall process that will be used in this thesis ought to be seen as abductive and is described in Figure 3 below.

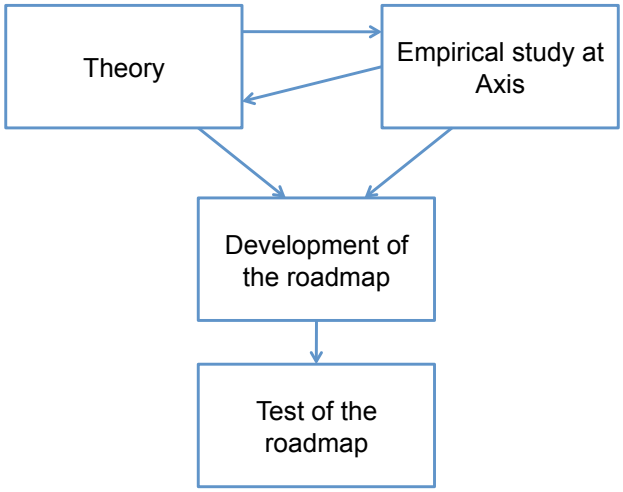

Figure 3: The process of the study

2.2.3 Data Collection and Analysis

Primary and secondary data

In this thesis, primary data will be collected through interviews, and meetings with personnel at Axis and the members within their supply chain. Following the qualitative approach, the primary data will be collected through qualitative interviews. The authors will have formalized interview questions, which will work as a frame, or a tool for setting the theme for the interviews. The goal of conducting the interviews is to gain insight in the interviewee's own opinions of the situation, and therefore they will, to some extent, have the ability to control the development of the interview. The purpose with the interviews will be sent in advance to the interviewee as well as presented during the conduction of the interview. Furthermore, in order to avoid misinterpretations of the collected data, the interviews will be recorded on tape and thereby evaluated multiple times in order to correctly analyze the material.

The theoretical foundation upon which this thesis will be based will solely be gathered from secondary data. The theoretical foundation will be created through an initial theoretical study as well as an additional comprehensive literature study. Books and articles available through Lund University's libraries and their electronic library information navigator will be used for this thesis. In addition, Internet databases, such as Google Scholar, and Google Books will to some extent be used in this thesis. Furthermore, secondary data in form of internal documents will also be used for understanding and describing Axis's business, organization and internal processes.

Furthermore, the collected theoretical data will be used as a guiding principle rather than a strict rule to follow. In order to develop a roadmap, the authors will structure their findings primarily using logical reasoning in order to find suitable ways of combining the findings into a roadmap.

Qualitative and quantitative data

This thesis will be written from a qualitative approach. By conducting interviews and continuously analyzing the gathered material, the authors believe that new insights will be gained, and the direction of the thesis will be easier to define. All data will also be analyzed cohesive so that the authors can get a more comprehensive view of the issues related to information sharing and its relation to supply chain flexibility. This ought to be seen as a strength, since it provides a deeper understanding of the issue of study.

2.2.4 Validity, Reliability and Objectivity

To increase the *internal validity* of this study, primary data regarding information sharing within Axis's supply chain will be gathered from both Axis's, and their supplier's point-of-view. The interview questions will be sent in advance to enable the interviewee to reflect and prepare on the topic in advance. The performed interviews will also be recorded on tape, and both authors will be present during the majority of the conducted interviews. Furthermore, by letting external researchers take part in the design of interview questions, the internal validity of the study will be strengthened.

The *external validity* of the study is hard to determine since the developed roadmap will only be tested by a single case study and must be tested through replication to fully determine whether generalization is possible. However, the intention is to develop the roadmap by using a logical structure, which ought to enable an easy transfer of the result to other cases. In addition, there will be emphasis on providing richness to the case description in order to further ease the transferring of results and comparison to other cases.

Objectivity needs to be taken into consideration when collecting both primary and secondary information. Within the scope of this study, two major issues regarding objectivity will be taken into consideration, the authors' objectivity when making the final conclusions and the objectivity of persons that will be interviewed. By being aware of these issues and take them into consideration throughout the completion of this thesis, the authors believe that the reliability of the results will increase.

To strengthen the *reliability* of the collected data, the authors will re-ask critical questions formulated in different ways in order to make sure that the correct information will be provided. To minimize the risk of using untrue sources, an effort will be made to validate the given information from multiple sources. The authors will search for articles published in renowned papers and books provided as course literature to courses given at Lund University, to vouch for high quality. Articles gathered from other sources, e.g. Google Scholar, will foremost be chosen based on the number of citations by other authors, this to further strengthen the reliability and validity of these secondary sources.

2.2.5 Overview of the Working Process

In this section, the working process used when writing this thesis will be presented. In Figure 4 below is the overall working process visualized.

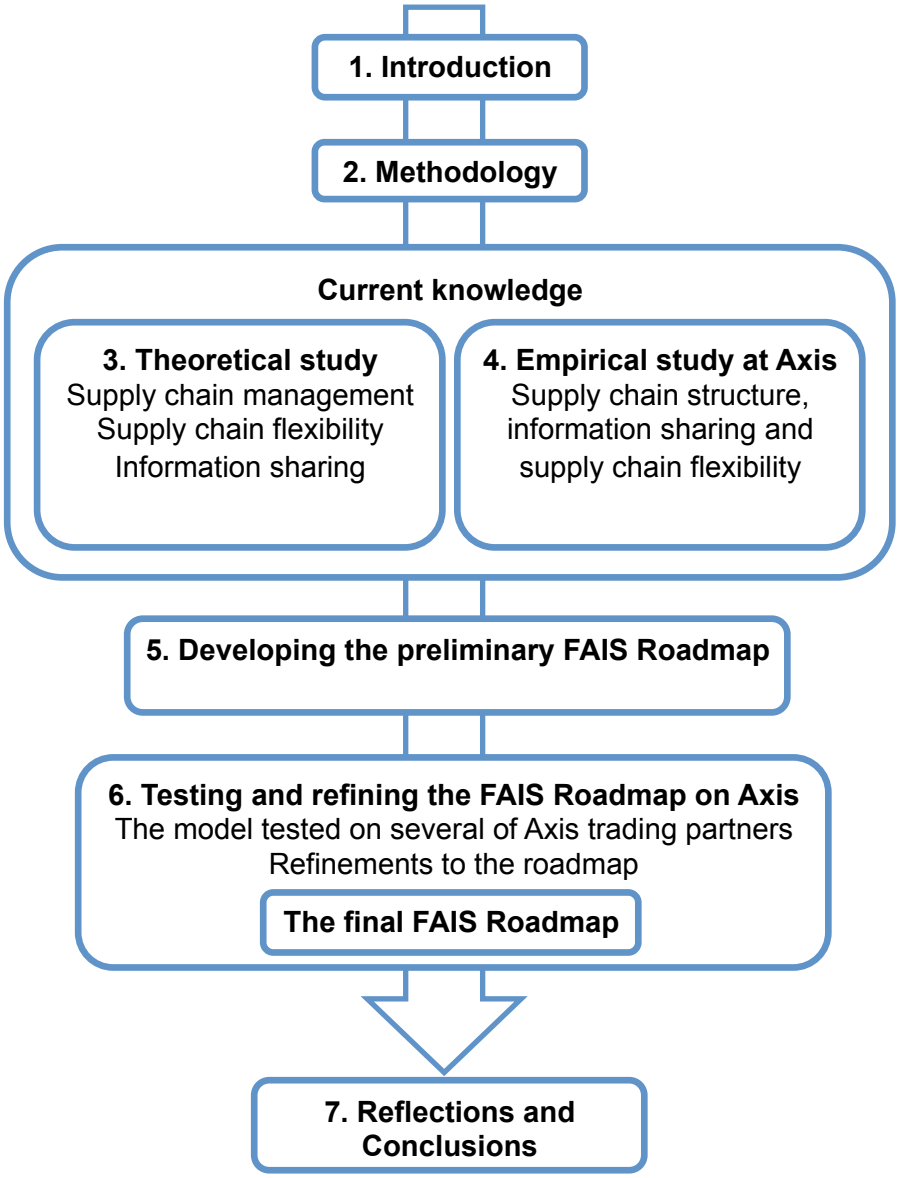

Figure 4: Illustration of the logic structure for the working process.

Introduction and Methodology
The work started with a pre-study and a methodological discussion. During this phase, an initial theoretical search was made parallel to a completion of a project plan in order to gain a basic understanding, plan the project and realize the amount of available literature for the issue of study. A first definition of the problem was developed followed by an initial purpose for this thesis. General methodology for a thesis of this character was also studied in order to gain knowledge of suitable methods for data collection and analysis. Specific case study methodology was also studied.

Current knowledge
An iterative process characterized this phase where the authors went back and forth between theory and empirics. A more thorough theoretical research was conducted in order to map the current theories regarding the issue of study. The theory was gathered mostly from articles, books and other case studies. Initial empirical studies were also conducted on Axis and two of Axis Swedish suppliers in order to get a better understanding of the real-life context of the issue of study and find inspiration for how to develop a roadmap. After this, the authors returned to theoretical studies and conducted a more extensive literature study to get a comprehensive picture of existing knowledge.

Developing the preliminary FAIS Roadmap
The empirical and theoretical findings in the previous stage were then combined and logically analyzed according to the qualitative analysis approach in order to develop a preliminary version of a roadmap for analysis of how to increase supply chain flexibility by changes in information sharing with suppliers.

Testing and refining the preliminary FAIS-roadmap on Axis
The preliminary FAIS-roadmap was then tested and applied on several of Axis's suppliers and subcontractors. Empirical data regarding the suppliers' current information access and information sharing was collected from a number of suppliers. The findings from the studies were analyzed in order to map and classify Axis's different suppliers in order to specify changes in information sharing. After the test, some adjustments were made to the roadmap, which led to the development of the final FAIS Roadmap. The testing of the preliminary roadmap also resulted in recommendations for Axis on how to increase their supply chain flexibility by changes in information sharing with their suppliers.

Reflections and Conclusions
Finally, a discussion of the developed roadmap and general conclusions regarding the conducted study could be made. The used theory and the roadmap were critically reflected upon and the study's generalizability was discussed.

3 Theory

This chapter will present theories regarding the definition of supply chain, supply chain management and flexibility and information sharing within a supply chain. Different methods for improving information sharing will be presented, and difficulties with information sharing will be discussed. Finally, a discussion about the link between different types of information to share and how they affect supply chain flexibility will be presented. The chapter concludes with a theory sum up.

Figure 5 describes the different areas that will be presented in this chapter in order to be able to develop a general roadmap that meet the objectives as stated in section 1.3. The chapter starts with an overall description of the term supply chain management. Thereafter, the focus is on supply chain flexibility and its underlying dimensions. In the following section, a more deeply description of supply chain information sharing is performed, presenting a number of types of information that can be shared in a supply chain, as well as presenting factors affecting supply chain information sharing. Furthermore, the authors describe the link between different types of information that could be shared and their relation to the underlying dimensions of supply chain flexibility.

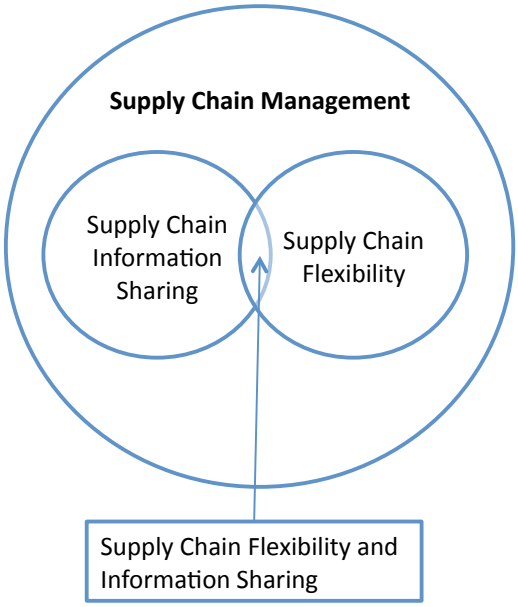

Figure 5: The Theoretical Framework

3.1 Supply Chain and Supply Chain Management

Different authors have different explanations of the term supply chain and they also set different boundaries of a supply chain. According to Martin Christopher, who is one of the most cited authors on the subject[49], a supply chain can be defined as:

"A network of connected and interdependent organizations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users."[50]

As seen in the definition, both the flow of material as well as information needs to be controlled, managed and improved mutually and cooperatively. The supply chain concept is in contrary to the traditional way, where organizations tried to in first hand improve their internal processes in order to beat competitors. However, the world has changed and is now characterized by global competition where rapid response to customers' needs at low cost is in focus.[51] Rapid response and low costs are in today's organizations very much dependent on upstream trading partners, whereas the improvement of internal processes is no longer enough. Organizations therefore have to look beyond their own borders to manage their supply chain in order to reduce costs and create superior value. This movement towards companies focusing more on managing the entire supply chain has been called *supply chain management*.[52] According to Christopher (1998), supply chain management can further be defined as;

"The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole."[53]

Supply chain management links all parties within the chain, including suppliers, carriers, third-party companies and information system providers as well as departments within an organization. Supply chain management includes the processes necessary to create, make to, and to deliver to demand. It encompasses the methods to gather information on market demands and exchange information between organizations.[54]

This thesis will focus on information shared between organizations in the supply chain in order to improve supply chain flexibility.

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[49] Google Scholar (2009)
[50] Christopher (1998), p. 19
[51] Skjott-Larsen et al. (2007)
[52] Lummus et al. (2003), pp. 447-448
[53] Christopher (1998), p. 18
[54] Lummus et al. (2003), p. 448

3.2 Supply Chain Flexibility

Lately, many organizations have realized that in order to meet the new market demands, they need to be flexible not only within their own company but also in their entire chain.[55,56] Supply chain flexibility therefore adds the requirement of flexibility within and between all partners in the chain to the term of supply chain management.[57]

The new market trends with focus on shorter lead times, shorter product life cycles, higher variety and faster product introduction resulted in the need to add flexibility as a new competitive priority.[58,59] Adding extra resources in form of excess capacity and inventories is a solution that can increase the ability to cope with changed market conditions and to some extent increase the perceived flexibility, but this can only be used to a limited extent. The extra costs caused by such initiatives cannot be justified in most industries. In environments with global competition, costs rather need to be continuously reduced. A more attractive alternative to extra resources is to considerably improve flexibility.[60] Flexibility in a supply chain can be defined as:

"The ability to rapidly respond to and carry out changes as conditions change."[61]

Furthermore, the rapid response should be able to be carried out with a limited amount of resources. The rapidness and limited amount of resources are important, otherwise any company or supply chain could in some extent be seen as flexible.[62]

Sánchez & Pérez (2005) performed a case study on 126 Spanish companies and found that there is a strong correlation between flexibility and firm performance. Mattsson (1999) states that a high degree of flexibility is a competitive weapon. Furthermore, lack of flexibility affects the tied capital for the entire supply chain. Studies show that customers tend to increase their stock if working with suppliers with low flexibility.[63]

3.2.1 Different Dimensions of Supply Chain Flexibility

Supply chain flexibility is a complex term that consists of numerous different dimensions. The literature study performed has showed that there is a lack of a standardized definition of the underlying dimensions of supply chain flexibility. Many authors divide supply chain flexibility into dimensions with regard to the supply chains ability to re-configure, e.g. *supply flexibility* or *re-configuration flexibility*, regarding the ability to find new suppliers for each specific component or

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[55] Schmenner & Tatikonda (2005), p. 1184
[56] Slack (2005)
[57] Lummus et al. (2003), p. 450
[58] Mattsson (2000), p. 188
[59] Lummus et al. (2003), p. 447
[60] Mattsson (2000), p. 188
[61] Ibid., p. 189
[62] Ibid., p. 45
[63] Ibid., p. 33

raw material[64,65], or *logistics flexibility* relating to the ability of receiving and delivering products as sources of supply and customers change[66]. Furthermore, supply chain flexibility can be divided into dimensions such as *trans-shipment flexibility*, referring to the ability to move stock between locations at the same echelon level, or *postponement flexibility* which implies the capability of keeping products in their generic form as long as possible in order to customize according to customer specifications in later stages[67].

However, important elements of supply chain flexibility that has been identified in literature is the *robust network flexibility*, that is the range of events that the existing supply chain structure is able to cope with, and *active flexibility* which is the supply chains ability to act as a chain either as a response to, or in anticipation of changes.[68]

Hence, flexibility as used in this thesis refers to the supply chain's ability to adapt to changes without changing the structure of, or the relations within, the supply chain. Therefore the authors have chosen the dimensions of supply chain flexibility as defined by Mattsson (2002):

- Product flexibility
- Product mix flexibility
- Volume flexibility
- Delivery flexibility

Product flexibility refers to the ability to develop and modify products according to market needs.[69] In manufacturing flexibility literature, product flexibility has been seen as a key competitive priority, but seen in a wider perspective it also requires effective collaboration between marketing, product design, sourcing and development. The definition of product flexibility as anticipated in this thesis, with support in the overall definition of flexibility, also refers to the ability to rapidly introduce new products to the market. As product lifecycles decreases, the ability to bring new products to the market is becoming even more of a competitive advantage.[70]

Product mix flexibility refers to the ability to fast adapt the supply of material after variations in demand between different products and product variations, to have the ability to fast adjust to produce more of some products and less of other than first planned with the same capacity.[71]

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[64] Stevenson & Spring (2007), p. 691
[65] Sánchez & Pérez (2005), p. 686
[66] Stevenson & Spring (2007), p. 690
[67] Sánchez & Pérez (2005), p. 686
[68] Stevenson & Spring (2007), p. 691
[69] Mattsson (1999), p. 32
[70] Sánchez & Pérez (2005), pp. 685-686
[71] Mattsson (1999), p. 32

Volume flexibility refers to the ability to produce and deliver according to changes in demand.[72] This regards both increased and decreased production and may require close coordination between a manufacturer and its suppliers. Volume flexibility has a direct impact on supply chain performance by preventing out-of-stock situations for products that are affected by a sudden increase in demand or by preventing high inventory levels when demand decreases.[73]

Delivery flexibility refers to the ability to cope with changes in open customer orders and customer order changes at short notice.[74] In many companies, the changes in open orders, and needs to reschedule planned activities are considered as elements of disturbance. The focus is on trying to stabilize variability by not allowing changes rather then adapt to new requirements. With the changed market characteristics, changes in customer orders have to be considered as normal business conditions rather than exceptions that should not be accepted.[75]

Mattsson (2002) states that the flexibility dimensions that are most interesting from a supply chain perspective are the latter three. The more a company outsources its production, the more dependent the focal company is on its supplier's ability to make flexible adjustments to product mix and delivery. In a highly outsourced production, the direct customer order controlled production can partly be placed on subcontractors, and thereby the ability to communicate changes efficiently are considerably lower than if the communication would be between for example manufacturing and assembly within the focal company.[76] However, as product life cycles shorten, the ability to develop and launch products in shorter time frames becomes an even greater competitive advantage[77]. Since the development of new products is often performed in close collaboration with suppliers, effective management across the supply chain becomes a key for success[78]; therefore product flexibility as defined above ought to be seen as most interesting from a supply chain perspective.

According to the reasoning above, a link between industry characteristics and the flexibility dimensions can be established, see Table 1.

[72] Mattsson (1999), p. 32
[73] Sánchez & Pérez (2005), p. 685
[74] Mattsson (2000), pp. 188,199
[75] Ibid., p. 200
[76] Ibid., p. 32
[77] Perçin (2008), p. 266
[78] Ibid., p. 266

Table 1: Industry characteristics and flexibility dimensions

Industry characteristics	Flexibility dimension
Fast pace of new product introduction	Product flexibility
Short product life cycles	Product flexibility
High product variety	Product Mix flexibility
Short customer order lead times	Delivery flexibility
High overall demand fluctuation	Volume flexibility

3.2.2 Measuring Supply Chain Flexibility

"Notwithstanding the importance and constant interest raised by flexibility in academia and managerial circles, the measure of flexibility is still an underdeveloped subject"[79]

The quote above regards the measure of flexibility associated with manufacturing. In addition, literature attempting to measure flexibility in a supply chain context remains in its infancy. Measuring supply chain flexibility is difficult since the majorities of the existing measures are situational and subjective and as a result lack in generality. In addition, it is hard to measure flexibility because of its multi-dimensionality. If an element of study is flexible in one dimension, it does not necessarily mean that it is flexible in another. As a consequence, two different supply chains could be just as flexible, but in different ways. In addition, if the measure of the current level of flexibility is successful, the potential flexibility in the supply chain could be hard to investigate.[80]

To diminish the situational and subjective impacts on measurements, Stevenson & Spring (2007) suggests that more hard factors could be used. These could for example be inventory levels or lead times. Furthermore, when evaluating supply chain performance, the number of metrics should be kept small.[81]

[79] De Toni & Tonchia (1998), p. 1605
[80] Stevenson & Spring (2007), pp. 691-693
[81] Supply Chain Management Review webpage (2009-02-03)

3.3 Supply Chain Information Sharing

As stated above, flexibility is a competitive factor, which importance is growing due to changed market characteristics, and there is a close connection between information sharing among supply chain members and the impact on the performance and flexibility in the supply chain[82,83]. This section will describe the importance of information sharing in the supply chain.

Insufficient information sharing among members in the supply chain can cause various kinds of uncertainties.[84]

"While every single member has perfect information about itself, uncertainties arise due to a lack of perfect information about other members. To reduce uncertainties, the supply chain member should obtain more information about other members. If the members are willing to share information, each of them will have more information about others. Therefore, the whole system's performance will be improved because each member can gain improvement from information sharing."[85]

As stated above, uncertainties in a supply chain are caused since it is impossible to have perfect information about trading partners. The uncertainties often result in higher costs because of errors in forecasting and demand processing, order batching and fluctuation of price.[86,87]

Even though sharing of information is critical for supply chains to operate as efficiently and effectively as possible, most companies do not share information to a satisfactorily extent. Information is in many cases kept secret in order not to lose negotiating power when making business agreements.[88]

Due to the lack of relevant information, there is often an element of guessing when decisions regarding supply chain activities are made, sometimes resulting in high inventory levels. If information was shared to a greater extent, members in the supply chain could act more efficiently, not only regarding their own operations but also with respect to supplier and customer's operations. A more frequent and extensive sharing of information can reduce these *information gaps*. Reducing information gaps can result in that inventory is replaced by information, and providing information is a much cheaper way to solve problems of uncertainties than building stock.[89]

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[82] Barratt (2004), p. 36
[83] Mattsson (2002), pp. 45-46
[84] Sandberg (2005), p. 35
[85] Yu et al. (2001), p. 115
[86] Bailey & Francis (2008)
[87] Yu et al. (2001), p. 114
[88] Mattsson (2000), p. 309
[89] Ibid., p. 310

One of the most well known phenomenon's that occurs in supply chains due to inefficient information sharing is the *bullwhip effect*. This phenomenon results in increased distortion in demand information as one move up the supply chain; see Figure 6. The bullwhip effect is mainly caused by the usage of order history from immediate downstream members when creating demand forecasts[90]. Rough estimations have indicated that demand variations double between each step in the supply chain[91]. The bullwhip effect can to a large extent be solved through improved information sharing.[92]

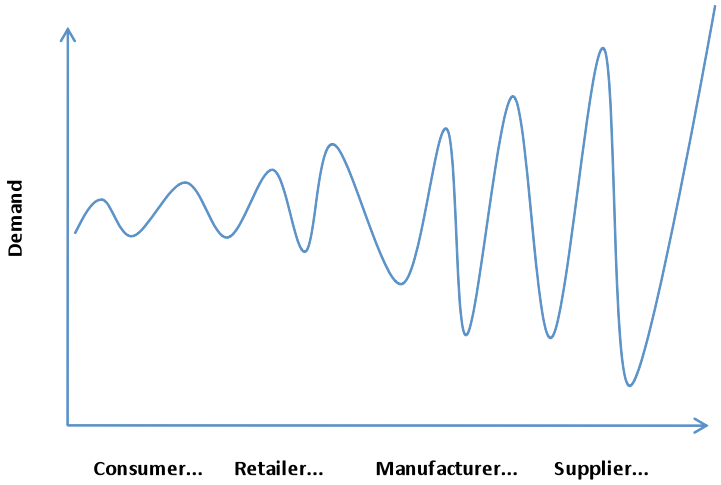

Figure 6: The Bullwhip effect, Miao et al. (2003) p. 1054

However, it is not enough to only share information in order to reduce the bullwhip effect, information gaps or increase flexibility. The information must also be accurate, in time and in the right format.[93] Information sharing is an activity and if information is shared in the right way, visibility is a potential outcome of such an activity.[94]

3.3.1 Different Information Types

The previous section has described the importance of sharing of information in a supply chain. This section will discuss different types of information that can be shared in a supply chain. The different types of information presented in this thesis are based on Lee & Whang (2000). This is one of the most referred articles on the subject of information sharing in supply chains[95]. The paper reports on some common

[90] Lee et al. (1997), pp. 93-101
[91] Mattsson (2002), p. 42
[92] Lee et al. (1997), pp. 93-101
[93] Mattsson (1999). p. 176
[94] Barratt & Oke (2007), p. 1218
[95] Google Scholar (2009)

types of information shared in a supply chain: *inventory level data, sales data, sales forecast, order status,* and *production schedules*.

Inventory level data

With access to supply chain inventory status at different trading partners, the total inventory level in the supply chain can be lowered. This is a result from coordinating the management of inventories at different sites. Then duplicated safety stocks or stock-outs at these sites can be avoided.[96]

The sharing of information regarding inventory levels can be implemented in different forms; one practice often employed by two collaborating members in a supply chain is vendor-managed inventory (VMI)[97]. VMI is a supply chain practice where the inventory is monitored, planned and replenished by the supplier, based on previously agreed minimum and maximum levels[98,99].

Sales data

In the traditional supply chain companies communicate demand information primarily in the form of orders. Order information is certainly an important source of information for future business. However, orders are to some extent processed results of a variety of information and guesses made by the buyer, which lead to distortion and the bullwhip effect.[100]

To dampening these effects, actual sales data need to be shared. The actual sales data can be from the point-of-sales (POS), e.g. data from retail stores, or sell-through data, which refers to a percentage of units shipped that were actually sold. POS data is less variable than other types of customer demand information since it is based on the lowest level of aggregation.[101]

Information technology has made it possible to spread real time information, such as POS data, to all sites in the supply chain at the same time, see Figure 7.

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[96] Lee & Whang (2000), p. 375
[97] Ibid., p. 375
[98] Dam Jespersen & Skjøtt-Larsen (2005), pp. 94-95
[99] For further reading regarding VMI, see for example Jespersen et al. (2005)
[100] Lee & Whang (2000), p. 376
[101] Kiely (1998)

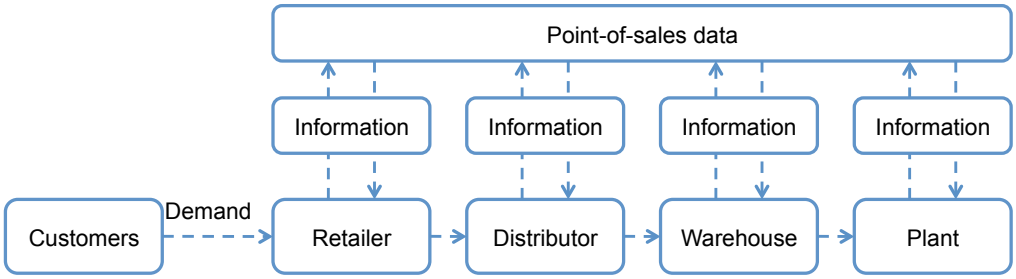

Figure 7: Real time demand information exchange, Sari (2008) p. 578

The sharing of sell-through or POS data results in the ability for manufacturers to better forecast the demand and to create better production plans[102,103]. However, if the focal company has many customers, the number of POS data may be substantial, and all POS units might not be able to collect and transmit data upstream[104].

Order status

A supply chain is in many cases characterized by the participation of several functions and companies in the delivery of goods to the end consumer. This results in difficulties for a customer to find out the exact status of an order. The sharing of order status information enables fast response time to customer inquiries.[105]

Sales forecast

The closer to the market an actor in the supply chain is, the more suitable that actor is to predict future market demand. The sharing of forecasts often involves a downstream site sharing information with its suppliers.[106] The new market trends, e.g. shorter product life cycle times, has led to more procurement and manufacturing activities have to be carried out based on forecasts. Operations are therefore becoming more dependent on forecasts. Additionally, demand is becoming harder to predict since the product life cycles are shorter and the variability is higher. The demand planning process and the availability of demand information is becoming crucial since the future is becoming harder to predict and at the same time, the time allowed to respond to changes is decreasing.[107]

The sharing of inaccurate forecasts is an activity that can cause non-optimized stock levels. It is therefore important that the forecasts are based on the best available data to ensure that the stock-levels can be kept as low as possible. As stated above, the conventional way of creating forecasts is by analyzing order history locally. The

[102] Mattsson (2000), p. 317
[103] Lee & Whang (2000), p. 377
[104] Kiely (1998)
[105] Lee & Whang (2000), p. 378
[106] Ibid., p. 379
[107] Mattsson (2000), pp. 186-187

forecasts are then processed into orders and sent further down the supply chain, see Figure 8.[108]

Figure 8: Traditional demand information exchange, Sari (2008) p. 578

A more accurate way of creating demand forecasts is to base them on actual consumption from POS and not only on order history[109].
When actual consumption, or POS data, is not available, the next best alternative for forecasting is daily inventory balances. When this data is aggregated across all customers it shows daily trade inventory levels. The major disadvantage of using this data is that it reflects processed demand and not real end customer demand.[110]

It is sometimes necessary to use multiple demand data if the customers have a wide range of technical systems. Especially large multinational corporations that sell products internationally to customers located in less developed markets where the technology is not that advanced. A mixture of customer forecasts, POS data, and inventory balances or order history can then be used in order to capture the entire consumption demand.[111]

Production schedules

A manufacturer can better ensure reliable supply and improve own production schedules by having access to its supplier's production schedules.[112] Exchange of this type of planning data can be used in order to synchronize activities.[113] Suppliers' production schedules can help buyers to expand their planning horizon of their own production and also help them quote more accurate due dates to their customers. The information can also be useful for suppliers by assuring reliable resupply.[114]

Other information types

Other information that could be shared in a supply chain is *performance metrics* and *capacity data*. Performance metrics can be for example: product quality data, lead times, queuing delays at workstations and service performance. This data can help the actors in a supply chain identify bottlenecks and thereby improve the supply chain performance. Information about capacity can indicate future shortage and diminish *shortage gaming* (customers inflate their orders to receive a better allocation in

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[108] Sari (2008), p. 578
[109] Mattsson (2000), p. 317
[110] Kiely (1998)
[111] Ibid.
[112] Lee & Whang (2000), p. 380
[113] Mattsson (2000), p. 319
[114] Lee & Whang (2000), p. 380

possible shortage situations[115]) in a supply chain. When shortage gaming is decreased, the uncertainties about future supply are also lowered, and the bullwhip effect can be diminished. In addition, if capacity data is shared well in advance it can be used by supply chain trading partners in order to synchronize activities and prepare against possible future shortage.[116]

Additionally, other information that could be shared between trading partners is *new product information*, e.g. drawings, component manufacturability or approved components. Lee & Whang (2000) do not include this in their article. However, the authors of this thesis find this type of information to be very important, and therefore, new product information has been added as an information type.

3.3.2 Factors Affecting Information Sharing

In section 0 the importance of information sharing, and the impact it has on supply chain performance was described. Furthermore, a number of different types of information that can be shared within a supply chain were presented. Despite the obvious advantages presented above, the sharing of information within a supply chain is in many cases limited[117]. There are many factors affecting the sharing of information, some of them will be presented in the following sections, see Figure 9.

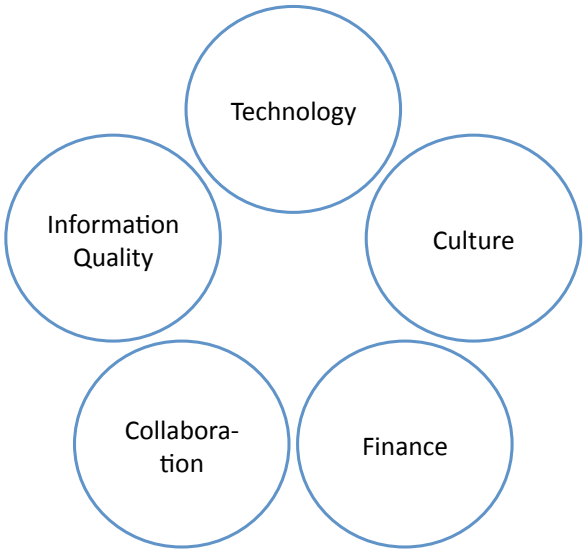

Figure 9: Factors affecting information sharing

[115] Cachon (1999), p. 844
[116] Lee & Whang (2000), p. 380
[117] Mattsson (2000), p. 311

Information quality

The quality of the information shared within a supply chain has a great impact on the degree of efficiency that can be achieved in that supply chain.[118]

Information quality can be divided into three different dimensions[119], to what extent the information is *correct*, *time relevant*, and *complete*.

Correct information

In order for the information to be correct, two different criteria must be fulfilled. The information must have a high degree of validity as well as reliability. Validity refers to whether the shared information regards what it is supposed to regard. If a supplier assures to deliver at a certain time, and with that time refers to when the goods will departure, and the customer expect that the information regards the time for arrival, the information cannot be seen as valid.
The information reliability refers to the shared information's trustworthiness. If a supplier and customer have agreed upon a delivery date, but because of different reasons the probability for the delivery to be in time is low, then the information quality is still low.[120]

As stated above, forecasts are an important notification towards suppliers regarding future orders. As a consequence, buyers can influence the supplier's inventory levels by slightly manipulate their forecasts. By overstating the demand, the buyer can make the supplier carry a higher inventory. This results in higher costs for the supplier, but secured delivery precision for the buyer.[121]

One important term when it comes to the correctness of information is the *information decoupling point*. The information decoupling point is the point in the supply chain at which the order information changes from POS data to forecast driven data. The information decoupling point in the supply chain should be placed as far upstream as possible, enabling as many actors in the supply chain as possible to access actual and correct data regarding real demand. Members in the supply chain can then decide how best to exploit undistorted information in their delivery and planning process.[122]

Time relevant information

For the information quality to be high, it must also be available when needed. If there is a delay in the transmission of information it could lose its relevance in two ways. Partly, it does not represent the right state at the time for its usage, since changes could have occurred in-between sending and receiving. Furthermore, it can become

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[118] Bartlett (2007), p. 309
[119] Mattsson (1999), p. 176
[120] Mattsson (1999), p. 176
[121] Lee & Whang (2000), p. 380
[122] Mason-Jones & Towill (1999), pp. 23-24

irrelevant since new decision situations can have arisen.[123] If for example an order confirmation is received after the ordered goods are received, the information is probably of little interest.

Information about demand is, as earlier mentioned, traditionally communicated from the customer to the supplier in a supply chain trough orders. However, this will create delays and can also distort information. Using orders to send information requires one replenishment cycle in each company in the supply chain, before the demand information is transferred to the next company upstream. Suppose the inventories for each company in the supply chain are replenished once a week, that is, the order quantities applied to customers and suppliers in the chain correspond to the demand during one week. To send information from the distributor to retailer to manufacturer and then to supplier, takes in average four weeks. Furthermore, at least three or four orders are needed in order to identify new demand trends.[124] This means that information about end-customer demand can in some cases be delayed as much as several weeks and therefore not represents the right state at the time for its usage. Volume flexibility for example is affected primarily by the time lag associated with the communication of changes in demand between actors in the supply chain. The longer the supply chain and the more information of changes in demand are based on orders between actors, the poorer the possibility to flexible adjust to changed demand volumes. The possible reaction time to make capacity adjustment is to a great extent consumed by inefficiency in information sharing.[125]

IT is sometimes seen as a solution to information flow difficulties. But IT driven solutions frequently fail to deliver the full potential benefits. The time relevance may increase by faster transfer, but if the current strategy for information sharing is unaltered, the implemented IT-solution will only succeed in moving distorted data faster.[126] Therefore, time relevant information is only useful if it also is correct.

Complete information

The third dimension of information quality refers to what extent the information is complete in comparison to what is needed in order to give a complete foundation for analysis and decision-making.[127] How complete the information shared between organizations is, is also a question about attitudes and willingness to share the information one possesses. Furthermore, the degree of complete information shared can be affected by the possibilities to share it efficiently. The better the abilities to share and receive information, the more information can be shared.[128]

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[123] Mattsson (1999), p. 177
[124] Mattsson (2000), p. 175
[125] Mattsson (1999), p. 32
[126] Mason-Jones & Towill (1999), p. 24
[127] Mattsson (1999), p. 178
[128] Mattsson (2002), p. 318

Technology

The vast development of information technology has made it possible for firms to efficiently share information to a greater extent. The technology exists, but the biggest hurdles regarding the use of it lies in costs and constrains of implementation[129,130]. However, technology related problems still remain in overcoming multiple standards and tailoring data flows to the information needs of the supply chain. The implementation of an IT system that would enable transparent information sharing within the supply chain would be costly, particularly in supply chains consisting of many members. One way of overcoming this is by identifying the members where this linkage would contribute the most. The major barrier is then to agree on the format on the information shared in the supply chain. It is important to point out that sending high quality information down a "traditional" channel will always be more effective than sending low quality information down a "modern supply chain" channel.[131]

Culture

Although the growing insights on the importance of supply chain information sharing and its effect on supply chain performance, there are still cultural barriers against achieving desired improvements. According to Childerhouse et al. (2003), 80 percent of problems that arise in supply chains are due to people, not technology. And since is it is people that are involved in real-world structures and situation, they have a significant impact on culture and therefore on behavior[132].

Culture is a program for behavior that everyone experience personally. Members of a certain culture share methods of coding, storing and retrieving information and each culture has different behavioral codes. In order to efficiently communicate internationally, one must understand what kind of information people from other cultures require. Experts in the field of communication estimate that approximately 90 percent of all communication is conveyed by nonverbal messages, i.e. other than language.[133] However, understanding culture is difficult. The most fundamental issue is the lack of a general way to define culture, and a consequent lack of a general way to conduct studies.[134]

Finance

As stated above, the costs associated with the implementation of better systems for improved information sharing can be substantial, but where the funding for such initiatives will come from is not certain. Childerhouse et al. (2003) has observed that the pressure for change is in most cases on the 1st tier supplier. They argue that the movement in most market sectors is towards a rationalization of the supplier base,

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[129] Childerhouse et al. (2003), p. 494
[130] Lee & Whang (2000), p. 385
[131] Childerhouse et al. (2003), pp. 494-497
[132] Childerhouse et al. (2003), p. 495
[133] Hall & Hall (2000)
[134] Tayeb (1994), p. 443

and most manufacturers are in the future expected to deal with considerably fewer 1st tier suppliers. These suppliers are therefore expected to provide a much wider range of services and therefore form networks with 2nd tier suppliers, whereas investments for infrastructure regarding information sharing can be seen as one of these services.[135]

Collaboration

The lack of well established structures of supply chains gives rise to issues regarding coordination and governance[136]. Even when supply chain members are assured to obtain a positive return for the sharing of information, there can be a haggle over how much, which may lead to a failure to share information. Accordingly, trust and collaboration become important factors to overcome barriers to supply chain information flows.[137]

One of the major hurdles for information sharing in supply chains is that of aligning incentives of different partners. It would be seen as naive of one actor within the chain to believe that the sharing of information would automatically increase the company's profit. The most probable is that each actor in the chain worries of the possibility that other actors will misuse information and reap all the benefits from information sharing. Sensitive cost data regarding for example production yield or component purchase price is information that is seldom shared by supply chain members. Furthermore, the confidentiality of the information shared can be a major concern, especially when two companies competing in the same market use the same supplier of some critical component.[138]

Establishing a close collaboration with customers and suppliers is central to implement information sharing that is extensive enough to optimize operations in supply chains[139]. Extensive information sharing on the other hand is a requirement for a successful collaboration between members in supply chains[140,141]. Quantitative studies have showed that the most important aspect for effective collaboration, according to both customer and supplier companies is information sharing[142]. The supplier can affect the buyer's flexibility and ability to plan through an open and extensive sharing of information. The supplier can also through short delivery times affect the buyer's replacement times. Provided that the delivery times are well known and fulfilled. As a consequence, shorten replacement times and secure deliveries, affects the buyer's inventory levels.[143] In addition, through an open sharing of

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[135] Childerhouse et al. (2003), p. 497
[136] Ibid.
[137] Lee & Whang (2000), p. 385
[138] Lee & Whang (2000), p. 385
[139] Mattsson (2000), p. 311
[140] Ibid.
[141] Sandberg (2005), p. 47
[142] Mattsson S.-A. , (2002), p. 113
[143] Mattsson S.-A. , (1999), p. 158

information, the buyer can improve the supplier's flexibility and ability to work with lower inventory levels. In the long run, improved forecast and planning information can lead to improvements in capacity utilization.[144]

However, supply chain collaboration of this sort is difficult to implement. There has been an over-reliance on technology and failures in understanding with whom to collaborate. Those who try to implement collaboration with a large number of customers or suppliers will not succeed. The implementation of efficient supply chain collaboration requires the commitment of significant resources. The cost of such implementation would most probably outweigh the benefits. Therefore, supply chain segmentation towards supply chain collaboration, limited to only a small number of suppliers and customers, is seen as a more suitable approach.[145]

3.4 The Link Between Information Sharing and Supply Chain Flexibility

There is a strong positive connection between supply chain information sharing and supply chain flexibility. Several authors have studied the effects of increased information sharing on supply chain flexibility[146,147,148].

However, there is a lack in literature explaining the link between different information data types and different dimensions of supply chain flexibility. This part of the thesis is an analysis, which aims to describe the link between the different information data types identified above and the previously defined flexibility dimensions. The link is important to identify in order to understand how flexibility can be improved by increased information sharing.

Inventory level information

The sharing of inventory information helps to dampening the bullwhip effect by helping upstream members of the supply chain to better interpret incoming orders and better anticipate and prepare for fluctuation in inventory needs downstream.[149] The sharing of inventory information allows for the supplier to synchronize its own operations according to customer demand, and enables high service levels[150]. Furthermore, the sharing of inventory level information may lead to reductions in inventories and inventory costs.[151] Furthermore, if the review period, that is when inventory levels are checked and possible orders are placed, is not synchronized between buyers and suppliers, the access to inventory information can help the supplier to make accurate order replenishment decisions at the time of its order

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[144] Mattsson S.-A. , (1999), p. 160
[145] Barratt (2004), p. 39
[146] Lee et al. (2000)
[147] Golden & Powell (1999)
[148] Lee et al. (1997)
[149] Croson & Donohue (2006), pp. 323-333
[150] Kaipia & Kallionpää (2007), p. 2
[151] Perçin (2008), p. 267

review.[152] As a consequence, the sharing of inventory levels can be used to cope with changes in customer demand and therefore have the highest impact on foremost *volume flexibility* and *product mix flexibility*.

Order status information

The main benefits of the sharing of order status information lies foremost within improved customer service. This since problems experienced by customers can be resolved with one call.[153] However, response to changes in customer orders are ought to be more rapid if the current status of the order is visible. Hence, order status information is seen to have an impact on *delivery flexibility*.

Sales data and sales forecast

The flow of accurate real time information is seen to be as important as the flow of goods in the supply chain[154]. Golden and Powell (1999) conducted a case study on ten different firms in two different supply chains. This study shows that the flexibility achieved along the entire value chain depends on the extent to which data are shared. The firms that receive forecast data from customers believe chain flexibility has increased.[155] To be able to achieve efficient planning and as high process synchronization as possible, it is necessary for suppliers to have access to relevant and accurate information in order to estimate future demand[156]. The different flexibility dimensions as defined above all refer to the ability to rapidly adapt to changes. There is no doubt that the sharing of accurate and timely sales data and sales forecasts provides members of the supply chain with necessary information about changes and therefore have a high impact *on all four flexibility dimensions*.

Production and delivery schedules

A manufacturer can better ensure reliable supply and improve own production schedules by having access to its supplier's production or delivery schedules.[157] The ability to re-schedule production plans or the supply/delivery of materials influences to a great extent the *product mix flexibility*.[158] With access to production/delivery schedules, the manufacturer can see the expected quantities that will be produced by its suppliers and subcontractors. Access to this information enables for the customer to better understand the suppliers' production planning and can therefore place orders that better fits the suppliers' already planned production.

Suppliers' production or delivery schedules can help manufacturers to quote more accurate due dates to their customers.[159] If the manufacturer knows the quantities that

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[152] Lee et al. (2000), p. 627
[153] Lee & Whang, 2000, p. 379
[154] Stevenson & Spring (2007), p. 696
[155] Golden & Powell (1999), p. 176
[156] Mattsson (2002), p. 381
[157] Lee & Whang (2000), p. 380
[158] Slack (1983), p. 9
[159] Lee & Whang (2000), p. 380

will be produced the next week, they will also know when they can send products to their customers. Having this information visible enables for the manufacturer to make correct decision when changes in open customer orders occur. The exchange of delivery schedules therefore affects *delivery flexibility*.

Exchange of production or delivery schedules can also be used in order for a manufacturer to make better decisions when fluctuations in demand occur. The exchange of production planning is a way of exchanging information about free capacity or the suppliers' capacity management, which is close related to *volume flexibility*[160]. In the event of sudden under capacity at one supplier, the exchange of planning information enables for customers to quickly adjust and seek other sources of supply, which affects *volume, product mix, and delivery flexibility*.[161]

Performance metrics

Supply chain members can jointly develop performance metrics for measuring the entire supply chain performance. For example, order break times can be used for tracking the amount of time each order spends at each stocking point. The sharing of performance metrics can lead to the identification of bottlenecks in the supply chain and an improvement of the overall supply chain performance.[162] Hence, the sharing of performance metrics and the possibilities of reducing bottlenecks is therefore seen to have a big possible impact on *all four flexibility dimensions*.

Capacity data

By having access to capacity data from suppliers and subcontractors, manufacturers can identify future shortages, thereby countering a potential source of the bullwhip effect[163]. The exchange of capacity data, as stated under the sharing of production planning, is close related to *volume flexibility.*[164] Furthermore, sharing of capacity data enables for a customer to quickly seek other sources of supply in case of sudden under capacity at current suppliers[165]. This affects *all four flexibility dimensions*.

New product information

For a supplier to have access to new product information such as drawings or which components that are approved, will make it possible for the supplier to comment on the products or components manufacturability. This can in some cases shorten development times, and therefore have a direct influence on *product flexibility*.

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[160] Slack (1983), p. 10
[161] Tachizawa & Thomsen (2007), p. 1125
[162] Lee & Whang (2000), p. 380
[163] Ibid.
[164] Slack (1983), p. 10
[165] Tachizawa & Thomsen (2007), p. 1125

The overall link between information data types and flexibility dimensions

The link between the sharing of different information data types and the different flexibility dimensions as argued for above are presented in Figure 10 below.

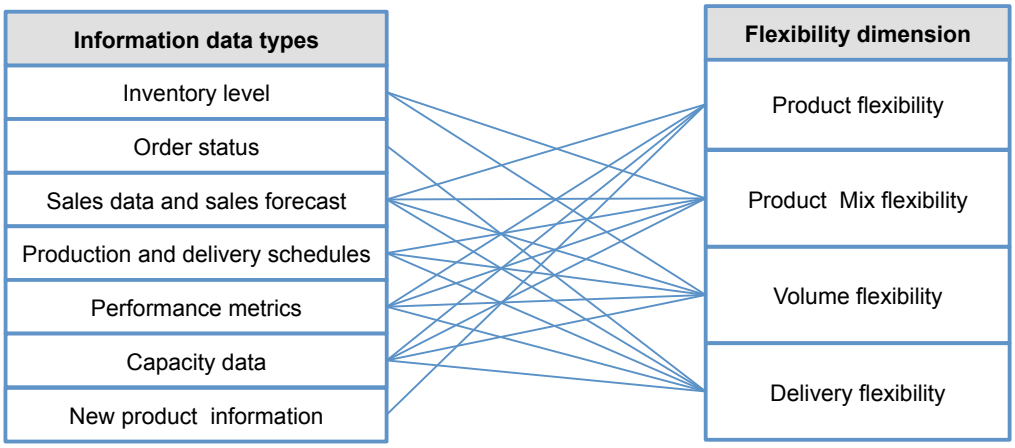


Figure 10: The link between information data types and flexibility dimensions, own development

3.5 Focus and Scope

The previous sections have described the need for flexibility and the benefits that can be achieved through more extensive information sharing. Furthermore, previous sections have showed that there is a strong link between improved information sharing and increased supply chain flexibility. But improvements in information sharing do not mean sharing all information with all members in the supply chain, but rather to share information that is useful and relevant[166]. As stated earlier, flexibility is a competitive weapon, and inefficient information sharing can affect the company's business in a negative direction.[167] But how should one go about, with who is an increase in information sharing wanted, and where is it a waste of resources?

In this section, a presentation of some documented case studies as well as the theoretical findings answering the questions above will be presented.

Kaipia et al. (2006) performed a case study exploring the current state of visibility in a supply chain. From this case study and a literature survey, they presented a number or proposals for how to proceed in improving the sharing of information. They suggest that only information that improves supply chain performance should be shared. They refer to the term *end-to-end visibility*, i.e. information that enables for all members of the chain to have access to information concerning what happens in different parts of the chain. In addition, they state that there is no purpose of sharing information if the other part does not have the processes to utilize the shared information.[168] Therefore, it is important to investigate whether one's trading partners have sufficient processes for receiving and processing information shared.

Furthermore, they suggest that the demand-supply planning processes should be *simplified*, *synchronized* and *stabilized*. *Simplified* means reducing planning times, plan on higher product hierarchy, or choose the right planning horizons. Many problems fund in the studied supply chain was due to time-related issues. There was a lacking *synchronization* between customer and suppliers' planning periods. Additionally, numerous manual steps in the process caused delays in the process. *Stabilized* refer to that major last minute changes in plans should be avoided. Slow reactions are preferred, and changes needed should be implemented during several future planning periods.[169]

As concluded in previous sections, there is in many cases an over-reliance on information technology to solve the issues of lacking information sharing. Furthermore, implementation of information systems, more extensive collaboration between trading partners in a supply chain, or better sharing of information within

[166] Kaipia & Hartiala (2006), p. 377
[167] Mattsson (1999), p. 33
[168] Kaipia & Hartiala (2006), p. 386
[169] Ibid., p. 387

existing relations requires significant resources. The cost of such improvements may, if done in an inefficient way, result in costs outweighing the benefits.[170] Childerhouse et al. (2003) proposes that one way of overcoming these problems is by identifying the relations within the supply chain where the contribution would be the greatest. Barratt (2004) has a similar approach when it comes to supply chain collaboration, where segmentation towards only a small number of supply chain members is suggested as an appropriate approach. This approach ought to be seen as most suitable when it comes to improvements in information sharing as well.

Sadlovska (2008) conducted a number of case studies on the subject of supply chain visibility and concludes that one should begin with identifying the key points in the supply chain where increased flexibility has the biggest impact on operational performance, and then identify the visibility that would enable added flexibility. When this has been achieved, the focus should be on enhancing the automation of supplier and customer collaboration capabilities, as well as on improving the quality of data shared.[171]

Mattsson (2002) states that component uniqueness and supply lead times are important factors when determining where to strengthen partner relations, and that the abilities to share and receive information have a significant impact on information quality. In addition, Lee & Whang (2000), Skjøtt-Larsen et al. (2007), Sánchez & Pérez (2005) and Mattsson (2000) concludes that the amount of trust and collaboration between supply chain partners is seen as important factors for implementing information sharing extensive enough to optimize operations.

The reasoning above leads up to the conclusion that supply chain segmentation is necessary for successful improvements in information sharing. According to the literature described above, this segmentation should be determined by the need for improvements, the ability to share and receive information as well as the benefits that can be reaped with improvements in information sharing. Additionally, the uniqueness and lead times of components are important factors when determining where to focus the improvements. Furthermore, there should be a mapping of the current information sharing in order to identify whether the existing processes for handling information are sufficient.

Accenture & ECR Europe (2001) presents in their report *"A Guide to CPFR Implementation"*, a number of case studies and segmentation suitable for the implementation of CPFR[172]. They state that segmentation is necessary for finding the trading partners relations where collaboration is most attractive and rewarding. They use a segmentation based on two perspectives, *potential benefits* that can be obtained through collaboration with a trading partner and the *willingness and ability* of the

[170] Barratt (2004), p. 39
[171] Sadlovska (2008), pp. 24-25
[172] Collaborative Planning Forecasting and Replenishment, for further reading see e.g. Accenture & ECR Europe (2001)

trading partner to collaborate.[173] These perspectives are measured through a number of *key performance indicators* and then mapped in a matrix, visualizing the segmentation.

This thesis does not aim at providing solutions for the implementation of CPFR; it aims at developing a roadmap for analysis of the need and possibilities to increase supply chain flexibility through changes in information sharing with suppliers. However, the perspectives used in this trade partner segmentation has strong support in the literature presented above, and therefore the segmentation perspectives used, and the matrix for mapping the results have been used as an inspiration in one step of the roadmap developed in this thesis.

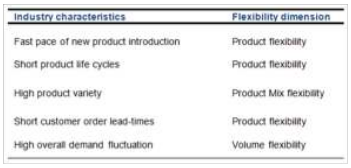
The findings in this section are summarized in Table 2 below.

Table 2: Findings in section 3.5 regarding focus and scope

Findings	Source
Segmentation is important in order to successfully improve information sharing / supply chain flexibility.	Childerhouse et al. (2003), Barratt (2004), Accenture & ECR Europe (2001)
Segmentations should begin with identifying the key points in the supply chain where increased flexibility has the biggest impact.	Sadlovska (2008)
Segmentations can be based on the factors: uniqueness and lead times of components, the need for improvements, trust and collaboration, ability to share and receive information and the benefits that can be reaped.	Mattsson (2002), Lee et al. (2000), Skjøtt-Larsen et al. (2007), Sánchez et al. (2005), Accenture & ECR Europe (2001)
Internal processes should be simplified, synchronized and stabilized.	Kaipia et al. (2006)
Mapping of external processes is necessary in order to make sure trading partners can utilize shared information.	Kaipia et al. (2006)

[173] Accenture & ECR-Europe (2001), p. 49

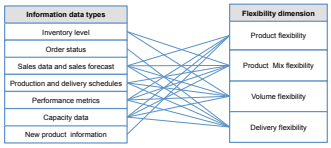
3.6 Sum Up and Commenting



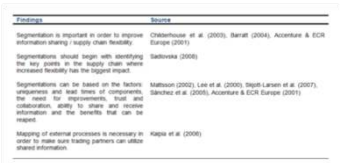
Industry characteristics	Flexibility dimension
Fast pace of new product introduction	Product flexibility
Short product life cycles	Product flexibility
High product variety	Product Mix flexibility
Short customer order lead-times	Product flexibility
High overall demand fluctuation	Volume flexibility

This chapter started with definitions of supply chain and supply chain management. Thereafter the term supply chain flexibility was presented. Supply chain flexibility was broken down into four different dimensions based primarily on Mattsson (2002). This section concluded with a figure showing the link between industry characteristics and different dimensions of supply chain flexibility.

In section 3.3.2, we discussed a number of factors that affects information sharing. The factors discussed in this thesis are Information quality, Technology, Culture, Finance and Collaboration.



A presentation of different types of information shared in supply chains based on Lee & Whang (2000) was performed. Section 3.4 concluded that information sharing affects supply chain flexibility, and discussed the link between the types of information and the different dimensions of supply chain flexibility. We found that different types of information affect different dimensions of supply chain flexibility.



Findings	Source
Segmentation is important in order to improve information sharing / supply chain flexibility.	Childerhouse et al. (2003), Barratt (2004), Accenture & ECR Europe (2001)
Segmentations should begin with identifying the key points in the supply chain where increased flexibility has the biggest impact.	Sadovska (2008)
Segmentations can be based on the factors: uniqueness and lead times of components, the need for improvements, trust and collaboration, ability to share and receive information and the benefits that can be reaped.	Mattsson (2002), Lee et al. (2000), Stejdt-Larsen et al. (2007), Sánchez et al. (2005), Accenture & ECR Europe (2001)
Mapping of external processes is necessary in order to make sure trading partners can utilize shared information.	Kapja et al. (2006)

The previous section summarized the literature findings regarding, where to focus and how to go about. The main findings was that important factors for segmentation are uniqueness and lead times of components, the need for improvements, ability to share and receive information and the benefits that can be reaped with improvements. Furthermore, a mapping of external processes is necessary.

4 Axis Communications AB and its supply chain

This chapter will start by describing the case company Axis and its supply chain. The chapter will further discuss and analyze two of Axis suppliers. This empirical study was used as an inspiration when developing the roadmap presented in the next chapter.

4.1 Axis Communications AB in General

Axis is a fast growing company that was the first company to launch network cameras in 1996. The product portfolio today includes network cameras, video servers, video management software, audio and video accessories and the market's broadest range of print servers.[174] Axis global presence is presented in Figure 11 below.

Axis's network cameras are today far more advanced than the original ones, and the trend is going towards even more advanced cameras. The new cameras consist of more complex mechanical components and electronics than before and Axis does not have all the in-house knowledge needed to develop these new cameras[175]. Therefore, Axis needs to find more suppliers and also needs to work closer with the suppliers in order to develop new advanced cameras[176]. To be able to keep the position as market leader, it is important for Axis to have a flexible supply chain.

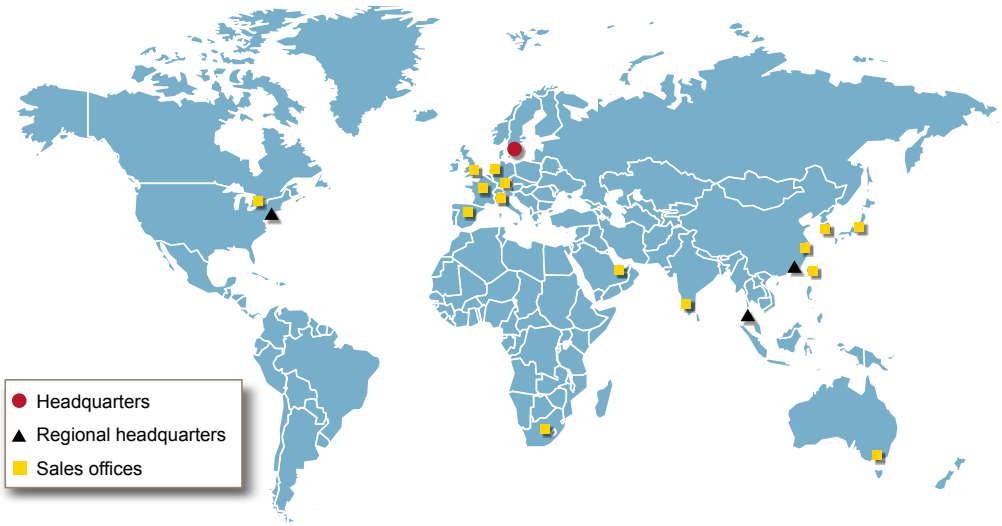


Figure 11: Axis worldwide presence, Axis internal documentation

[174] Axis webpage (2009)
[175] Jeppsson (2009-01-26)
[176] Axis internal documentation

4.2 Axis Supply Chain Structure in Brief

This part of the chapter intends to describe Axis supply chain structure. The focus is on the flow of goods. The flow of information is presented later on in this thesis. Below is a figure describing the relation between different trading partners and their role in the supply chain, see Figure 12. The information has been gathered from interviews with Axis personnel, webpage as well as company internal documentation.

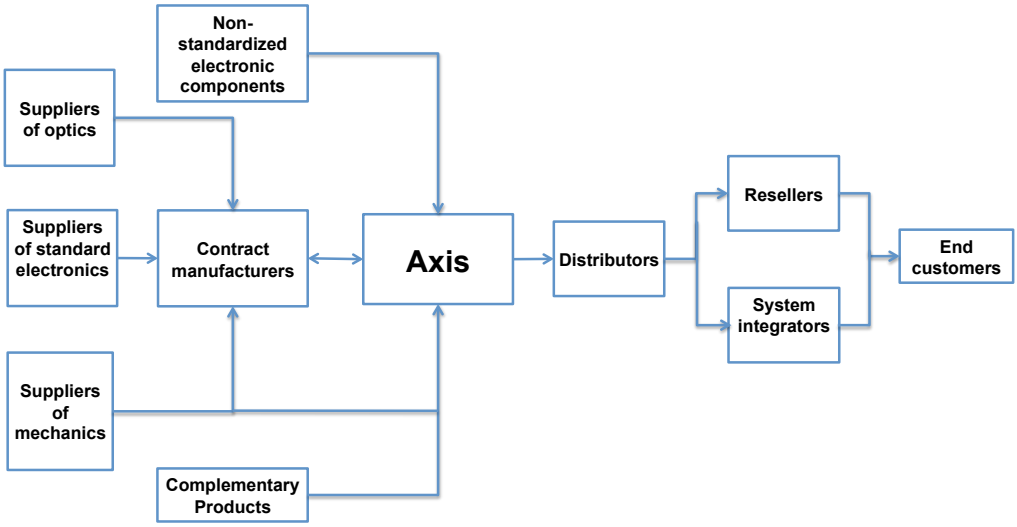


Figure 12: Axis supply chain in brief with focus on the flow of goods

Axis upstream trading partners

Axis development of new products is done in-house but in close collaboration with the suppliers of different components. Axis has never had production in-house; all production is outsourced to external contract manufacturers.[177,178] Axis has the objective to stand for more than 5 percent, but less than 25 percent of each supplier's annual turnover[179].

Contract manufacturers

Axis has always relied on contract manufacturers for production. Today, Axis uses two contract manufacturers.[180]

Suppliers of electronics and specific components

The contract manufacturers control the supply of standard electronic components, which are mostly bought from distributors. However, Axis has approved manufacturers and distributors that fulfill Axis specifications regarding component

[177] Richard (2009-02-25)
[178] Nilsson (2009-01-26)
[179] Ädelroth (2009-03-19)
[180] Nilsson (2009-01-26)

performance. For some components Axis takes the full responsibility throughout the whole supply chain. That is for components with very long lead times, for example special optics or Axis specific, highly advanced circuits. These components are consigned by Axis, and a safety stock is kept in-house. The contract manufacturers then source these components from Axis when needed.[181]

Supplier of mechanics

These suppliers are those that deliver all components of mechanics, for example plastic or metal housings or mechanics for movement, directly to Axis or to contract manufacturers. The components are mostly Axis specific, except for screws and other standard mechanics. The Axis specific components are developed in close collaboration between Axis and the supplier. The suppliers of mechanics are highly specialized and therefore a large number of suppliers are used.[182]

Complementary products

Complementary products are non-strategic items such as power supplies, packaging material, and user manuals etcetera.[183]

Axis's distributions centrals

The products are delivered to different distribution centrals owned by Axis. These are located in Lund, Hungary, Bangkok and USA. There are different ways a product or component can reach Axis's distribution centrals:

Subcontractor → Axis
Subcontractor → Contract Manufacturer → Axis
Subcontractor → Subcontractor → Contract Manufacturer → Axis
Subcontractor → Subcontractor → Axis

In the first case, the subcontractor delivers directly to the distribution central at Axis, where assembly or packing of the components is done. This can be components like power supplies or plastic or metal brackets. In the second case, the contract manufacturers order components from the subcontractor, mount their components and deliver the finished product to the distribution central. This is the most common way to deliver products to the distribution central. In the third and the fourth cases, the subcontractor delivers to another subcontractor where additional processing is performed before delivering to a contract manufacturer or directly to distribution centrals.[184]

Axis downstream trading partners

Axis' branded products are sold through distributors and then resellers or system integrators, see Figure 12. The system integrators use Axis' products as integrated

[181] Berenji (2009-02-16)
[182] Jeppsson (2009-01-26)
[183] Nilsson (2009-01-26)
[184] Lindkvist (2009-03-23)

parts of larger system installations. Axis has more than 24,000 system integrators worldwide and partners in more than 70 countries.[185]

Distributors, Resellers and System Integrators

Axis has a strategy of not selling directly to the end user. Therefore, all products are shipped from Axis distribution centrals to their distributors. From there, the products are either sent to resellers or system integrators before reaching the end user.[186] In some cases, Axis has direct contact with very large customers, but all sales are done through distributors.[187]

End users

Axis' has end users ranging from large multinational corporations to small-to-midsize enterprises. Axis prioritizes six primary end user segments. The segments are: [188]

- **Education** (universities, schools, educational institutes)
- **Banking and Finance** (banks, post offices, insurance companies)
- **Retail** (stores, gas stations, supermarkets)
- **Transportation** (airports, railways, harbours, traffic surveillance, toll stations)
- **Government** (authorities, police, city surveillance, health care, prisons, museums, casinos)
- **Industrial** (process industries, engineering, construction, pharmaceutical, energy companies)

4.3 Two Suppliers in Axis Supply Chain

In order to develop a roadmap for increasing supply chain flexibility by changes in information sharing with suppliers, Axis's upstream supply chain trading partners were seen as a good source for inspiration. Therefore, two suppliers were visited. The two suppliers were chosen since they represent 1st and 2nd tier in Axis's supply chain, one supplying product specific mechanical components and the other is a contract manufacturer. Additionally, the collaboration with the two suppliers has been ongoing for several years, whereas the chance of getting qualitative interviews and discussions could be seen as high. The first supplier – Supplier A – is a 1st tier supplier and Supplier B is a 2nd tier supplier to Axis, see Figure 13.

[185] Axis webpage (2009)
[186] Ibid.
[187] Jacobsson (2009-01-29)
[188] Axis webpage (2009)

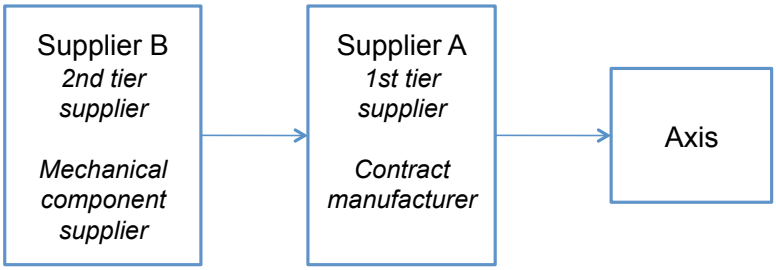


Figure 13: Two suppliers and Axis

4.3.1 Supplier A

Supplier A was visited in March 2009 in order to map the company's processes for receiving, processing, and sending information, as well as to discuss improvement areas. Below are the results from the interviews with the supplier presented[189].

Supplier A is a contract manufacturer developing electronic products for a numerous of different markets. The company has approximately 1,600 employees at several plants in Europe, the United States and China.

VMI is implemented with Supplier A, which means that supplier A replenishes Axis inventory continuously according to a weekly stock level target. Axis sends VMI reports with the average stock level target as well as minimum and maximum stock level targets for almost all products. For the remaining products, Axis sends Supplier Schedule Reports. Supplier Schedule Reports contain purchase order quantities, material authorization quantities and forecasted quantities. Material authorization means that Axis is obliged to buy the material that the supplier source, but the time frame is not set. The VMI reports are updated and transmitted daily. The reports include forecasted volumes for the next 6 months. Additionally, Axis sends data regarding inventory quantities that are already booked by customers.

The information received by suppler A is processed according to different factors, such as minimum order quantity, pallet sizes, component lead times, and transport time. When all of this is taken into consideration as well as Axis's current inventory levels and booked inventory quantities, supplier A refills Axis's stock. Supplier A initially handles the sent data and VMI-reports manually. However, supplier A is implementing the same ERP[190] system, already in use at Axis, which could reduce the manual handling of information.

Axis also provides supplier A with new product information, such as drawings and expected demand through an online database.

[189] All information gathered in this section is from interviews with supplier A 2009-03-02
[190] Enterprise Resource Planning

As soon as the components in the new products have been approved, ramp up for volume production starts. Axis is responsible for approving components and products. As soon as a component is approved, supplier A can initiate the surcing.

4.3.2 Supplier B

Supplier B was visited in March 2009 in order to map the company's processes for receiving information from Axis and 1st tier suppliers, as well as the company's processes for processing that information. Improvement areas were also discussed with the supplier. Below are the results from the interviews with the supplier presented[191].

The supplier is a relatively small company that makes plastic details and tools for liquid injection molding. The supplier has knowledge in prototyping and assembly of modules and part systems.

Supplier B delivers components to both supplier A and other 1st tier suppliers used by Axis. Supplier B experiences collaborative difficulties with some 1st tier suppliers, which they believe is a result of cultural differences and lacking communication due to geographical distances. The lacking communication causes problems for Supplier B when it comes to production planning and sourcing of raw material. Supplier B experience difficulties in discussing these problems with the 1st tier suppliers due to their size and low negotiating power. In addition, there is a confusion regarding with whom at Axis they should discuss such problems with.

Supplier B receives information about new products such as drawings and expected quantities from Axis. Supplier B has also access to Axis's product database. Supplier B has extensive knowledge within their field, and mechanical design and tooling regarding new products are often discussed with supplier B.

Axis or the 1st tier suppliers do not send any forecasts to supplier B. Supplier B has however expressed a need for forecasts in order to better plan their production and source material with long lead times.

Supplier B has information about capacity, production schedules and delivery plans, but do not pass this information on to Axis or any 1st tier suppliers, because it has not been requested.

4.4 Sum Up and Comments on the Information Sharing Situation

The initial study of the two Swedish suppliers showed that problems in the 2nd tier easily could go unnoticed by Axis. Therefore, it is necessary to not only look at information sharing to the 1st tier suppliers, but also to investigate how they process and send information further up the supply chain in order to find problems and areas of improvement.

[191] All information gathered in this section is from interviews with supplier B 2009-03-19

Another finding from the initial empirical study of Axis supply chain is the fact that 2nd tier suppliers are in some sense "forced" on to the 1st tier suppliers. Axis chooses which suppliers of mechanical components they want to collaborate with, then the contract manufacturers have to source components from these suppliers. Therefore Axis should be seen as the focal company or supply chain "leader" in the chain, the supply chain member that has the possibilities to successfully drive changes regarding information sharing in the supply chain.

Furthermore, the initial empirical study on Axis supply chain proved the complexity of supply chains, and that it is difficult to go about with a too broad approach. Therefore, the need for segmentation proved to be uttermost necessary.

5 The Preliminary Flexibility and Information Sharing (FAIS) Roadmap

The Flexibility and Information Sharing (FAIS) Roadmap consists of a number of steps that can help an organization to increase their supply chain flexibility. The roadmap can be used for evaluating the current information sharing and flexibility situation and for choosing suitable strategies for further advancement. Hence, the results presented in the FAIS Roadmap gives the focal unit a direction for how to increase supply chain flexibility by changes in information sharing with suppliers.

5.1 Roadmap Background

The purpose of this thesis is to add to the knowledge on how organizations can increase their supply chain flexibility by changes in the sharing of information with suppliers. The FAIS Roadmap is developed in order to meet this purpose.

Since many companies with need for increased flexibility are acting in a high velocity market with constant changes, the goal of the roadmap was to make it a non-complex tool that easily could be used by a wide range of organizations. The structure of the roadmap is therefore logical and the application is intended to go very quickly.

Nilsson et al. (1995) states that the raison d'être of a framework rests on its usefulness. In order to be useful, the framework must be flexible enough to allow the user to make conditional adjustments of the framework when using it, and the heart of the problem must be addressed.[192] The FAIS Roadmap is created with this in mind.

The roadmap is to be used as a tool for analyzing the need and possibilities to increase supply chain flexibility by changes in information sharing with suppliers.

5.2 The Method for Building the Roadmap

The logic behind the roadmap is to first estimate the need for flexibility, then to evaluate whether this need can be satisfied through increased flexibility achieved by changes in information sharing. If there is a need for supply chain flexibility and a possibility to satisfy that need by changes in information sharing, there is a potential to improve overall supply chain flexibility, see Figure 14.

[192] Nilsson & Nordahl (1995), p. 9

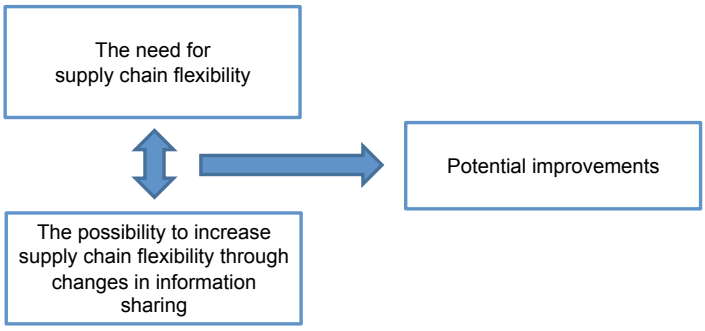
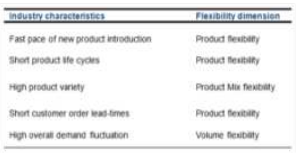


Figure 14: The logic behind the FAIS Roadmap

In order to develop a roadmap that can be used to estimate if there is a need for supply chain flexibility as well as if it is possible to satisfy that need, the literature findings presented in the theory chapter and the initial empirical study at Axis was logically analyzed. The analysis was used as a base when building the roadmap and below is the analysis presented structured according to Figure 14.

The need for supply chain flexibility



Industry characteristics	Flexibility dimension
Fast pace of new product introduction	Product flexibility
Short product life cycles	Product flexibility
High product variety	Product Mix flexibility
Short customer order lead-times	Product flexibility
High overall demand fluctuation	Volume flexibility

It was found in section 3.2.1 that there is a link between supply chain flexibility dimensions and industry characteristics. An estimation of the need for supply chain flexibility could therefore be based on industry characteristics. However, it should first be defined which organization's need for supply chain flexibility that is to be analyzed. It is the focal unit's industry characteristics that need to be analyzed in order to estimate the need for supply chain flexibility.

The possibility to satisfy the need for supply chain flexibility

When the need for flexibility has been estimated, the possibility to satisfy that need ought to be evaluated.

It was found in section 3.4 that improved information sharing leads to increased supply chain flexibility. To evaluate whether it is possible to satisfy the need for supply chain flexibility, one can evaluate whether it is possible to improve information sharing between different links in the chain. In order to find out if changes in information sharing with suppliers are possible, the suppliers' processes for receiving, processing and sending information should be mapped. However, in most cases it would be very time-consuming and complex to map all suppliers' processes.

It was found in section 3.5 that segmentations can be used among supply chain trading partners in order to make the mapping more efficient. Therefore, the roadmap concludes how to segment different suppliers. Firstly, it is

done on a more general level, where supplier groups, and not specific suppliers, are to be chosen. Then a more detailed segmentation is conducted in order to find specific supplier relations where the potential for flexibility increase is considerable.

In section 3.5 it was also found that in order to specify changes in information sharing, it is important to map the trading partners' processes for utilizing information. Therefore the next part of the roadmap explains how to map suppliers' processes for receiving, processing, and sending information. The mapping of suppliers' processes should be based on what type of different information that could be shared and how it can increase supply chain flexibility, as found in section 3.4.

It is also important to map factors that affect information sharing. The factors affecting information sharing was found in section 3.3.2.

When the mapping of processes and factors affecting information sharing has been conducted, it is possible to see what changes in information sharing that are possible.

Potential improvements that could satisfy the need for supply chain flexibility

In this part of the roadmap the idea was to set a path for how to change the information sharing with suppliers, in order to satisfy the need for supply chain flexibility. The changes in information sharing that increase supply chain flexibility, and that are possible to conduct, needs to be specified based on the conducted mapping. Since changes in information sharing affects both the external supplier as well as the focal unit, an internal study also needs to be made in order to see what internal adaption that is necessary. In order to see if the changes in information sharing have been successful, an estimation of the flexibility increase in the supply chain ought to be performed and evaluated.

5.3 The Preliminary FAIS Roadmap

The FAIS Roadmap is a roadmap for increasing supply chain flexibility by changes in information sharing with suppliers. This section aims at in detail explaining the different steps in the preliminary roadmap, see Figure 15.

5.3.1 Step 1: Specify the Focal Unit

The supply chain is seen from the point of view of a certain focal unit in the chain. This focal unit could for instance be an organization, a specific unit or a department. This roadmap is intended to improve information sharing between that focal unit and other external links in the supply chain. The focal unit should be responsible for driving the changes, and therefore the focal unit needs to be specified. It is important though to clarify that being responsible for satisfying the need for flexibility does not mean that the focal unit can satisfy that need by itself, cooperation between different links is necessary.

5.3.2 Step 2: Estimate the General Need for Supply Chain Flexibility

When the focal unit is specified, the next step is to analyze if any of the flexibility dimension (product mix -, volume -, product - or delivery flexibility) is desirable. It should also be determined which one or which ones that are more preferable than others. It was found in section 3.2.1, that there is a link between specific industry characteristics and different supply chain flexibility dimensions. This link could be used as a base for the estimation, see Table 3.

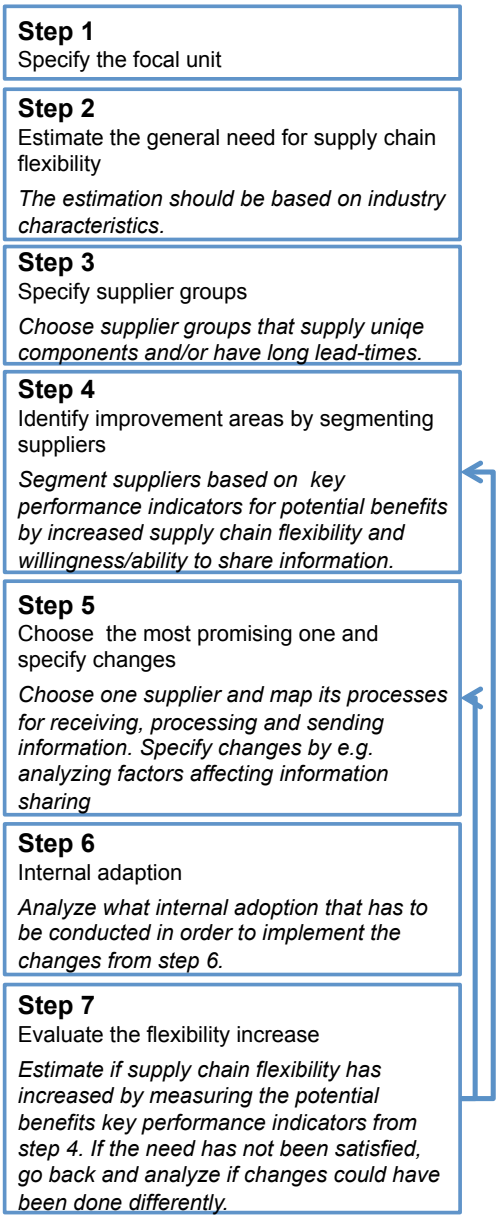


Figure 15: The preliminary FAIS roadmap

Table 3: Example of industry characteristics and flexibility dimensions

Industry characteristics	Flexibility dimension
Fast pace of new product introduction	Product flexibility
Short product life cycles	Product flexibility
High product variety	Product Mix flexibility
Short customer order lead times	Delivery flexibility
High overall demand fluctuation	Volume flexibility

5.3.3 Step 3: Specify Supplier Groups

As concluded in section 3.5 it is very complex to change information sharing with all suppliers. Therefore, a group of suppliers where changes in information sharing ought to have high impact on supply chain flexibility needs to be specified.

The supply chain groups where supply chain flexibility is needed can be chosen based on factors such as supply lead times and products or components uniqueness, as seen in section 3.2.1. When evaluating supplier lead times and products or components uniqueness, an intuitive reasoning about the supply chain as a whole is preferable rather than specific measurements. In order to analyze these factors correctly, one should have a comprehensive understanding of the supply chain as a whole.

5.3.4 Step 4: Identify Improvement Areas by Segmenting Suppliers

Once specific groups of suppliers are selected, these suppliers should be evaluated in order to see with whom to start change information sharing. This step is also conducted in order to see with which suppliers changed information sharing could have the highest impact on supply chain flexibility and with which suppliers it is a waste of resources.

The segmentation is based on evaluating each trading partner within the in step 3 identified groups from two perspectives: *Potential benefits* that can be obtained from increased supply chain flexibility through improved information sharing and the *willingness and ability* of the trading partner to share information. These perspectives are based on the findings in section 3.5. In order to make the process of mapping the different trading partners efficient, the measures can be plotted on a scale from low to high in comparison to each other.

Key performance indicators for measuring potential benefits

The idea of using *key performance indicators* was found in section 3.5. The intention is to measure on each specific supplier found in the in step 3 identified supplier groups in order to in detail find where changes in information sharing has potential

benefits. Below are the different key performance indicators presented and summarized in Figure 16.

Inventory levels
As stated in section 3.2.2, inventory levels are a good measure for determining the degree of achieved flexibility in the supply chain. In absence of shortages, low inventory levels throughout the chain can in some cases be seen as an effect of high flexibility and thereby satisfied degree of information sharing.

However, in this step inventory levels are only measured for one supplier in the chain. Therefore, the measure it not completely perfect, but can give an indication on where to focus. The measure should be based on inventory levels in relation to sales.

Incorrect delivery
Estimate the supplier's rate of deliveries that are incorrect compared to other suppliers. Incorrect deliveries means that a supplier do not deliver goods as agreed, in terms of time, quantity and quality. Is the rate of incorrect deliveries high or low?

Sales Volume
Sales volume is an important measure, since improved flexibility within a relation with a large supplier of for instance scarce components ought to have greater impact on the total flexibility for the whole supply chain than improved information sharing with a smaller supplier of scarce components. Estimate whether the suppliers' sales volumes are high or low in comparison to each other.

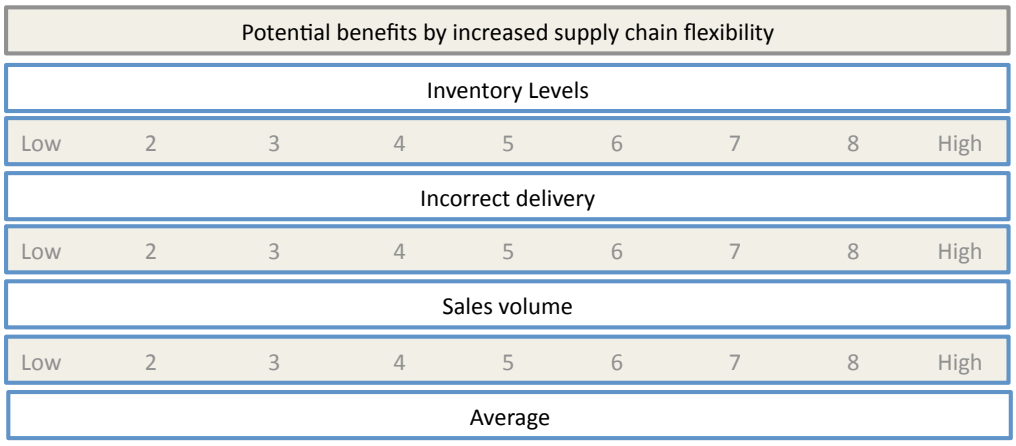


Figure 16: Key performance indicators for evaluating potential benefits

Key performance indicators for measuring the willingness and ability to share information

As concluded in section 3.5, the willingness and ability for trading partners to share information has great effect on the possibilities to increase the level of flexibility in the supply chain. Low willingness or ability to share information can result in low supply chain flexibility. The key performance indicators for measuring the willingness and ability to share information can in most cases not be measured by hard facts. Hence, an estimation should be done by the focal unit to segment the suppliers. The key performance indicators presented below are all based on the findings in section 3.5 and related appendix. See Figure 17 for a summary.

Openness and trust

Openness and trust are very important in a supply chain relationship because the trading partner and the focal company must be willing to share sensitive information in order to increase flexibility in the supply chain.

Grade of complementary abilities

Complementary abilities can also affect supply chain flexibility. If one trading partner has knowledge related to the manufacturability of products, the focal unit can benefit from collaborating with that trading partner and vice versa.

Capabilities to use existing and new information

The trading partner should also have dedicated resources for analyzing data, e.g. forecast accuracy and inventory levels.

Trading partner's collaborative initiatives

If the trading partner has conducted collaborative initiatives with the focal unit or other trading partners earlier, the implementation of changes in information sharing will probably be easier.

Willingness and ability to share information								
Openness and trust								
The trading partner see relationship from a win/lose perspective and do not share information if it is not strictly necessary.			In some cases the trading partner tried to collaborate with us by sharing knowledge and/or data.			The trading partner see collaboration as a way to optimize the supply chain. They have regularly collaborated openly to resolve any exceptions .		
Low	2	3	4	5	6	7	8	High
Complementary abilities								
The trading partner has very limited knowledge or information related to the manufacturing of our products that could provide us with added value.			The trading partner is able to provide us with some information about our products and their manufacturability.			The trading partner has very good knowledge about our products that may be of interest to us.		
Low	2	3	4	5	6	7	8	High
Capabilities to use existing and additional information								
The trading partner do not rely on information or have dedicated resources to analyze it.			The trading partner work with analyzing some information, such as forecasts and inventory levels. Some data is sent further to us.			The trading partner has dedicated resources for analyzing a wide range of data.		
Low	2	3	4	5	6	7	8	High
Trading partner's collaborative initiatives								
The trading partner do not have any collaborative initiatives with you or with other companies.			The trading partner have collaborative initiatives with other companies, such as VMI or CPFR.			The trading partner already have collaborative initiatives with you, such as VMI or CPFR.		
Low	2	3	4	5	6	7	8	High
Average								

Figure 17: Key performance indicators for evaluating willingness and ability

Mapping the results

In order to map the results from the evaluation of the different suppliers, the suppliers can be plotted in the matrix in Figure 18. The plotting should be based on the scores from the measurements conducted above.

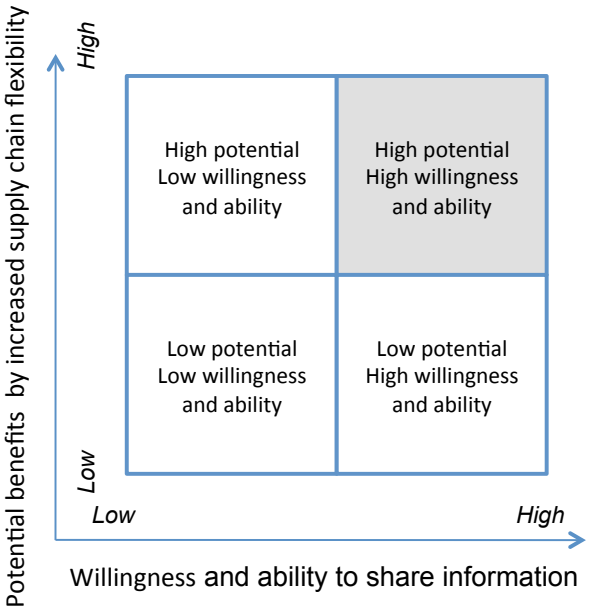


Figure 18: Segmentation matrix

In the upper right corner of the segmentation matrix, changes in information sharing has great effect on supply chain flexibility, and implementations are relatively easy since trading partners' willingness and ability to implement changes in information sharing are high.

In the lower right corner, changes in information sharing would probably strengthen the relationship with the trading partner, since the trading partner has a high willingness to share information. However, since the potential benefits are low, the flexibility within this relation ought to be seen as sufficient.

In the upper left corner, changes in information sharing have great impact on supply chain flexibility. However, the implementations of changes are relatively complex since the trading partner might not have sufficient abilities or the willingness needed to implement changes in information sharing.

In the lower left corner of the segmentation matrix, changes in information sharing has low overall impact on supply chain flexibility and trading partners might not have sufficient abilities or the willingness needed to implement changes in information sharing. Therefore changes in information sharing with trading partners located in this corner are a waste of resources.

5.3.5 Step 5: Choose the Most Promising one and Specify Changes

When the different suppliers have been plotted in the matrix, the supplier with the highest potential benefit and willingness and ability to share information should be chosen for further advancement.

Mapping of processes and factors affecting information sharing

The supplier's processes for receiving, processing and sending information should then be mapped. The questionnaire in appendix II could be used when mapping these processes. The structure and content of the questionnaire is based on section 3.3.1 and section 3.3.2. The questionnaire includes some questions regarding factors affecting information sharing, such as information quality, e.g. if the information is timely, in the right format, and if any additional information is needed. The questionnaire also considers the technology used by the supplier. Other factors, such as finance, culture and other underlying reasons for not sharing information are hard to understand and a questionnaire is not recommended as an only tool for analyzing these issues, since questionnaires are not very deep in their character. All factors should be discussed during for example an interview with the supplier where the questionnaire could be used as a base.

As found in section 3.3.2, improved information sharing, and hence supply chain flexibility, is only possible if the quality of the information shared is sufficient. It is therefore crucial to analyze the factors affecting trading partners' willingness and abilities to share high quality information and their collaborative incentives. This was to some extent considered in the previous step, but could also be more thoroughly analyzed during interviews. It is also important to map what commitments that some information sharing comes with, for example if there are commitments with forecast accuracy. Because in many cases, that affects the way the receiver uses the information.

Specify changes

When the mapping of the supplier's processes is conducted, the results need to be analyzed. This is done in order to specify changes in information sharing that can satisfy the estimated need for supply chain flexibility found in step 2. When analyzing the results, the following areas should be covered:

- Analyze the mapped factors that affect information sharing with the supplier
- Analyze the supplier's real need for information
- Analyze if there is any additionally information that could be received from the supplier in order to improve internal processes

Structure the findings and discuss in collaboration with the supplier what changes that needs to be conducted.

5.3.6 Step 6: Internal Adaption

When changes in information sharing are set in collaboration with the supplier, analyze what internal adaption that needs to be conducted in order to implement the changes.

The focal unit should consider if any changes are necessary in their processes for receiving, processing and sending information in order to implement the specified changes from step 5. Before analyzing, it is important to have a comprehensive understanding of the internal processes for receiving, processing and sending information. If one does not understand the current processes, the changes will be much harder to implement. If changes in internal processes are preferable, the focal unit needs to consider the costs of the changes compared to the perceived increased supply chain flexibility. Another issue that should be regarded is what factors and underlying incentives that affect the internal processes. A good idea could be to have discussions with concerned employees regarding the changes and get their point of view. To change internal processes is not always easy. One must make sure that the employees understand why changes are implemented and how their work will be affected.

5.3.7 Step 7: Evaluate the Flexibility Increase

Measure the potential benefits key performance indicators from step 4 once again in order to estimate the new potential benefits by increased supply chain flexibility. If the new potential benefits are lower, the need for increased supply chain flexibility is lower as well, e.g. if the supplier now is located in the lower right corner of the segmentation matrix the flexibility within this relation ought to be seen as sufficient.

In contrary, if there is still a need for increased supply chain flexibility, the focal unit should go back to step 5 and analyze what could have been done differently and make required changes. For instance, the focal unit might need to analyze factors affecting information sharing once again to make sure that all factors have been considered. If changes are implemented, but not enough, the focal unit should go back to step 4 and analyze if the measurements have been done correctly and if they could have been conducted differently.

6 Testing and Refining the Preliminary FAIS Roadmap at Axis

In this chapter the FAIS Roadmap will be tested on Axis and Axis's suppliers in order to find where changes in information sharing have greatest impact on supply chain flexibility and which changes that should be performed. The chapter ends with a discussion about refinements found during the test, and a presentation of the final roadmap, as well as recommendations to Axis.

6.1 Working Procedure and Purpose

A case study was conducted in order to test the developed roadmap. The test started with an initial data collection at Axis through interviews in order to specify the focal unit as well as to find the need for supply chain flexibility according to the different dimensions. A number of Axis's suppliers were then selected for the test, based on the criteria in step 3. The roadmap was then applied on the selected suppliers, which were evaluated according to the key performance indicators in step 4. Instead of choosing just one of the suppliers to go further with to step 5, all suppliers were taken to the next step in the test. This was done in order to get a better evaluation of the applicability of the preliminary roadmap. The suppliers were then visited and interviews were held with them, in order to map the suppliers' processes for receiving, processing and sending information so that changes in information sharing could be specified. The factors affecting sending or not sending high quality information were also analyzed. After changes were specified, an evaluation was conducted in order to see what internal adaption that was needed in order to implement the changes. The internal adaption was discussed, but not implemented during this test because of the restricted time frame for the study. Step 7 could therefore not be conducted.

The test aims at finding out if the developed roadmap is applicable and if any adjustments need to be done. Furthermore, the test aims at specifying recommendations for changes in information sharing in Axis's supply chain in order to increase the supply chain flexibility.

6.2 Testing the Preliminary FAIS Roadmap

In this section, the results from the test will be presented. The test followed the roadmap steps and the results will therefore be presented in that order.

6.2.1 The Need for Supply Chain Flexibility Investigated

Step 1: Specify the focal unit

The focal unit that was chosen for testing the roadmap was the department Operations at Axis in Lund, Sweden. Operations has the overall responsibility for optimizing processes with suppliers and are further also in charge of processes for production and delivery of products, from component purchasing and electronics production to final

assembly, quality control and delivery. Another of Operations areas is planning, managing and following up the order processing and forecasting.[193]

Step 2: Estimate the general need for supply chain flexibility

As stated in chapter 4, Axis is a Swedish-based IT company providing network based video surveillance solutions. The market for network video is characterized by a high rate of new product introductions, short lead times, high product variety and relatively short product life cycles. This applies high pressure on Axis's ability to fast react to changes in market demand, both when it comes to rapid increase or decrease in volumes as well as changes in product mix. Hence, *volume flexibility* and *product mix flexibility* is important for Axis. Furthermore, up to this date, there is a lack of standardization in the business, meaning that once a customer has chosen one specific brand of network video products, the ability to substitute or complement with other brands are limited. As a consequence, a fast pace of new product introductions is necessary, and therefore a high degree of *product flexibility* is uttermost important for Axis in order to retain the position as market leader.

Table 4: Estimation of Axis's general need for supply chain flexibility

Industry characteristics	Flexibility dimension
High overall demand fluctuation	Volume flexibility
High product variety	Product Mix flexibility
Short product life cycles	Product flexibility
Fast pace of new product introduction	Product flexibility

Step 3: Specify Supplier Groups

Mapping of different supplier groups

The components in Axis's products are very different in character and in terms of sourcing. Electronic components are sourced by the contract manufactures and in most cases, these are standard components manufactured in bulk that easily can be obtained from a number of vendors. These components are seen as non-strategic, and the contract manufacturers have the responsibility to source these components. Axis's influence lies only in certain Approved Manufacturer and Vendor Lists that contains suppliers retailing components that fulfill Axis's demand on component specifications. These lists exist mainly because components with similar specifications can perform differently in different applications.

[193] Axis webpage (2009)

For mechanical components, the situation is different. Even though the costs of one produced component might be very low, the costs accumulated up to the first produced unit are very high. The product development at Axis is performed in close collaboration with the suppliers of mechanical components. The process is very iterative and in many cases, the timeframe from the start of the product development until the start of volume production is substantial. Therefore, these components are characterized by their uniqueness and the difficulties and costs associated in changing suppliers. As a consequence of the uniqueness, the risk within this supplier relation is considerable and the benefits from improved information sharing are not to be underestimated. Furthermore, Axis strives towards using fewer suppliers with which they creates strategic collaboration. This since the complexity of products increases, and the development of mechanical parts therefore needs to be developed in collaboration with the suppliers since Axis to some extent are lacking the relevant knowledge needed.[194]

During product development, Axis has a close relationship with the suppliers of mechanics, who to some extent are involved in the choice of design, materials and the setting of tolerances etcetera. When these characteristics are set, production ramp up starts, and the running communication with the suppliers are in most cases handed over to the contract manufacturers.[195,196] For the contract manufacturer, which primary core competence lies in manufacturing of printed circuit boards (PCB), the relation to supplier of mechanics is to some extent forced. This emphasizes Axis's initial relation with these suppliers in order to ease the running collaboration between these suppliers and the contract manufacturers.[197,198]

Choice of supplier groups

According to the reasoning above, the supply chain processes where improved information sharing is uttermost important and would have the biggest impact on supply chain flexibility are those between Axis, their suppliers of mechanics and the contract manufacturers, see Figure 19.

[194] Jeppsson (2009-01-26)
[195] Ädelroth (2009-03-19)
[196] Lindkvist (2009-03-23)
[197] Richard (2009-02-25)
[198] Olsson (2009-03-15)

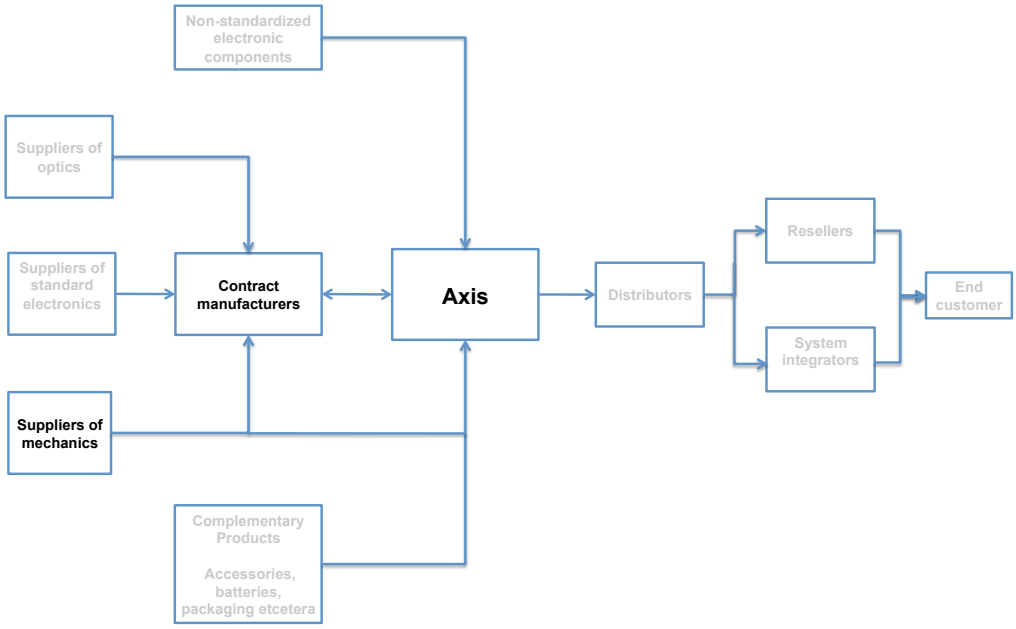


Figure 19: Choice of supplier groups

6.2.2 The Roadmap Applied on Four Different Suppliers

Step 4: Identify improvement areas by segmenting suppliers

Due to the limited time frame of this thesis, only a small group of mechanical suppliers and one contract manufacturer have been part of this test, see Figure 20.

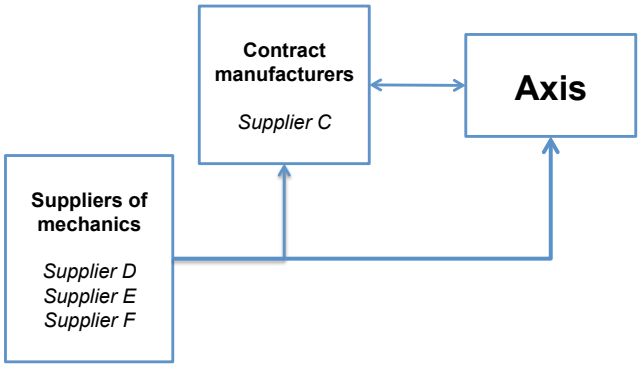


Figure 20: The four different suppliers in the test

The segmentation of the suppliers is presented below:

Supplier C

Supplier C is one of Axis's contract manufacturers located in Thailand. Supplier C is an electronic manufacturing service company providing printed circuit boards. Supplier C focuses on the Scandinavian and the American market and has a sales office in Denmark.[199]

Potential benefits

Supplier C is the largest supplier in Axis's supply chain with a high sales volume of Axis's products. When measuring the key performance indicator regarding inventory levels, it was found that these were higher than those of other suppliers. Furthermore, there have been problems with incorrect deliveries; therefore the key performance indicators are higher than for other suppliers, see Figure 21.

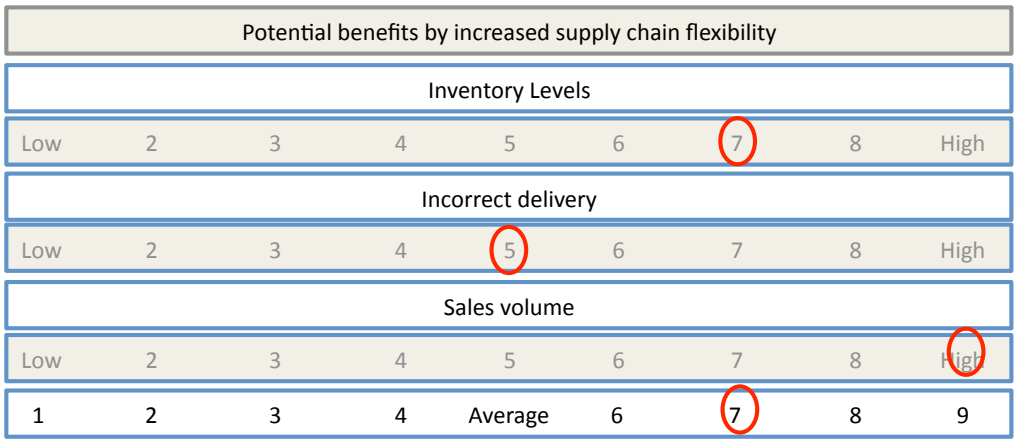


Figure 21: Potential benefits by increased supply chain flexibility for Supplier C

Willingness and ability to share information

Supplier C is willing to collaborate, but is to some extent more interested in improving internal processes than the overall supply chain performance, see Figure 22. However, the supplier is open and share information about future shortage and is not afraid of bringing issues up to the surface. Supplier C is an organization with competent coworkers in the field of electronics, whereas their complementary abilities are seen as high. Supplier C and Axis are currently using VMI for approximately 70 percent of the goods.

[199] All information gathered in this section is from interviews with supplier C 2009-04-01—2009-04-03

Figure 22: Willingness and ability to share information for Supplier C

Supplier D

Supplier D is a Malaysian company, designing and developing electronic end products, prototypes and tooling, mainly in the mobile phone accessories, computer peripherals and consumer technology segments.[200]

Potential benefits

Supplier D is a relatively large supplier, working with high inventory levels in order to keep high service levels towards customers. Since the stock levels are high, the number of incorrect deliveries can be kept quite low, see Figure 23.

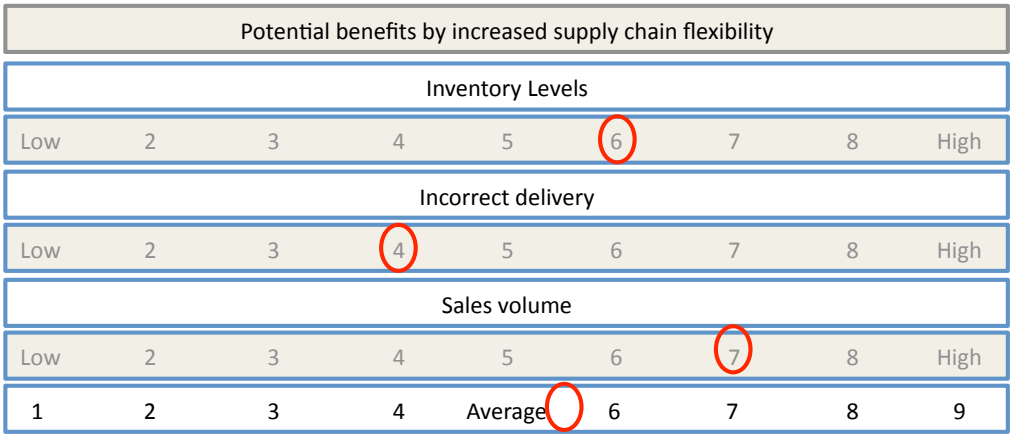


Figure 23: Potential benefits by increased supply chain flexibility for Supplier D

[200] All information gathered in this section is from interviews with supplier D 2009-03-30

Willingness and ability to share information
Supplier D understands benefits from collaboration and always tries to share correct information with customers in order to create long-term relationships. Supplier D has a high level of in-house knowledge, for example mechanical engineers, who can provide Axis with complementary skills. In addition, supplier D has well defined structures and capabilities for handling information, see Figure 24.

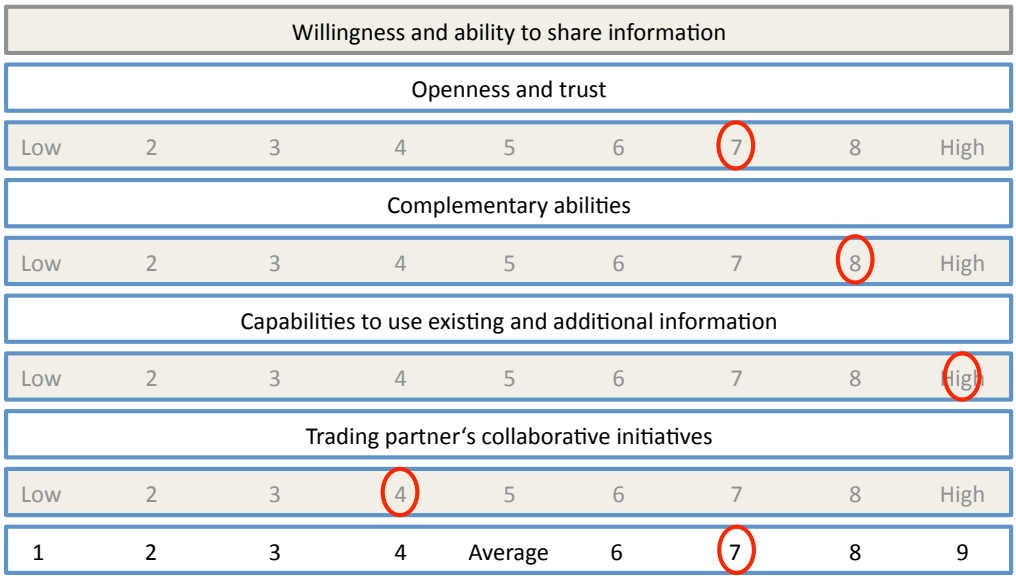


Figure 24: Willingness and ability to share information for Supplier D

Supplier E
Supplier E is a small Chinese aluminum and zinc die-casting manufacturer, providing Axis with metal brackets. The supplier's production methods are relatively advanced compared to other of Axis suppliers providing comparable components.[201]

Potential benefits
The potential benefits for supplier E is seen as low, see Figure 25. The inventory levels and sales volumes are relatively low and the supplier delivers almost all products on time and in full.

[201] All information gathered in this section is from interviews with supplier E 2009-03-24

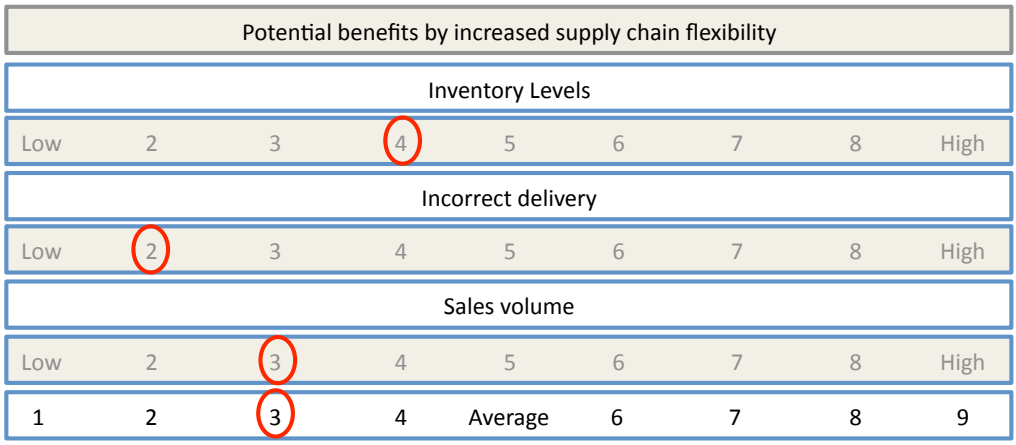


Figure 25: Potential benefits by increased supply chain flexibility for Supplier E

Willingness and ability to share information

Supplier E shares more information with other customers than with Axis. A possible reason for this could be that supplier E is a relatively new supplier for Axis. Supplier E has a high level of knowledge within mechanical engineering; whereas they can provide Axis with complementary information regarding manufacturability of components, see Figure 26.

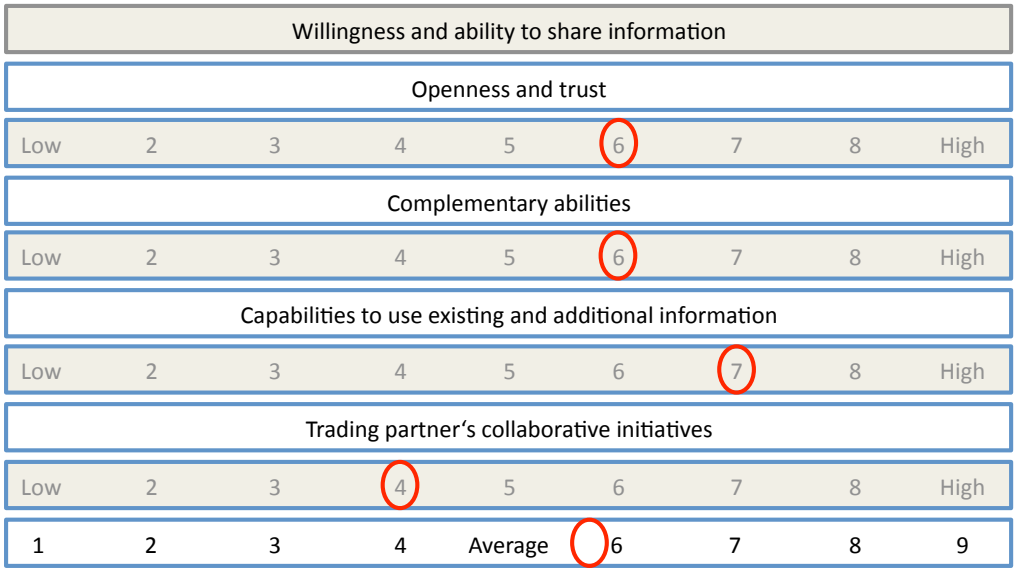


Figure 26: Willingness and ability to share information for Supplier E

Supplier F

Supplier F is a Chinese mechanical supplier of plastic brackets for some of the network cameras. Axis represented approximately 15% of supplier F's annual turnover 2008.[202]

[202] All information gathered in this section is from interviews with supplier F 2009-03-25

Potential benefits

Supplier F is a small supplier to Axis. Furthermore, the supplier does not have high inventory levels, and safety stock is only kept for special raw material. However, Axis experiences problems with the quality of supplier F's deliveries. The average potential benefits for Supplier F are low, see Figure 27.

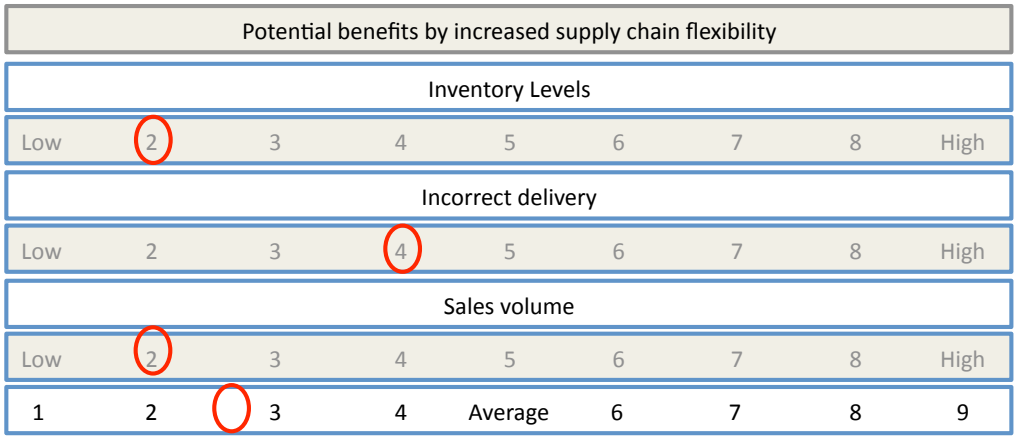


Figure 27: Potential benefits by increased supply chain flexibility for Supplier F

Willingness and ability to share information

Supplier F has a somewhat high willingness to collaborate but poor ability. The supplier does not use computerized systems for order handling or production planning. There have been some quality issues with components supplied by supplier F, and the production knowledge of supplier F is therefore not seen as very high, see Figure 28.

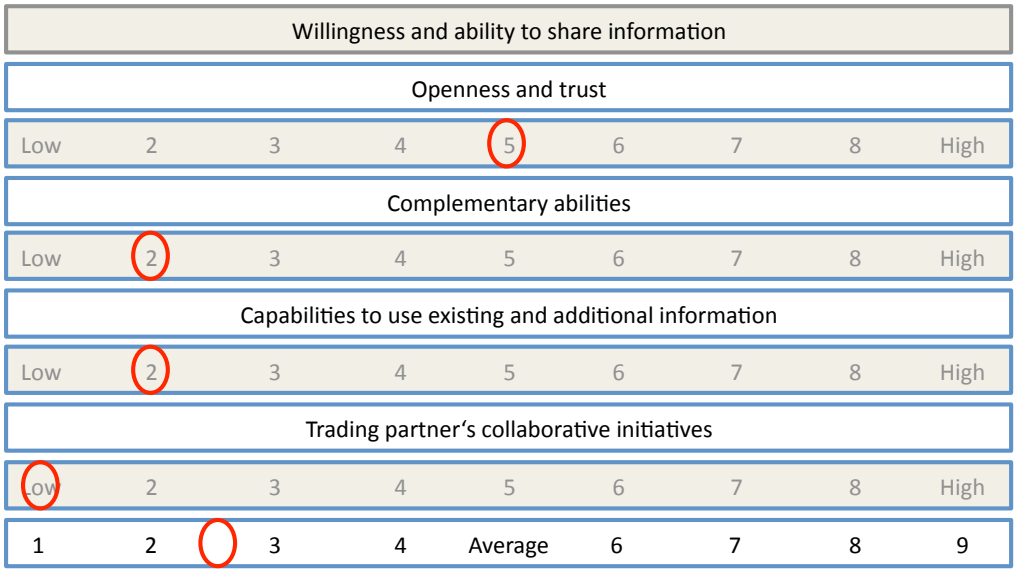


Figure 28: Willingness and ability to share information for Supplier F

Supplier segmentation

In order to visualize the results from the evaluation of the different suppliers, the suppliers have been plotted in the matrix in Figure 29. The plotting is based on the scores from the measurements conducted above.

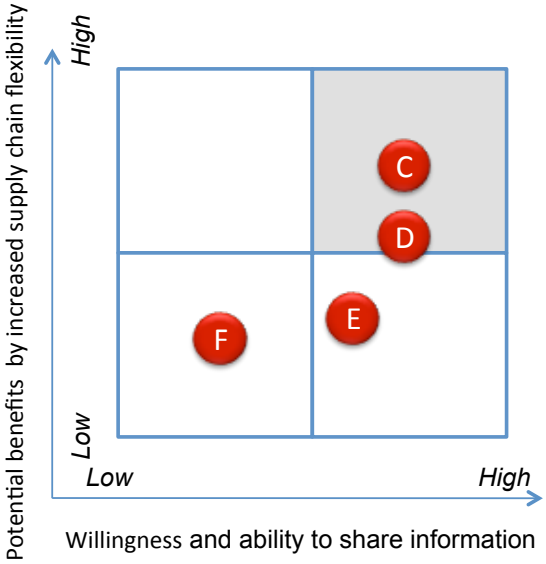


Figure 29: Segmentation of suppliers

The supplier with highest potential benefits and willingness and ability to share information, is supplier C.

Step 5: Choose the most promising one and specify changes

Instead of choosing the most promising supplier based on the results in step 4, the test was conducted on all the suppliers from step 4. The questionnaire was applied on the selected suppliers together with deep interviews in order to map their current information sharing with Axis. Below is the result from the mapping.

Mapping of processes for receiving, processing and sending information for supplier C

The processes for supplier C were mapped during interviews and are described in detail and presented in Figure 30 below[203].

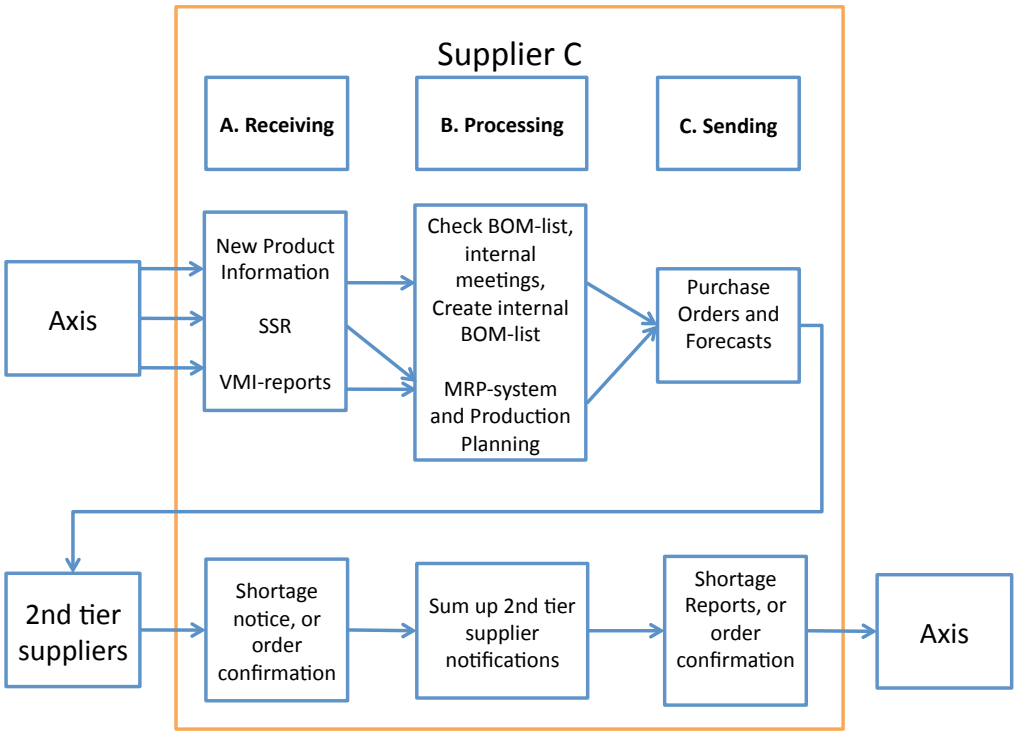


Figure 30: Supplier C's processes for receiving, processing, and sending information

A. Receiving

New product information

Axis has a database where they have gathered all their products, components and drawings in different lists, called Bill-of-Material lists (BOM). Supplier C has access to the database and can thereby see the latest information regarding new and existing products. Supplier C analyzes the information in the database in order to see which components that need to be sourced in order to produce these products. Supplier C sees changes in BOM-lists and drawings when the changes are uploaded into the database. However, supplier C would like to get a pre-notice about the changes and whether they are supposed to be large or small.

Axis sends AVL- and AML-lists, which are lists with approved vendors and manufacturers that Supplier C needs to use when sourcing material. Additionally,

[203] All information gathered in this section is from interviews with supplier C 2009-04-01—2009-04-03

Axis provides supplier C with material authorizations[204] for sourcing the needed components. Before supplier C can source a component, it has to be approved by Axis. Currently, supplier C does not always know when components are about to be approved and it usually takes time to find out if components are approved or not.

SSR
Supplier C primarily sends all products and components to Axis. Axis sends Supplier-Schedule-Reports (SSR) to Supplier C. These reports contain purchase orders for the next 8 weeks, material authorization for 16 weeks, and forecasts for the next 6 months. The reports also contain delivery dates, prices and order quantities.

VMI-reports
Supplier C receives daily VMI-reports over weekly demand from Axis by e-mail. The format is not synchronized with supplier C's format, which highly affects the processing of the reports. Supplier C believes that the processing time for the reports would decrease by an estimated 50 percent if the reports would have been in a synchronized format. Supplier C sends an order to Axis of the quantities that they would like to send. It then takes approximately 3-4 days for Axis to approve the order and then the products are sent.

Order confirmation and shortage notice
Supplier C receives order confirmation and delivery dates from their suppliers if the suppliers can deliver. Otherwise, they receive shortage notices.

B. Processing

MRP-system
Supplier C has an installed Material Resource Planning-system (MRP). The MRP system plans the material sourcing according to a wide range of different factors such as current stock levels, order size, delivery date, production lead times, safety stock levels, number of working days, and minimum order quantities.

Production planning Process
The MRP-system is run weekly and thereafter the production planning is conducted. Different departments log into the MRP-system and use the information to plan their activities. For example, how much raw material that has to be purchased in order to produce a product. Current stock levels are checked and a kitting is done where different components used in the same product are gathered and placed nearby the production line. Supplier C plans the production every Friday. When there are rush orders, the frequency of the production planning processes increase.

[204] The receiver of the material authorization is authorized to source agreed quantities. The sender is obliged to buy unused quantities.

BOM-list evaluation for new products
Supplier C analyzes Axis's database and translates the BOM-lists into their own internal BOM-lists where only the components that they are responsible for sourcing or producing are added. When changes to drawings occur, Axis notifies Supplier C. If there is any need for new parts, the internal BOM-list is changed. The target is to do this within approximately two weeks, but sometimes it takes 4-6 weeks.

Sum up supplier reports
All 2nd tier supplier notifications are summed up into shortage reports or order confirmations.

C. Sending

Purchase Orders
Supplier C uses an internal BOM-list and MRP-system in order to see what components that need to be sourced. They then send purchase orders to different suppliers according to current demand.

Forecasts
Axis's forecasts are sent into Supplier C's MRP-system. Since the MRP-system plans sourcing of material according to factors that only affect nearby purchase orders, the forecasts will not be affected by the MRP-system. Forecasts to suppliers are for three months ahead and divided into weekly demands. The forecasts are divided into two groups, since some of supplier C's suppliers are using VMI. The forecasts to these work as VMI-reports and are binding. The other group of suppliers is those without VMI. The forecasts could then be used in order to estimate future demand, but are not binding. The forecasted quantities are adapted to minimum order quantities, production times, cancellation windows and transport times. The data is updated weekly. The forecasts are provided on supplier C's homepage and sent automatically to suppliers.

Shortage reports or order confirmation
If issues arise when sourcing needed components, Supplier C evaluates why by contacting the involved suppliers, and notifies Axis by sending shortage reports over the missing components. Axis and supplier C have weekly telephone meetings about underlying issues for the shortages and discuss how the issues could be solved. When no shortage occurs, or if the components are already in stock, order confirmations are sent to Axis.

Factors affecting information sharing for supplier C

The factors affecting supplier C's information sharing is presented in Table 5.

Table 5: Factors affecting information sharing for supplier C

Factors	Description
Technological	Technological issues could be seen as quite low. Supplier C has both MRP- and ERP-systems implemented. However, they do not have the same systems as Axis, which increase the degree of manual handling.
Cultural	Supplier C seems to have a somewhat hierarchical company structure. Otherwise, this is a supplier that Axis has been working with for a very long time and the cultural understanding for each other is high.
Collaborative	The collaboration and communication between Axis and supplier C is working well. However, some smaller mechanical supplier has been having problems with the communication towards supplier C.
Information quality	Supplier C cannot see to which extent Axis's inventory is already booked by customers. Supplier C would like for Axis to notify about coming changes in drawings. Today, supplier C receives these changes first when they are uploaded to Axis's database. Supplier C would also like to have a specific contact at Axis that can tell them if components have been approved. This would make the information more complete and correct.

Specified changes for supplier C

Supplier C has problems with the accuracy of Axis's forecasts. Supplier C buys components after forecasts if the lead times are long. Since the accuracy is low, Supplier C has to keep stock. The accuracy of the forecasts has been very low the last months. This is probably an effect of the current financial crisis, which creates a lot of demand fluctuations, but another contributing reason could be that Axis has a very complex forecasting process. In order to increase the flexibility in the supply chain, it could be a good idea for Axis to review their forecasting process. Sales forecasts impact all different flexibility dimensions and it was seen in section 3.5 that demand planning processes should be simplified, synchronized and stabilized. Since supplier C is a 1st tier supplier, it is crucial that the information that this supplier receives and sends is of high quality.

Supplier C currently receives VMI reports in a non-synchronized format. This highly affects the processing of the reports. Supplier C believes that the processing time for the reports would decrease by an estimated 50 percent if they would have received the reports in a synchronized format. Axis needs to internally discuss what the advantages

or disadvantages could be with sending the reports in another format or installing a database where this information could be shared. Additionally, there are delays when Axis approves orders sent by supplier C. If the processing time can be diminished, this affects *volume flexibility* as seen in section 3.3.2. To implement Axis's current system at supplier C could possibly reduce administrative lead times, but the current market situation has lowered sales and the timing of such an implementation is probably not optimal.

Supplier C does not know to what extent Axis's inventory levels are booked by customers, this information is something that Axis could send to the supplier.

If supplier C would send delivery or production schedules to Axis and other suppliers, Axis can ensure reliable supply. The ability to reschedule the supply and delivery of materials influences *product mix flexibility* to a great extent.

Regarding new product information, the communication with the supplier could be more frequent, resulting in the supplier having knowledge about future design changes and whether the changes are about to be large or small, what components that are approved or not and when other component approvals are planned. The supplier also request that communication regarding approved components are done through one channel at Axis and in a more standardized manner. Furthermore, sometimes supplier C has problems meeting the target of making internal changes to the BOM-list within 2 weeks. If changes could be made so that Axis supports supplier C when making this list as well as follow up the process, lead times could probably be reduced. The above ought to increase the *product flexibility*.

Mapping of processes for receiving, processing and sending information for supplier D

The processes for supplier D were mapped during interviews and are described in detail and presented in Figure 31 below[205].

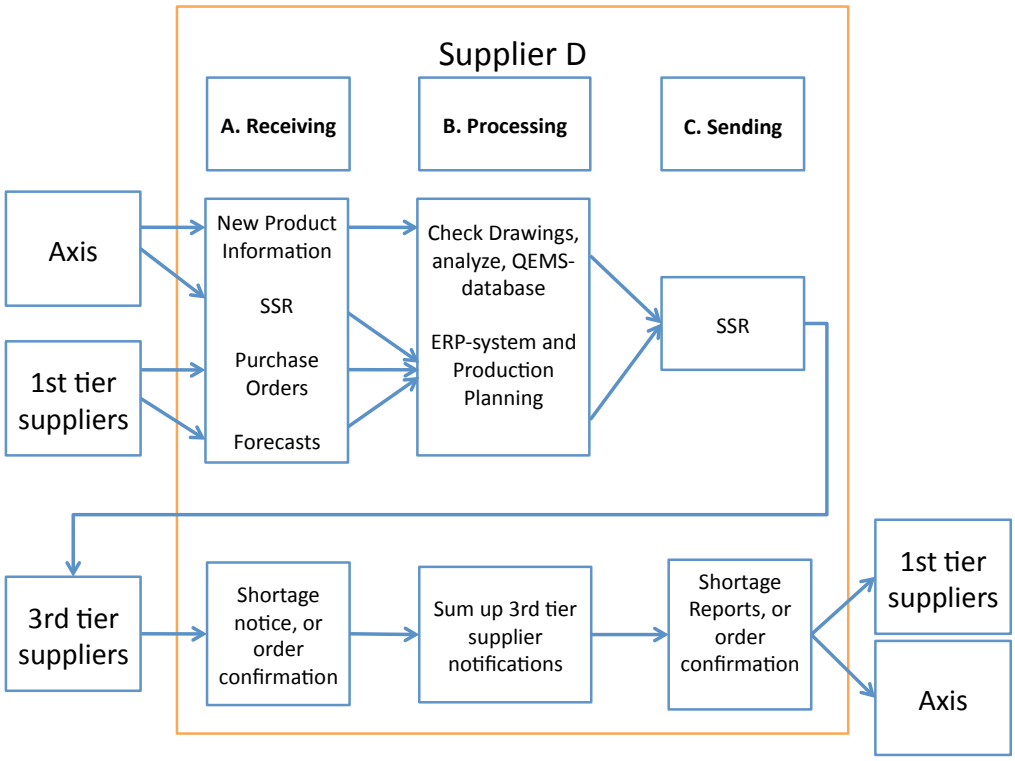


Figure 31: Supplier D's processes for receiving, processing and sending information

A. Receiving

New product information

Supplier D has access to Axis's database. Thereby they can see the latest drawings for different products as well as the BOM-lists. Supplier D is very pleased with the database. Some other customers provide servers where Supplier D can download information, but those documents are not updated as frequently as the online database that Axis offers. However, Axis does not provide Supplier D with new product information such as assembly drawings or prototypes.

If there are any major problems during the product development phase, Axis visits supplier D, otherwise all contact is made by e-mail or phone. Supplier D believes that the total development time for new components or products could decrease by three weeks if Axis visits supplier D more often.

[205] All information gathered in this section is from interviews with supplier D 2009-03-30

SSR
Axis sends SSR to Supplier D by e-mail. Supplier D acknowledges that they have received the reports, but do not state whether or not they can deliver according to the purchase orders.

Receiving from 1st tier suppliers
Supplier D only works with two 1st tier suppliers. Both 1st tier suppliers send purchase orders. However, one of the 1st tier suppliers sends very fluctuating purchase orders without set delivery dates. Then they send an additional document close to delivery with the specific date. One of the 1st tier suppliers does not send forecasts, but the other one sends forecasts once a month with weekly updates.

Receiving from 3rd tier suppliers
Supplier D receives information about the 3rd tier supplier's ability to produce according to purchase order quantities. If the supplier cannot produce, a shortage notice will be sent to supplier D, otherwise an order confirmation will be sent. Supplier D does not receive any inventory level information from their suppliers.

B. Processing

BOM-list evaluation and the QEMS-database
When there are changes in new product information, such as updated drawings, Axis notifies Supplier D by e-mail. Supplier D then accesses Axis's database and adds the changes into their own database, QEMS. The QEMS-database contains drawings, BOM-lists, error reports etcetera. This database is only used internally whereas it is hard to map all the information in the database. However, Supplier D is planning on giving customers access to the database in the nearby future.

ERP-system
All purchase orders, material authorizations and forecasts from Axis and the purchase orders and forecast from 1st tier suppliers are added to Supplier D's ERP-system. The time for receiving a purchase order, processing it in the ERP-system and conduct the material planning is approximately 4-6 weeks. Current stock levels, safety stock levels, and lead times for production affects the information during the production planning process.

Sum up supplier reports
All 3rd tier supplier notifications are summed up into shortage reports or order confirmations.

C. Sending

SSR
Supplier D sends SSR's further to their suppliers. Material authorizations are only included when needed, for example when Supplier D source specific components only used in a small number of products. When sourcing more common components, no material authorizations are used. The forecasts are sent further when lead times for

components are long. The forecasts can be used by the suppliers in order to secure material, but are not binding.

Shortage reports or order confirmation
If there are any problems with sourcing needed components, Supplier D evaluates why and notifies Axis and suppliers by sending shortage reports of the missing components. They also have telephone meetings about underlying issues for the shortages and discussions of how the problems could be solved. When no shortage occurs or if the components are already in stock, order confirmations are sent further.

Factors affecting information sharing for supplier D
The factors affecting supplier D's information sharing is presented in Table 6.

Table 6: Factors affecting information sharing for supplier D

Factors	Description
Technological	Supplier D has an own database and well established ERP-systems. Hence, technological issues are seen as low.
Cultural	Supplier D seems to have a somewhat hierarchical company structure. Otherwise, the view is that supplier D has an open climate where the customer comes in first hand. The cultural barriers for supplier D are seen as low.
Collaborative	Well defined project structures and project maps have been developed by supplier D. One 1st tier supplier does not send delivery dates, which makes it hard for supplier D to plan production. However, supplier D has a good relationship with this supplier and the current situation is seen as satisfying.
Information quality	Supplier D would like that the information that they receive from Axis regarding new product information is more complete. Other customers send prototypes, which makes it easier for supplier D to see the context of different components.

Specified changes for supplier D
Regarding new product information, lead times could be greatly decreased which would positively affect *product flexibility*. For example, if Axis visits Supplier D in Malaysia, the lead times for new product development could, according to Supplier D, be reduced with up to three weeks. However, Axis must first take the costs of such initiatives in consideration before deciding if the benefits with reduced lead times are enough.

Supplier D receives prototypes from other customers and can thereby see the context of their components. If Axis does not wish to work with prototypes, they could send

assembly drawings. Supplier D could then easier give Axis recommendations about changes in the drawings. This would affect *product flexibility*.

If supplier D would send delivery or production schedules to Axis, Axis can ensure reliable supply. Currently, supplier D acknowledges that they have received a purchase order, but do not state whether or not they can deliver. It would be better if they would send delivery reports with the next shipments and combining these reports with shortage reports. Then Axis could see if the purchase order quantities can be delivered or not and also when they will be delivered. This would influence the *product mix flexibility* to a great extent.

Supplier D has also stated that they would like to change the material authorization so that it applies for finished or semi-finished goods instead of components. When their material have not been processed, it expires, sometimes already after 3 weeks in stock and they therefore want to process as much material as possible.

Mapping of processes for receiving, processing and sending information for supplier E

The processes for supplier E were mapped during interviews and are described in detail and presented in Figure 32 below[206].

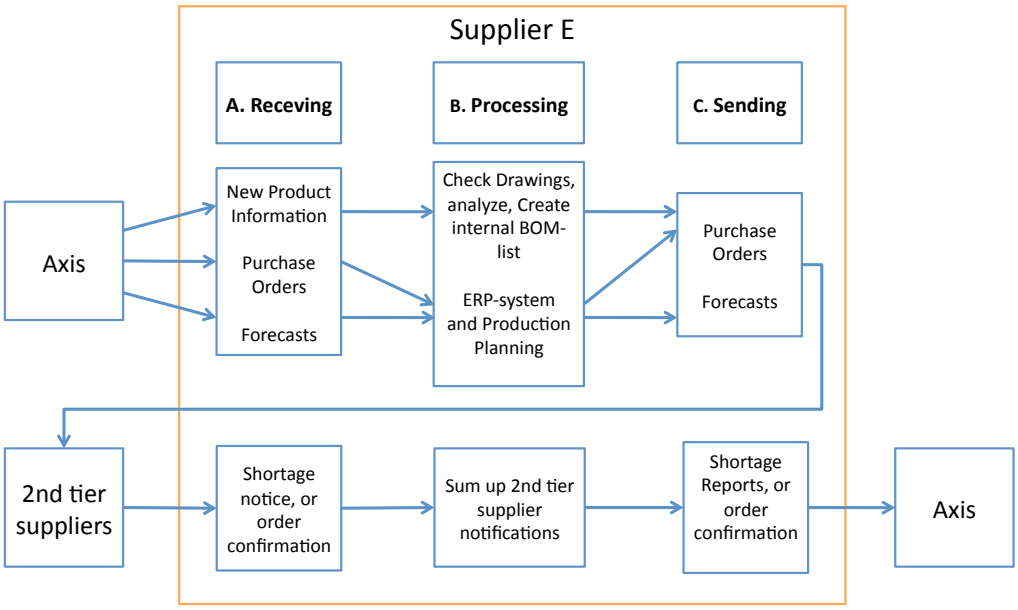


Figure 32: Supplier E's processes for receiving, processing and sending information

A. Receiving

New product information

Axis sends AVL-, AML-lists, quotation requests and CAD-drawings to supplier E by e-mail. Supplier E does not have any access to online databases with drawings or BOM-lists.

Purchase Orders

Supplier E only ships to Axis and no 1st tier suppliers. Axis sends purchase orders to supplier E by e-mail. The purchase orders contain delivery dates, prices and order quantities.

Forecasts

Supplier E receives forecasts by e-mail from Axis once a month about demand for the coming 6 months.

[206] All information gathered in this section is from interviews with supplier E 2009-03-24

B. Processing

ERP-system
All purchase orders from Axis are input to Supplier E's ERP-system. Production is planned according to production lead times, order quantities for all recent orders, estimated time of departure and estimated time of arrival.

BOM-list evaluation for new products
Supplier E uses the CAD-drawings and the AVL- and AML-lists as input when making their internal BOM-lists. Additionally, Supplier E evaluates their suppliers in order to ensure that suppliers have sufficient capacity, optimal lead times, and stable quality.

Sum up supplier reports
All 3rd tier supplier notifications are summed up in order to see if delivery is possible or if any shortages will occur.

C. Sending

Purchase Orders
Supplier C sends purchase orders to different suppliers according to what components or raw material that is needed.

Forecasts
Supplier E sends forecasts to some suppliers with long lead times.

Shortage notice or order confirmation
If there are any problems with sourcing needed components, Supplier E give Axis a shortage notice. Otherwise, an order confirmation is sent.

Factors affecting information sharing for supplier E

The factors affecting supplier E's information sharing is presented in Table 7.

Table 7: Factors affecting information sharing for supplier E

Factors	Description
Technological	Supplier E has a well established ERP-system that e.g. plan production and the sourcing of material. Supplier E has access to other customers' databases, and would like to get access to Axis's database as well.
Cultural	The cultural issues with this supplier seems to be quite small, however since only a few interviews very conducted it is hard to draw any general conclusions about the supplier's culture.
Collaborative	There were some communication difficulties with this supplier before, but recently the communication has become much better and today there are no communication problems. The supplier recently changed Axis's contact person, which could be a contributing factor.
Information quality	Supplier E would like to receive more complete information, such as material authorizations and forecasts. Supplier E believes that such information could be very helpful for production planning and material sourcing. Supplier E would also like to know more about Axis's specific market and whishes that Axis sends more information about current trends, expected market growth etcetera.

Specified changes for supplier E

Supplier E has a request for more information since other customers provide supplier E with much more information than Axis currently does. If Axis starts sending forecast to supplier E or material authorizations, supplier E could easier source material and plan production. This would greatly affect the *volume flexibility*. Axis could also try to involve supplier E more in the company's business and give supplier E information about current trends and market characteristics.

Additionally, supplier E had a very high request for getting access to Axis's database, or in some other way have access to a live document where changes in drawings are instantaneous. Today, the supplier receives drawings of new products by e-mail. It would be easier for the supplier to give Axis input and recommendations as well as being up to date with changes if the supplier would have access to Axis's database. If Axis could provide supplier E with these types of solutions, the *product flexibility* could be increased.

Mapping of processes for receiving, processing and sending information for supplier F

The processes for supplier F were mapped during interviews and are described in detail and presented in Figure 33 below[207].

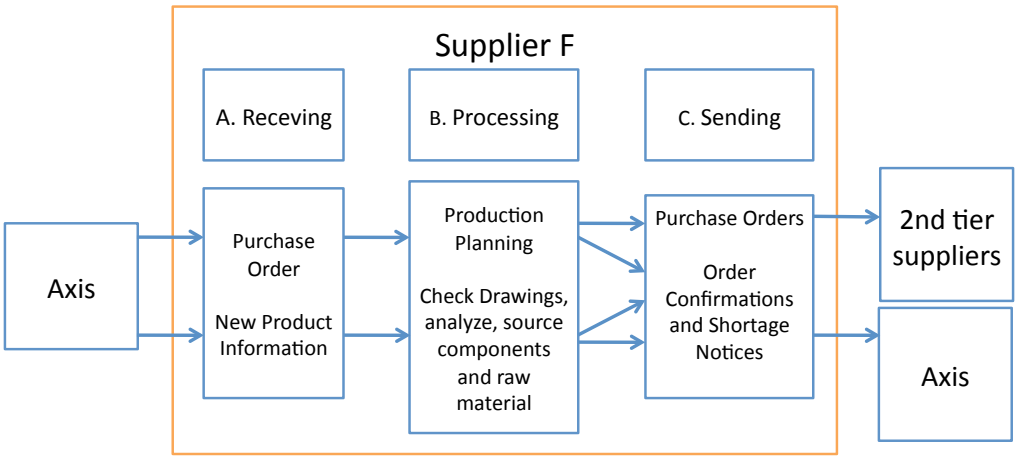


Figure 33: Supplier F's processes for receiving, processing and sending information

A. Receiving

Purchase Orders

Supplier F does not work with 1st tier supplier. Supplier F receives purchase orders from Axis, approximately two months in advance. Changes to the purchase orders are sometimes made 2-3 weeks before delivery by e-mail from Axis. Supplier F receives no forecasts.

New product information

Axis sends quotation requests and CAD-drawings to Supplier F by e-mail. Axis also sends AVL- and AML-lists.

B. Processing

Production planning Process

When Supplier F receives Axis's purchase orders, the stock of Axis's products and internal production lead times for injection, assembly and painting are analyzed in order to make an internal BOM-list. This list is then compared to the stock of raw material and if needed, raw material is sourced.

BOM-list evaluation for new products

When new product information is received by supplier F, an internal BOM-list is created where only the components or raw material that supplier F uses are added.

[207] All information gathered in this section is from interviews with supplier F 2009-03-25

C. Sending

Purchase Orders
Purchase orders are sent to suppliers regularly. No material authorizations or forecasts are sent upstream the chain. Supplier F mostly sources plastic raw material and always keep the raw material in stock. Therefore, they do not need to ask 3rd tier suppliers for order confirmations before giving order confirmations to Axis.

Factors affecting information sharing for supplier F
The factors affecting supplier F's information sharing is presented in Table 8.

Table 8: Factors affecting information sharing for supplier F

Factors	Description
Technological	Supplier F does not work with computerized business systems or material planning systems. The technological issues could be seen as relatively high.
Cultural	The cultural issues with this supplier seems to be quite high, the supplier is a very small Chinese manufacturer. However since only a few interviews very conducted it is hard to draw any general conclusions about the supplier's culture.
Collaborative	The collaboration with the supplier works well. There are no major communication issues. However, there are key personnel responsible for the communication with Axis, and if they are switched, problems could possibly arise.
Information quality	Supplier F is pleased with the information received from Axis and believes it is timely, complete and correct.

Specified changes for supplier F
All communication with supplier F is conducted by e-mail. However, supplier F does not have any experience of electronic receiving processes and do not wish to receive information from Axis in any other way.

Supplier F does not receive any forecasts or material authorization currently. Supplier F has very short lead times and the orders sent from Axis are very stable, hence supplier F has no need for material authorizations or forecasts.

I would be hard to increase supply chain flexibility by changes in information sharing with this specific supplier. Trying to do so would probably be a waste of resources.

Step 6: Internal adaption
In this step, the internal adaption that needs to be performed in order to implement the changes from step 5 needs to be set according to the perceived increased supply chain flexibility as well as estimated costs of the implementation. However, since this thesis

does not focus on calculating costs of an implementation, this section only presents potential changes in internal processes and some comments regarding the costs. However, the costs needs to be calculated more specifically and factors and underlying incentives that affect the internal processes also needs to be considered before implementing changes. This has not been a part of the test.

Below are the potential changes in internal adaption regarding processes for receiving, processing and sending information presented:

Receiving

If Axis decides to request production and delivery schedules from their suppliers in order to secure reliable supply, Axis must have internal processes that can utilize that information. The information could be used in order to see if suppliers have problems with producing or shipping needed material. If problems arise, Axis will have that information in an instant and has a greater chance of finding other ways to source or transport material. The information could also be used in order to give customers more accurate delivery dates, since it is easier to see when finished goods will be in stock. The costs of an implementation of processes for receiving and utilizing this information will probably be relatively low, but have high affect on supply chain flexibility.

Processing

One of the major issues found in the theory that affect supply chain flexibility is sales forecasting. During the test of the preliminary roadmap it was found that some suppliers have problems with the accuracy of Axis's forecasts. The low forecast accuracy could be an effect from the financial crisis, but it could also be an effect from inefficient forecasting processes. The internal forecasting process is something Axis can control and should control, whereas a good idea could be for Axis to evaluate their forecasting process in order to see if it is possible to simplify the process. The internal adaption that has to be made in that case is a mapping and an evaluation of the process, changes in the process if necessary, and a follow up of the results. The costs with such an internal adaption would probably be relatively low, but could have great affect on overall supply chain flexibility.

Regarding new product information, sometimes Axis makes changes in new product information that affect the components the suppliers have to source. The internal processes for some suppliers, regarding finding new components or making changes in components, can be very time consuming. If Axis would implement a process for following up these lead times, the time to market for new products will probably be reduced.

Finally, there are delays when Axis approves orders sent according to VMI agreements. The processing time of approving orders should get more focus, so that the internal administrative lead times can be diminished.

Sending

There are some issues with Axis's VMI-reports. The first issue concerns the fact that some suppliers do not receive information regarding booked inventory. Secondly, the format of the VMI-reports makes the manual handling for some suppliers ineffective and thereby time consuming. The internal adaption needed at Axis is to send additional information to suppliers about booked inventory quantities. The format of the VMI-reports should also be considered in order to try to synchronize the format according to suppliers' formats.

Furthermore, some suppliers have an extensive request for more information. It was for instance found that one mechanical supplier wish to have additional information regarding foremost forecasts, but also material authorizations. The supplier also believes that with access to Axis's database, the supplier could give Axis input and recommendations as well as being up to date with changes in drawings that is made by Axis.

Regarding new product information, some issues were found during the test. Initially, suppliers request a more standardized communication with Axis regarding information about approved and not approved components and they would also like to know an approximate time for the approval. Furthermore, it was found that time to market probably could be reduced significantly if Axis visits the suppliers or at least has more communication with suppliers and notify suppliers of planned design changes. Additionally, some suppliers requested prototypes or context drawings in order to be able to give more specified recommendations and additional information about how the components will react when they are assembled.

Step 7: Evaluate the flexibility increase

This step has not been performed in the test since no changes in information sharing have been implemented, and there has not yet been an increase in supply chain flexibility.

6.3 Refining the Roadmap

When conducting the test, it was found that by mapping both 1st and 2nd tier suppliers and their relation to each other, a more comprehensive understanding can be made compared to when just one supplier is mapped. Step 5 was therefore redefined so that the mapping is not only conducted on one supplier, but also on a few of that supplier's trading partners that are part of the focal unit's supply chain. The choice of these additional trading partners should be based on the same process as the initial supplier; therefore one must go back to step 3 and 4 in order to segment the supplier's trading partners. The specified changes as well as the internal adaption are then based on the mapping of all of these trading partners. In order to get a good structure of this refinement, step 5 was divided into two steps.

After conducting the test, the key performance indicators were discussed, and if whether the results from the key performance indicators could be a base for an adequate segmentation. It was found that the key performance indicators for

evaluating potential benefits were somewhat insufficient. Two key performance indicators were therefore added to the final version of the roadmap. The key performance indicators are described in detail below:

Incorrect forecast impact

The impact of incorrect forecasts can vary a lot between different suppliers and depends on to what extent suppliers use forecasts when sourcing products, components or services. High forecast accuracy from the focal company to its suppliers ought to be seen as primary in order to achieve supply chain flexibility. Inaccurate forecasts can result in higher inventory levels, long lead times, followed by out of stock scenarios and disbelief towards the focal company. Incorrect forecast impact is measured from the supplier's point of view where the supplier estimates how much of its material that is sourced according to forecasts.

Order window and cycle reaction time

This key performance indicator should measure the cycle reaction time for a supplier divided by the order window. The cycle reaction time is the average time it takes for a supplier to source and produce according to an order. The order window is the time between the order is placed and the expected delivery date. Sometimes the cycle reaction time is shorter than the order window. This would have resulted in a key performance indicator smaller than 1, e.g. if the cycle reaction time for a supplier is 25 days and orders are sent 30 days in advance, the key performance indicator would be: 25/30 = 0,83333.

Se Figure 34 for a summary of the key performance indicators for measuring potential benefits with the two new key performance indicators added.

Potential benefits by increased supply chain flexibility								
Inventory Levels								
Low	2	3	4	5	6	7	8	High
Incorrect delivery								
Low	2	3	4	5	6	7	8	High
Sales volume								
Low	2	3	4	5	6	7	8	High
Incorrect forecast impact								
Low	2	3	4	5	6	7	8	High
Order window and cycle reaction time								
Low	0,25	0,5	0,75	1	1,25	1,5	1,75	High
Average								

Figure 34: Key performance indicators for measuring potential benefits

6.4 The Final FAIS Roadmap

The refinements above have been done to the preliminary FAIS Roadmap resulting in a final version of the FAIS Roadmap. Since the goal of the developed roadmap was to make it a non-complex tool easy to use, the final FAIS Roadmap is more summarized in its character and presented in Appendix I.

6.5 Recommendations for Axis

It is the authors' belief that the roadmap presented could be used as a tool for Axis in order to further evaluate its supplier base and find suitable approaches towards developing strategies for information sharing with suppliers. The findings during the testing of the preliminary roadmap have already resulted in the development of some specific changes that Axis can make in their supply chain. Furthermore, a number of overall recommendations have been identified that are presented below:

Understand suppliers' real need for information

It was found during the application of the roadmap that some 1st tier suppliers of mechanical components did not receive forecasts from Axis even though the lead times for their sourced components or raw material were longer than the order window given by Axis. Hence, some suppliers had to guess which quantities they needed to source. These suppliers had a need for forecasts. Additionally, they also requested more information about current trends in the market place as well as the estimated market growth. However, Axis was unaware of these needs.

Since only the preliminary roadmap was applied, the segmentation of the suppliers presented in step 4 was not totally correct. A recommendation for Axis is to measure all suppliers found in step 3 with the new key performance indicators, so that suppliers with insufficient information sharing can be found. These suppliers' processes for receiving, processing and sending information should then be mapped according to the roadmap and the questionnaire in the appendices. If it is found that some suppliers do not receive sufficient information, more thorough discussions could be held with these suppliers in order to understand their real need for information.

Simplify and synchronize internal information processes

It was found during the application of the roadmap that some suppliers considered Axis's forecast accuracy to be unsatisfying. This could be a consequence of Axis having a complicated or not synchronized demand planning process. Secondly, some suppliers had problems with the format of the information that Axis sends, which causes problems with the handling of the information. Additionally, suppliers request one information channel at Axis when receiving information regarding component approval. Finally, it was also found during the test that information to suppliers within the same group is not standardized. Therefore, a recommendation for Axis is to evaluate internal information processes so that they are synchronized with suppliers' processes, both in format and in time, as well as simplified and internally synchronized.

Make sure that high quality information is passed on further up the chain

During the application of the roadmap it was found that some 2nd tier suppliers are unpleased with the quality of the information that they receive from 1st tier suppliers. For instance, some 2nd tier suppliers do not receive forecasts from 1st tier suppliers. Axis should therefore continuously evaluate whether 2nd tier suppliers receive high quality information by using the roadmap as a base. If there are any issues, Axis should evaluate why 1st tier suppliers do not send high quality information further by mapping their processes for receiving, processing and sending information as well as underlying incentives. If the 1st tier suppliers do not receive sufficient information from Axis, Axis should satisfy the 1st tier suppliers' real need for information according to previous recommendations. In contrary, if it is found that information is not processed correctly or distorted by the 1st tier supplier, Axis should take the responsibility as a supply chain leader to ensure that 2nd tier suppliers receive high quality information. Axis is a large customer for the 1st tier suppliers and Axis's possibility to influence these suppliers is therefore relatively high.

Since Axis has a close collaboration with the 2nd tier suppliers during the product development phase, it is the authors' belief that problems with information sharing between 1st and 2nd tier suppliers during running volume production in the long run may affect the 2nd tier suppliers' willingness to collaborate with Axis. It is furthermore not recommendable for Axis to send information such as forecasts directly to 2nd tier suppliers at this stage since it will not improve the relationship between 1st and 2nd tier suppliers in the long run and hence the cause of the problems will still be unaddressed. It is unquestionable that the direct sharing of information beyond the closest tier would shorten the time for transmission and administrative lead times. However, it is the authors' belief that the initial focus should be on improving the relations within the supply chain, and enhancing the importance of seeing the supply chain as a whole. When these issues have been addressed, it is still important to continuously evaluate the supply chain to prevent future problems, but the focus could instead be on evaluating how to share information beyond the closest tier in order to further increase the supply chain flexibility.

Benefit from extensive information sharing in early stages of product development

A majority of the participating suppliers did not feel that their knowledge regarding mechanical design or component manufacturability was thoroughly utilized, due to incomplete information from Axis. This caused quality and mounting problems resulting in long lead times, which could be avoided with improved information sharing. It is therefore the authors' belief that the product flexibility in the supply chain could be increased if Axis improved the information sharing with these suppliers during early stages of product development.

Share additional information in order to decrease lead times

As seen in the previous sections, performance metrics are not shared in Axis's supply chain. The authors believe that performance metrics should be developed, measured, and shared among supply chain members of the same supplier group.

For mechanical suppliers, tool lead times and quality performance would be suitable measures. Sharing this information to all mechanical suppliers across the supply chain would make it possible for the suppliers to check their performance and relative standing compared to other suppliers. Using tool lead times as a performance measure would apply pressure on shortening lead times, not only from Axis, but also from competitors.

7 Reflections and Conclusions

In this last section of the thesis, different aspects of the thesis and its content are reflected upon. Firstly, a reflection about the fulfillment of the objectives and purpose will be conducted. Moreover, a critical view of the roadmap will be made and the choice of theory will be discussed. Finally, a presentation of possible further studies as well as recommendations for Axis based on the findings from the study will be concluded.

7.1 Meeting the Objectives

The objectives of this thesis were:

- To develop a roadmap for analyzing the need and possibilities to increase supply chain flexibility by changes in information sharing with suppliers.
- With support of this roadmap, present recommendations aiming at increasing the flexibility in Axis's supply chain by changes in information sharing with suppliers.

Supply chain flexibility as well as information sharing within the supply chain has been studied through an extensive literature study. Furthermore, the link between different information sharing types and supply chain flexibility has been investigated and documented case studies have been reviewed in order to further investigate how supply chain flexibility and information sharing relates. All of these findings were analyzed and functioned as a foundation when developing the FAIS Roadmap. It is the authors' belief that the developed FAIS Roadmap therefore meets the first objective. The final version of the FAIS Roadmap can be found in Appendix I.

This thesis includes a number of recommendations for Axis based on the findings from the test of the preliminary FAIS Roadmap. Therefore, the second objective has been satisfied.

7.2 Fulfilling the Purpose

The purpose of this thesis was *to add to the knowledge on how organizations can increase their supply chain flexibility by changes in the sharing of information with suppliers*. The FAIS Roadmap is a tool that can be used in order to specify what changes that should be made in order to increase the flexibility in a supply chain. Therefore, the authors believe that the purpose has been fulfilled.

7.3 Theory Reflection

Theory on supply chain management has highlighted the importance of looking beyond the firm's boundaries, to other actors in the supply chain.

Theories about supply chain flexibility have contributed to the understanding of the importance of being able to react fast to changes. Supply chain flexibility was divided

into a number of different dimensions. The chosen dimensions may be criticized for looking too much on internal capabilities of a specific firm, and that the supply chain perspective might be lost. Other dimensions of supply chain flexibility focus more on the ability to fast react to changes by being able to, for example, re-configure the supply chain. However, investigating how the sharing of information would affect this type of flexibility was not the purpose of this thesis. The aim was to see how the flexibility in the existing supply chain could be increased by changes in information sharing; therefore these dimensions are seen as suitable.

During the initial theoretical study, many articles about different types of information to share in the supply chain were reviewed, the majority of these articles referred to one single article, Lee & Whang (2000). This article discusses numerous types of information that are, or could be, shared in supply chains. The article was chosen as the foundation for further investigation about information sharing in supply chains.

This theory has enabled the authors to fulfill the overall purpose of this study, namely to add to the knowledge on how organizations can increase their supply chain flexibility by changes in the sharing of information within their supply chain. Hence, the authors do not see any major issues with the chosen theory in this study.

An important part of this thesis has been to provide the academia with a theoretical contribution. Firstly, this has been achieved by investigating how the sharing of different types of information affects different dimensions of supply chain flexibility. Secondly, a roadmap for analysis of the need and possibilities to increase supply chain flexibility through changes in information sharing with suppliers were developed.

7.4 A Critical Look at the FAIS Roadmap

The roadmap was developed from the findings in the conducted theoretical study consisting of supply chain management, supply chain flexibility and information sharing, findings in the initial empirical study at Axis, as well as from a number of documented case studies. Hence, the utilization of these findings ought to ensure the reliability of the roadmap.

With the support of the developed roadmap, the current level of information sharing between Axis and a number of its suppliers could be mapped, changes that would increase the supply chain flexibility could be specified and recommendations to Axis could be developed. Therefore, the authors consider the internal validity of the FAIS Roadmap to be satisfying.

Only the preliminary FAIS Roadmap was tested through a case study. The final roadmap presented in this thesis was not tested. The authors believe that the roadmap needs to be tested on more cases in various contexts to be able to confirm the external validity of the developed roadmap.

The key performance indicators used for segmenting different suppliers within the identified need area are based on theoretical findings, but the measuring of them is primarily based on intuitive measuring and reasoning. This is a consequence of the aim at making the roadmap a non-complex tool easy to use. However, if the roadmap is intended for continuous evaluation, or for a more detailed study, the choice of key performance indicators should be done more precise. For each metric used, the trading partners should agree on factors such as the definition of each measure and how it is calculated, the frequency and time frame for its calculation etcetera, this has not been done in this study.

The FAIS Roadmap was developed using an abductive method, i.e. the authors moved between the theoretical and empirical world in order to develop the roadmap. The use of an inductive method alone would have required more objects of study in order to produce reliable empirics, but if achieved, the approach could probably have provided a higher external validity to the developed roadmap. On the other hand, since the research on supply chain flexibility to some extent remains in its infancy, it is most realistic to believe that so does the knowledge of it in practice. Thus, overlooking the current theoretical knowledge within the field of supply chain flexibility ought to be seen as imprudent.

7.5 Generalizability

During the study the focus was on one company, the focal organization, and its supply chain. As stated above, findings from the initial empirical study at the focal organization has influenced the development of the roadmap. However, the goal of the developed roadmap was to make it applicable on other organizations. The four studied companies in the supply chain consisted of both 1st and 2nd tier suppliers within different industries, from suppliers of die-casted aluminum components, to manufacturers of printed circuit boards. The companies examined in the focal organizations supply chain have demonstrated that the roadmap is applicable in different industries.

Organizations working under industry characteristics that accentuate the need for the same flexibility dimensions as the studied focal organization, should, without additional customization, be able to apply the developed roadmap and use the test presented in this thesis as a reference of how to use the FAIS Roadmap. Additionally, the authors have emphasized towards providing a detailed case description in order to further simplify the ability for other organizations to replicate the conducted study. For companies working under different industry characteristics, the roadmap can be used, but using the results from this study as a reference can be more difficult, since different industry characteristics emphasize different flexibility dimensions.

If the roadmap is to be used by organizations in other positions in a supply chain, e.g. a reseller receiving goods from an upstream distributor, the roadmap may need some adjustments. Questions regarding e.g. the sharing of production schedules from distributors ought to be seen as irrelevant since distributors, by definition, do not produce.

For the roadmap to be applicable on companies working in businesses where the supply chain structure differs from that of a manufacturing company, the roadmap needs to be developed further. Even though the chosen flexibility dimensions might be appropriate, the different types of shared information within a supply chain presented in this thesis are probably to some extent irrelevant. However, it is the authors' belief that the frame for the roadmap, the logical structure, is in itself robust enough to be adjusted to other aspects regarding information sharing. This is also the case if the roadmap is to be applied on downstream trading partners. The initial steps regarding the need for flexibility can be unaltered. However, the segmentation of downstream trading partners must be based on other criteria than component uniqueness or supply lead times.

The FAIS Roadmap could be seen as a good start for managers trying to develop strategies for information sharing with different groups of suppliers within their supply chain.

7.6 Suggestions for Further Research

Regarding the developed roadmap, one improvement to the FAIS Roadmap would be to add steps investigating downstream supply chain trading partners. This would enable for the focal unit to get a more comprehensive understanding of the needs and improvement potentials for the supply chain as a whole. This was unfortunately beyond the scope of this study.

Regarding the key performance indicators developed for the roadmap, they all have the same impact on the potential benefits by increased supply chain flexibility and the willingness and ability to share information. It is the authors' belief that one improvement that would be most interesting is to determine these key performance indicators relative impacts, and therefore develop some sort of weighting for these measures.

During the writing of this thesis, the authors found that cultural difference and different supply chain member's underlying incentives truly affects the sharing of information. However, it was found that trying to investigate these aspects would be too big of a challenge, and beyond the scope of this thesis. Therefore, these aspects have been brought up in this study, but only in brief. Further development of the FAIS roadmap could take these aspects into account.

Regarding the theory used in this thesis, there are areas where the authors believe that the literature in some cases is insufficient. For example, a generic definition of the term supply chain flexibility has not been found. Different authors divide the term into different dimensions. Additionally, it was found that more studies investigating the link between information sharing and different dimensions of supply chain flexibility needs to be performed, since there is a lack of literature regarding this subject. This thesis provides a brief investigation in this issue, but further studies are necessary.

7.7 Recommendations for Axis

As concluded in section 6.5, five overall recommendations for Axis have been developed, which are presented below:

- Understand suppliers' real need for information
- Simplify and synchronize internal information processes
- Make sure that high quality information is passed on further up the chain
- Benefit from extensive information sharing in early stages of product development
- Share additional information in order to decrease lead times

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Supplier A
Customer Account Manager, 2009-03-02
Purchase and Logistics Manager, 2009-03-02

Supplier B
Managing Director, 2009-03-19
Production Engineering, 2009-03-19

Supplier C
Manager for Program Management, 2009-04-01—2009-04-03
Senior Manager for Program Management, 2009-04-01—2009-04-03
Assistant Manager for Program Management, 2009-04-01—2009-04-03
Global Supply Manager, 2009-04-01—2009-04-03
Sales Manager, 2009-04-01—2009-04-03

Supplier D
Senior Project Engineer, 2009-03-30
Project Specialist, 2009-03-30
Materials Specialist, 2009-03-30
Materials Planner, 2009-03-30

Supplier E
General Manager, 2009-03-24
Sales Executive, 2009-03-24
Sales Representative, 2009-03-24

Supplier F
Marketing Director, 2009-03-25

Appendices

Appendix I: The final FAIS Roadmap

The FAIS Roadmap is a roadmap for increasing supply chain flexibility by changes in information sharing, see Figure I: 1 for an overview of the roadmap.

Step 1: Specify the focal unit

The supply chain is seen from the point of view of a certain focal unit in the chain. This focal unit could for instance be an organization, a specific unit or a department. This roadmap is intended to improve information sharing between that focal unit and other external links in the supply chain. The focal unit should be responsible for driving the changes and therefore the focal unit needs to be specified.

Step 2: Estimate the general need for supply chain flexibility

When the focal unit is specified, the next step is to analyze if any of the flexibility dimension (product mix -, volume -, product - or delivery flexibility) is desirable. Then one should also determine which one or which ones that are more preferable than the others. The link between specific industry characteristics and different supply chain flexibility dimensions can be used as a base for the estimation, see Table I: 1.

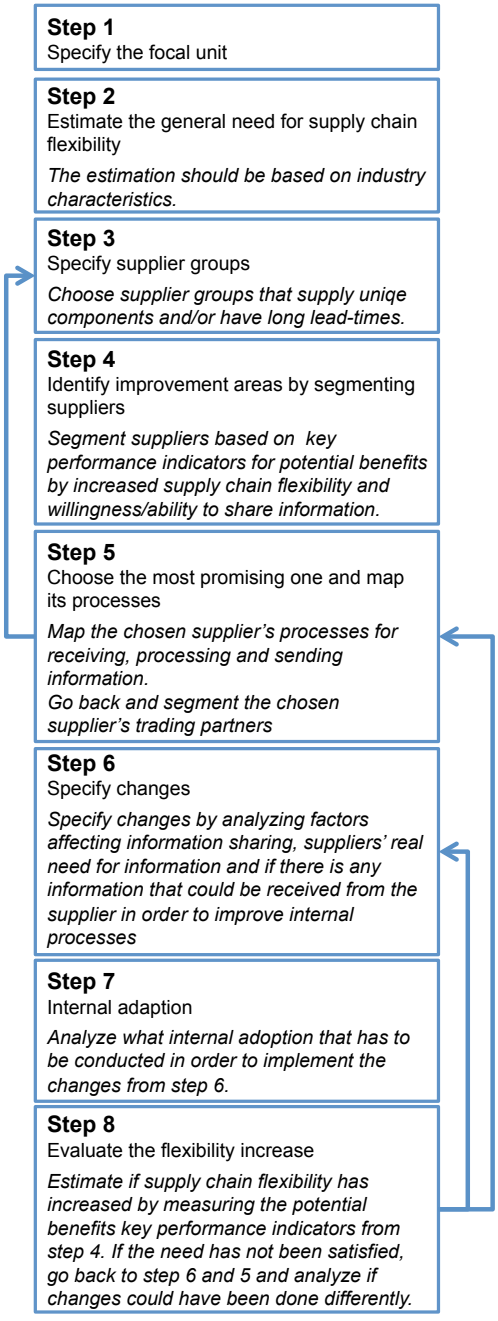

Figure I: 1: The FAIS roadmap

Table I: 1: Example of industry characteristics and flexibility dimensions

Industry characteristics	Flexibility dimension
Fast pace of new product introduction	Product flexibility
Short product life cycles	Product flexibility
High product variety	Product Mix flexibility
Short customer order lead times	Delivery flexibility
High overall demand fluctuation	Volume flexibility

Step 3: Specify supplier groups

It is very complex and time-consuming to improve information sharing with all suppliers. Therefore, a group of suppliers where improved information sharing ought to have high impact on supply chain flexibility needs to be specified.

The supply chain groups where supply chain flexibility is needed can be chosen based on factors such as supply lead times and products or components uniqueness. When evaluating supplier lead times and products or components uniqueness, an intuitive reasoning about the supply chain as a whole is preferable rather than specific measurements. In order to analyze these factors correctly, one should therefore have a comprehensive understanding of the supply chain as a whole.

Step 4: Identify improvement areas by segmenting suppliers

Once specific groups of suppliers are selected, these suppliers should be evaluated in order to see with whom to start improve information sharing. The segmentation is based on evaluating each trading partner within the in step 3 identified groups from two perspectives: *Potential benefits* that can be obtained from increased supply chain flexibility through improved information sharing and the *willingness and ability* of the trading partner to share information. In order to make the process of mapping the different trading partners efficient, the measures can be plotted on a scale from to low to high in comparison to each other.

Key performance indicators for measuring potential benefits

The intention with the key performance indicators is to measure each specific supplier, found in the in step 3 identified supplier groups, in order to in detail find where there are potential benefits by increased supply chain flexibility. Below are the different key performance indicators presented and summarized in Figure I: 2.

Inventory levels

Inventory levels are a good measure for determining the degree of achieved flexibility in the supply chain. In absence of shortages, low inventory levels throughout the chain can in some cases be seen as an effect of high flexibility and thereby satisfied

degree of information sharing. The measure should be based on inventory levels in relation to sales.

Incorrect delivery
Estimate the supplier's rate of deliveries that are incorrect compared to other suppliers. Incorrect deliveries means that a supplier do not deliver goods as agreed, in terms of time, quantity and quality. Is the rate of incorrect deliveries high or low?

Sales Volume
Sales volume is an important measure, since improved flexibility within a relation with a large supplier of for instance scarce components ought to have greater impact on the total flexibility for the whole supply chain than improved information sharing with a smaller supplier of scarce components.

Incorrect forecast impact
The impact of incorrect forecasts can vary a lot between different suppliers and depends on to what extent suppliers use forecasts when sourcing products, components or services. High forecast accuracy from the focal company to its suppliers ought to be seen as primary in order to achieve supply chain flexibility. Inaccurate forecasts can result in higher inventory levels, long lead times, followed by out of stock scenarios and disbelief towards the focal company. Incorrect forecast impact is measured from the supplier's point of view where the supplier estimates how much of its material that is sourced according to forecasts.

Order window and cycle reaction time
This key performance indicator should measure the cycle reaction time for a supplier divided by the order window. The cycle reaction time is the average time it takes for a supplier to source and produce according to an order. The order window is the time between the order is placed and the expected delivery date. Sometimes the cycle reaction time is shorter than the order window. This would have resulted in a key performance indicator smaller than 1, e.g. if the cycle reaction time for a supplier is 25 days and orders are sent 30 days in advance, the key performance indicator would be: 25/30 = 0,83333.

Potential benefits by increased supply chain flexibility								
Inventory Levels								
Low	2	3	4	5	6	7	8	High
Incorrect delivery								
Low	2	3	4	5	6	7	8	High
Sales volume								
Low	2	3	4	5	6	7	8	High
Incorrect forecast impact								
Low	2	3	4	5	6	7	8	High
Order window and cycle reaction time								
Low	0,25	0,5	0,75	1	1,25	1,5	1,75	High
Average								

Figure I: 2: Key performance indicators for measuring potential benefits

Key performance indicators for measuring the willingness and ability to share information

The willingness and ability for trading partners to share information has great effect on the possibilities to increase the level of flexibility in the supply chain. Low willingness or ability to share information can result in low supply chain flexibility. The key performance indicators for measuring the willingness and ability to share information can in most cases not be measured by hard facts. Hence, an estimation should be done by the focal unit. Below are the key performance indicators for measuring the willingness and ability to share information presented and then summarized in Figure I: 3.

Openness and trust

Openness and trust is very important in a supply chain relationship because the trading partner and the focal company must be willing to share sensitive information in order to increase flexibility in the supply chain.

Grade of complementary abilities

Complementary abilities can also affect supply chain flexibility. If one trading partner has knowledge related to the manufacturability of products, the focal unit can benefit from collaborating with that trading partner and vice versa.

Capabilities to use existing and new information

The trading partner should also have dedicated resources for analyzing data, e.g. forecast accuracy and inventory levels.

Trading partner's collaborative initiatives

If the trading partner has conducted collaborative initiatives with the focal unit or other trading partners earlier, the implementation of changes in information sharing will probably be easier.

Willingness and ability to share information								
Openness and trust								
The trading partner see relationship from a win/lose perspective and do not share information if it is not strictly necessary.			In some cases the trading partner tried to collaborate with us by sharing knowledge and/or data.			The trading partner see collaboration as a way to optimize the supply chain. They have regularly collaborated openly to resolve any exceptions .		
Low	2	3	4	5	6	7	8	High
Complementary abilities								
The trading partner has very limited knowledge or information related to the manufacturing of our products that could provide us with added value.			The trading partner is able to provide us with some information about our products and their manufacturability.			The trading partner has very good knowledge about our products that may be of interest to us.		
Low	2	3	4	5	6	7	8	High
Capabilities to use existing and additional information								
The trading partner do not rely on information or have dedicated resources to analyze it.			The trading partner work with analyzing some information, such as forecasts and inventory levels. Some data is sent further to us.			The trading partner has dedicated resources for analyzing a wide range of data.		
Low	2	3	4	5	6	7	8	High
Trading partner's collaborative initiatives								
The trading partner do not have any collaborative initiatives with you or with other companies.			The trading partner have collaborative initiatives with other companies, such as VMI or CPFR.			The trading partner already have collaborative initiatives with you, such as VMI or CPFR.		
Low	2	3	4	5	6	7	8	High
Average								

Figure I: 3: Key performance indicators for evaluating willingness and ability

Mapping the results

In order to map the results from the evaluation of the different suppliers, the suppliers can be plotted in the matrix in Figure I: 4. The plotting should be based on the scores from the measurements conducted above.

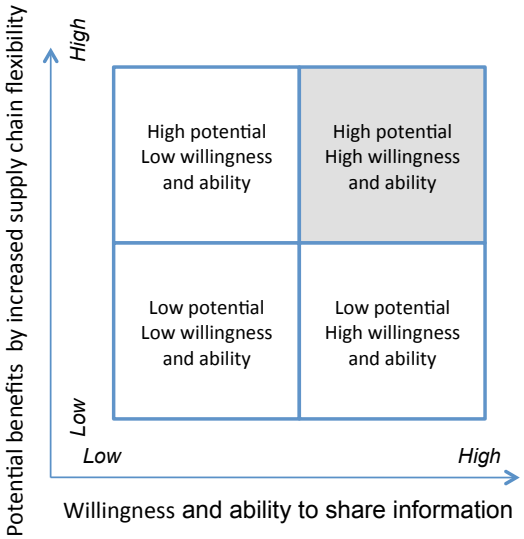

Figure I: 4: Segmentation matrix

In the upper right corner of the segmentation matrix, changes in information sharing has great effect on supply chain flexibility, and implementations are relatively easy since trading partners' willingness and ability to implement changes in information sharing are high.

In the lower right corner, changes in information sharing would probably strengthen the relationship with the trading partner, since the trading partner has a high willingness to share information. However, since the potential benefits are low, the flexibility within this relation ought to be seen as sufficient.

In the upper left corner, changes in information sharing have great impact on supply chain flexibility. However, the implementations of changes are relatively complex since the trading partner might not have sufficient abilities or the willingness needed to implement changes in information sharing.

In the lower left corner of the segmentation matrix, changes in information sharing has low overall impact on supply chain flexibility and trading partners might not have sufficient abilities or the willingness needed to implement changes in information sharing. Therefore changes in information sharing with trading partners located in this corner are a waste of resources.

Step 5: Choose the most promising one and map its processes

When the different suppliers have been plotted in the matrix, the supplier with the highest potential benefit and willingness and ability to share information should be chosen for further advancement.

Mapping of processes and factors affecting information sharing for the chosen supplier

The supplier's processes for receiving, processing and sending information should then be mapped. The questionnaire in appendix II could be used when mapping these processes. The questionnaire includes some questions regarding factors affecting information sharing, such as information quality, e.g. if the information is timely, in the right format, and if any additional information is needed. The questionnaire also considers the technology used by the supplier. Other factors, such as finance, culture and other underlying reasons for not sharing information are hard to understand and a questionnaire is not recommended as an only tool for analyzing these issues, since questionnaires are not very deep in their character. All factors should be discussed during for example an interview with the supplier where the questionnaire could be used as a base.

Improved information sharing, and hence supply chain flexibility, is only possible if the quality of the information shared is sufficient. It is therefore crucial to analyze the factors affecting trading partners' willingness and abilities to share high quality information and their collaborative incentives. This was to some extent considered in the previous step, but could also be more thoroughly analyzed during interviews. It is also important to map what commitments that some information sharing comes with, for example if there are commitments with forecast accuracy. Because in many cases, that affects the way the receiver uses the information.

Mapping of processes and factors affecting information sharing for the chosen supplier's trading partners

When this is done with the chosen supplier, an additional mapping should be done with a few of that supplier's trading partners that are part of the focal unit's supply chain. The choice of these additional trading partners should be based on the same process as for the initial supplier; therefore one must go back to step 3 and 4 in order to segment the supplier's trading partners.

Step 6: Specify changes

When the mapping of the supplier's processes is conducted, the results need to be analyzed. This is done in order to specify changes in information sharing that can satisfy the estimated need for supply chain flexibility found in step 2. When analyzing the results, the following areas should be covered:

- Analyze the mapped factors that affect information sharing with the supplier
- Analyze the supplier's real need for information
- Analyze if there is any additionally information that could be received from the supplier in order to improve internal processes

Structure the findings and discuss in collaboration with the supplier what changes that needs to be conducted.

Step 7: Internal adaption

When changes in information sharing are set in collaboration with the supplier, analyze what internal adaption that needs to be conducted in order to implement the changes.

The focal unit should consider if any changes are necessary in their processes for receiving, processing and sending information in order to implement the specified changes from step 5. Before analyzing, it is important to have a comprehensive understanding of the internal processes for receiving, processing and sending information. If one does not understand the current processes, the changes will be much harder to implement. If changes in internal processes are preferable, the focal unit needs to consider the costs of the changes compared to the perceived increased supply chain flexibility. Another issue that should be regarded is what factors and underlying incentives that affect the internal processes. A good idea could be to have discussions with concerned employees regarding the changes and get their point of view. To change internal processes is not always easy. One must make sure that the employees understand why changes are implemented and how their work will be affected.

Step 8: Evaluate the flexibility increase

Measure the potential benefits key performance indicators from step 4 once again in order to estimate the new potential benefits by increased supply chain flexibility. If the new potential benefits are lower, the need for increased supply chain flexibility is lower as well, e.g. if the supplier now is located in the lower right corner of the segmentation matrix the flexibility within this relation ought to be seen as sufficient.

In contrary, if there is still a need for increased supply chain flexibility, the focal unit should go back to step 5 and analyze what could have been done differently and make required changes. For instance, the focal unit might need to analyze factors affecting information sharing once again to make sure that all factors have been considered. If changes are implemented, but not enough, the focal unit should go back to step 4 and analyze if the measurements have been done correctly and if they could have been conducted differently.

Appendix II: Questionnaire

Do You receive:	Yes	No	N/A
Material Authorizations	☐	☐	☐
Inventory level information	☐	☐	☐
Purchase Orders	☐	☐	☐
Free Capacity Information	☐	☐	☐
Quality data	☐	☐	☐
Delivery schedules	☐	☐	☐
Production schedules	☐	☐	☐
Lead-time information	☐	☐	☐
Information about Quening delays	☐	☐	☐
Forecasts	☐	☐	☐

What information do you receive from us regarding new products?

	Yes	No	N/A
Drawings	☐	☐	☐
Bill of material	☐	☐	☐
Approved suppliers and manufacturers	☐	☐	☐
Project lead-time	☐	☐	☐
Dates when parts will be approved	☐	☐	☐
Forecasted demand	☐	☐	☐

Is information regarding new products timely?

_____

_____

_____

_____

Is there any information that you do not receive today that you would like to receive?

_____

_____

_____

_____

_____

_____

_____

How often do you in average receive information from us about:

	Daily	Weekly	Monthly	N/A
Material Authorizations	☐	☐	☐	☐
Inventory level information	☐	☐	☐	☐
Purchase Orders	☐	☐	☐	☐
Free Capacity Information	☐	☐	☐	☐
Quality data	☐	☐	☐	☐
Delivery schedules	☐	☐	☐	☐
Production schedules	☐	☐	☐	☐
Lead-time information	☐	☐	☐	☐
Information about Quening delays	☐	☐	☐	☐
Forecasts	☐	☐	☐	☐

Is this information timely?

_____

_____

_____

_____

How do you receive information from us about:

	E-mail	Tele	Meeting	EDI	N/A
Material Authorizations	☐	☐	☐	☐	☐
Inventory level information	☐	☐	☐	☐	☐
Purchase Orders	☐	☐	☐	☐	☐
Free Capacity Information	☐	☐	☐	☐	☐
Quality data	☐	☐	☐	☐	☐
Delivery schedules	☐	☐	☐	☐	☐
Production schedules	☐	☐	☐	☐	☐
Lead-time information	☐	☐	☐	☐	☐
Information about Quening delays	☐	☐	☐	☐	☐
Forecasts	☐	☐	☐	☐	☐

Would You like to receive information in another format?
(E.g. Computerized system, PDF, Excel, Database, Mail, Telephone, Meetings, etc)

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Do you work with any Inventory Cooperation such as VMI, VMR etc?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

What do your processes for receiving, processing and sending information look like?

Receiving:

Processing:

Sending:

Do you use any business system? (If Yes, which?)

Is there any information that you receive that you do not have use for?

_____
_____
_____
_____
_____
_____
_____

Do you send any information further to suppliers?	Yes	No	N/A
Material Authorizations	☐	☐	☐
Inventory level information	☐	☐	☐
Purchase Orders	☐	☐	☐
Free Capacity Information	☐	☐	☐
Quality data	☐	☐	☐
Delivery schedules	☐	☐	☐
Production schedules	☐	☐	☐
Lead-time information	☐	☐	☐
Information about Quening delays	☐	☐	☐
Forecasts	☐	☐	☐