Digitalisation of sourcing processes

– A case study at Axis Communications AB

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Elaine Nilsson and Josefine Westberg

Abstract

Title: Digitalisation of sourcing processes – A case study at Axis Communications

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Background: Axis Communications AB is a global network surveillance company based in Lund, Sweden. Axis assemble and store some components and products in their own facilities, however manufacturing is handled by contract manufacturers. It is Axis sourcing department that are responsible for establishing and maintaining relationships with these contract manufacturers, as well as suppliers. The sourcing department is currently working towards world class commodity management, which is a strategic approach to maximise the supplier's contribution and drive development of the company. One step towards reaching world class commodity management is to increase efficiency. This can be accomplished by integrating digital technologies such as Big Data analytics and cloud storage within processes. Digitalisation can improve procurement results through reduced costs and increased efficiency and transparency.

Problem formulation: In order to maintain supplier relationships and optimize the supplier database many processes and tasks are performed. Some of these activities include non-value adding and time-consuming work. These activities will be identified, and possible digitalisation technologies investigated, with the aim of increasing efficiency and effectiveness. The thesis is finalised with an investigation of implementation possibilities, including how easy the technologies will be to implement and their impact.

Purpose: The purpose of this study is to investigate the current sourcing processes at Axis Communications AB in order to identify digitalisation opportunities, digitalisation technologies and their impact and implementation effort.

Methodology: Initially a combination of descriptive and exploratory research purpose was used to identify problems, thereafter the study became problem solving in order to find a solution for these problems. The approach throughout the thesis was primarily qualitative, however quantitative data was used to strengthen some findings. Firstly, a literature review on sourcing, digitalisation and process change was conducted. A single case study was then performed. Interviews were held with employees at Axis in order to get an understanding of the current sourcing processes. A small-scale survey was performed to ensure the validity of the interviews and to analyse the identified processes. Data on systems and technologies were gathered through system providers and documents. The empirical data was then analysed with models and frameworks from the literature review.

Conclusion: The result of the thesis lay a foundation for future digitalisation within the company. Digitalisation technologies and systems were found for several sourcing processes, with the aim to increase efficiency. Each process and the suitable technology were divided into projects, which were analysed based on impact and ease of implementation. Based on this a course of action for further investigation was recommended. Digitalising the identified processes will eliminate the non-value adding work currently spent on them and facilitate strategic decision making.

Keywords: *Sourcing, digitisation, digitalisation, digital sourcing, sourcing technologies, Axis Communications AB*

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Abbreviations

AI - Artificial intelligence

ANSI – American national standards institute

ASL – Article status list

BOM – Bill of materials

BPM – Business process management

BPMN – Business process modelling notation

BPR – Business process reengineering

CLC – Configuration and logistics centre

CB – Commodity buyer

CE – Component engineer

CM – Commodity manager

COGS - Cost of goods sold

ECM - Enterprise contract management

EDI – Electronic data interchange

EMS – Electronic manufacturing service

EOL – End-of-life

eRA – Electronic reverse auctions

eRFX – Electronic request for information/proposal/quotation

ERP – Enterprise resource planning

HPDP – Hardware product development process

IaaS – Infrastructure as a Service

ICT – Information and communication technology

IoT – Internet of Things

KPI – Key performance indicator

MOQ – Minimum order quantity

NDA – Non-disclosure agreement

NPD – New product development

PaaS – Platform as a Service

PDM - Product data management

PLM - Product lifecycle management

PP – Project purchaser

RFI – Request of information

RFP – Request for proposal

RFQ – Request of quotation

RMA – Return material authorization

RPA – Robotic process automation

R&D – Research and development

SaaS – Software as a Service

SE – Sourcing engineer

SM – Sourcing manager

SPDP - Sourced product development process

SRM – Supplier relationship management

1. Introduction

This chapter firstly describes the background of the thesis. A presentation of the case company is provided. Furthermore, the project description, research purpose and research questions are described. This is followed by focus and delimitations. Lastly, the outline of the report is presented.

1.1 Background

Procurement have increasingly taken a strategic role in supply chain management, since an efficient and effective procurement process can have a substantial impact on company results (Johnsen et al., 2014, van Weele, 2014). The procurement function connects actors in the supply chain and is responsible for the satisfaction and management of supplier quality. Well managed relationships with suppliers will result in quality supplies, thereby impacting the quality of the final product. Purchased parts and services are a large part of the total cost, which means that supplier relationships are crucial for both financial results and competitive position (Novack and Simco, 1991, van Weele, 2014). The procurement process spans over both interorganisational and intraorganizational boundaries, it thereby requires coordination and large amounts of information in order to be effective. Achieving an efficient and effective procurement process is therefore complex (Novack and Simco, 1991).

The efficiency within procurement functions can be increased by involving more digitalisation. The term digitalisation can be defined as the usage of digital technologies and an integration of different models and processes (Srai and Lorentz, 2019). Digitalisation thereby focuses on improving and reconstructing business processes, operations and other activities (Savić, 2020). Digital technologies can be specified into technologies such as Big Data analytics, Internet of Things, cloud storage and social media (Srai and Lorentz, 2019). The usage of digital technologies also comes with several other benefits, such as reduced costs, improved data storage and transparency. Despite these advantages, a study within the procurement division of 200 of UKs largest industry sectors shows a low occurrence of digitalization within procurement and many tasks are still done manually (Seyedghorban et al., 2020).

The revolution of Industry 4.0 contributes to the relevance of digitalisation. Industry 4.0 can be described as the fourth industrial revolution and thereby new methods to manage supply chains and product lifecycles. This includes the development and usage of different technologies, for example, Big Data analytics, Internet of Things and other systems. Industry 4.0 is not initiated or dependent on one specific technology, but instead the interaction between multiple technologies (Glas and Kleemann, 2016). It integrates humans, systems and machinery and can bring improvements in supply chain management (Fatorachian and Kazemi, 2021). As previously mentioned, these new technologies are not fully implemented within procurement yet (Seyedghorban et al., 2020).

Therefore, there is a need for more contextual research regarding digitalisation within procurement processes. Especially parameters to identify processes feasible for digitalisation and ease of implementation. This is also in line with the Swedish governments research and innovation propositions, where digitalisation is classed as one of five challenges for society (Regeringskansliet, 2020).

1.2 Axis Communications AB

Axis Communications AB, hereby referred to as Axis, uses network technology to connect devices, so called network solutions. It all started in Lund 1984 with print servers and have evolved into video, audio and access control solutions. Axis evolution started in 1996 with the world's first network camera which was primarily used in the security market (Axis communications, 2021b). However, with new technology and innovation Axis products are now used in a wide range of industries and applications. Some being retail, transportation, education, people counting, license plate recognition and sound detection (Axis communications, 2021c). 2015 Canon became a majority owner, however Axis still operates as an independent company and the HQ have remained in Lund. These factors have taken Axis from a small company to a global one, present in more than 50 countries with more than 3 600 employees (Axis communications, 2021a).

Axis has a global supply chain, the different entities and functions involved can be seen in Figure 1.1. Axis works with contract manufacturers, EMSs, which their component suppliers are connected to. The EMSs mainly purchases components directly from the component suppliers. Axis has their own Configure and Logistics Centres, CLCs, where some components are kept in stock. Furthermore, components which are found critical can be bought by Axis and stored at the CLCs, and then sold back to an EMS if needed. Some products are also assembled at the CLCs. The products are not sold directly to the end users by Axis. Instead, they work with distributors and resellers who are responsible for delivery to the end users. Lastly, Axis is working with Return material authorization partners, RMA, which are responsible for returns and repairs (Axis employee, 2020, personal meeting 11/12).

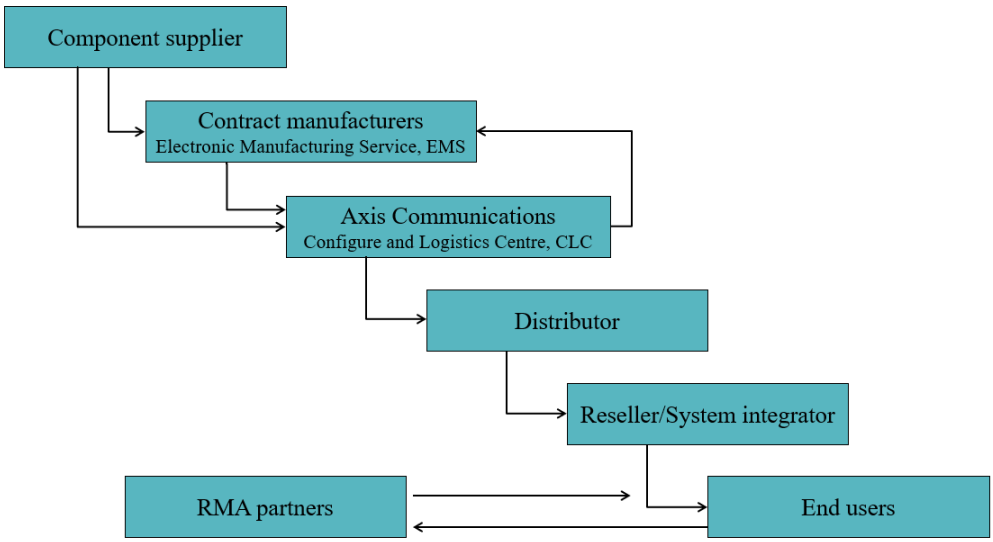

Figure 1.1.Axis supply chain

The sourcing department at Axis are responsible for finding suppliers and maintaining supplier relationships. The sourcing department's goal is reaching world class commodity management, which is a strategic approach to maximise the supplier's contribution and drive development of the company. The supplier base should be optimised to fulfil Axis goals regarding factors such as quality, cost, risk and sustainability (Axis employee, 2021, personal meeting 10/2).

1.3 Project description

The goal of reaching world class commodity management includes several processes to maintain supplier relationships and optimize the supplier database. Some of these activities include non-value adding and time-consuming work. To make work at the sourcing department more effective, new technologies to perform these activities are needed. This is also made clear by the sourcing departments goal to automate 70% of 2019s manual work until 2024 (Axis employee, 2020, personal meeting 11/12).

The project will therefore identify non-value adding activities and find digitalisation opportunities for these. Firstly, the internal processes at the Axis sourcing department will be investigated in order to understand their current work procedures. The processes will be analysed to find opportunities for digitalisation, with the aim of increasing efficiency. The research will further investigate which technologies that could be implemented for these processes. The project is finalised with an investigation of implementation possibilities, including how easy they will be to implement and their impact.

1.4 Research purpose

The purpose of this study is to investigate the current sourcing processes at Axis Communications AB in order to identify digitalisation opportunities, digitalisation technologies and their impact and implementation effort.

1.5 Research questions

Based on the purpose, the following research questions were formulated:

RQ1: How are the current sourcing processes structured at Axis Communications AB?

RQ2: Which sourcing processes can be digitalised and what technologies could be used in order to increase efficiency at Axis Communications AB?

RQ3: How easy would the identified technologies be to implement and what impact would they have on Axis Communications AB?

1.6 Focus and delimitations

The focus area of this study is investigation of the processes at Axis sourcing department, with the aim of finding digitalisation opportunities. Due to the time limit, the research only focuses on internal processes within Axis and interviews was therefore not held with external suppliers. Additionally, the research focuses on processes with no ongoing development projects. This was due to the time limit and in order to avoid duplication of effort and resources.

The study does not focus on comparing different systems and system providers. Instead, the research compares the opportunities for digitalisation and what type of system that could be implemented. No implementation plans will be made, the aim is rather to describe different alternatives.

1.7 Report outline

The thesis consists of six chapters which are briefly described below to provide an overview of the thesis.

Chapter 1: Introduction

This chapter introduces a background on digitalisation within sourcing as well as the company, Axis Communications AB. The background is followed by the problem formulation, research purpose, research questions as well as the focus and delimitations.

Chapter 2: Methodology

This chapter addresses the methodology and research method used for the thesis. Firstly, the research purpose and research approaches are presented. The research method is then described and motivated. Finally, different data collection methods and research quality are discussed. The aim of the chapter is to provide an overview of the thesis structure.

Chapter 3: Literature review

This chapter describes theoretical findings on sourcing and digitalisation based on a literature review. Firstly, a background of digitalisation and sourcing is presented. This is followed by a description of sourcing and strategic sourcing. Digitalisation opportunities within sourcing are described and lastly, process change, and process mapping are explained.

Chapter 4: Empirical data

This chapter describes the empirical data for the thesis. Firstly, the sourcing department, their internal processes, their current information systems and ongoing projects are described. This is followed by a description of the identified processes that could benefit from being digitalised and the results from the survey. Lastly, technologies and systems that could be used to increase efficiency in the identified processes are presented.

Chapter 5: Analysis

This chapter presents the analysis of the identified processes and the related technology. Firstly, all identified digitalisation opportunities are analysed based on impact and implementation. The chapter is summarised by categorising the processes with models from the literature review.

Chapter 6: Conclusion

The last chapter describes the conclusion of the thesis. Firstly, the research questions are answered, and a recommendation is presented. This is followed by describing the thesis contribution and limitations. Lastly, future research is discussed.

2. Methodology

The methodology chapter describes the research method for the thesis. Firstly, research approaches are presented and followed by a description of research methods. Furthermore, the methodology for the thesis is described and motivated. A description of case study and research data are presented. Lastly, research quality is discussed.

2.1 Research purpose

Methodology defines the principles and framework for how to undertake a research project. The methodology should be selected based on the character and aim of the research. Depending on the aim of the project the research purpose differs, see Table 2.1.

Table 2.1 Different research purposes and their explanation (Höst et al., 2006).

Purpose	Explanation
Descriptive	Investigate and *describe* how a phenomenon work or is performed.
Exploratory	The aim is to *thoroughly understand* how a phenomenon work or is performed.
Explanatory	Seek *casual links and explanations* on how a phenomenon work or is performed.
Problem solving	Aims to *find a solution* for an identified problem.

In practise the elements influencing the choice of research purpose can be more complex. It can therefore be difficult to limit the research to one specific purpose. In that case a combination might be a more realistic procedure (Höst et al., 2006).

This project will research the possibilities for digitalisation within procurement processes at Axis. The research also investigates which technologies could be applied to digitalise the processes. A combination of purposes where therefore used. Initially a descriptive and exploratory purpose was used to identify problems and problem solving were thereafter used to find a solution for these problems, see figure 2.1.

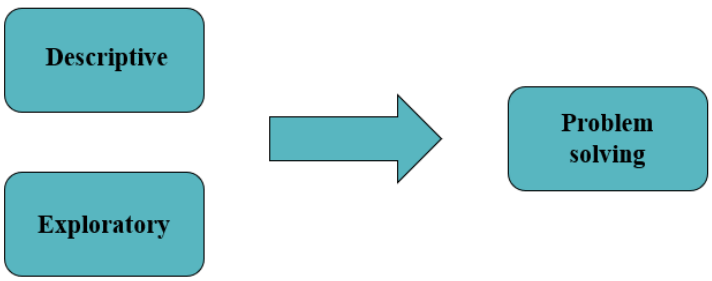

Figure 2.1 The research purposes used throughout the project (Source: own).

2.2 Research approach

There are two different research approaches, a qualitative inductive approach and a quantitative deductive approach. The characteristics of quantitative and qualitative as well as the two research approaches are described below.

2.2.1 Quantitative and qualitative approach

Methods or data can either be quantitative or qualitative. The purpose of quantitative research is to apply findings and conclusions outside the context of the project. Conclusions are drawn from data collection and statistical analysis, which results in a broad view (Borrego et al., 2009, Kotzab et al., 2005). Qualitative research focuses on the context within which the project takes place. Textual data is collected and analysed, which leads to a detailed, narrow view (Kotzab et al., 2005). Numbers can be used to summarise quantitative data, while qualitative data requires contextual descriptions (Borrego et al., 2009).

Interviews and internal documents were used to map the current sourcing processes at Axis. Therefore, the primary approach in this project is the qualitative one. A survey was performed to strengthen the received information by collecting quantitative data. Documents, websites and personal communication were used to identify relevant digitalisation technologies and systems.

2.2.2 The balanced approach

Two research approaches are the inductive and deductive. The inductive approach is usually qualitative, and the deductive approach is quantitative. The choice of approach is dependent on the type of phenomenon, which is the question or topic that is being studied. These approaches can be described in two different paths, see Figure 2.2 The two approaches can be used together as a balanced approach, by alternating between the different paths and steps (Kotzab et al., 2005).

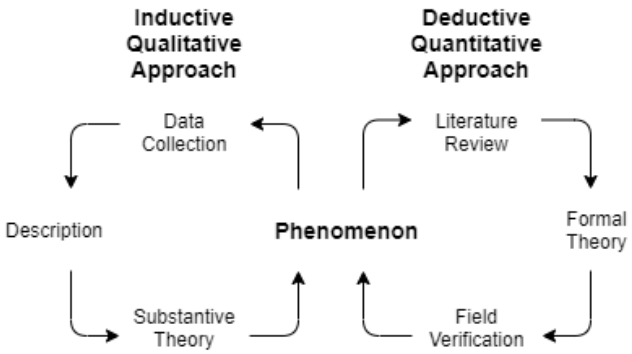

Figure 2.2 The balanced approach (Kotzab et al., 2006).

The aim of the inductive path is to learn about the phenomenon on its own. The inductive path starts with data collection, which is done to get an understanding of the phenomenon. The data is usually collected by observing the phenomenon. Literature is not a step on its own, it is integrated in various steps of the inductive approach. The second step is the description phase, which describes the phenomenon from the informants' point of view. Information is gathered

through quantitative data such as interviews, observations and documents. The information is gathered to get a thorough description of the phenomenon. The third step is substantive theory, whereby the data is analysed to build up a theory. The analysis is firstly narrow to subsequently become more general. This is the last step in the circle, by going through these steps, a deeper understanding of the phenomenon is reached (Kotzab et al., 2005).

The goal of the deductive path is to gather knowledge about the phenomenon by explanatory theory. The first step is to review literature in order to obtain a framework with relevant perspectives and understand how they relate to each other. After the literature review, the next step is to build a formal theory. This involves building general theories about the phenomenon. A hypothesis is generated from the theory in order to answer research questions. The last step is the field verification, which includes collection of data through experiments or field surveys. The purpose of this step is to test the hypothesis and verify the formal theory. A broader understanding of the phenomenon is achieved by fulfilling the deductive path (Kotzab et al., 2005).

The balanced approach can also be described as an abductive research process. The abductive research process is an iterative process which alternates between the inductive and deductive research approach. Moreover, it is an overlap of finding theory and the data collection, and is said to be an analysis from consequences to explanation. Another notation is that collecting quantitative data does not have to generate in a quantitative data analysis. For example, if open-ended questions are added in a survey, it can be explained as a qualitative approach. It is the technique of the data analysis which determines if the research method is quantitative or qualitative (Spens and Kovács, 2006).

This project follows a balanced approach. The inductive path is used for data collection through interviews and a survey. Additional data will be gathered through the literature review, internal documents and system providers.

2.3 Research methods

Following a relevant and well-planned research methodology is crucial for maintaining high quality throughout the research project (da Mota Pedrosa et al., 2012, Dubois and Araujo, 2007). There are several research methodologies which all have their own characteristics and are therefore suitable for different projects (Kotzab et al., 2005). These methodologies and their characteristics will be further described below.

2.3.1 Action research

Action research is a strategy focusing on research in action rather than research about action and is suitable for highly unstructured problems (Kotzab et al., 2005). This focus is achieved by studying social or organisational issues through a scientific approach, together with people experiencing them (Coughlan and Coghlan, 2002). Action research follows a cyclic process of diagnosing, action planning, implementation taking, observation and reflection (Kotzab et al., 2005). Members of the studied system actively takes part in these processes. The goal of action research is to make the action more effective while still contributing to theory. Therefore, action research is both a series of events and an approach to problem solving (Coughlan and Coghlan, 2002, Kotzab et al., 2005).

2.3.2 Survey research

Survey research allows for the effective collection of large amounts of data and is commonly used within supply chain management research (Kotzab et al., 2005). The collection of data is done by asking people for information in a structured format. Survey research is a quantitative method and standardized information is needed to study relationships between different factors. The information is collected from samples and therefore needs to be generalised to be suitably applied to the population (Malhotra and Grover, 1998). The data is analysed with statistical methods such as mean and dispersion (Höst et al., 2006). The aim of survey research is to describe the prevalence of a phenomenon and thereby contributing to the development of theory (Malhotra and Grover, 1998, Yin, 2009).

2.3.3 Modelling research

Quantitative modelling is based on the assumption that models explaining behaviours and problems in real operational processes can be built. Quantitative modelling research can be divided into two classes. The first class is driven by the model and handles strict processes of theorems and logistical evidence. The knowledge used is produced by formal methods originating in areas such as mathematics, statistics and computer science. For the second class, the primary concern is a good model fit between the model and the actions and observations its modelled after. The second class is first and foremost driven by measurements and empirical findings (Bertrand and Fransoo, 2002, Kotzab et al., 2005).

2.3.4 Case study research

Case study research is used when thoroughly investigating a real-life phenomenon. The strategy is especially favourable when examining how and why questions, as this can lead to both theory testing and development (Voss et al., 2002, Yin, 2009). In addition to the form of research question, Yin (2009) mentions two other conditions which help determine if case study research should be used. These conditions are that there are no requirement for control of behavioural events and that the focus is on contemporary events. In general case study research can be conducted either as a single case study or as a multiple case study (Voss et al., 2002, Yin, 2009). The process is an integrative one, which can involve multiple methods, researchers and an evolution of concepts. Patterns of data should be analysed both within and across cases (Voss et al., 2002).

2.4 Our methodology

Based on the purpose and the appurtenant research questions, case study research was deemed to be the appropriate research method. The project will investigate the current purchasing processes and digitalisation opportunities at Axis. The research questions mainly focus on "how" and the project does not require any form of control of behavioural events. As there has been little previous research at Axis sourcing department regarding the subject and due to the time limit, action research and modelling was deemed as unsuitable methods. The limited amount of research also leads to the need for a thorough investigation of the phenomenon. This validates the use of case study research as the preferred method for this project. Therefore, the case study research methodology will be described in further detail in *2.4 Case study*. Due to

time restraints and the ambition to thoroughly investigate the chosen case a single case study was performed. The collected data will be validated and analysed with the help of theory derived from a literature review. This will lead to an alternation between the deductive and the inductive approach, and thereby, resulting in the use of a balanced approach.

2.5 Case study

Yin (2009) suggests a six-step course of action for case study research, see Figure 2.3, which was followed throughout the thesis. All steps except the first is performed in an iterative manner.

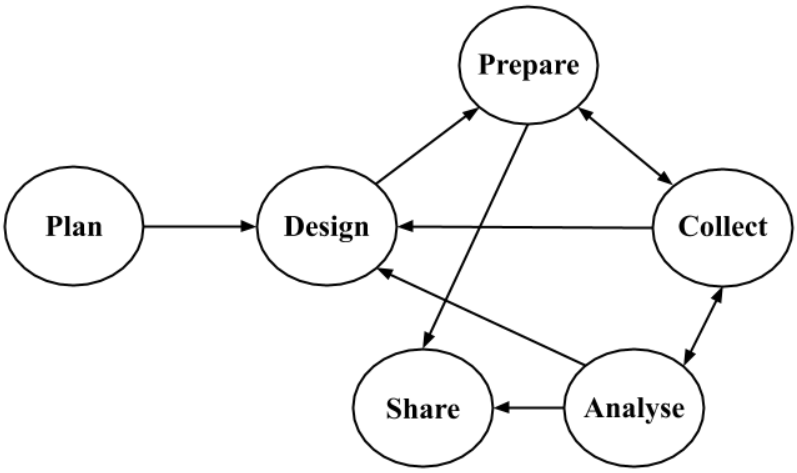

Figure 2.3 Case study research process (Yin, 2009).

An important design decision in case research is the number of respondents. If a set of questions cannot be answered by a single person or if viewpoints on the subject can differ, multiple respondents might be considered. But according to Voss et al. (2002) it is important to be aware of the time and resources spent on searching for multiple viewpoints. Various sources can be used for data collection within case study research, both quantitative and qualitative (Meredith, 1998). This can for example be interviews, direct observation, participant observations, questioners, informal conversations, documents etc. (Meredith, 1998, Voss et al., 2002, Yin, 2009). A conclusion based on multiple sources is inclined to be more accurate and convincing. Hence, Yin (2009) suggests that various sources should be used when conducting a case study. It can be challenging to know when to stop gathering data for the case. Voss et al. (2002) recommends finishing while there is still time to meet the deadline or when the data can sufficiently address the research questions. While Eisenhardt (1989) suggest finishing when there is little more to learn from data collection, so called data saturation.

Prioritising what to analyse and why, should be done by following an analytical strategy. To be able to draw empirical based conclusions the data analysis should consist of examining, categorising and recombining evidence (Yin, 2009). According to Voss et al. (2002) the first step is to analyse patterns within cases and thereafter search for cross-case patterns. The analysis is performed throughout the data collection and beyond and is an iterative process (Ellram, 1996).

The results and findings of a case study should be composed and presented in a report. Identifying the audience, creating a dispositional framework, external reviewing and re-writing are all an important part of the composition (Yin, 2009). It is important that the report contains enough information for the reader to draw their own conclusions. The composition should start early on and continue throughout the project, which is illustrated by the iterative process in Figure 2.2 (Höst et al., 2006, Yin, 2009).

This thesis will use both quantitative and qualitative data to answer the research questions. Interviews were held to answer RQ1 and identify digitalisation opportunities. A survey was performed to validate the identified digitalisation opportunities and to rank the processes based on the time it takes to perform it, how often it is performed and the usability of the process. RQ3 was answered through an analysis facilitated by models identified through the literature review.

2.6 Research data

There are several different types of data collection methods. The ones relevant to this thesis are described below.

2.6.1 Literature review

The literature review is conducted to get a deeper knowledge and analyse a specific area by research of existing literature. Some of the purposes of a literature review are to receive an understanding of the topic and relevant fields, define relevant concepts and understand how the research can contribute to future knowledge (Efron and Ravid, 2019, Kotzab et al., 2005, Rowley and Slack, 2004). The literature review also assures that the research is built on current knowledge (Höst et al., 2006). Information can be gathered from books, academic articles, conferences and web-based literature etc. These can be found through library catalogues and online databases or other search engines (Höst et al., 2006, Rowley and Slack, 2004). The literature review contains five steps, scanning, writing notations, organise the literature review, writing the review and creating a bibliography (Rowley and Slack, 2004). There are different approaches to search and gather literature, see Table 2.2 (Efron and Ravid, 2019, Rowley and Slack, 2004).

Table 2.2 Methods to search for literature (Based on Efron and Ravid, 2019, Rowley and Slack, 2004).

Method	Description
Citation pearl growing/ Snowball method	Starting with a key article and finding new documents by identifying relevant terms/references in the first article and use these for further searches.
Briefsearch	A few documents are researched, which is a good starting point for future work.
Building blocks	Generate a thorough search by taking the search words and extending them by using synonyms and related terms.
Successive fractions	Used to reduce a large amount of documents. By searching within retrieved research, documents that are found to be less relevant can be eliminated.

The literature for this research was found through search engines that are available through Lund University, LubSearch and Web of Science. Google Scholar was also used. Different keywords such as "purchasing", "sourcing", "purchasing and digitalisation", "sourcing and digitalisation" and "Procurement 4.0" was used to find relevant articles. The search for information and writing of the literature review followed the five steps. Firstly, different documents were scanned to get an overview of the different topics. The snowball method was used to find relevant articles. After that, notations and summaries were written down on relevant articles for this literature review. The method of successive fractions was used after this step to specify which articles that were relevant as a foundation for the review. The literature review was organised according to relevant topics specified to the purpose of this master thesis. Lastly, the articles found were used to write the review. The bibliography contains all references used in this report and have been updated systematically during the writing of the report.

2.6.2 Interviews

One common approach to gather data in qualitative research is through interviews (Kallio et al., 2016). Interviews are an important source of information in case studies. Meaningful insights in relevant areas can be found by having interviews with well-informed participants. Information about other relevant sources of data can also be received through the interviewees (Yin, 2009).

Three common approaches to interviews are structured, semi-structured or unstructured interviews. In a structured interview, the questions are organised and standardised, and read to the interviewee exactly as they are written down. Unstructured interviews have minimum structure, where questions are not set beforehand but instead arise through a conversation with the interviewee. The third approach is semi- structured, which is a mixture between unstructured and structured. Areas for questions are determined beforehand, but the approach

is freer since there is a dialogue between the interviewer and the participant. The interviewer can ask follow-up questions on important areas (Brinkmann, 2013). Semi-structured interviews are the most common in qualitative research (Brinkmann, 2013, Kallio et al., 2016).

Interviews can be individual or held in a group. An interview in a group tends to be more of a conversation and can be useful when the interviewer is interested in how the participants argue about a specific topic. One benefit of an individual interview is that the interviewer has the ability to lead the interview in an appropriate direction. The interviewee might also feel more trust during the interview. Interviews can be carried out face- to- face, through phone or other digital media (Brinkmann, 2013).

The interview can be carried out in four different phases: context, introductive questions, main questions and summary. The first phase, context, describes the interview and why the interviewee is chosen. In the second phase some fundamental questions are asked, such as education and work tasks. The third phase contains the main questions. The interviewee should feel that the questions are carried out in a logical order. Lastly, the interviewer summaries the interview. In this step, the interviewee also gets the possibility to relate additional information (Höst et al., 2006)

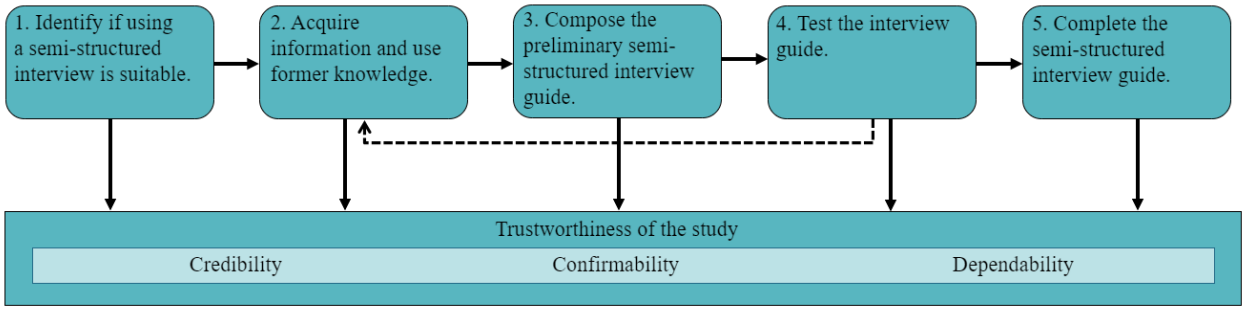

Figure 2.4. The phases of a semi- structured interview guide (adapted from Kallio et al., 2016).

Kallio et al. (2016) describes how to execute a semi- structured interview guide, see Figure 2.4. This is done by following a five-step model:

1. Identify if using a semi-structured interview is suitable.
2. Acquire information and use former knowledge.
3. Compose the preliminary semi-structured interview guide.
4. Test the interview guide.
5. Complete the semi-structured interview guide.

The first step is to determine the prerequisites for the interview guide. It should be determined if a semi-structured interview is a suitable method for data collection with regards to the research questions. In the second step, the goal is to gain an understanding of the phenomenon by using previous knowledge. This information can be acquired by a broad literature review, complemented with other sources of empirical information such as consulting experts or workshops with research teams. The third phase contains the development of the interview guide. It is important to assure that the main themes are covered, and that the follow-up questions are relevant. The main themes should cover the research topics. The follow-up

questions can be written beforehand or asked spontaneously during the interview. Testing of the interview guide in order to make changes and improve it, is done in the fourth phase. There are different techniques for testing: internal testing, expert assessment and field-testing. Internal testing is when the evaluation is made by other members in the research team, in contrast to expert assessment where the guide is analysed by an expert who is not a part of the team. In field- testing, the guide is tested with potential interviewees for the study. The fifth and final phase is to present the finished semi-structured interview guide (Kallio et al., 2016).

This research used an unstructured and semi- structured approach during the interviews. The interviews were held with employees at Axis in order to get an understanding of the current sourcing processes and to identify digitalisation opportunities. The primary interviews were unstructured in order to get a holistic view of the sourcing department and their processes. The second set of interviews were semi-structured to enable a discussion on more specific topics and to receive more detailed process descriptions. The semi-structured interview guide was composed based on the model by Kallio et al. As detailed descriptions and employee opinions were required to answer the research questions, semi-structured interviews were deemed suitable. The literature review and the unstructured interviews was used as a base for the semi structured interview guide. The interview guides were created in order to assure that all relevant topics were covered. The interview guide was validated by the supervisors at the company and university. Thereafter the final interview guide was created see Appendix B. The interviews also followed the four phases described above. A table containing all interviewees, interview dates and the interview structure used can be found in Appendix A.

2.6.3 Documents

One source for information in a case study is documentation. The documents can be of different types, such as agendas, notes from meetings, articles in media, personal documents or administrative documents. Personal documents can be for example e-mail conversations or calendars, while administrative documents can be reports and other internal information. In a case study, documents are used to validate other sources. Names and titles that are mentioned during an interview can be confirmed by documents. Furthermore, it can justify other sources of information. If the information from the documents is conflicting with other data, more research about the topic may be needed. The third usage of documents is to generate new conclusions in the study (Yin, 2009).

To attain validity and access additional information internal documents were reviewed and compared to the interview results. The internal documents consisted of PowerPoint presentations, process descriptions, templates, Excel macros and Excel sheets.

2.6.4 Survey

A method for collecting data is to design a survey, which can be both of large- or smaller-scale. Large-scale surveys are for example opinion polls, while smaller surveys can be carried out by an institution or individuals. By performing a survey, a broad range of people can be reached. On the other hand, since the questions are specific and intended to generalise, the answers can be limited (Andres, 2012).

The survey can be performed differently depending on the situation, it can be executed online, by pen and paper, mail, on the phone or face-to-face. The survey can be self-administered or

performed as an interview, with open-ended or closed questions (Andres, 2012, Czaja and Blair, 2005). Open-ended questions are those questions which provide a blank space for the respondents, where they can write their own answers. The advantages of open questions are that the respondents can comment on previous questions and possibly add aspects that the researchers have not considered. The setup of close-ended questions can vary from only having two answers to ranking with rating scales. Before designing the survey, four aspects should be considered (Andres, 2012):

1. The questions should be relevant for the research and possible for the respondent to answer.
2. The questions should only involve one topic or thought.
3. The language in the survey should be easy to understand.
4. Information about how the questions should be answered can be added.

The data collected through the survey can be either quantitative, qualitative or both depending on the questions. Furthermore, data that has a qualitative approach can be analysed quantitatively. A quantitative survey can also include open-ended questions which can be analysed both quantitatively and qualitatively (Andres, 2012).

This study used a small-scale digital survey for gathering of information, which were sent out to all employees at the sourcing department. The survey was performed to ensure the validity of the interviews and to rank and prioritise the identified processes. The processes were prioritised in order to facilitate the investigation on digitalisation technologies and systems. The prioritisation was based on how much time each process requires, how frequently the process is performed and the process current degree of usability. The processes are categorised according to high, medium or low priority. Processes with high prioritisation are those which require a significant amount of time and has low usability. Due to the limited time frame of the thesis, the focus when searching for digitalisation solutions followed this categorisation, with a higher focus on finding solutions for higher priority processes. The survey contained eight closed questions and one open-ended. The closed questions were used to rank different aspects of the processes used today, as well as suggestions of new systems that could be implemented. The open-ended question gave the opportunity to add additional information regarding additional digitalisation opportunities. The survey and the results can be seen in Appendix C.

2.7 Research quality

Quality associated with research refers to the rigor of the research design, the credibility of the researcher and the believability of the research findings. Research of a high quality are more likely to make a difference (Rose and Johnson, 2020). Therefore, researchers should thoroughly explain the research design and method so that the reader can examine their relevance and sufficiency (da Mota Pedrosa et al., 2012). To achieve quality in case study research four tests connected to validity and reliability are commonly used, see Table 2.3 (Yin, 2009). Reliability is the extent to which a procedure generates the same answer regardless of when and how it is performed. Validity is the extent to which the procedure generates the correct answer (Kirk and Miller, 1986). Several tactics used in the tests should be applied throughout the case study (Yin, 2009).

Da Mota Pedrosa et al. (2012) also suggests the quality criteria: transferability, truth-value and traceability, especially for case study research. Transferability is the extent to which a study can be applicable in other contexts. Truth-value is the match between the contrived reality of the informant and the ones represented by the researcher. Its therefore important that the informant corrects or confirm the researcher's reality. Traceability is connected to the documentation of the sources and processes used (da Mota Pedrosa et al., 2012).

Table 2.3 Four tests used to establish the quality of case study research (Yin, 2009).

Test	Explanation
Construct validity	Establishing accurate operational measures for the concepts being studied. An example of a case study tactic is using multiple sources of data.
Internal validity	Only used for explanatory or casual studies. Forming relationships, through which certain conditions lead to other conditions, separated from spurious relationships. An example of a case study tactic is trough pattern matching or logic models.
External validity	Defining the field to which a study's discoveries can be generalised. An example of a case study tactic is the use of theory in single case studies.
Reliability	Demonstrate that the procedures of a study can be repeated, generating the same result.

Evaluating resources is an important part of any literature review (Brewerton and Millward, 2001, Rowley and Slack, 2004). To ensure reliability and quality of a resource the authors status in the field should be evaluated. The authors purpose for writing and publishing the article should also be reflected upon (Brewerton and Millward, 2001). The use of references is another way to evaluate reliability and quality. Books and articles should include extensive references to relevant literature, which allows for validation (Brewerton and Millward, 2001, Rowley and Slack, 2004). Academic articles are also generally peer reviewed before publication, which further ensures reliability (Rowley and Slack, 2004).

In this chapter the research design and methodology for the project have been thoroughly described to ensure a high degree of reliability. Multiple data sources, such as documents and interviews, were used, compared and analysed. To further increase validity the collected data was analysed with the help of a literature review. The majority of the literature used is either books or academic articles, even so the motive for writing and publishing was reflected upon for all literature. Literature was also validated through the use of multiple sources which discusses the same subject.

3. Literature review

This chapter describes the theoretical framework for the thesis. The framework contains three main topics and their intersection, described by the Venn diagram in Figure 3.1. The overlapping areas between two topics is also covered in the literature review. Firstly, a background of digitalisation and sourcing is presented. This is followed by a description of sourcing and strategic sourcing. Digitalisation opportunities within sourcing are described and lastly, process change and process mapping are explained.

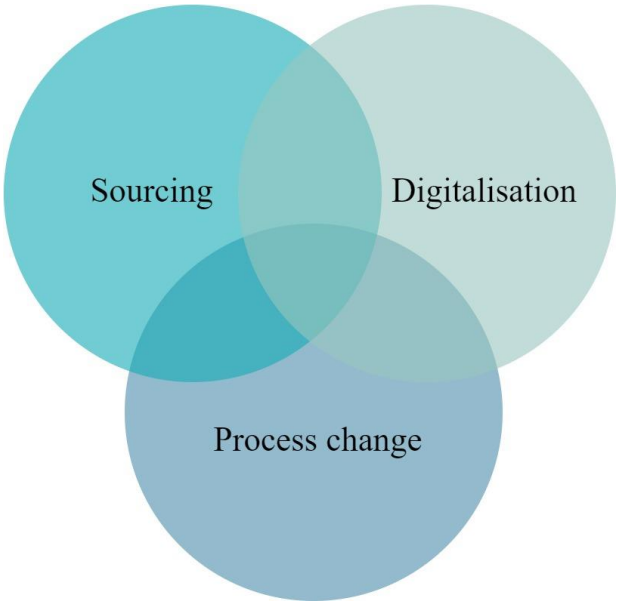

Figure 3.1 Venn diagram describing the scope of the literature review.

3.1 Sourcing

In the making and selling of products, different processes are necessary. The flow of goods goes through the supply chain, which contains the necessary entities and originates from traditional manufacturing companies. The supply chain often begins with the purchase of raw material from a supplier. This can be followed by production and inventory, before the product is sold to the customer (Johnsen et al., 2014). In the supply chain, there are different functions which are necessary for material flow. Examples of these functions are purchasing and procurement, logistics, inventory and production (Arshinder et al., 2008). The importance of purchasing management has increased over the years, since decisions regarding suppliers and purchasing can have a beneficial impact on a company's performance. Management of purchasing have also evolved from being only tactical towards becoming more strategical (Lawson et al., 2006).

The main activities of the purchasing function have been described by different authors. Robinson et al. (1967) defined the activities of a purchase as an eight-step process: (1) recognition of a need, (2) establishing the characteristics and quantity of the needed item, (3) describe the established characteristics and quantity, (4) search for and qualify potential sources, (5) obtainment and analysis of proposals, (6) assessment of proposals and selection of suppliers, (7) choosing an order routine, (8) performance feedback assessment. However, Webster Jr and Wind (1972) focuses on decision-making in the organisational buying process: (1) anticipation of a need, (2) determining specifications, (3) identify alternatives, (4)

assessment of alternatives, (5) supplier selection. A common model used to describe the purchasing activities is van Weele's purchase process model, see Figure 3.2 (Johnsen et al., 2014, Mendoza and Ventura, 2012, Meyer et al., 2020, van Weele, 2014). Van Weele's purchase process model is used throughout the thesis in order to facilitate descriptions and clarifications. The activities classified as sourcing and follow-up and evaluation, see Figure 3.2, will be further described as these are the activities performed at Axis sourcing department.

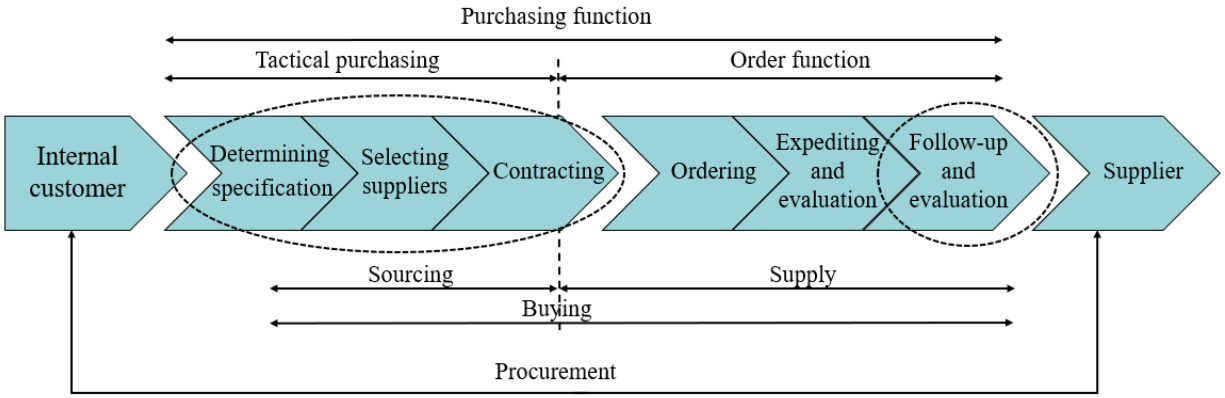

Figure 3.2 Purchase process model showing the focus of this thesis (adapted from van Weele, 2014).

Several terms are discussed for the purchasing function, the definition of some key terms can be seen in Table 3.2. The meaning and usage of the terms can vary, for example, in some cases purchasing and procurement are used interchangeably. National differences can also affect the usage of the terms (Johnsen et al., 2014).

Table 3.1 Explanation of terms in the purchasing process.

Term	Explanation
Purchasing	Purchasing is the acquisition of supplies needed for production of a product or service (Joyce, 2006). It involves activities such as ordering and payment (Johnsen et al., 2014).
Procurement	Procurement is the purchasing of input supplies for the company. This can include raw material and other supplies, but also products such as machines, office material and properties (van Weele, 2014). It can also be defined as the total acquisition of goods and services from the beginning to the end (Johnsen et al., 2014).
Sourcing	Sourcing is the search of suppliers for goods and services. It involves activities such as finding, choosing and contracting suppliers (Johnsen et al., 2014, van Weele, 2014).
Strategic sourcing	Strive to make the sourcing process as efficient as possible (Johnsen et al., 2014).

3.1.1 Determining specification

In this initial phase the specifications needed to select the correct supplier is documented in a purchase order specification (van Weele, 2014). The document can subsequently be used as a point of reference throughout the remaining process. As the specifications should reflect the company's needs it is important that they are aligned with customer requirements (Johnsen et al., 2014). There are two types of specifications, functional specifications and technical specifications. Functional specifications describe the functionality that needs to be fulfilled, but not how the supplier should achieve this. Technical specifications describe the activities that should be performed by the supplier as well as technical properties and characteristics. Both functional and technical specifications are a part of the purchase order specification, which is comprised of specifications linked to different categories, see Table 3.3. Many of the specifications should be developed by cross functional collaboration (Johnsen et al., 2014, van Weele, 2014).

Table 3.2 Categorisation of specifications in the purchase order specification (van Weele, 2014).

Categories	Explanation
Quality specifications	Describes how the product should be delivered and the technical standards the product should fulfil.
Logistic specifications	The quantities needed, place and time of delivery.
Maintenance specification	Relates how the product should be maintained and serviced by the supplier.
Legal and environmental requirements	Ascertain that product and production processes should consent with health, safety and environmental regulations.
Target budget	The financial restraints for the solution provided by the potential supplier.

3.1.2 Selecting supplier

After specifications have been developed and the purchase order specification drawn up, the search for a supplier can begin. Initially a large number of suppliers are identified and gradually decreased, until one supplier is selected. This selection contains four activities (van Weele, 2014):

1. Decide on a method for subcontracting.
2. Initial qualification of suppliers and construction of the 'bidders' list.
3. Composing the request for quotation and analyse received bids.
4. Supplier selection.

Subcontracting methods primarily consist of two choices, turnkey or partial subcontracting and fixed price or cost-reimbursable contract. In turnkey subcontracting the responsibility of the entire task lies with the supplier. Partial subcontracting on the other hand, is when the task and the responsibilities connected to it are contracted out separately. For the fixed price contract,

the price and timeframe for the activities are set in advance. However, this is not the case for cost-reimbursable contracts. Instead, the activities are performed at an hourly rate and a settlement is reached between buyer and supplier after the activity is completed (van Weele, 2014).

Pre-qualification requirements, based on the purchase order specification, are decided upon. The bidders long list consists of the suppliers that satisfies these requirements but require further investigation. A request for information (RFI) is sent out to these suppliers in order to gather information about their capabilities and previous experiences. This results in the elimination of some suppliers on the bidders long list, leading to the short list. The suppliers on the short list will then be contacted with a request of quotation (RFQ) or a request for proposal (RFP) which serve as an invitation to bid. This is referred to as the tendering process (van Weele, 2014). An RFQ primarily focuses on the cost factor, in addition to that the RFP also consider factors such as qualifications, innovation, experience etc. (Stocks, 2001). The bids are then evaluated, different ranking systems can be used to facilitate this. For strategic suppliers the evaluation should be performed by cross functional teams and a risk analysis carried out. The suppliers are informed of the decision and negotiations can start with the selected supplier/suppliers (Johnsen et al., 2014, van Weele, 2014).

3.1.3 Contracting

The contract is set up when a supplier is chosen. The agreed terms differ depending on industry and type of agreement and can consist of different price agreements. The different price agreements are described in Table 3.4. The price is commonly a fixed price and determined by negotiation or competitive bidding. During competitive bidding, different suppliers provide bids to the buyer (van Weele, 2014).

Table 3.3 Different purchase agreements and explanations (van Weele, 2014).

Purchase agreements	**Explanation**
Fixed- price plus incentive fee contract	A contract that is used to drive the suppliers to perform above the agreed terms, by adding rewards. The incentives can be reduced costs, faster delivery or higher quality.
Cost- plus contract	An additional cost is added to the original cost, this can for example be a percentage fee or a fixed fee. Are used if the work cannot be fully specified or a fixed price is a high risk.
Cost- reimbursable contract	A contract that uses fixed hourly rates for personnel and equipment.
Agreement with price- adjustment	The price is related to price fluctuations in external factors, for example changes in cost, material or labour. This contract is normally used for long- term projects.

Another decision that is agreed upon are payment terms. One common method is to divide the payment in several parts. The supplier usually makes big investments for manufacturing of the product and therefore need to divide the payment. The payment can also be based on the supplier's performance. The supplier then receives a certain amount of the payment during the project and the rest when the final product or service is delivered. If the delivery is not performed as agreed upon, the buyer can add penalties, or the product can be sent back to the supplier (van Weele, 2014).

3.1.4 Follow-up and evaluation

The last step of the purchasing process is follow-up and evaluation. After the buyer has received the goods, administerial tasks such as penalties need to be worked out, files need to be updated and an evaluation of the supplier is established. If the purchased products are investment goods, terms regarding maintenance needs to be decided upon. Evaluation of the suppliers should be done continuously. The quality of the products and delivery time are information that should be documented, and the information should be reported to both the buyer's and supplier's management. By evaluating suppliers, the company is aware of the performance of their suppliers and can choose to continue working with those of high quality. The information can also be used when creating the bidders' short list (van Weele, 2014). In order to evaluate and measure the performance of suppliers, key performance indicators (KPIs) can be used. KPIs are various measurements that are defined by the company on factors such as quality, payments and delivery (Hudnurkar and Ambekar, 2019).

This last step concludes the purchasing process. Since the different steps influence each other, it is important to handle each of them efficiently. The consequences are otherwise that the company's operational performance can be affected (van Weele, 2014).

3.2 Strategic sourcing

The sourcing department at Axis performs several strategic sourcing activities in order to maintain their relationship with suppliers and facilitate long-term decisions. Therefore, the theory relating to these activities are described below.

Maintaining strategic sourcing has become more important throughout the years (Shook et al., 2009). Different procurement processes have evolved to become more strategic with the increase of global businesses (van Weele, 2014, Vitasek, 2016). The aim of strategic sourcing is to connect the purchasing and supply function with other departments of the company and the company's objectives. Relationships towards the suppliers are another type of strategic decision (van Weele, 2014). Several models and theories have been developed to support and determine strategic decisions within purchasing (van Weele, 2014, Vitasek, 2016). Examples of strategic purchasing and sourcing processes are categorisation, commodity strategies, supplier relationships and supplier integration in product development (van Weele, 2014).

3.2.1 Categorisation of products and suppliers

To determine a purchasing strategy for different products, they can be categorised into strategic, leverage, bottleneck and routine items. The products are classified according to level of supply risk and profit impact and thereby determine the categorisation of a product. The risk is determined by factors such as number of suppliers on the market, accessibility and competitiveness. The profit impact is decided based on the percentage of purchasing cost, the purchased volume or influence on business growth. This leads to the four different product categories and strategies, seen in Figure 3.3 (Kraljic, 1983, van Weele, 2014).

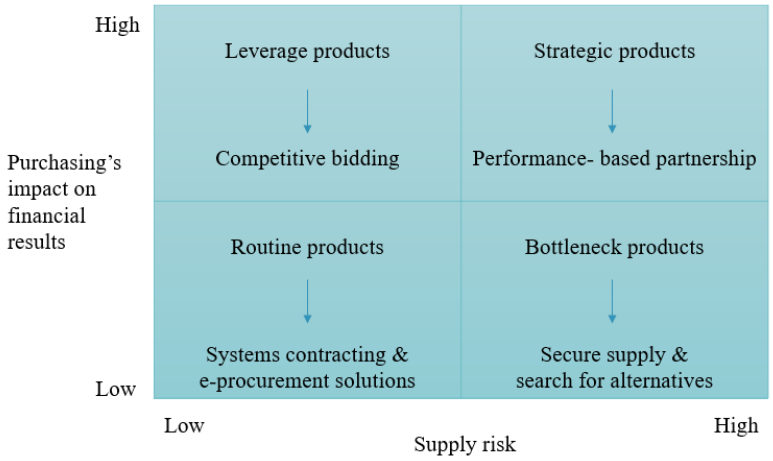

Figure 3.3 The purchasing portfolio (van Weele, 2014).

Strategic products are those with high supply risk and high impact on financial results. The strategy for these products is performance-based partnership, which involves a close relationship with the supplier with the aim of collaboration or partnership. Leverage products have low supply risk and high profit impact. These can be purchased in similar quality from several suppliers. The strategy for these products is competitive bidding or tendering. Bottleneck products can only be purchased from one supplier but do not have a high financial impact. The strategy is to secure supply but also minimize the reliance on specific suppliers, which is done by searching for new suppliers or the development of other products. The fourth product category is routine products, which are products with both a low financial impact and low supply risk. The connected strategy is systems contracting or e-procurement solutions, with the aim of reducing complexity (van Weele, 2014).

Another model for categorisation of suppliers is the supplier hierarchy, Figure 3.4. The model distinguishes between preferred, approved and potential suppliers. Preferred suppliers are few suppliers with a long-term assessment. Due to the long evaluation, the suppliers are seen as low risk. Approved suppliers are suppliers who have had a short or medium- term evaluation. Firms tend to devote time to assess and monitor these suppliers and the preferred suppliers. Finding new suppliers is expensive and comes with high risk, companies therefore tend to use their current supplier base if possible. Potential suppliers are at the bottom of the supplier hierarchy model and represents the broad base of new potential suppliers (Johnsen et al., 2014).

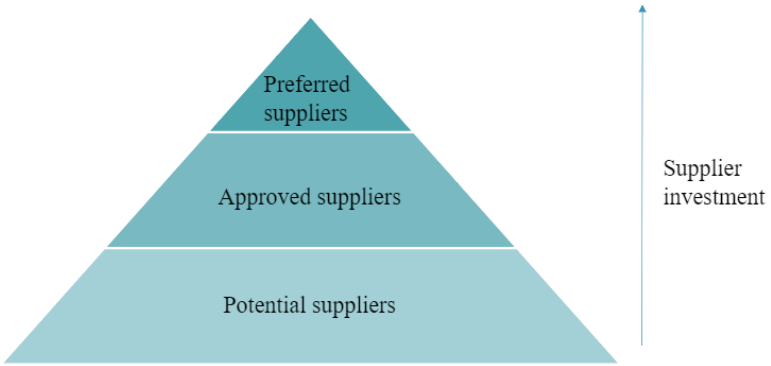

Figure 3.4 The supplier hierarchy (Johnsen et al., 2014).

3.2.2 Commodity strategies

Products can be categorised into different commodities, which means that they are grouped according to different factors such as homogeneity or standard. Products are not categorised according to their value or risk (Englyst et al., 2008). Examples of commodities are raw materials and technical or high-tech components. Categorisation enables control of the spend for different commodities (van Weele, 2014) and allows for contact and negotiation across different units in the business. A certain commodity can be managed by a commodity team. The main responsibility for the team is to source, choose and assess suppliers and reduce costs (Englyst et al., 2008).

3.2.3 Suppliers and product development

The change in customer demand and usage of new technologies has led to an increase of supplier involvement in New product development (NPD) (Le Dain et al., 2020). Collaboration with suppliers in NPD allows for opportunities in innovation, which can lead to competitive advantages. Supplier integration also enables usage of new technology and shared benefits. Having a strong supplier–buyer relationship is crucial when collaborating with suppliers in product development (Le Dain et al., 2020, Sjoerdsma and van Weele, 2015). Five factors that are important in the relationship is trust, communication, information sharing, cooperation and commitment (Sjoerdsma and van Weele, 2015).

3.3 Digitalisation and sourcing

Supply chains are facing challenges such as globalisation, scarcity of resources, an increasingly volatile environment and a need for flexibility (Kersten et al., 2017, Zangiacomi et al., 2020). A crucial part in managing these challenges is innovative and strategic procurement (Nicoletti, 2020). The procurement function identifies, sources, manages and guarantees access to the external resources needed by a company (Bag et al., 2020, Tripathi and Gupta, 2020a). According to Nicoletti (2020) innovation can improve effectiveness, efficiency and economies for procurement departments. The aim of innovation can be summarised in: smarter sourcing with fewer more valuable transactions, savings within company resources and maximise utilisation of new solutions (Nicoletti, 2020). Digitalisation and implementation of technology constitutes a big part of the current innovation within procurement and can give companies a strategic vantage point (Nicoletti, 2020, Tripathi and Gupta, 2020a).

Two terms that are used commonly in the context of digital implementation is digitisation and digitalisation. Digitisation refers to the conversion of analogue signals into digital bits, for example, the movement of information on paper into a digital program. Digitalisation refers to the usage of digital technologies in a broader perspective, it concerns the use of the technologies in an organisational aspect to create value (Gobble, 2018, Legner et al., 2017, Srai and Lorentz, 2019). The term digital technologies include technologies such as big data analytics, Internet of Things (IoT), cloud storage and social media (Srai and Lorentz, 2019). Digitalisation involves automation of different business processes, and focuses on improving and reconstructing operations, processes and other activities. This is done by applying the technologies and an extensive use of digitised data while keeping a specific aim in consideration (Savić, 2020).

Digitalisation do not only play a vital role in aligning current sourcing strategies, but also in producing new strategies to achieve organisational growth and competitiveness (Viale and Zouari, 2020). The amount of data produced by, available to and collected by procurement departments, suppliers and partners is massive. This makes the identification and extraction of relevant information complex, which in turn becomes a problem as information is the driving force behind supply chain decisions. To take advantage of data and the added value it can provide, technologies such as artificial intelligence and big data analytics can be used (Allal-Chérif et al., 2021, Kache and Seuring, 2017). An important part of improving buyer-supplier relationships, and thereby procurement, is communication. A vital part of communication is information sharing, which has changed alongside technology, from paper-based to electronic communication (Handfield et al., 2019).

3.3.1. The evolution of procurement

Just as technology, procurement have evolved over time. Nicoletti (2020) divides this evolution into four different phases, see Table 3.1.

Table 3.4 The different evolution phases of procurement (Nicoletti, 2020).

Procurement phase	Explanation
Procurement 1.0	Connected to the first industrial revolution and the introduction of the steam engine. Procurement was handled by small business owners or individual members. The work was manual, and the goal was to get the correct product to the right place at the right time in the right condition.
Procurement 2.0	Connected to Industry 2.0 and the introduction of electricity and the telegraph. Mass production, the introduction of the assembly line and transportation development resulted in increased sourcing distances. Buyers now needed expertise within engineering, electronics, mechanics etc. Integrated procurement services were also developed.
Procurement 3.0	Connected to Industry 3.0 and the introduction of the computer. Several computer applications, such as WMS, ERP and later e-procurement, was developed to support procurement. Procurement also became increasingly global.
Procurement 4.0	Connected to Industry 4.0, which can be defined as the convergence between production and information and communication technology (ICT). Companies' current movement towards digitalisation marks this new era. The integration and connection procurement 4.0 entails will impact all parts of procurement.

3.3.2. Differentiating procurement 4.0 and e-procurement

Since ICT is a critical component in both e-procurement and procurement 4.0, it is important to define what distinguishes the two concepts (Tripathi and Gupta, 2020b). E-procurement was a part of procurement 3.0, see Table 3.1, and have therefore been used by some companies for years (Kosmol et al., 2019). It can be defined as the use of electronic means, primarily the internet, to support operative functions within the procurement process. One of the key ideas of e-procurement is to include the end-user in the procurement process and thereby remove certain processes, for example the re-entry of information, for indirect goods (Thomas and Rainer, 2005).

Procurement 4.0 on the other hand, does not support the procurement process but instead focuses on automating parts of or the whole procurement process. Automation of the procurement process and reaching a greater depth of integration are both possible with procurement 4.0. Through production schedules and inventory stock the procurement need is identified, and an order is placed autonomously. Technologies in procurement 4.0 can also

provide a real-time flow of information and a common interface for internal and external coordination (Tripathi and Gupta, 2020a). The two concepts do not only approach digitalisation of procurement in different ways, but they also include different technologies. Kosmol et al (2019) divides these into basic and advanced digital technologies. Basic digital technologies include e-procurement applications and advanced digital technologies include more recent technologies, such as cloud computing, IoT, big data etc. Deloitte (2017a) instead divides the digital technologies into core, maturing and emerging. Core technologies encompasses solutions which procurement already depends upon, mainly larger systems with longer implementation. Solutions which can reshape procurement with minimal investment are categorised as maturing. Emerging technologies include the solutions that are not yet used but could impact procurement in the future.

3.4 Digitalisation technologies

Several technologies could be used to digitalise activities within the supply chain. The technologies described in this chapter are those relevant for the scope of the thesis and are described from a sourcing perspective. The technologies covered in this section can be seen in Figure 3.5, where they are classified in three different categories: core, maturing and emerging. Core technologies are solutions presently used within procurement and are larger systems with a more extensive implementation. Maturing technologies are currently transforming procurement processes at lower expenses. The emerging technologies could be used for procurement in the future (Deloitte, 2017a). This chapter will firstly provide more detailed information about each one of the core technologies in Figure 3.5, and then describe the maturing technologies. The emerging technology is shortly mentioned in contract management.

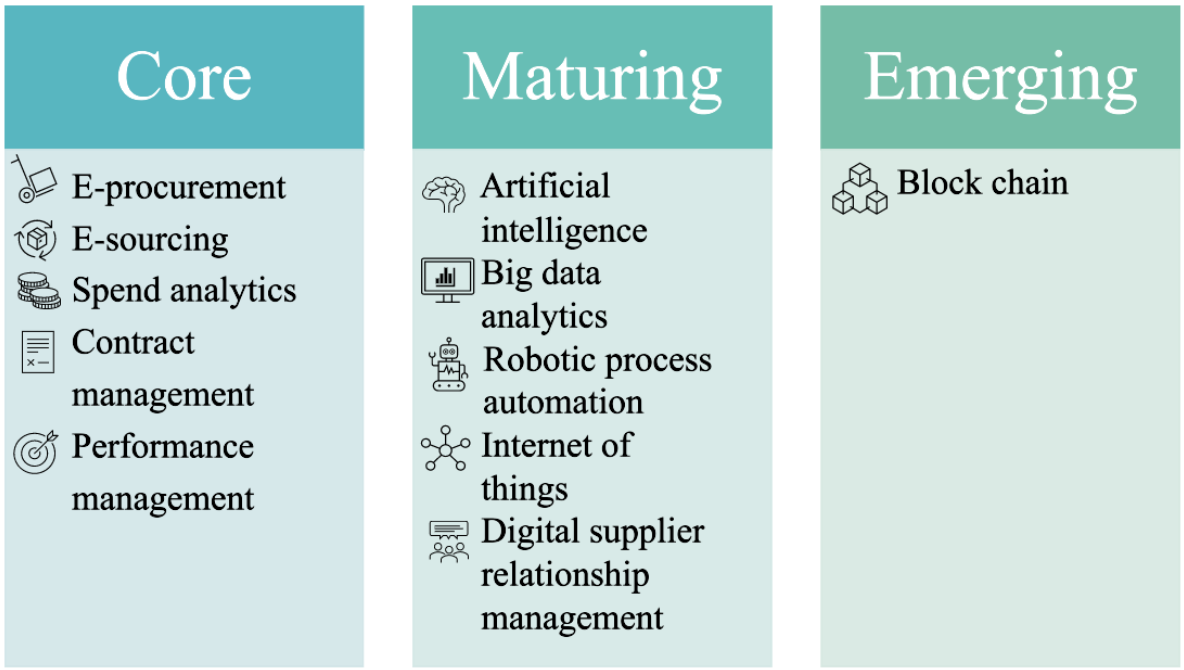

Figure 3.5 Digitalisation technologies for procurement, categorised in core, maturing and emerging (Adapted from Deloitte, 2017a).

Digitalisation of processes can lead to increased efficiency and effectiveness within the supply chain (Srai and Lorentz, 2019, Nicoletti, 2020). However, there are several challenges which can complicate the implementation of new technology. One of the biggest challenges is an inadequate understanding of the technologies and their functionality (Luthra and Mangla, 2018, Rejeb et al., 2018). Additionally, using multiple different systems can lead to a varying level of maturity between systems, which will threaten IT effectiveness and visibility. Integration of technology is essential for effective communication between systems and thereby between departments and companies (Kache and Seuring, 2017, Luthra and Mangla, 2018). It is therefore important with engagement across departments and that manufacturers and supplier are willing to adopt new technology (Rejeb et al., 2018). The definition and standardisation of common interfaces could also lead to a higher level of integration between systems (Kache and Seuring, 2017).

3.4.1 E-procurement

E-procurement is the use of electronic means to facilitate the acquisition of goods (Johnson and Klassen, 2005, Matunga et al., 2013, Presutti Jr, 2003, Schoenherr, 2019). Nevertheless, just as for the key terms in the purchasing process the scope of e-procurement varies among authors. Bartezzaghi and Ronchi (2005) defines e-procurement as the streamlining of the supply process. This definition focuses on activities related to the ordering function, see Figure 3.2. However, many authors include the whole purchasing process in the scope of e-procurement (Johnson and Klassen, 2005, Matunga et al., 2013, Presutti Jr, 2003, Schoenherr, 2019).

Traditionally, procurement has been facilitated by several communication mediums. These include mail, phone and electronic data interchange (EDI), which was one of the first B2B e-commerce technologies. However, recently e-mail and the internet has been the primary communication mediums (Asher, 2007, Gunasekaran and Ngai, 2008). With the increased use of technology and the internet, e-procurement emerged. As e-procurement evolved, software focusing on different activities in the purchasing process appeared. Even so, these systems were predominantly stand-alone and did therefore not share information. Today, several companies offer so called sourcing-suites, which integrates different applications. This integration can lead to an increase in data accuracy, efficiency, effectiveness and data analytic capabilities. Sourcing suites contains both strategic and operational modules. The most common strategic modules in sourcing-suites are e-sourcing, spend analysis, contract management and performance management. Some operational modules are catalogue management, requisition management, purchase order management and invoice management (Schoenherr, 2019). Due to the scope of this thesis and the activities performed at Axis sourcing department the focus will be on the strategic modules.

3.4.2 E-sourcing

E-sourcing includes forward and reverse auctions (e-auctions) and electronic tendering (eRFX). Different sourcing processes have different requirements, and it is therefore important to use the most suitable selection method (Capgemini Conuslting, 2016, Johnson and Klassen, 2005). Electronic RFI, RFP and RFQ are all stages of the eRFX (Capgemini Conuslting, 2016, Jandoš, 2006). Electronic RFI, RFP and RFQ fulfil the same function as their manual counterparts, but they are facilitated by electronic means. An example is the company General

Electric's, where everything from RFP to negotiation and contracts are performed online (Presutti Jr, 2003). The use of eRFX can result in reduced cycle times, a decrease in cost and an increase in organisation and analytical capabilities (Scanmarket, 2021).

E-auctions are a negotiation tool which uses internet auctions to facilitate supplier selection (Capgemini Conuslting, 2016, Jandoš, 2006). There are different types of e-auctions, however it is primarily electronic reverse auctions (eRA) that have replaced competitive bidding for sourcing decisions (Hartley et al., 2004). For eRA the traditional auction, where multiple buyers bid on an object from one seller, is reversed. For eRA there is only one buyer and multiple sellers, which allow suppliers to compete in real-time for a buyer's business. During the auction, suppliers place several bids over a set time-period and compete to offer a product for the lowest possible price. There are several benefits for the buyer such as lower transaction costs, shorter order cycle times, a big supplier pool and competitive prices. However, the seller can also attain benefits such as increased efficiency due to volume discounts and sales for complementary products and services (Hartley et al., 2004, Rothkopf and Whinston, 2007).

3.4.3 Spend analytics

Spend analytics or spend analysis is a process where the historical spend is analysed in order to find opportunities to reduce procurement cost and understand how spend is being managed (Barrad et al., 2020, Limberakis, 2012, Pandit and Marmanis, 2008). Procurement information is organised by supplier hierarchies, commodity alignment and spend amount. This categorisation is done in order to discover category spend, identify expense reduction and identify strategic sourcing opportunities through demand gathering and supplier rationalisation (Pandit and Marmanis, 2008). An effective spend analysis requires integration of data sources, defined data processes and technology (Limberakis, 2012). However, as companies often have several systems generating spend data, one of the biggest challenges is to aggregate data from different systems (Barrad et al., 2020, Limberakis, 2012). Spend analytics can today provide a holistic view on spend. However, to do so it is important to standardise spend intelligence processes and methods, increase automated integration of spend data and improve ease of use for the spend analysis tool. When this is achieved the integration of supplier data should be increased in order to reach a more advanced spend analysis (Limberakis, 2012).

3.4.4 Contract management system

The contracting process has evolved through the years, from being paper-based with physical signatures to become more digital. The development of electronic contract management stem from the increased usage of information systems, and the aim is to carry out and follow up on contracts. The benefits of digital contract management are reduced costs and increased efficiency and security compared to paper-based contracts (Guo et al., 2021).

Many companies use different types of software programs, such as Excel or document management, to store and manage their contracts. By implementing an Enterprise contract management (ECM) system, different functions can be handled electronically (Bochicchio et al., 2011). An ECM system offers visibility and facilitates accessibility and managing of the contracts, which in turn results in an increased fulfilment of legal requirements (Deloitte, 2017b). A contract system can also provide updates on the status of the contracts with information about renewal date. (Deloitte, 2017b, Schoenherr, 2019).

Guo et al. (2021) discuss how blockchain technology can be used for digital contract management in commodity procurement, by applying the technology to a power grid company. It is used for activities such as signing and storing contracts. Blockchain is a data structure, which is designed to secure immutability of data and access for the public. The technology is built up as a chain of blocks of transactional records, where every block has a specific value. By applying blockchain in contract management, the benefits are increased efficiency and decreased risks, such as the risk of signature forgery.

3.4.5 Performance management

One module that can be part of an electronic sourcing suite is performance management, where information regarding the suppliers can be stored. This involves data such as general information about the supplier, contracts, risk evaluation and other relevant information. The module can also store data regarding the performance of the suppliers. This information can be beneficial for performance monitoring and decision making, both in operational and strategic work (Schoenherr, 2019).

In more advanced solutions, the internal data can be broadened by adding external data such as news about the supplier or risk scores. Some modules also offer the possibility for suppliers to update information (Schoenherr, 2019).

3.4.6. Artificial intelligence

The maturing technology artificial intelligence, AI, is used in various processes in procurement. AI is a computer technology which replicates the human mind and intelligence, in order to create knowledge which is used in decision making and problem solving. AI can find new ideas, learn from experience, make rational decisions and draw conclusions. AI is applied in, for example, robotics, machine learning, vision systems, data mining and expert systems(Min, 2010, Schoenherr, 2019).

The most frequent use of AI in procurement is to automate processes and thereby make them more efficient (Allal-Chérif et al., 2021, Cui et al., 2020). Processes which can be automated are spend analyses or optimisation of the different stages in the purchasing process model. Automation of processes enables access to real-time data, easier monitoring and fewer mistakes by reducing human errors. AI can also handle larger amounts of data faster and are more reliable than humans, which increases efficiency and reduces costs (Allal-Chérif et al., 2021) The technology can also be used to recognise patterns, for example in spend analyses or predictions on prices (Schoenherr, 2019), or to simplify strategic sourcing (Cui et al., 2020).

One area that can be facilitated by AI is supplier selection and relationships with suppliers. This can be done by for example using chatbots, which can communicate and negotiate with either humans or other chatbots. A chatbot is an intelligent application which automates different interchanges and can gather relevant data and communicate the information. This can be used in both the RFI and RFQ processes (Allal-Chérif et al., 2021, Cui et al., 2020). They also have the possibility to suggest suppliers (Cui et al., 2020). Another example of when AI facilitates supplier selection, are so called matching systems. These systems find suppliers that fulfils the company's need, and thereafter select the most suitable supplier (Allal-Chérif et al., 2021).

3.4.7 Big data analytics

Strategical, tactical and operational decisions are taken based on information. Supply chain management is also increasingly reliant on data in order to be efficient and effective (Kache and Seuring, 2017, Moretto et al., 2017). However, companies generate and collect a massive amount of data, both structured and unstructured (Handfield et al., 2019). The increase of data relating to supply chains is due to digitisation and the use of information systems. This increase also applies for data related to procurement (Kaur and Singh, 2018, Nicoletti, 2020, Rejeb et al., 2018). The challenge is to identify and extract the relevant data, which can be facilitated by big data analytics. Big data analytics is the systematic and computational analysis of big data sets. The analysis is performed through the application of statistics, mathematics, simulations or optimisation (Moretto et al., 2017, Wang et al., 2016).

Within procurement there are large amounts of data, such as historical purchasing transactions, contracts, supplier performance and pricing. With big data analytics this data could be used to improve several procurement phases and activities (Moretto et al., 2017, Rejeb et al., 2018). These advancements include improved operational planning and decision making, reduced lead times and more accurate forecasts (Rejeb et al., 2018). According to Moretto et al. (2017) big data analytics have the biggest impact on the strategic sourcing and the sourcing phases of the procurement process. Within strategic sourcing big data analytics can support procurement strategy, reverse marketing and spend analysis. Sourcing planning and forecasting are both important parts of procurement strategy. Big data analytics can support the identification of the best planning strategy, which will provide an answer to where, when and how goods should be ordered. In addition to predicting future demand, forecasts can be used in long-term decisions concerning procurement timing and quantity. In reverse marketing, big data can be used to analyse supplier prices in order to revise the supplier base and detect trends (Moretto et al., 2017).

Within sourcing big data can support supplier evaluation, negotiation and supplier selection. For supplier evaluation, big data can monitor supplier performance through the collection and analysis of internal data, structured data from suppliers and data from external sources. Valuable information regarding the supplier or the product will increase the buyer's bargaining power during a negotiation. When selecting a supplier big data can facilitate analysis of both "hard" qualities, for example operative and financial performance, and "soft" qualities, for example reputation (Moretto et al., 2017).

3.4.8 Robotic process automation

Robotic process automation (RPA) is a software tool for automation of simple and repetitive tasks (Nicoletti, 2020, Strohmer et al., 2020). RPA is based on a program with a sufficient amount of AI and can therefore replicate some human actions (Nicoletti, 2020). RPA is beneficial for older system, processes consuming substantial resources or manual and repetitive processes (ATEA, 2021, Chopra, 2018). RPA have benefits such as increased accuracy, reduction in cycle times and increased transparency. In Table 3.5 the procurement areas that could benefit from RPA are listed (Strohmer et al., 2020, Viale and Zouari, 2020).

Table 3.1 The possible use of RPA within different procurement areas (Strohmer et al., 2020, Viale and Zouari, 2020).

Procurement area	Possible use of RPA
Spend data	Can be used to preserve spend and supplier data.
Contracting	Can assess contracts and compare them with standard terms and conditions.
Sourcing	Advanced bots can be used to compare pricing and assist in the RFI and RFP processes.
Supplier relationship management	Can keep criteria for supplier categorisation up to date by gathering and evaluating quantitative and qualitative performance metrics.
Risk management	Can conduct reviews on suppliers across multiple risk categories by gathering data and comparing KPIs.
Payments	Already used to confirm supplier invoices and initiate invoices.

3.4.9 Internet of Things

IoT is a technology which uses sensors that can connect both with each other through wireless and non-wireless communication, and to the internet. The sensors have a unique code and can be placed on products, which makes it possible to track and gather data from them. One example of this is radio-frequency identification tags (Fang et al., 2016, Osmonbekov and Johnston, 2018). The data is collected in real-time and can therefore be helpful when analysing inventory levels. Furthermore, this provides knowledge of the current location of products (Rejeb et al., 2018). The usage of IoT can also increase collaboration between different stakeholders. Digitisation of different processes, such as sourcing and logistics, makes it possible to integrate and share real-time data between involved actors (Nicoletti, 2020, Rejeb et al., 2018).

3.4.10 Cloud computing

Cloud computing technologies allow processing and storage of data through virtualised software or hardware in the network, usually the internet. It enables companies to access digital assets such as applications, platforms and infrastructures (Kazemargi and Spagnoletti, 2020, Nicoletti, 2020). Cloud vendors charge customers based on usage, the service is managed by the vendors and customers only require an access device and internet connection (Nicoletti, 2020, Prasad et al., 2016). There are several types of cloud computing services, the most common can be seen in Table 3.6.

Table 3.2 The most common cloud computing services (Nicoletti, 2020).

Cloud computing service	Included in service
Software as a Service (SaaS)	A full software suite is provided. Customers can only configure the software in a self-service mode. Pays a monthly charge or fee based on use.
Platform as a Service (PaaS)	An entire platform. Platform managed, kept stable and contemporary by provider. Can be accessed by remote and in-house employees. Tends to be very customisable.
Infrastructure as a Service (IaaS)	An infrastructure on-demand service. Customers outsource servers, storage etc. The provider owns the equipment and are responsible for the distribution, operations and maintenance.

Cloud procurement or cloud sourcing is when procurement or sourcing is supported by cloud computing. Well established systems in the cloud, for example ERP, are used for administration and management activities. Just as for cloud computing, the use of cloud procurement enables information to be viewed, updated and applied at any time and any place, as long as a device is connected to the internet (Nicoletti, 2020). Nicoletti (2020) also writes about the use of cloud procurement in the so called B2B cloud. The B2B cloud could facilitate collaboration, integration and the construction of a procurement network. The biggest concerns companies have regarding cloud computing are security and privacy (Kazemargi and Spagnoletti, 2020, Nicoletti, 2020). However, Nicoletti (2020) states that experts believe that the cloud is as secure as an on-premise system. Potential benefits with cloud procurement are cost convenience, agility, flexibility and scalability of resources (Kazemargi and Spagnoletti, 2020, Nicoletti, 2020).

3.4.11 Digital supplier relationship management

The relationship between supplier and buyer is crucial for purchasing processes, and the management of those relations can be handled digitally. Strohmer et al. (2020) mentions that one action in the digital transformation of Supplier relationship management (SRM) is to implement a digital SRM program. The system should manage all partners along the supply chain. Additionally, the program is able to distinguish between different suppliers, and therefore manage the relationship between them differently. The aim of this is to use more automation on non-strategic suppliers and thereby have more resources focusing on the relationship with strategic suppliers.

Performance measurements will become more relevant and easier to update with more digital processes. The amount of data that can be collected simplifies analyses and monitoring of suppliers, since different data can be used to measure supplier's performance and improvement areas (Strohmer et al., 2020). Different technologies such as IoT, big data, AI and cloud computing are contributing to easier access to data. IoT can provide information on for example delivery performance, whereas big data can gather data on supplier performance and thereby be used in performance measurements. (Nicoletti, 2020). By using AI, many different factors can be measured and updated in real-time, such as quality and delivery. Some companies can

also see their performance from the suppliers' point of view (Allal-Chérif et al., 2021). Cloud computing gives a broader access to information and different tools, such as big data and AI. This simplifies the sharing of data in the organisation and thereby also the possibility to observe the performance of different partners (Nicoletti, 2020).

3.4.12 Digitalisation and procurement framework

To provide an overview of the different technologies discussed in this chapter, they are categorised in the purchase process model, see Figure 3.6. The technologies are placed according to where in the process they are applicable.

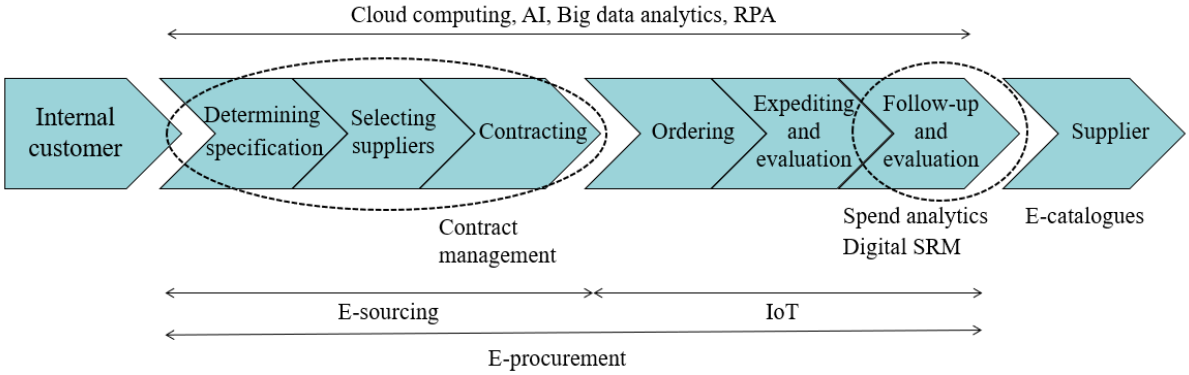

Figure 3.6 Categorisation of different technologies in the purchase process model.

3.5 Process change

Several models exist that can be applied to accomplish successful process change. This section covers some models that are relevant to the digitalisation of processes at Axis sourcing department. Hence, specific models covering both process change, and digitalisation are described. The analysis of the thesis is facilitated by applying these process change models.

A process is according to Cambridge Dictionary (2021) a series of actions taken in order to realise an objective. A business process is consequently defined as a series of actions taken to produce a product or service (Mohapatra, 2013). The current business environment requires companies to constantly improve, and change is a vital part of this improvement (Kasim et al., 2018, Mohapatra, 2013). Several business process change initiatives, such as business process reengineering (BPR), Six Sigma or business process management (BPM), have emerged in the last 30 years. The desired outcome of business process change is the increase of both efficiency and adaptability, which in turn can lead to increased competitiveness (Harmon and Trends, 2010, Kasim et al., 2018).

Several of the process change initiatives are described with a cyclic model. The different stages vary slightly between the initiatives, however the models do resemble each other, see Figure 3.7. The stages of BPR and BPM can also be compared with define, measure, analyse, improve and control, which are the five stages of Six Sigma (Chakravorty, 2009, Dumas et al., 2013, Mohapatra, 2013).

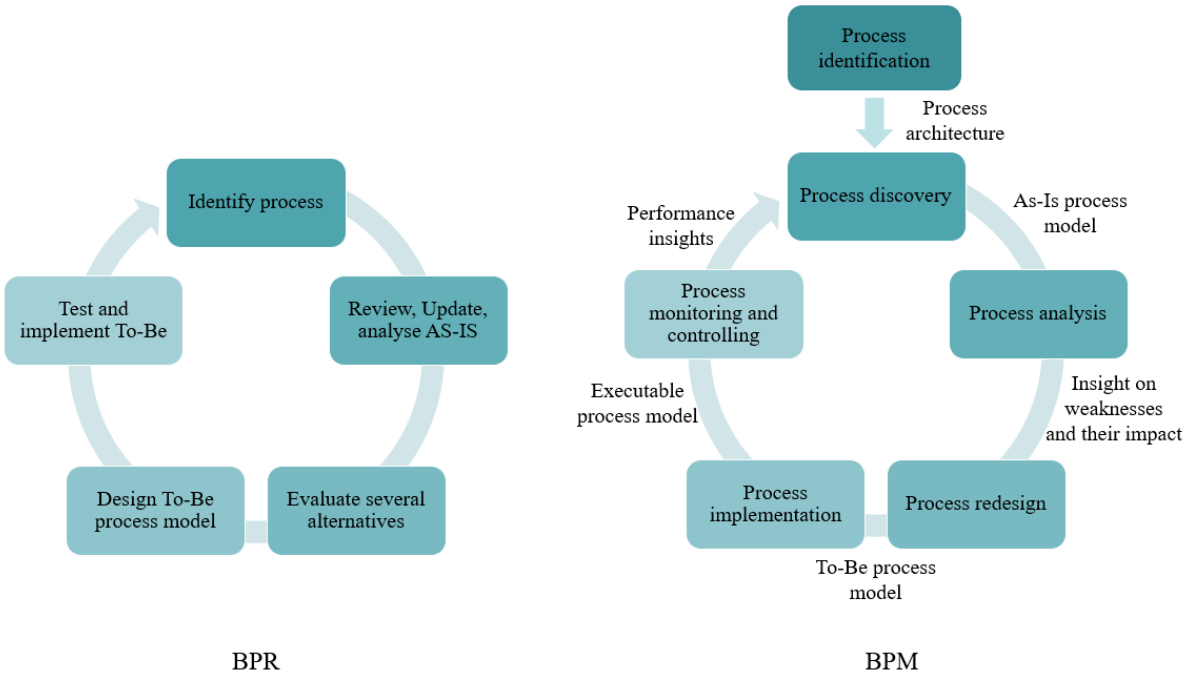

Figure 3.7 The BPR and BPM cycle (Dumas et al., 2013, Mohapatra, 2013).

The change initiative starts by identifying and delimiting processes related to a business problem. This leads to an updated process architecture, displaying a holistic picture of the processes and their relation. The current processes are then documented and analysed in order to determine their underlying issues. Multiple changes that could help address these issues are identified, analysed and compared. The most promising changes are combined into a to-be process model. The activities and changes needed to move to the redesign process are planned, prepared and performed. To determine how well the new process is performing, relevant data should be gathered and analysed. The cycle needs to be repeated continuously as new issues may arise in the same or other processes (Dumas et al., 2013, Mohapatra, 2013). Further information on how to document and model processes can be found in *3.6. Process mapping.* Due to the scope of the thesis the process change models were only used until the development of the to-be processes model.

3.5.1. Prioritising of processes

When deciding which processes to redesign and in which order, they need to be prioritised. Several methods for prioritisation exist (Ohlsson et al., 2017), which were developed when the need to rank different requirements arose. Prioritisation is also used when discussing trade-offs (Botta and Bahill, 2007). One method is to prioritise according to three criteria, which are described in Table 3.7 (Bhaskar, 2018).

Table 3.3 Three criteria for prioritisation (Bhaskar, 2018).

Criteria	Explanation
Dysfunction	Dysfunction relates to the processes with the most problems and thereby needs to be changed first. Examples can be processes that involves transferring of data, duplicate work or complexity.
Importance	Importance describes how important the processes are for the company and its customers. To evaluate this, companies can decide which factors that are most important to the customers, and match that with relevant processes. Thereupon, a priority list is received.
Feasibility	Feasibility relates to how likely the change is to succeed. For example, a larger project may result in a higher reward, but is less likely to succeed due to all factors involved.

Heberle et al. (2017) introduces a model in their case study, which describes how the execution of a project relates to business benefit and implementation effort. In the model, different projects can be categorised according to low, medium and high effort and benefit, see Figure 3.8. Smaller projects are easier to implement, and therefore have low benefit and low effort. These projects are called quick wins, and it can be a good idea for a company to start with these implementations. Larger projects come with greater benefits, but the risks of failure or not finishing are higher. These should therefore start early and be divided into parts with their own separate objectives.

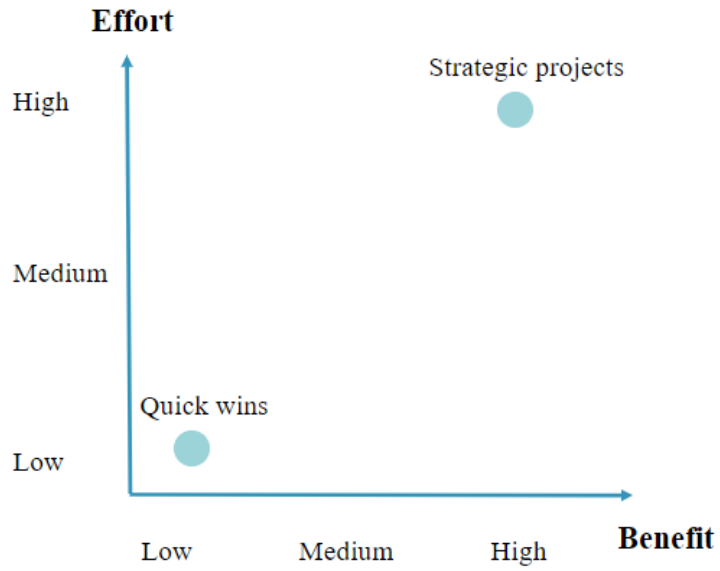

Figure 3.8 Assessment of benefits and efforts of a project (Adapted from Heberle et al. 2017).

3.5.2. Digitalisation and process change

For several years a significant part of BPM has consisted of automated or software-controlled processes. New technologies and digitisation can improve business processes and create new opportunities and business models (Heberle et al., 2017). For a company to attain digitalisation of their business processes several projects and initiatives must be planned and realised (Richard et al., 2020). As digitalisation affect the entire supply chain all processes and sub-processes are possible contenders to improvement (Heberle et al., 2017). Due to the number of improvement possibilities and projects needed to reach digitalisation an approach or management strategy is required to categorise and prioritise (Heberle et al., 2017, Richard et al., 2020). Some general models for process categorisation and prioritisation are presented in *3.5.1. Prioritising of processes*, however there are models specifically developed for digitalisation.

Heberle et al. (2017) proposes a general approach to identify digitalisation activities and define projects, the digitalisation canvas, see Figure 3.10. The digitalisation canvas together with interviews and workshops are used to identify improvements and break them down into implementation projects. The results from interviews with employees within the value chain are documented in the digitalisation canvas. Which then is reviewed by experts from the company and finalised in a workshop conducted with a cross functional team. The final project portfolio contains a rough estimation and prioritisation of the identified projects (Heberle et al., 2017).

The business perspective of the digitalisation canvas is represented by the top two tiers of the digitalisation canvas. Heberle et al. (2017) suggest using the business model canvas to provide input on vision, value proposition, threats and issues. The three middle tiers represent the improvements that can be achieved through digitalisation. Digitalisation benefits can be realised through implementation of useful features, using a data science approach or new digital business models. Data sources are utilised for process and business improvement and can be categorised as useful/available or desired but not available. The *Improvements through digitalisation* part of the framework can be structured differently depending on the case. The last section of the digitalisation canvas represents the project portfolio and its categories. The projects are categorised with the help of the effort versus benefit matrix, see Figure 3.9 (Heberle et al., 2017).

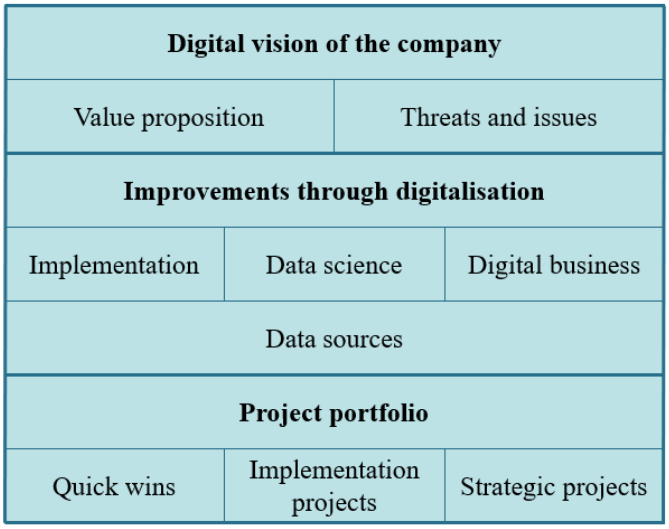

Figure 3.9 The digitalisation canvas (Heberle et al., 2017).

3.6 Process mapping

Process mapping is a tool which facilitates the description of processes within an organisation, by using workflow diagrams (Hunt, 1996). As previously mentioned, van Weele's purchase process model will lay the foundation for an understanding of the activities performed by Axis sourcing department. However, process mapping will be used to describe specific internal processes in detail. By mapping processes, existing processes can be improved, or a new structure can be implemented. The mapping reveals which process that would benefit from changing or being eliminated (Hunt, 1996). A business process can be seen as the steps taken to deliver a product or service (Soliman, 1998). Processes may be isolated to a specific function, nevertheless most processes are cross functional (Hunt, 1996). Process mapping generally follows three steps (Soliman, 1998):

1. Identify processes related to products or services. The process starting and end point is also identified.
2. Data collection.
3. Visualising the data in order to identify bottlenecks, delays and inefficiencies.

Two types of process maps for process reengineering are As-Is and To-Be mapping (Hunt, 1996, Okrent and Vokurka, 2004). The As-Is mapping describes the processes in the current situation. It can be constructed in order to solve a problem by eliminating work that is non-value adding. The To-Be mapping is made to display how the business should be run in an optimal setting. The To-Be mapping is made by analysing processes that can be improved (Okrent and Vokurka, 2004).

3.6.1 Flowchart

A flowchart is a type of workflow diagram which graphically describes the activities needed to create a specific output (Damelio, 2011). Bekaroo and Warren (2016) points out that the flowchart also depicts the connections between different stages of a process. The flowchart consists of a set of symbols and connections that gradually describes the process (Bekaroo and Warren, 2016). These symbols are further described in *3.6.3. Process notations.*

3.6.2 Swimlane diagram

Swimlane diagrams have become a popular tool for business process engineering. They can for instance be used to structure and facilitate validation of flowcharts (Burns, 2007, Jeyaraj et al., 2014). The defining characteristic for swimlane diagrams is the definition of user roles for the workflow. Each actor or department involved in the business process is represented by its own swimlane. All activities executed by a specific actor or department are positioned in the corresponding swimlane (Jeyaraj et al., 2014). Thereby, showing what is done, by who and in what order (Burns, 2007). The top lane of a swimlane diagram should be reserved for the actor or process which initiates the depicted process (Harmon and Trends, 2010). The creation of a swimlane diagram is an iterative process, where input is needed from the source of information. The iteration should only be performed a couple of times, as focus otherwise shifts to trivial details (Burns, 2007).

3.6.3 Process notations

Notations are used to describe different steps of a process. It is important that the same notation is used within a company, so that everyone can read and understand common process maps. Historically, many different notations were used for flowcharts (Harmon and Trends, 2010). However, some common notations have emerged, for example the business process modelling notation (BPMN) and American national standards institute (ANSI) (Chapin, 1970, Harmon and Trends, 2010). ANSI can represent both algorithms and systems, however the focus differs between the two. When representing algorithms, the focus is on the data transformations needed to create an output. While for systems the focus is on the input and output created by a series of procedures (Chapin, 1970). BPMN is used for process modelling and can sometime result in a smaller diagram, due to the expressive notation (Long, 2014). In Figure 3.10 the notations for both ANSI and BPMN can be seen. Due to the characteristics of the notations and the use of process modelling in the thesis, BPMN was deemed to be the most suitable notation.

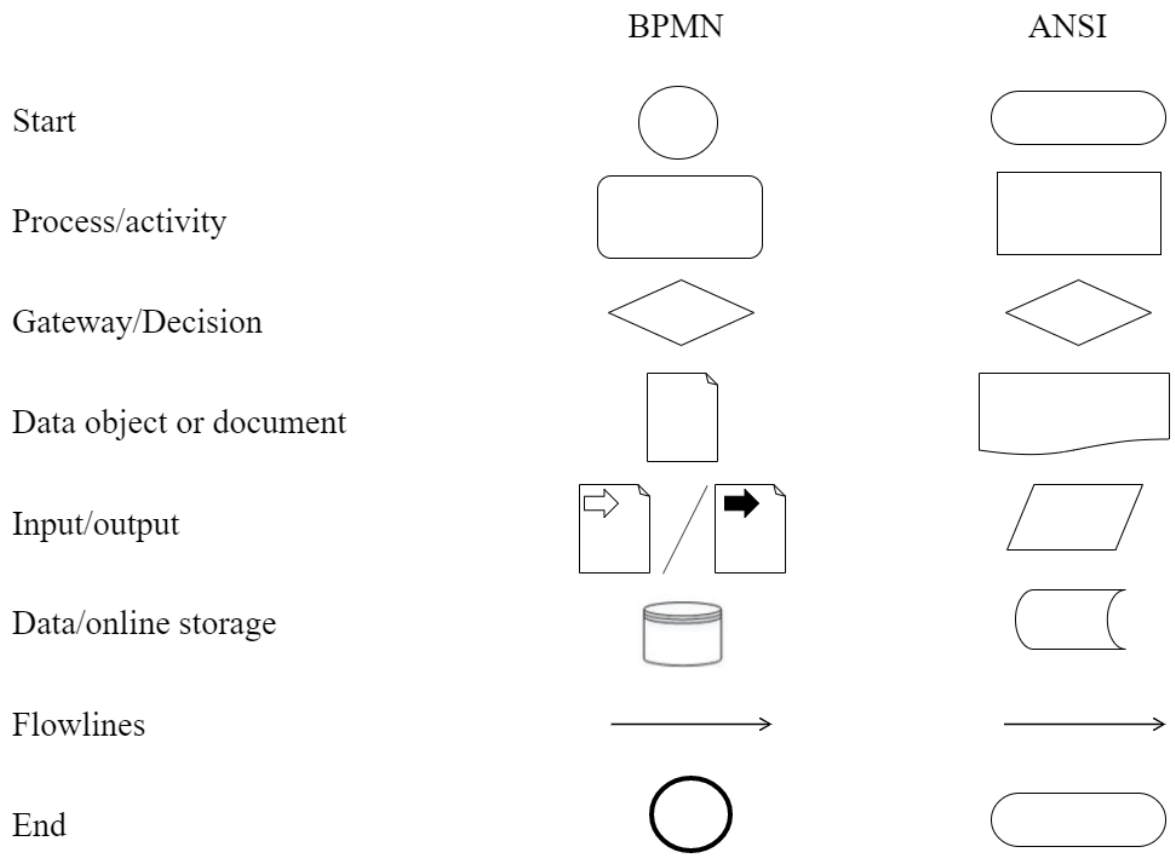

Figure 3.10 Notations for BPMN and ANSI diagrams (Chapin, 1970, Harmon and Trends, 2010, von Rosing et al., 2015).

3.7 Theoretical framework

Figure 3.11 provides both an overview of the literature review and a base for the data collection and analysis. The research questions are related to different parts of the literature, see Figure 3.11. RQ1 is a prerequisite for RQ2, which in turn is a prerequisite for RQ3.

In order to answer the research questions, several phases of the process change models were covered. RQ1 represents the identification of sourcing processes, RQ2 the process analysis and redesign and RQ3 the analysis of the redesign and its impact. Therefore, process change theory is connected to all three research questions. An understanding for sourcing and common sourcing activities were necessary to understand the sourcing processes at Axis and how they relate to each other. However, as RQ1 is a prerequisite for RQ2 and RQ3, sourcing theory will pervade the thesis. In order to increase efficiency and analyse ease of implementation, an understanding of digitalisation technologies relating to sourcing were imperative.

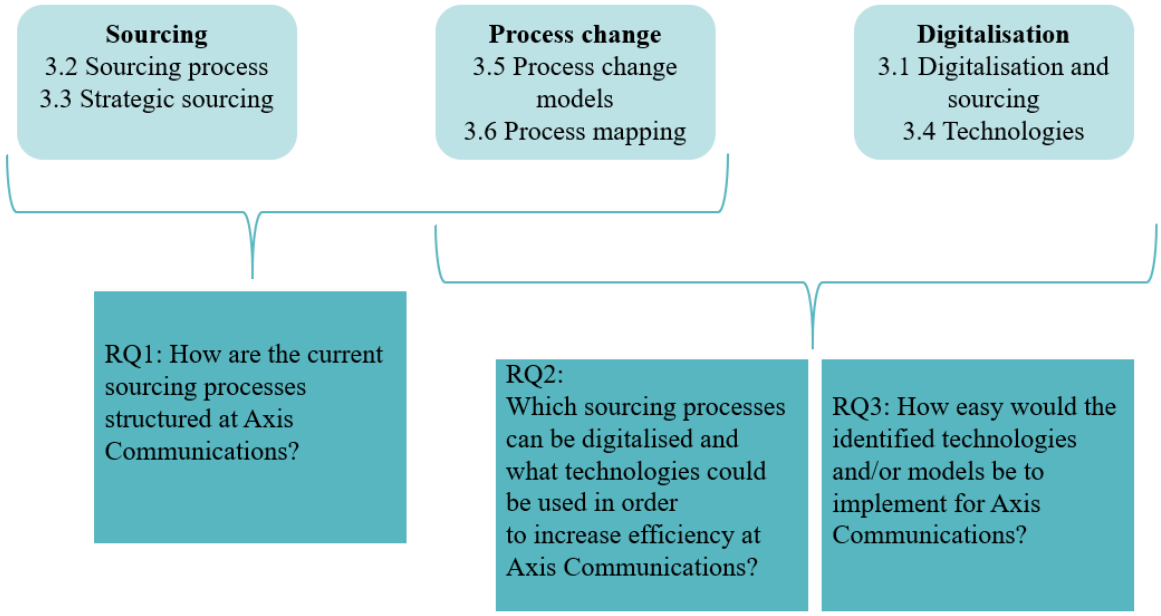

Figure 3.11 Theoretical framework depicting the connection between the literature review and the research questions (Source: own).

4. Empirical data

This chapter describes the empirical findings for the thesis. Firstly, the sourcing department, their different processes, supplier rating, current information systems and ongoing projects are described. This is followed by the identified digitalisation opportunities based on the interviews and thereafter the results from the survey. Lastly, digitalisation solutions are presented.

4.1 Sourcing department

4.1.1 Sourcing department in general

Axis supply chain consists of five phases: plan, source, make, deliver and reverse. The planning phase includes the planning and forecasting of customer demand. The second phase concerns the sourcing of components from suppliers and Electronic manufacturing services (EMS). The making phase consists of product planning, assembly and consolidation, which are all performed at Axis Configuration and logistics centres (CLC). Deliver includes the delivery and customs clearance for Axis distribution orders. The last phase, reverse, is the return, repair or scrap of Axis products which is done through the Return material authorization (RMA) partners. Figure 4.1 depicts Axis supply chain, the actors involved, and the five phases. The arrows in Figure 4.1 represents the flow of goods within the supply chain. The EMSs mainly purchases components directly from the component suppliers. Axis has their own CLCs, where some components are kept in stock. Furthermore, components which are found critical can be bought by Axis and stored at the CLCs, and then sold back to an EMS if needed. The products are not sold directly to the end users by Axis. Instead, they work with distributors and resellers who are responsible for delivery to the end users.

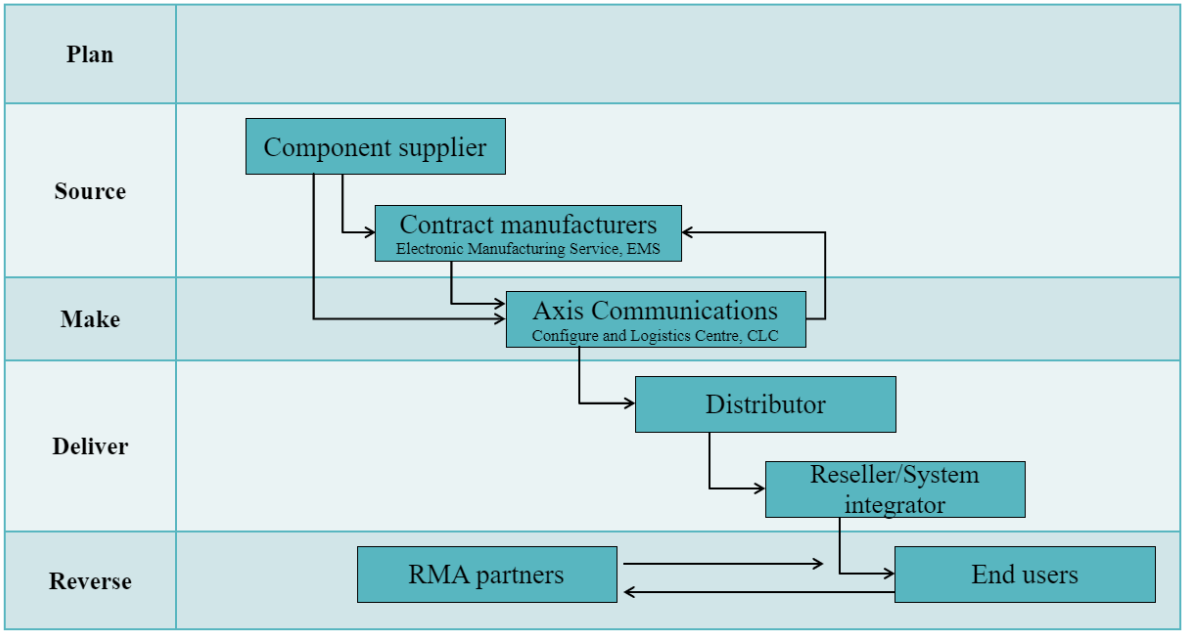

Figure 4.1 Axis supply chain design and product flow divided into the five phases of the supply chain.

The sourcing department strives to maximise their contribution to Axis goals of cost, quality, technology and growth. An optimal supplier base can support these goals by reducing supply chain costs, maintaining quality standards, minimise risk and having a high service level towards R&D. To achieve and maintain an optimal supplier base, the sourcing department finds new suppliers, develop existing ones and maintain relationships, all in line with their sourcing strategies. These strategies include: working long-term and proactive, consider customer value, systematic and structured risk management, considering both market intelligence and technology. The sourcing department is also responsible for establishing purchasing agreements, terms and price with both new and existing suppliers. The main activities of the sourcing department can be seen in Figure 4.2.

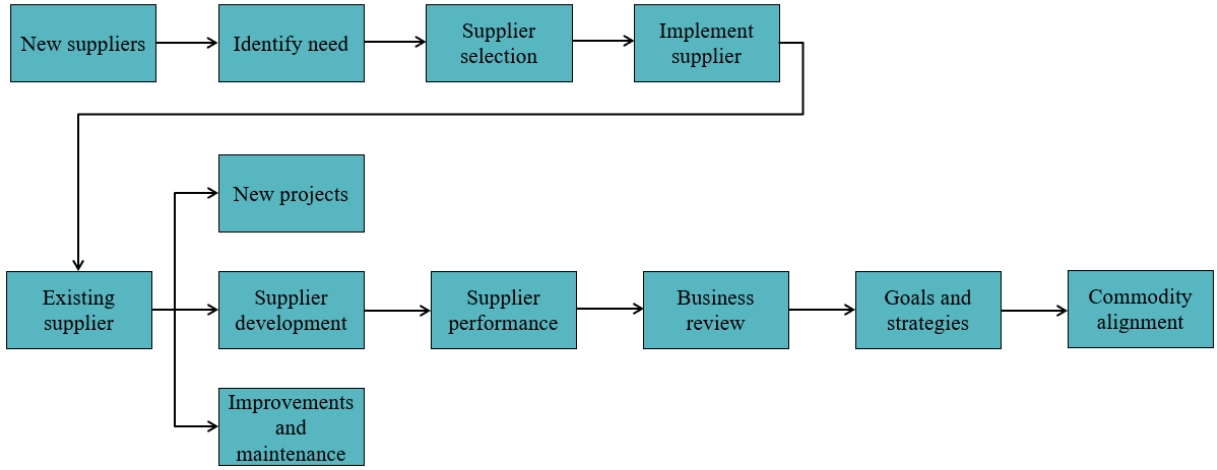

Figure 4.2 Axis sourcing process.

4.1.2 The sourcing department

The sourcing department at Axis is organised in two teams, Mechanics and projects and Electronics and manufacturing, which in turn consists of multiple commodity areas. An organisational diagram of the sourcing department can be seen in Figure 4.3. The project purchasers and sourcing engineers work in all areas and are therefore not assigned to a specific commodity, except for optics. The project purchasers instead focus on a specific product group, for example extended video projects, fixed camera, pan-tilt-zoom etc.

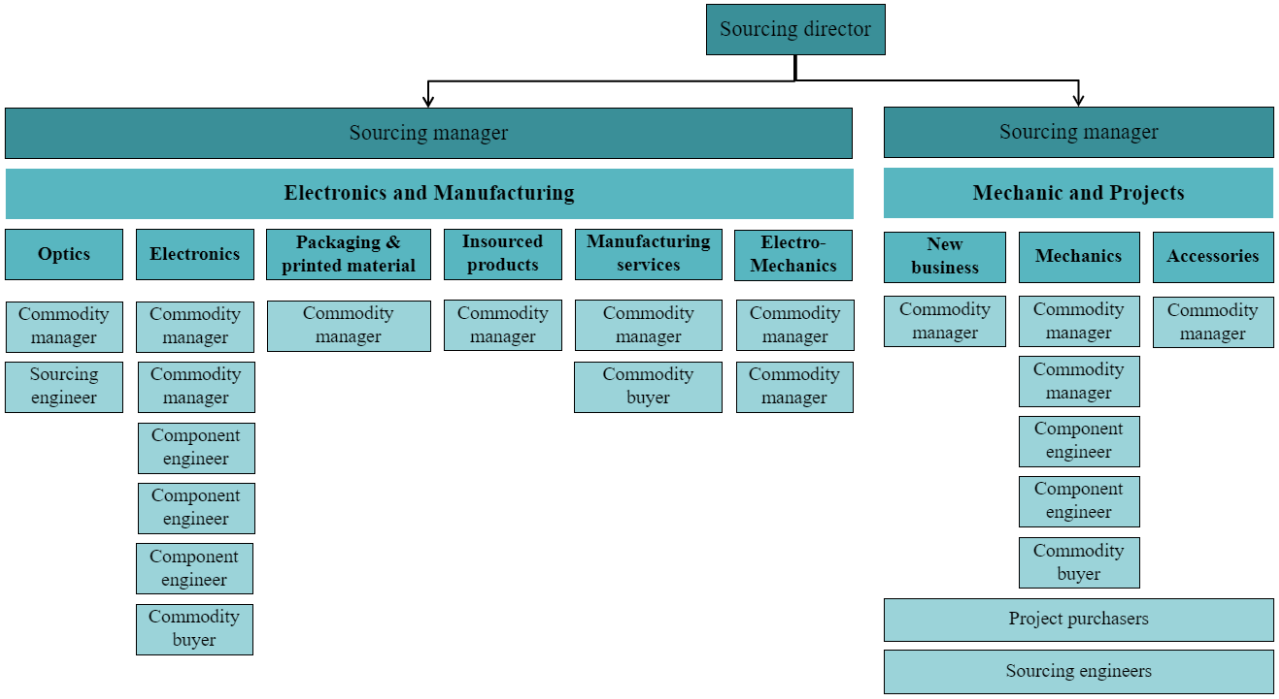

Figure 4.3 Organisational chart depicting the structure of Axis sourcing department.

There are six different roles at Axis sourcing department, each with their specific responsibility area. The six roles are described in Table 4.1.

Table 4.1 Descriptions of each role within the sourcing department.

Role	Description
Sourcing manager (SM)	Responsible for managing one of the sourcing departments two teams.
Commodity manager (CM)	Responsible for the development and maintenance of an optimal supplier database, which will contribute to Axis goals on growth, technology, quality and cost. The link between Axis and suppliers throughout the entire product lifecycle.
Commodity buyer (CB)	Supports the commodity team trough tasks related primarily to the volume phase. The volume phase includes products from product introduction until phase out. Close cooperation with both internal and external stakeholders.
Component engineer (CE)	Responsible for keeping the component database up to date. Also find and evaluates second source options for components. Responsible for either mechanical or electric and electromechanical components. Primarily works with products and components in the volume phase.

Project purchaser (PP)	Responsible for sourcing related matters in product development projects. These projects span from concept phase until part approval and have a time horizon of around one year.
Sourcing engineer (SE)	Working from Malaysia, China or Japan. The connection between HQ and local suppliers. Their responsibilities are similar to PPs, however they also aid CM with regional matters.

Employees with different roles at Axis sourcing department primarily work within one of three processes. These processes relates either to a specific part of the product lifecycle or to a specific kind of product. These processes are the commodity management process, the hardware product development process and the sourced product development process. The commodity management process is performed by the CMs throughout the entire product lifecycle, from product development until end of life. The CM uses the process while focusing on a specific commodity and the related suppliers. The hardware product development process is performed by the PP during the development of new products. The process focuses on a specific product and the activities related to bringing that product to the market. However, for some strategic activities such as finding new suppliers and supplier selection, the CM responsible for the relevant commodity is involved. The sourced product development process is performed when an Axis product is based on an existing supplier product. This process together with the commodity management process is performed by the CMs responsible for insourced products and accessories. Below all three processes are described further.

4.1.3 Commodity management process

The commodity teams work according to the commodity management process, which can be seen in Figure 4.4. The process consists of seven steps, with an ongoing risk management involved in all of them. The commodity teams are cross-functional teams of different sizes and roles depending on the commodity. The teams are joined with employees from other departments, such as R&D, Quality and Supply.

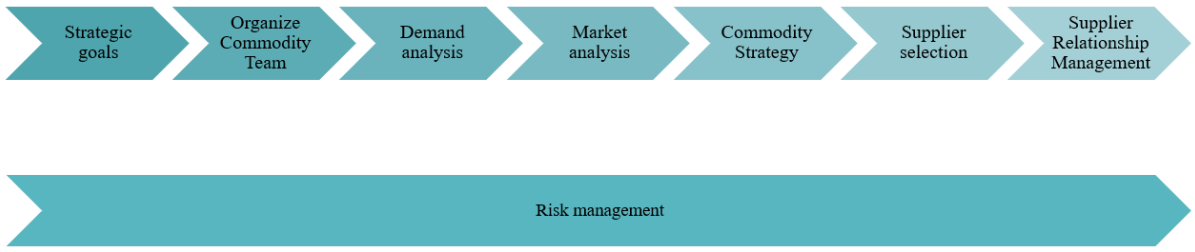

Figure 4.4 The commodity management process.

Each one of the phases within the commodity management process includes several other steps, see Figure 4.5. This is a general commodity management process, but the process steps can vary between different commodity teams.

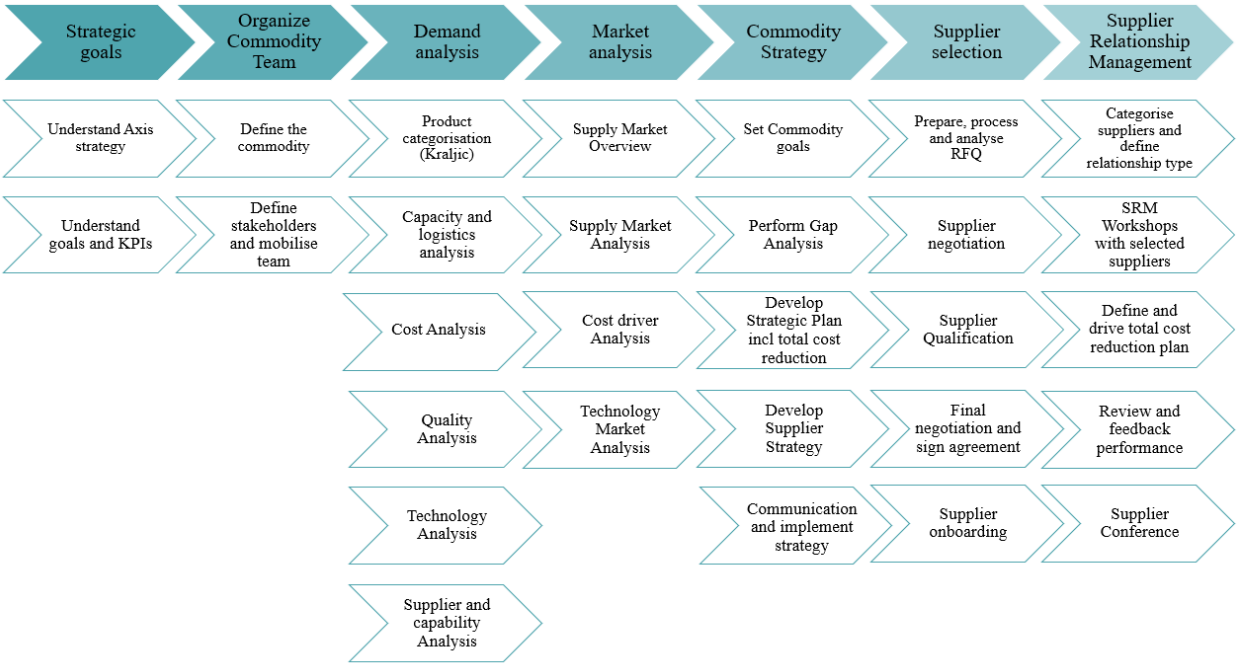

Figure 4.5 Different actions within the commodity management process.

4.1.4 Hardware product development process

When developing new products within Axis the hardware product development process (HPDP) is followed. The process is initiated after a pre-study has been executed, critical resources are available, and a project manager is assigned to the project. The project then spans from the concept phase until part approval, whereafter it is handed over for volume production. The HPDP team is a cross functional team and consists of a project manager, industrial lead, quality engineers, R&D personnel, production engineers and a product purchaser. The PPs objective within the project is to minimise cost of goods sold (COGS), optimise components supply base, minimise the project ramp up time and be proactive regarding risks from suppliers. The PPs activities during each phase of the HPDP can be seen in Figure 4.6.

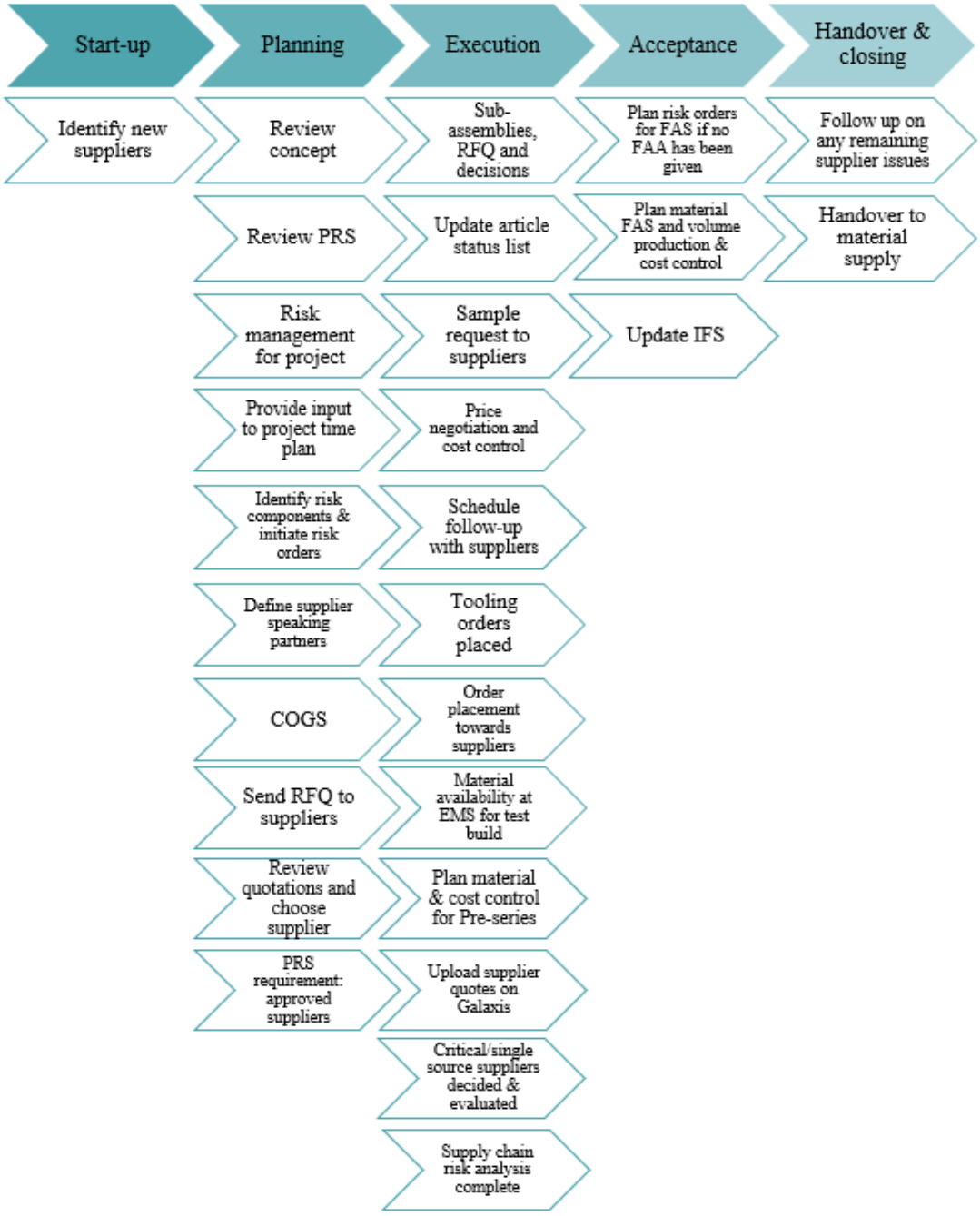

Figure 4.6 The five phases of HPDP and the PPs activities within these phases.

4.1.5 Sourced product development process

The sourced product development process (SPDP) is used when an Axis product is based on an existing supplier product. There are three different project types depending on if and how the product is modified. Axis can either specify a product and order its development, the product can be bought off the shelf with the possible addition of an Axis logo or the product bought can be used for a different purpose than at the suppliers. The project is managed by a cross functional team, which includes departments such as mechanics, electronics, quality, sourcing and a project manager. The phases of the SPDP can be seen in Figure 4.7, the pre-study is related to but not included in the project. The commodity areas using the SPDP are

accessories and insourced products. The CM is primarily involved in the pre-study phase, as this is when suppliers, price and risk are evaluated. During the start-up phase the CM is responsible for negotiations and contracts. Throughout the remainder of the project the CM manages the relationships, connection and evaluation of suppliers.

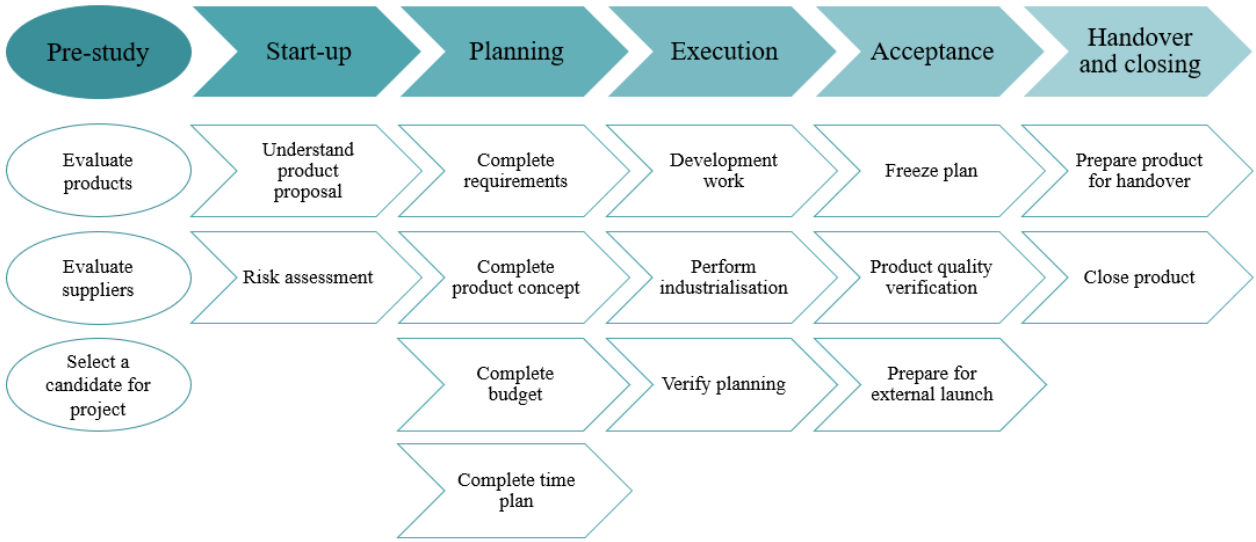

Figure 4.7 The phases of the HPDP process.

4.1.6 Supplier rating

Axis supplier base are classified into different categories, which can be seen in Figure 4.8. The purpose of the categorisation is to optimize the supplier base, develop supplier performance in current products and give opportunities for new businesses to certain suppliers. The strategic suppliers are those who are beneficial to increase competition. Preferred suppliers are the category where it is rewarding to source a large volume of products. To maintain flexibility in the supplier base, certain suppliers are categorised as approved. These are useful if another supplier experiences difficulties or if the preferred supplier base needs to increase. When new suppliers are tested, they are placed in the phase in category. The following phase is approved or under observation. Under observation consists of suppliers who are underperforming and will be phased out if they do not increase their performance. A potential supplier base is kept if there are any problems with the existing suppliers. If a supplier is banned, nonapproved actions have occurred.

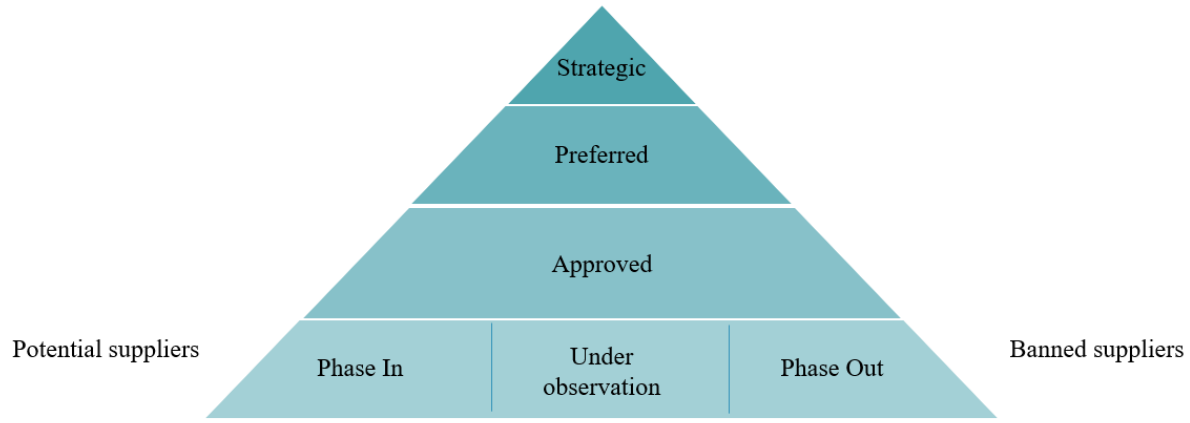

Figure 4.8 Supplier classification.

4.1.7 Current information systems

The sourcing department are currently using several systems for information sharing and data storage. The systems have different purposes and further explanation of each system can be seen in Table 4.2.

Table 4.2 The information systems used at Axis sourcing department.

System	Explanation
Galaxis	Galaxis is an internal site for all employees at Axis. Suppliers can have access to some parts of Galaxis. The sourcing department uses Galaxis to upload internal documents, such as documents about processes, Excel files with supplier information etc.
IFS	IFS is a kind of ERP system used for supplier management. IFS is used to find suppliers, update information about prices etc. The system is also used by other departments at Axis, such as Material Supply, who uses it for ordering and invoices.
Qlik	The application used in Qlik is Spend Tool. This tool is used to find both historical and forecast data regarding spending for different suppliers and components.
Windchill	Windchill is a Product Data Management (PDM) system. New parts are created in Windchill, and all information about the part is stored here. The information is sent to IFS and Camel when the part is finished.
Camel	Stores information about parts, and the EMSs have access to Camel.

4.1.8 Ongoing projects

Axis is always looking for ways to improve current processes and there are several ongoing improvement projects. The projects described in Table 4.3 were the ongoing improvement projects at Axis sourcing department during the time of the thesis. The digital signature project was launched in April 2021, while the rest of the projects were not yet launched during the timeframe of the thesis.

Table 4.3 The current improvement projects at Axis sourcing department.

Projects	Explanation
Digital signature	In order to decrease manual handling and increase efficiency, digital signatures can be used when signing documents. Previously agreements and contracts were signed manually and sent via the post. The system DocuSign will enable documents to be signed and sent digitally.
Mammut	The Mammut project consists of two parts, product change management and traceability. Within product change management, information such as the supplier of a part and approved vendors will be added to Windchill. Internal and external users will be able to see and work with Windchill data through customised apps, and it will replace Camel. These changes will make supplier data more accessible. The second part of Mammut will increase the traceability within Axis supply chain. This will include increased knowledge on availability in CLCs, the return flow, etc. Increased traceability will for example make the identification of root causes for quality issues quicker and facilitate the mapping of affected products.
Monster	The Monster project is investigating integrated business planning, specifically the visibility regarding EMSs stock, order and forecast information. This information is currently received from the EMSs through Excel sheets. More information on the current process can be found in *4.2.9 Stock at EMSs*. To improve the process, the aim for the Monster project is to create a system or method to process the data received by the EMSs, create a data storage and an application to analyse the data. This will increase the supply chain visibility and facilitate various sourcing decisions. The long-term goal is to implement EDI-connections to all EMSs and an integrated business planning application.
Digital RFQ	RFQs are currently handled via e-mail, with an attached Excel sheet for pricing, minimum order quantity (MOQ), etc. Suppliers fill in the Excel sheet and respond by e-mail. The comparison between RFQs is done in Excel. The digital RFQ project investigates the possibility to implement a digitalised RFQ solution. This would decrease manual handling and increase efficiency. The solution will facilitate the preparation, distribution and analysis of RFQs.

Supplier performance management	Currently there is no common system for supplier performance management. Instead, Excel sheets are used to evaluate suppliers. In the supplier performance management project, the supplier evaluation will be standardised. Surveys for suppliers and Axis employees will be constructed from a database with questions. The survey result will be connected to an analysis tool, in order for the information to be compiled and presented to suppliers.
Risk management	The risk management project aims to implement a standardised tool for risk management. Risk management is currently mentioned in the commodity management process, and risks are assessed by using an Excel template. The new process will involve workshops, a risk template at Galaxis, an application in Qlik and business cases. This will provide a broader and more extensive risk assessment.

4.2 Identified digitalisation opportunities based on the interviews

The information gathered from the interviews led to twelve different processes that could benefit from being digitalised. These processes are numbered and categorised in the purchase process model, see Figure 4.9. The interview guide was structured according to this model and the categorisation is based on information that was collected during the interviews. Some processes could not be categorised in the original model. Therefore, two new categories were created based on the information collected during the interviews. The new categories are information sharing and data storage, see Figure 4.9. Information sharing includes both internal and external information sharing, and data storage relates to how and where information is stored. Each one of the processes and why they are an opportunity for digitalisation will be described more in this section. The structure of this section is based on Figure 4.9, starting with the opportunities to the left and working its way to the right.

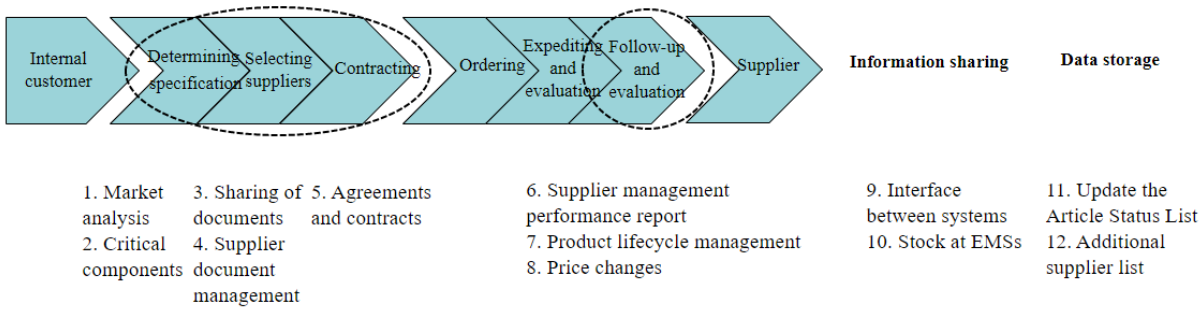

Figure 4.9 Categorisation of different digitalisation opportunities in the purchase process model.

1. Market analysis

A market analysis describes the current state of the market and future trends. Market trends can be found in a report at Galaxis, which is updated quarterly. The document describes a general market overview and additional overviews on freight and different product groups, both from a regional and global perspective. An additional quarterly report with global and regional lead time trends is uploaded at Galaxis. The document also provides lead time trends for different

product groups. It is up to each employee to read the relevant documents and use it in their everyday work. As the report is only updated quarterly each employee also needs to gather information on current events and changes in trends.

2. Critical components

A critical component is a component which either have a small ordering quantity or have zero quantity for the coming three months. To find critical electronic components, an Excel document with a macro calculates if the component is critical or not. These components are important in order find and secure material in advance. The spend forecast for the three coming months is compared to a fixed warning quantity and if the forecast quantity is lower than the critical limit, the component is critical. Firstly, the BOM for a product is downloaded from Windchill, in order to detect which components that are a part of the product and to receive additional comments about design risk from R&D. Secondly, data regarding spend is downloaded from the Spend Tool, the data extends from the last seven months up until 13 months into the future. In the last step the macro uses this data to calculate critical components. A more detailed process map can be seen in Figure 4.10. This process can be time-consuming and there is also risk for human errors since data is downloaded from two systems.

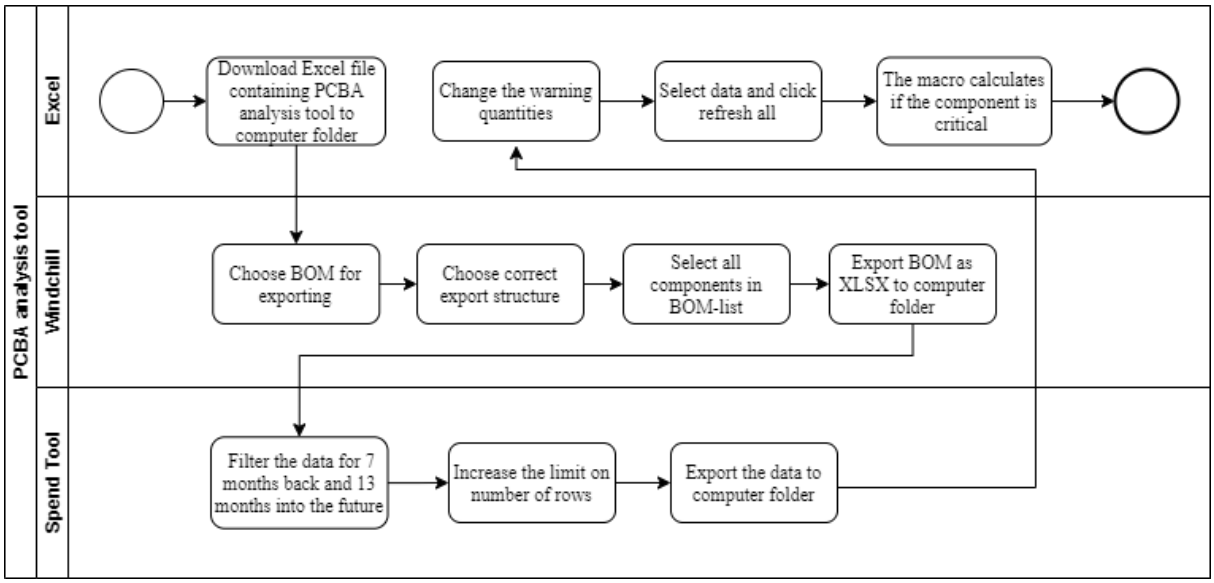

Figure 4.10 Process map describing how to find critical components.

3. Sharing of documents

During the daily work, several documents are shared both externally and internally. These documents contain varying information and are usually shared by e-mail. One example is during the new supplier evaluation process, where a considerable number of documents needs to be sent out to the supplier. Several of these documents should also be received back from the supplier. Examples of documents that are sent are non-disclosure agreements (NDA) and code of conduct, all documents can be seen in Appendix D. As the documents are shared by e-mail, there is a considerable risk that they are down prioritised or forgotten if not saved immediately.

4. Supplier document management

As mentioned above, several documents are sent out and received during the new supplier evaluation process. There is currently no system or standardised process that keeps track of which documents has been sent out or received. Instead, some employees have information regarding this in personal documents on their computers. Therefore, other actors involved in the process do not have any information on the progress. There is also a risk that there is no follow up on missing documents.

5. Agreements and contracts

The sourcing department have several agreements with suppliers, such as NDA and contracts. Some of these agreements are stored on Galaxis and others are stored at Axis legal department. If the agreement is stored at the legal department, employees need to send them an e-mail in order to receive the agreement. Some agreements are also stored by the employee on their computer or kept in their e-mail inbox. The contracts are categorised and have an expiration date. There is no automatic reminder for expiration of agreements, therefore, there is a risk that the renewal of an agreement is missed.

6. Supplier management performance report

The supplier management performance report is an Excel document that can be found at Galaxis. It is used to evaluate the performance of suppliers by scoring different factors. The factors are a part of one of the five categories: delivery, service, price, quality and technology performance. The performance evaluation is executed once every half year and the score is compared to the previous score. There are both objective and subjective measurements. The objective are numerical measurements, such as the percentage of deliveries that are on time. The subjective are measured in a scale from poor to excellent, one example is if communicated promises are kept. Data for this is gathered from example the EMSs or other departments at Axis. The purpose of the performance evaluation is to follow-up on supplier performance and discover if there are any areas that need improvement.

Even though this document exists, performance evaluation can vary between different commodity teams. For example, some have their own Excel sheets with additional questions. Thereby, there is no common foundation for performance management.

7. Product lifecycle management

Product lifecycle management (PLM) relates to the management of the different stages in a products life. Phase out is when a products volume starts to decrease, and the product is nearing its end-of-life (EOL). A products EOL describes the ending of a products lifecycle, when reaching EOL the product can either be replaced by another product or discontinued. The phase out date at Axis is internal and can change continuously, while EOL is a fixed date which is shared with stakeholders. When a forecast for a component is decreasing it should be investigated why this change is occurring. The first step is to check what products the component is a part of. After that, EOL or the phase out date for each product must be found. A products EOL or phase out date could be found somewhere at Galaxis. If it is not, information about EOL could be found at Axis external website. As phase out date is internal information it will not be displayed on the external website. The next step is instead to contact the product owner, this can also be done for EOL. Sometimes all relevant sources need to be investigated before the information is found, see the full process in Figure 4.11. Information regarding the replacement product can be found at the same place as the EOL. Since the information can be

hard to retrieve, it can be a time-consuming task to find information regarding PLM for a product There is currently only PLM information for products and no lifecycle information on components.

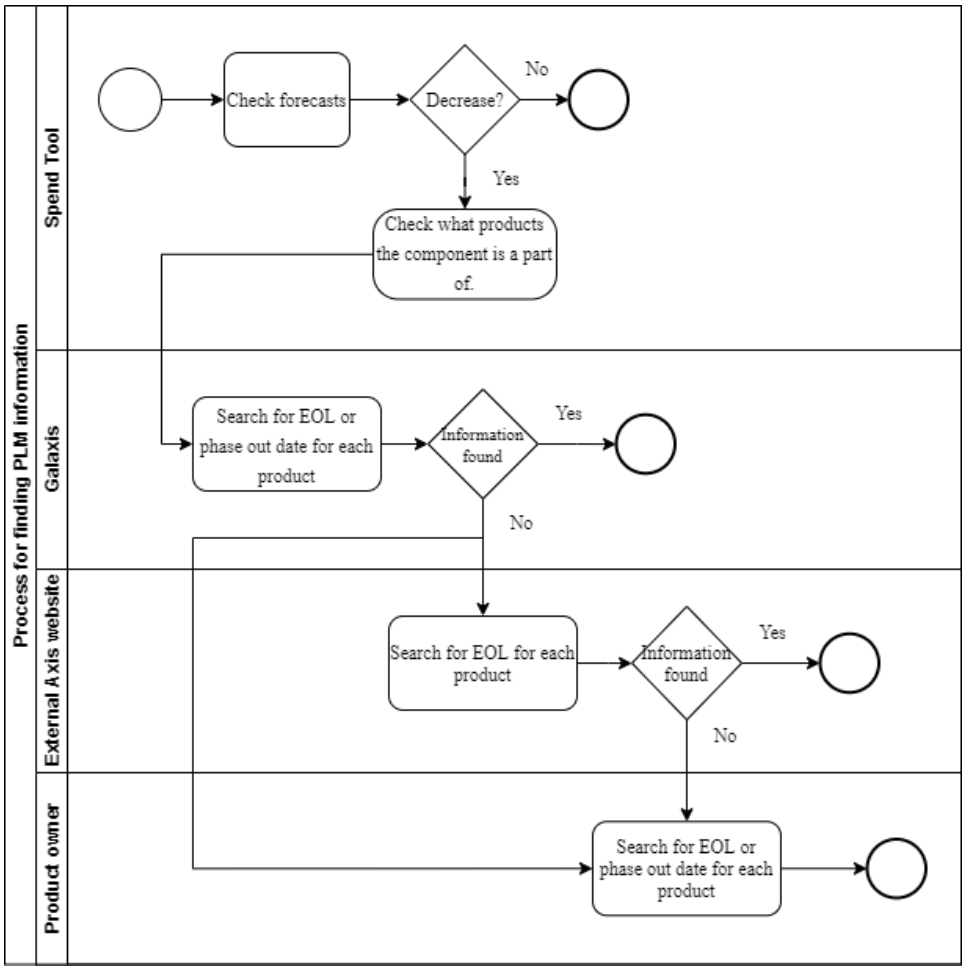

Figure 4.11 Process map describing the search for PLM information.

8. Price changes

When suppliers change their prices on parts, the information need to be changed in IFS. This is done manually by CMs. The information is received in documents from the supplier and needs to be copied and then pasted in IFS. Because of this, the information might be wrongly updated or not updated at all. This can in turn lead to problems further down the supply chain.

9. Interface between systems

Different data related to sourcing is stored in separate systems or Excel files. There is currently no common interface between these programs. Therefore, in some cases, data needs to be extracted from different systems and organised in another system, such as Excel. This is done in order to compile and analyse information from different systems. The data extraction from different systems can be time-consuming. There is also a risk for human errors when compiling information.

10. Stock at EMSs

The current stock level at the EMSs can be seen in an Excel file at Galaxis. Axis currently has an EDI-connection with two of the EMSs, however the system has low quality and functionality and have therefore not been implemented towards other EMSs. Instead, Axis receives weekly Excel files from all EMSs. These contain information regarding stock, orders and forecasts. This information is important in order to be able to analyse supply capacity. The information from these documents is compiled in another Excel file. This file is large and difficult to handle, which leads to reduced visibility.

11. Update the Article Status List

The Article Status List (ASL) is a template at Galaxis that contains information regarding parts that are currently being developed. The purpose of the list is to display all information regarding each part and assembly during a project. The list is updated by PPs during a project and is shared with other departments, such as R&D and Quality engineers, who are also updating information in the list. The list contains data regarding, for example, part number, part name, component type, supplier, unit price, tool price and MOQ.

During a project, the list is updated manually by a PP when new information is received from a supplier. This is done by copying information from supplier documents into the ASL. Some projects contain a large number of parts or require several changes regarding components. For the PP in these projects updating the list is tedious and can lead to human errors.

12. Additional supplier list

The additional supplier list contains data about components from the EMSs and information on related sub-suppliers. IFS cannot handle information regarding sub-suppliers and therefore this information is currently stored in an Excel file on Galaxis. This file is updated manually with new information received quarterly from the EMSs. The Excel file is extensive and contains around 87 000 rows at the time of writing this thesis. The file contains three different sheets with several columns, such as part number, description, manufacturer, supplier and MOQ, all columns can be found in Appendix E. To find specific information, data needs to be filtered manually in the file. Sometimes the name of the EMSs and suppliers are misspelled. Because of the need to check several spellings the search becomes extensive and ineffective. The file is used for different purposes, both in the daily work and for larger analyses. An example of daily usage is when a CM wants to check price, MOQ or supplier for a specific part number, see process map in Figure 4.12.

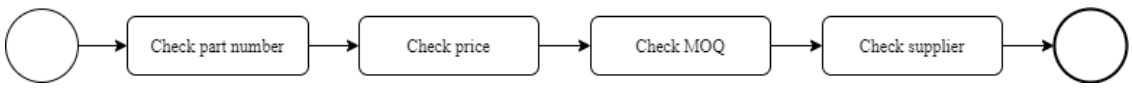

Figure 4.12 Process map describing the daily use of the additional supplier list.

Quarterly and yearly analyses are executed by using the data, such as finding, comparing, and analysing spend for EMSs and their suppliers. In these processes more data needs to be extracted from the file, see Figure 4.13. Due to the manual input of data and the needed filtration, there is a risk for human errors. The vast amount of data makes the file slow to work with and the extensive search is time-consuming.

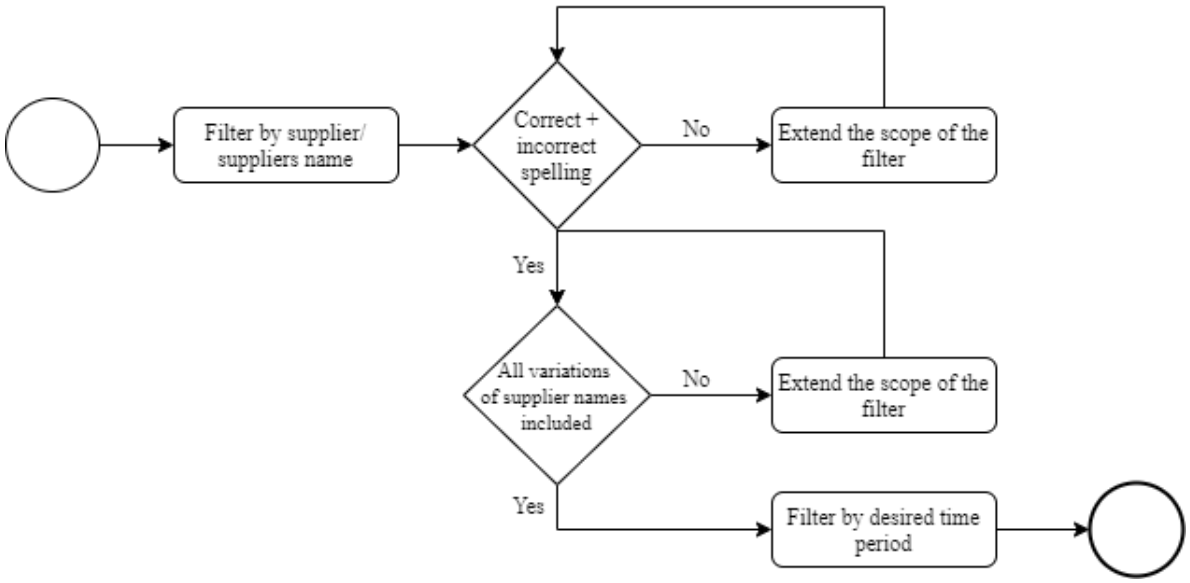

Figure 4.13 Process map describing the use of the additional supplier list when performing larger analyses.

4.3 Results from the survey

A survey was performed to ensure the validity of the interviews and to analyse the identified processes. The survey that was sent out to the sourcing department received 22 responses. All results from the survey can be seen in Appendix C. The processes were prioritised in order to facilitate the next step, which was the investigation on digitalisation technologies and systems. The prioritisation was based on how much time each process requires, how frequently the process is performed and the process current degree of usability. Table 4.4 displays this prioritisation, where the processes are categorised according to high, medium or low priority. Processes with high prioritisation are those which require a significant amount of time and has low usability. Due to the limited time frame of the thesis, the focus when searching for digitalisation solutions will follow this categorisation, with a higher focus on finding solutions for higher priority processes. However, the search for technologies relating to other processes might lead to the discovery of a solution for a lower priority process.

In addition to the processes mentioned in the section above, the survey included a question regarding implementation of a system for scorecards. A scorecard would be used to continuously measure supplier performance and provide quantitative measurements, which could be shared regularly with the supplier. The answers from the survey also brought up three additional improvement areas:

- The gathering of data to fulfil certain environmental requirements, since this needs to be assembled manually.
- Display spends for new projects, that is currently not possible to find in Spend Tool.
- Automatically send out forecasts to Axis controlled suppliers.

These ideas and the scorecard system were also prioritised and displayed in Table 4.4. Since the new ideas was not a part of the original survey, they did not have any score that could be used for ranking. Therefore, they were categorised as low priority. Another project that was

categorised as low priority, even though it was highly ranked, was stock at EMSs. This was in order to avoid duplication of effort, as information regarding the Monster project was found by the authors after the survey was sent out.

Table 4.4 The identified processes categorised after degree of prioritisation.

High	Additional supplier list
	Product lifecycle management
	Critical components
	Market analysis
	Interface between systems
Medium	Update the Article Status List
	Supplier document management
	Agreements and contracts
	Scorecard
Low	Price changes
	Sharing of documents
	Supplier performance management report
	New projects in spend tool
	Environmental requirements
	Automatic forecast to suppliers
	Stock at EMSs

The survey was divided into two different areas, one addressing current processes and one which provided suggestions for implementation of new systems. The section regarding current systems had three different questions for each process, while new systems only had one question. During the analyses of the survey, it was noted that some questions received answers which clearly displayed that a new solution would benefit the current process. One example is the question concerning interface between systems. It only received answers rating it a three or higher, where one is equal to no benefit and five is a high benefit. A compilation of the data can be seen in the chart in Figure 4.14.

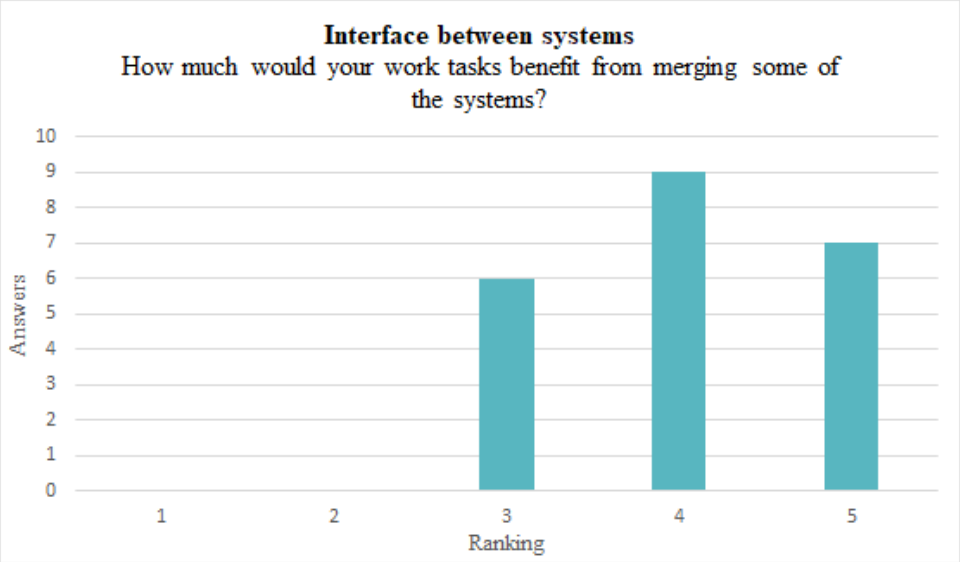

Figure 4.14 Bar chart displaying the responses to the question regarding interface between systems.

Another example of a highly prioritised process is the current process of finding critical components. For this process there were three questions: how much time that is spent on the process each time it is performed, how often it is performed and the usability of the process. The questions and responses can be seen in Figure 4.15. The answer “not applicable” is chosen if the process is not relevant for the respondents' work. The first question regarding time spent can be seen in the top left corner. It is ranked on a scale from 1-5, where one is a low amount of time and five is an excessive amount of time. The bottom graph in the figure, relating to usability, is also ranked on a scale from 1-5, where 1 is very low usability and 5 is very high usability. Usability stands for the effectiveness, efficiency and overall satisfaction for the user during the process. From these bar charts it can be seen that the identification of critical components has a medium result for the time spent performing the process, it is mostly performed weekly or monthly and have a low usability. This implies that finding critical components is a process that would benefit from being digitalised.

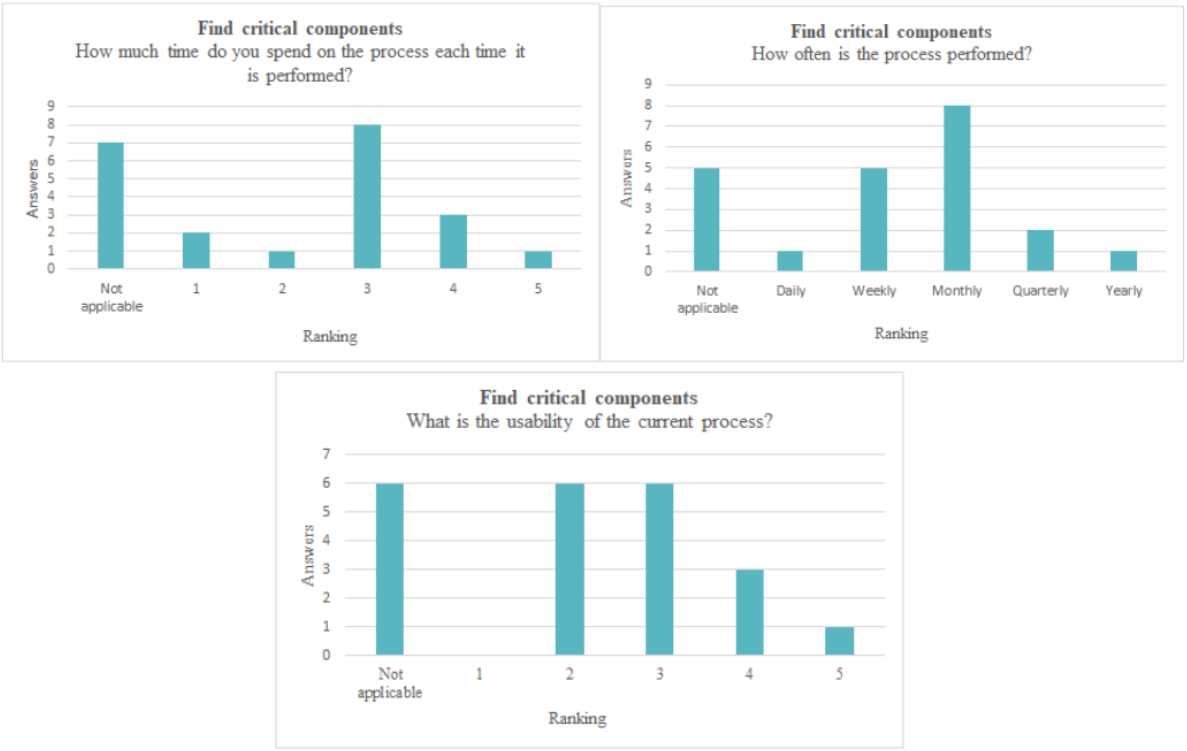

Figure 4.15 Bar charts displaying the responses to the question regarding finding critical components.

4.4 Digitalisation solutions

After the survey was compiled and the processes categorised the second part of the data collection were carried out. In the second part of the data collection, information on systems and technologies that could increase efficiency were compiled. This section describes these technologies and systems, along with other findings.

4.4.1 Sourcing site

The sourcing department are currently in contact with several system providers regarding the digital RFQ process. For all system providers, the RFQ process is a part of a sourcing site, which provides additional features that could improve some of the current processes. Examples are contract management, performance management, supplier scorecard and risk management. The functionalities described in this section are derived from the system providers Axis are in contact with. The information comes from documents and brochures that were sent from the providers to Axis. The sourcing department has compiled a short list with the system providers that fulfils Axis requirements, therefore other system providers will not be taken into consideration in this section. The system providers will be referred to as system provider A, B or C.

One area where implementing a sourcing suite can assist is handling and storing different types of documents. System provider B has a document management module. The module stores documents, provides a search function and the availability to set access for users or user groups. The documents can be linked to additional information such as keywords and categories, for

contracts this can be valid dates, signees etc. As many documents are shared during the new supplier evaluation process, a digitalised onboarding process could facilitate document sharing and handling. All system providers offer an onboarding module, where a customised supplier profile can be created and some of the tasks are shifted to the suppliers. Additionally, all system providers deliver a contract management module. The module supports contract lifecycle management with features such as storing, notifications on important dates, creation of contracts directly from RFQs and signing through DocuSign.

All system providers also have some sort of performance management module, which can gather and analyse performance data from suppliers. The modules provide KPIs which are both hard, for example delivery performance, and soft, for example willingness to cooperate. The providers offer the alternative to create customisable questionaries that can be used to assess the suppliers. The systems provide an overview of different KPIs and the possibility to easier compare the performance of different suppliers. Additionally, the system providers have a supplier scorecard, which is displayed as a dashboard containing key data for a supplier. In addition to the KPIs supplementary data from other systems can be visualised, such as financial information, to provide a broader perspective on supplier performance. The scorecard can also be shared with the suppliers.

All system providers offer a risk management module. The module provides the opportunity to evaluate supplier risks, send notifications on high-risk suppliers and the possibility to compare several suppliers. They also work with a third-party risk company, which provides data regarding market risks. The data is updated in real time with regards to factors such as natural disasters, financial, cyber or geopolitical risks.

4.4.2 Independent market analysis systems

Stand-alone systems for market and risk analysis can be provided as an alternative to the risk management module in a sourcing suite. These systems facilitate supply chain risk management by providing real time analysis on different relevant factors. These could be natural disasters, financial risks, political issues, labour strikes, cyber risks or operational risks. The system can also analyse and predict events before they happen. This is done by collecting big amounts of data from different sources and compiling and analysing it. Using this type of system allows for supplier evaluation based on real-time data (Prewave, 2021, Riskmethods, 2021).

4.4.3 Robotic process automation

Updating the article status list, identifying critical components and price changes are all manual, repetitive, error prone and involve multiple systems. CGI (2021) mentions both repetitive tasks and processes which require data from different systems among the situations which are facilitated most by RPA. Updating the article status list and identifying critical components are also tailored to Sourcing's needs and the working procedures at Axis. Therefore, it is difficult to find a suitable standardised system. However, all processes are rule-based which make them a good fit for RPA (Automation anywhere, 2021).

RPA bots are capable of tasks such as copy-paste, make calculations, analyse documents, log into and retrieve data from different systems, connect to APIs, etc. (Automation anywhere, 2021, Help systems, 2021b). RPA can extract and transport data from web pages, e-mail, Excel,

PDF, CSV, OCR and data bases (Help systems, 2021a). However, for the bot to be able to handle the information it needs to be received in a standardised format (RPA Specialist at ATEA, 2021). This means supplier information such as price changes or updates for the ASL can be analysed and retrieved from e-mails, Excel files, PDF etc. This information could then be copied, and the correct system updated with the latest information. For critical components RPA bots could retrieve data from different systems and then run the Excel macro to identify critical components. The Excel file could also be connected to a Qlik application in order to increase usability.

4.4.4 Product lifecycle management tool

Storing the PLM data in an easily accessible and structured way would facilitate retrieving and analysing PLM information. For information regarding products to be relevant for the sourcing department it needs to be broken down to component level. Within the Spend Tool there is already a software structure which does this, therefore internal tools and systems were investigated for this process. Three tools which progressively would increase the visibility of PLM information were found.

Firstly, the product which will replace a product with an EOL can be added to the Spend Tool. This information could be added to the Spend Tool immediately. A Qlik application which will contain information on PLM are currently being developed internally at Axis. Even though the application is currently being developed at another department, the sourcing department could benefit from the use of this application. The application, just as Spend Tool, contain the product structure. It also contains phase in date, phase out date, the supplier which the component is sourced from, replacement product and phase out site/sites. Other functions which will be added is product stock and more effective search functions. When the application is launched it can replace the information which can be implemented in Spend Tool and provide additional PLM information. However, the application will only provide data on the lifecycle for products and not for components. A components lifecycle could be dramatically different from the lifecycle of the products it is currently a part of. Considering this as well as that the sourcing department solely works with components, it should be investigated how data on the lifecycle of components could be retrieved, structured and made visible. This investigation could lead to a third tool, containing lifecycle information for components.

4.4.5 Further investigation

In order to investigate if the additional supplier list could be incorporated in IFS, the system provider needed to be contacted. Involving an external partner in an improvement process is more complex than Axis internal improvement process. Firstly, an internal project group is formed, this group is responsible for planning and implementing the project. The project group presents the project scope and the time, budget and resources required, to a steering group which decides if the project can proceed. If the project is approved, the desired outcome can be presented to the system provider. The project group and system provider can together investigate the best way to reach that outcome. These activities would span over a time period which exceed the time frame of this thesis and were therefore not performed.

To implement a common interface between the systems currently used at Axis would be a complex process, which would require substantial resources and time. A solution would involve either the implementation of a new system or implementing additional functions in currently used systems, for example IFS, in order to decrease the total number of systems. To determine the solutions feasibility and to compare them would require an extensive investigation into currently used systems, systems on the market, relevant system providers, etc. This is therefore outside the scope of this thesis.

Both the additional supplier list and a common interface were categorised as high priority after the survey and should therefore be further investigated by Axis.

4.4.6 Non investigated

As this thesis have a timeframe, systems and technologies for all processes could not be investigated. The categorisation derived from the survey, Table 4.4, was used to structure and select the investigated processes. Due to the time constrains and their degree of prioritisation, systems or technologies have not been investigated for: stock at EMS, new projects in Spend Tool, environmental requirements and automatic forecast to suppliers.

4.4.7 Summary of the digitalisation solutions

To provide an overview of the recommendations for the different processes mentioned in this chapter, these are summarised in Table 4.5.

Table 4.5 Identified systems or technologies for each process.

Recommendations	**Processes**
Sourcing suite	Sharing of documents
	Supplier document management
	Agreements and contracts
	Supplier performance management report
	Scorecard
Sourcing suite & independent systems	Market analysis
RPA	Critical components
	Update the article status list
	Price changes
Product lifecycle management tool	Product lifecycle management
Further investigation	Additional supplier list
	Interface between systems

Non investigated	Stock at EMS
	New projects in Spend Tool
	Environmental requirements
	Automatic forecast to suppliers

5. Analysis

The identified processes and the related technology from the empirical study are in this chapter analysed based on impact and implementation. However, within these factors the three prioritisation criteria: dysfunction, importance and feasibility were also incorporated. The structure of the chapter follows the one in Table 4.5, however the processes where no solutions were investigated are not a part of the discussion. The chapter is summarised by categorising the processes and related technologies using the benefit versus effort matrix and the digitalisation canvas.

5.1 Sharing of documents

Implementing a sourcing suite would facilitate the sharing of documents between the sourcing department and suppliers. This section will analyse sourcing suite modules which can facilitate the sharing of documents, based on impact and implementation effort.

5.1.1 Impact

A digital onboarding process would facilitate the new supplier evaluation process, as it involves sharing and receiving numerous documents. A standardised form can be created and used as a base for all new suppliers. The supplier will then fill in the profile and upload the required documents. This would decrease the time spent on onboarding, as some tasks are shifted to the suppliers. It would also lead to a more user friendly and structured onboarding process. As the documents are uploaded to the sourcing suite it would eliminate the risk that documents disappear among other emails. With systems provider Bs document management module documents can be shared with multiple suppliers, which eliminates the need to send each supplier an individual email. Suppliers are made aware of any mandatory documents and can confirm the content. Using the module can thereby save time, as the number of emails sent out would decrease.

5.1.2 Implementation

The complexity of the implementation depends on if a sourcing suite is implemented at Axis, and if so, which system provider is selected. If the same sourcing suite is used for the modules mentioned above and the digital RFQ, this would facilitate implementation. Many complexities, such as connecting the sourcing suite with other systems, are the same for the digital RFQ project. Therefore, the groundwork for the implementation of a sourcing suite will have to be made in the digital RFQ project. There would still be additional implementation for the document and onboarding modules, however it would be related to the specific modules rather than the whole sourcing suite. The same reasoning can also be applied for costs. If a sourcing suite were to be implemented a substantial part of the implementation cost would be the same whether one or several modules were implemented. However, there will still be additional implementation, licensing and maintenance costs when implementing new modules. Because of this both the cost and complexity of implementing the document management from system provider B would be very high if another system provider were selected for the digital RFQ.

The modules would primarily work as a new communication channel from the document sharing perspective. It is therefore imperative that the suppliers are willing to work in the sourcing suite. The system will otherwise not be used to its full potential and tasks might be performed both in the sourcing suite and through other channels. This might lead to confusion for both suppliers and employees at the sourcing department regarding where to send, receive and store documents.

5.2 Supplier document management

The document management at the sourcing department would be facilitated by implementing a sourcing suite. This section will analyse modules that would facilitate document management based on implementation and impact.

5.2.1 Impact

Digitalising the onboarding process would lead to a more user friendly and structured onboarding process. Everyone with access to the sourcing suite could follow the onboarding process and easily see which documents have been received. This would eliminate the need to contact the responsible CM for updates regarding the onboarding. It would also eliminate the requirement to keep track of which documents have been sent out and received. There is currently a risk that documents can get lost if an employee quits. Some documents are stored on computers or can only be found in someone's inbox. These documents need to be handed over when an employee is leaving the sourcing department and some documents can easily be missed. These documents can be hard to retrieve after the employee has left Axis. By using a document management module, the risk of documents disappearing decreases, as everything is stored in one place. Documents can also be categorised and linked to suppliers, the module will therefore provide an overview of a supplier's documents.

5.2.2 Implementation

As the modules recommended for supplier document management and sharing of documents are the same, the reasoning for implementation complexity and cost is the same. If the same sourcing suite is used for both document management and digital RFQ, the implementation effort and cost will be split between two modules. However, the increase in efficiency would have to be weighed against the licensing and maintenance cost of the module. In order for the document management to be used to its full potential, all relevant documents need to be uploaded to the module. This will require all employees to upload relevant documents, which are currently stored on Galaxis, their work computer or in an inbox. It is also crucial that the suppliers are willing to work in the supplier suite for it to be used in an effective way.

5.3 Agreements and contracts

The management of agreements and contracts would be simplified by implementing a contract management module, the impact and implementation of this module will be analysed in this section.

5.3.1 Impact

A contract management module would provide an overview of a specific supplier's agreements and contracts. Additionally, it will provide an overview of the contracts and agreements for all suppliers, which will lead to increased accessibility. Since the contract management system can send notifications on important dates, such as expiry date, these dates will not be missed. Therefore, the risk of contracts or agreements not being updated in time will decrease significantly. It is crucial that contracts are up to date from a legal perspective. A contract management system is also beneficial if an employee changes position or quits. Just as for the document management, no information needs to be handed over. Instead, all contract information is stored in the sourcing suite.

If the same sourcing suite is chosen as for the digital RFQ, contracts can be created directly from the RFQ process. The sourcing suites can also be connected to DocuSign for digital signing of contracts and agreements. As the contracts are sent out and the received through the sourcing suite, this will decrease the e-mails between the sourcing department and suppliers. These functions will increase the efficiency of the process.

5.3.2 Implementation

The implementation will be less complicated if the same system is used for the digital RFQ and the contract management module. On the other hand, additional costs will arise with the implementation of an extra module. The sourcing department are already using DocuSign, which the sourcing suites can be linked to. Thereby, no implementation is needed for this system and the learning curve for employees will be lower, since they already are familiar with DocuSign. A requirement for using the contract management module is supplier cooperation. However, as DocuSign is already used suppliers would be accustomed to a part of the new system, which would facilitate collaboration.

5.4 Supplier performance management report

Implementing a sourcing suite would facilitate the supplier performance management at the sourcing department. This section will analyse the supplier performance management module based on impact and implementation complexity.

5.4.1 Impact

Implementing a supplier performance management module to replace the current supplier performance management report would improve the process in several areas. Firstly, it would provide an overview of supplier performance with increased accessibility. The module would provide a standardised digital process to handle KPIs and thereby reduce manual work. It will also be faster and easier due to the ability to choose KPIs from a set list. The ability to have

both quantitative and qualitative measurements will give a broader perspective on supplier performance. Quantitative measurements can also be connected directly to other systems to receive KPIs that are constantly updated on factors such as quality and lead time. The KPIs are visualised and thereby easy to present and share with suppliers. The module will provide a broader perspective and the ability to constantly evaluate and analyse suppliers, in order to reach the sourcing department's goal of world class commodity management.

5.4.2 Implementation

The sourcing department are currently working on a project to implement a new supplier performance system. The new supplier performance system would be an internal, stand-alone system. Each system comes with their own pros and cons. By implementing a performance measurement module in the sourcing suite, the KPIs and supplier information will be displayed in the same system. Additionally, everyone with access to the sourcing suite can find the KPIs. If the performance management module uses the same sourcing suite as the digital RFQ, the complexity of the implementation will decrease. On the other hand, an external system may come with a higher cost compared to the internal system. Maintenance and support may also be more accessible with the internal system. However, a new internal solution would add an additional system, which will increase the complexity of data sharing and system integration.

5.5 Scorecard

Implementing a scorecard module would be beneficial as it would continuously measure supplier performance and provide quantitative measurements. This section will analyse the scorecard module based on impact and implementation complexity.

5.5.1 Impact

The scorecard is similar to the supplier performance management module but is a faster approach to analyse performance measurements. Scorecards provide an overview of each supplier's performance, and thereby the possibility to easier identify changes in a supplier's performance and analyse this. This facilitates more proactive decision-making as the KPIs are updated regularly. Additionally, it is possible to add KPIs from different sources, for example regarding quality or financial information. This provides a broader perspective on supplier performance, which can be relevant for strategic decision-making. Eliminating the need to search for data in several sources will decrease non-value adding time.

5.5.2 Implementation

The scorecard is a module in the sourcing suite, which decreases the effort of an implementation. Additionally, if the performance measurement module is implemented in the same sourcing suite, these KPIs can be linked to the scorecard. On the other hand, if the internal supplier performance system is implemented, adding the scorecard will come with a greater implementation. In that case, implementation of a scorecard might not be necessary since supplier performance can be found in the internal system. Another factor to take into consideration is how the module connects to other data sources and if it can connect to the systems that are used by Axis today. For example, data from the EMSs would be useful in order

to provide information on both their performance and the sub-suppliers performance. Therefore, further investigation regarding how this can be implemented is needed.

5.6 Market analysis

Implementing a market analysis system or incorporating the module in a sourcing suite would facilitate supply chain risk management, by providing real time analyses on both market trends and risks. In this section, the market analysis module will be investigated on impact and implementation effort.

5.6.1 Impact

Both the independent market analysis systems and the one incorporated in the sourcing suite module analyses and compiles real-time data. This allows for a market analysis that is updated continuously with new information. Employees will therefore not need to investigate current events in order to be updated, this will instead be done by the system. The system will both provide a broader and more detailed perspective. Several risks are assessed, and the data can be analysed and visualised for a group of suppliers or for one specific supplier. This would provide an overview on all suppliers in for example a commodity or a specific country. The real-time data, continuous updates and the different degree of detailed analysis provides the possibility to handle risks quicker and to be more proactive. By being proactive both time and money can be saved. The usability will also increase as real-time information on relevant risks and events can be found in one place. The main difference between the independent systems and the sourcing suite is that the module provides additional KPIs, on for example sustainability.

However, risk and market analysis are combined in both the independent systems and in the sourcing suite, which also make them relevant for the risk project. Therefore, the functions of the market analysis systems will have to be compared to the risk tool currently being developed, in order to assess the benefit. Questions which will need to be answered are for example, will some functions overlap, will there be similar information in both tools, etc. If this is the case, using both systems might make things more confusing and complex. However, there can also be functions within the market analysis systems which can be used within the risk project.

5.6.2 Implementation

The main differences between using a module within the sourcing suite or independent systems are related to implementation. If a sourcing suite is implemented and additional modules used, many tasks would be performed within the same system. This would provide a better overview, since the information is in the same format and there would be no need to transfer data between systems. Sourcing suites can be connected to IFS, and it would thereby be possible for the supplier information to be automatically transferred and updated. However, for the independent system the possibility of a connection with IFS would have to be investigated. If this is not possible, the suppliers would have to be added manually. However, the sourcing suite is the more expensive alternative, especially if the market analysis module would be the only module which was to be used. In this case the independent market analysis system is the cheaper alternative. Even so, it would mean implementing a new system.

5.7 Critical components

Implementing RPA would facilitate the process of finding critical components, below this solution will be described from an impact and implementation perspective.

5.7.1 Impact

By implementing RPA to extract the correct data and run the critical component macro, the non-value adding work connected to the task would be eliminated. This would free up time for value adding work and at the same time terminate human errors. The RPA bot can work all hours of the day, which would keep the information up to date. By keeping the information up to date and eliminating human errors, the identification of critical components will be more reliable.

5.7.2 Implementation

RPA follow the same security and data integrity standards as the ones used by humans, in order to access systems. RPA is therefore a non-disruptive technology which can work within current processes and systems. However, as the sourcing department currently does not use RPA there will be both costs and a steep learning curve related to implementation. RPA does not require any coding or programming knowledge to build, deploy and manage software robots. To do so you instead need to learn and understand the program, which may take some time, however RPA is a user-friendly system. RPA do not have the same error detection as humans, which means it will not detect errors that may seem obvious to a human. Subsequently, an error can be passed on within the organisation, and it is therefore important that RPA is implemented and managed correctly. Since RPA is customised according to a company's specific processes it will need to be maintained when relevant processes change.

5.8 Update the article status list

Implementing RPA would facilitate the updating of the article status list. In this section the solution will be analysed from an impact and implementation perspective.

5.8.1 Impact

Updating the article status list with the use of RPA would lead to a list which is always up to date. An RPA bot can be activated by an email or another type of document containing supplier changes relating to the ASL, for example price or specification changes. The bot will then analyse the document, retrieve the relevant information, copy it and paste it into the ASL. This will ensure that the information in the ASL is correct and up to date, thereby making it reliable for everyone in the project team. An RPA solution would also free up time for the PPs, which can be spent on tasks that provide value to Axis.

5.8.2 Implementation

The complexities and costs would be similar to the ones related to implementing RPA for critical components. A substantial part of the resources needed for implementing RPA is the same whether it is used in one or more processes. However, if RPA is used in several processes

this will further reduce time and costs, which will decrease the payback time of the investment. It can thereby be beneficial to implement RPA for several processes, nevertheless it is imperative that the processes are well suited to RPA. The information received needs to be in a standardised format, which will require a certain degree of cooperation from suppliers.

5.9 Price changes

Implementing RPA would facilitate the updating of price changes and will be further analysed based on impact and implementation.

5.9.1 Impact

A price change for a component will affect the price of the finished product. Therefore, an error or mistake regarding the price of a component could affect the remainder of the supply chain. Price changes from suppliers are currently received via email and copied to IFS, which can lead to missed updates or errors when copying. An RPA bot can analyse the e-mail containing price changes, retrieve the relevant information, copy it and paste it into IFS. If RPA were to be used for updating component prices human errors could be eliminated, thereby preventing price errors affecting the supply chain. It would also eliminate the non-value adding time connected to the task.

5.9.2 Implementation

A large part of the resources required for implementation are linked to implementing the RPA technology as a whole and not for a specific process. This is because RPA is not currently used at the sourcing department. Subsequently, the resources, difficulties and opportunities are the same as for critical components and updating the article status list. The need for supplier cooperation is also the same as for the article status list However, as RPA would have to be configured specifically for price changes this will require additional resources and costs. Nevertheless, if several processes were to utilise RPA the payback time of the investment could be decreased.

5.10 Product lifecycle management

The implementation of the three different tools for product lifecycle management will be analysed in this section.

5.10.1 Impact

Simplifying the search for EOL and phase out for products will reduce the time spent searching for this information. The recommendations for the product lifecycle management tool are a three-step solution, where the efficiency for the process will increase in every step. The first tool, adding certain data to Spend Tool, would facilitate the daily work as information regarding EOL and the replacement product can be found in the same system. Additionally, it will facilitate decision-making. This solution has a lower impact than the other tools but is a good starting point.

The internal application would have a larger impact due to the additional features, but the impact will differ depending on which functions that will be implemented. The application as it is currently constructed, will provide a more accessible process to find EOL, phase out date etc. This will minimise time spend on the process since all data can be found in the same system. The sourcing department can be involved in the continued development of the application by suggesting other functions that would benefit their daily work. One example is if products could be sorted by commodity, since that would benefit for example CMs and CBs. Additional functions such as phase out date, phase in date, phase out site, etc, would increase the impact compared to the first tool. Another benefit with the application is that it can be used by other departments at Axis and thereby no information needs to be sent between departments.

In the long run, the largest impact in terms of efficiency would be to provide supplemental data for components and tools in the application. Currently, lifecycle data is only provided for products and since EOL for a product and component can differ, component data would have a great impact. A component can outlive the products it is currently a part of or live on in new products, therefore the component's lifecycle data may differ. Having this information in the application would provide a more efficient process than analysing the product and then searching for component information in different sources. This would lead to increased efficiency and saved costs, as it provides a better foundation for strategic decision-making. One example is ordering of component tools, by having more accurate information regarding components, the risk of ordering unnecessary tools is minimised.

5.10.2 Implementation

The first solution, to add information in Qlik is the easiest to implement, since it has been investigated and resolved by Operations Development on behalf of the authors. The replacement product information is currently in the test version of Qlik and can be launched if desired.

The second tool is the application which is currently being developed by another department. It is a Qlik application and since this is a system the sourcing department already uses, it would facilitate the implementation. This tool is a larger internal project, where the sourcing department can come with suggestions and input on information that can be added and provide insights on future development. The implementation effort for this application is quite low, since the application is constructed by another department. However, it is imperative that the sourcing department is involved in order for the application to be relevant for them.

The most complex implementation will be lifecycle information regarding components. There is currently no development project investigating this, however as component lifecycle information could provide useful insights this is something that should be researched further. The complexity lies in the many factors which affect the EOL and phase out for a component. The lifecycle information needs to be retrieved and analysed from a component perspective, which requires the set-up of a new application or system. As this is currently not a development project, the implementation will take time.

5.11 Additional supplier list

The integration of the additional supplier list with IFS would be beneficial for several reasons; minimise manual transferring of data, facilitate data analyses, decrease the risk of the Excel file becoming unable to run etc. This section will analyse the integration based on impact and implementation complexity.

5.11.1 Impact

The additional supplier list contains information which together with the information in IFS constitutes the foundation of many sourcing decisions. As IFS is an ERP system, the information can be automatically transferred to other systems and tools, for example the Spend Tool. Connecting the additional supplier list with the same systems and tools as IFS is difficult, as the information need to be transferred manually and is in a different format. The additional supplier list is therefore not connected to for example Spend Tool. Instead, forecasting information regarding sub-suppliers is stored in the same Excel file as the additional supplier list. The same problem will occur for other systems which require supplier information and will thereby decrease the efficiency of these systems. An example is the digital RFQ where the sourcing suite would connect to IFS in order to access supplier information, which would be used in the digital RFQ process. The sub-suppliers whose information is stored in the additional supplier list will therefore not be a part of the digital RFQ process. Instead, the sourcing department could either proceed with the current RFQ process or establish an additional solution for the sub-suppliers. The digital RFQ process would therefore not be used for all suppliers, which results in a less efficient use of the sourcing suite and the digital RFQ module. Storing information regarding different suppliers in different places also affects the possibility to make holistic and strategic analyses. To make a holistic analysis data currently need to be retrieved from different sources, transformed into the same format and processed by a system able to handle the large amount of data. Storing the information in the same place and in the same format would facilitate this kind of analysis.

The large amount of data currently stored in the Excel file and the manual updates poses a risk. Manual updates can easily result in human errors, it is also easy to mistakenly change something in the file while working with it. As Axis keeps growing the additional supplier list will probably grow with them. As the amount of data in the file grows, the risk that the file will crash or become unable to run increases. If this happens there might also be problems related to retrieving the lost data. These problems would have a huge negative impact on the sourcing department as the information in the additional supplier list is imperative for many tasks.

5.11.2 Implementation

Integrating the additional supplier list with IFS could be time consuming and costly. In the IFS version currently used there is no possibility to work with sub-suppliers. Therefore, a customised version of IFS might be needed to incorporate the additional supplier list. However, due to the amount of resources and time needed to involve an external partner in the development this has not been confirmed. In order to obtain the exact cost and resources needed IFS would have to be involved. To get more exact implementation information and due to the impact generated by incorporating the additional supplier list with IFS, Axis sourcing department should investigate this further.

5.12 Interface between systems

Reducing or integrating the number of systems would minimise the transferring of data and reduce human errors. This section will analyse the aim towards a well-functioning interface between systems based on impact and implementation effort.

5.12.1 Impact

Integrating the different systems or minimising the number of programs can lead to increased efficiency and reduce human errors. This since there is less transferring of data between systems and thereby the non-value adding work is minimised. It may not be possible to find one system for all processes at the department, but a future aim would be to minimise the total amount of systems. It is also beneficial if the systems can interact with each other since this would minimise the copying of data. When choosing the sourcing suite, it would be favourable to select the same system for the modules as for the digital RFQ. This as it would be beneficial to have as much information as possible at the same place. Data would be easier to find and merge, and data would be updated automatically between the different modules. Aspects to take into consideration is that with fewer systems the company is more dependent on the system provider, which can lead to problems if the system is not working. Some of the current systems, for example IFS, are linked to other departments. Therefore, information that are used by several departments cannot be moved to the sourcing suite without providing access to all relevant employees. Increasing the accesses might be more expensive and involves decision-making regarding who should have access.

Implementing RPA is another approach to integrate systems. This would add an additional system, but RPA would work as an interface between different systems. Thereby, the time spend on finding and downloading information from various programs would decrease. It could therefore be used while working towards a long-term goal of decreasing the number of systems.

5.12.2 Implementation

The implementation of a sourcing suite can be complex in the beginning due to the tasks of finding a system provider, implementing the system, transferring data to the system and assure that it is working as desired. Following that initial implementation, adding more modules would require less effort to implement. Obtaining a new system comes with implementation costs, but if more modules are added this cost will be dispersed on more functions.

Integrating information from all current systems into one system is an extensive implementation, which would disrupt the daily work at the sourcing department. Nevertheless, integrating new functions within current systems is something to have in mind when investigating future decisions.

5.13 Summary of analysis

The analysed projects each have their own impact and implementation complexities. In order to summarise and compare each project the effort versus benefit matrix and digitalisation canvas were used. Impact and implementation effort were considered, and each project was placed in the matrix. When considering the implementation effort, it was assumed that a sourcing suite will be implemented to facilitate the digital RFQ and that the additional modules would be implemented in the same sourcing suite. Each process was assessed independently, not taking the other projects into consideration. The processes were then categorised into the project portfolio part of the digitalisation canvas based on the matrix.

Figure 5.1 display each project and its placement in the effort versus benefit matrix. Project one to three are placed higher on the effort axis than the rest of the sourcing suite modules. This is because it is imperative that all suppliers work within the sourcing suite for these modules to function in an optimal way. This will require Axis to communicate the benefits of using a sourcing suite and how to use the modules, which will increase the implementation effort. Implementing project four and six would provide the sourcing department with tools which could provide strategic insights. This will facilitate more proactive decision-making and help the sourcing department reach their goal of world class commodity management. The projects which use RPA, project seven to nine, all have a higher degree of implementation effort than the projects using the sourcing suite. This is because RPA would be a completely new system for the sourcing department, which has not been researched. Sourcing suites on the other hand have been researched and a short-list of systems providers compiled, due to the ongoing digital RFQ project. In the matrix in Figure 5.1 each project was assessed independently, however some projects are connected because they would use the same technology. For example, project one and two which would use the same module in the sourcing suite, the same is true for project four and five. This means that if one of these projects were implemented the implementation effort for the connected project would be very low. This is something to have in mind if one of these modules were to be implemented.

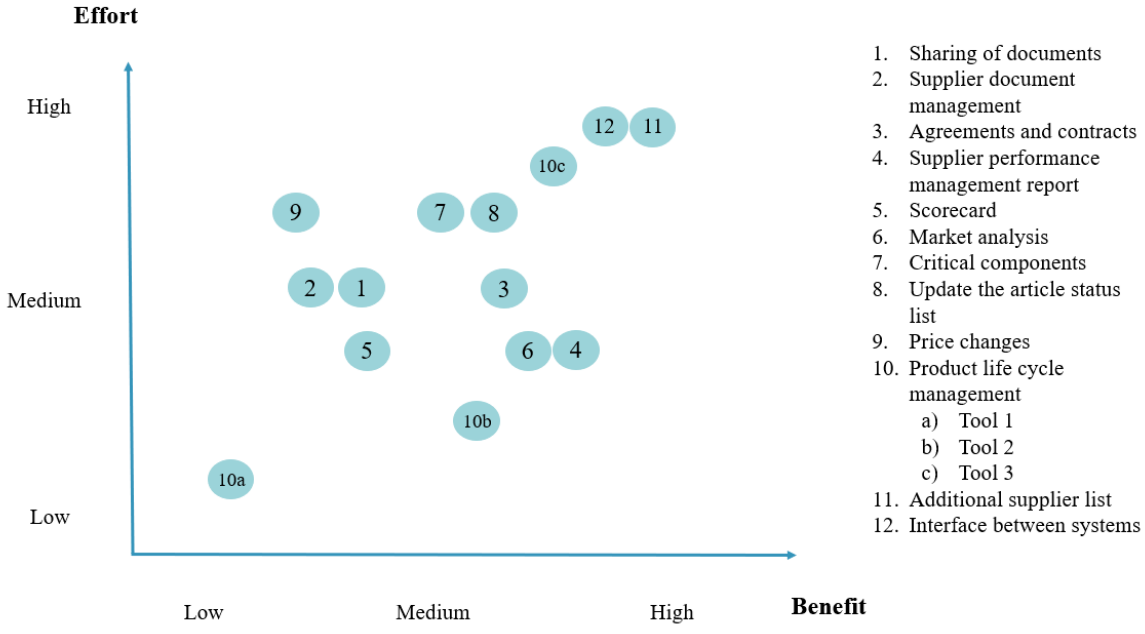

Figure 5.1 The digitalisation projects placed in the effort versus benefit matrix.

Based on Figure 5.1 the projects were categorised into the digitalisation canvas, see Figure 5.2. The processes were categorised into quick wins, implementation projects and strategic projects within the project portfolio part of the matrix. This as “Digital vision of the company” and “Improvement through digitalisation” are related to the business perspective and finding relevant processes and technology. While the “Project portfolio” is related to prioritising and categorising the identified digitalisation projects. The projects within each category are ranked according to decreasing impact and increasing implementation effort.

Digital vision of the company		
Improvements through digitalisation		
Project portfolio		
Quick wins	Implementation projects	Strategic projects
- Product lifecycle management: tool 1	- Supplier performance management report - Market analysis - Product lifecycle management: tool 2 - Agreements and contracts - Update the article status list - Critical components - Scorecard - Sharing of documents - Supplier document management - Price changes	- Additional supplier list - Interface between systems - Product lifecycle management: tool 3

Figure 5.2 The digitalisation projects categorised in the digitalisation canvas.

When several projects use the same technology, the impact will increase more than the implementation effort. This is because some parts of the implementation are the same whether the technology is used for one or several projects, while the projects impact is constant. In order to display this and to provide a more holistic view, an additional matrix, where the projects with the same technology were grouped together, can be seen in Figure 5.3.

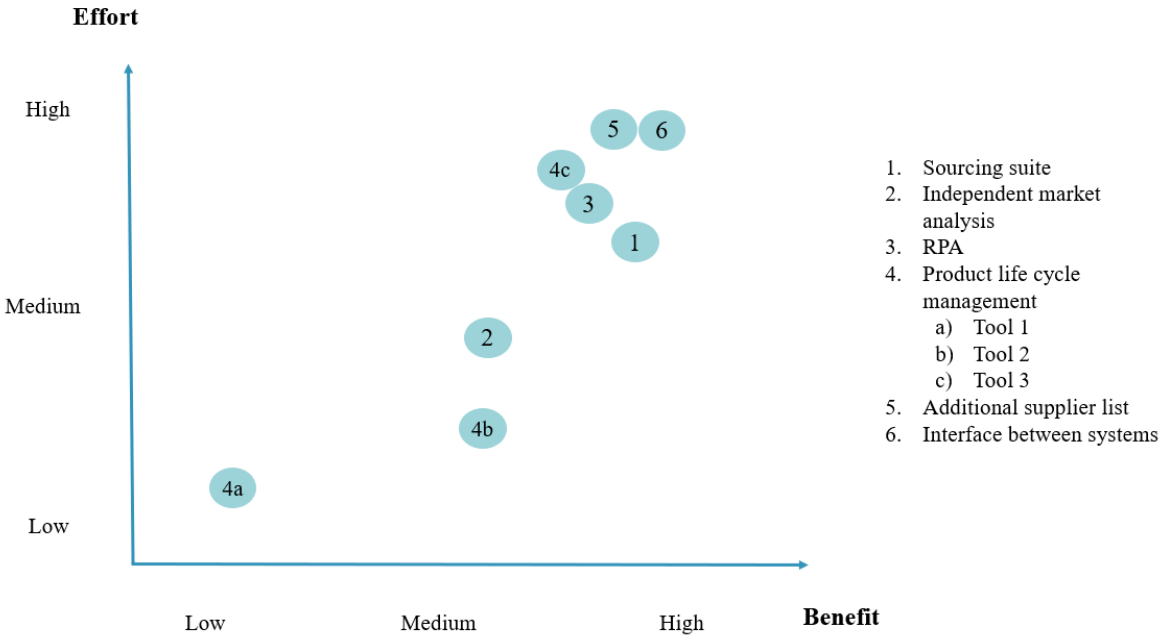

Figure 5.3 The projects placed in the effort versus benefit matrix, grouped according to technology.

6. Conclusion

The purpose of the thesis has been to analyse the internal processes at Axis sourcing department in order to identify digitalisation opportunities and technologies. The digitalisation technologies impact and feasibility of implementation has also been investigated. Finding these processes and how they can be digitalised has been accomplished by answering three research questions. This chapter will also include a recommended course of action for the digitalisation projects. Finally, contribution, limitations and future research will be discussed.

6.1 Research question 1

RQ1: How are the current sourcing processes structured at Axis Communications AB?

The sourcing processes have been investigated through interviews and internal documents. The sourcing department at Axis is organised in two teams, Mechanics and projects and Electronics and manufacturing. Employees with different roles at the sourcing department primarily work within one of three processes. The processes are the commodity management process, the hardware product development process and the sourced product development process. The commodity management process is performed by commodity managers throughout the entire lifecycle of a product and consists of seven steps, from defining strategic goals to maintaining supplier relationship management, which can be seen in Figure 4.4 and 4.5. The CM uses the process to focus on a specific commodity and the related suppliers. The hardware product development process is performed by project purchasers during the development of new products. The process is used for a specific product and the activities of bringing that product to the market. The process consists of five steps from start-up to handover and closing, see Figure 4.6. The third process is the sourced product development process and is performed by CMs responsible for insourced products and accessories. The process is used when an Axis product is based on an existing supplier product. The process consists of the same steps as the hardware product development process, except the additional pre-study phase, see Figure 4.7. All steps in the three processes contain additional activities within each process step.

6.2 Research question 2

RQ2: Which sourcing processes can be digitalised and what technologies could be used in order to increase efficiency at Axis Communications AB?

The information gathered from interviews and documents were validated and strengthened by a survey. The information from the interviews, documents and the survey led to the identification of 16 processes which could benefit from being digitalised. The survey was also used to prioritise the processes in order to facilitate the investigation on digitalisation technologies and systems. The prioritisation was based on the amount of time a process requires, how frequently a process is performed and the process degree of usability. Due to the time frame of the thesis digitalisation technologies and systems were not found for all processes. Therefore, the investigation followed the prioritisation, with a greater focus on finding solutions for higher prioritised processes. The empirical data gathered on both current processes and digitalisation technologies were compiled. The result can be seen in Figure 6.1, where the processes are sorted under the relevant digitalisation technology. The processes

under further investigation had a high prioritisation, however when investigated it was concluded that the projects were outside the time frame of the thesis. Due to their high prioritisation Axis should investigate more thoroughly how these processes could be digitalised. Because of their low prioritisation and the time frame of the thesis, no digitalisation technologies were explored for the non-investigated processes.

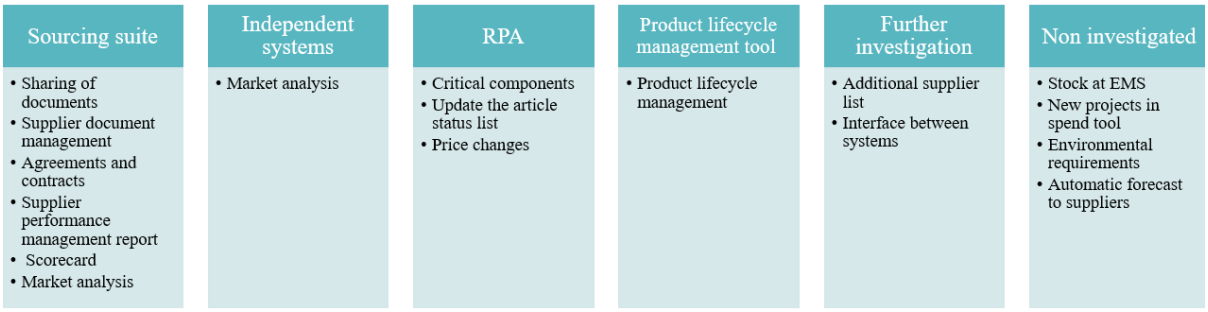

Figure 6.1 The identified processes sorted under the relevant digitalisation technology.

6.3 Research question 3

RQ3: How easy would the identified technologies be to implement and what impact would they have on Axis Communications AB?

In order to determine the ease of implementation, the projects were analysed according to effort versus benefit and the digitalisation canvas. Firstly, impact and implementation effort were considered and categorised on a scale from low to high. It was assumed that a sourcing suite will be implemented to facilitate the digital RFQ when considering the implementation effort and that the additional modules would be implemented in the same sourcing suite. Additionally, each process was assessed independently, not taking the other projects into consideration. The projects were then categorised in the digitalisation canvas in three categories: quick wins, implementation projects and strategic projects. The categorisation can be seen in Figure 6.2. Within each category, the projects are ranked according to decreasing impact and increasing implementation effort.

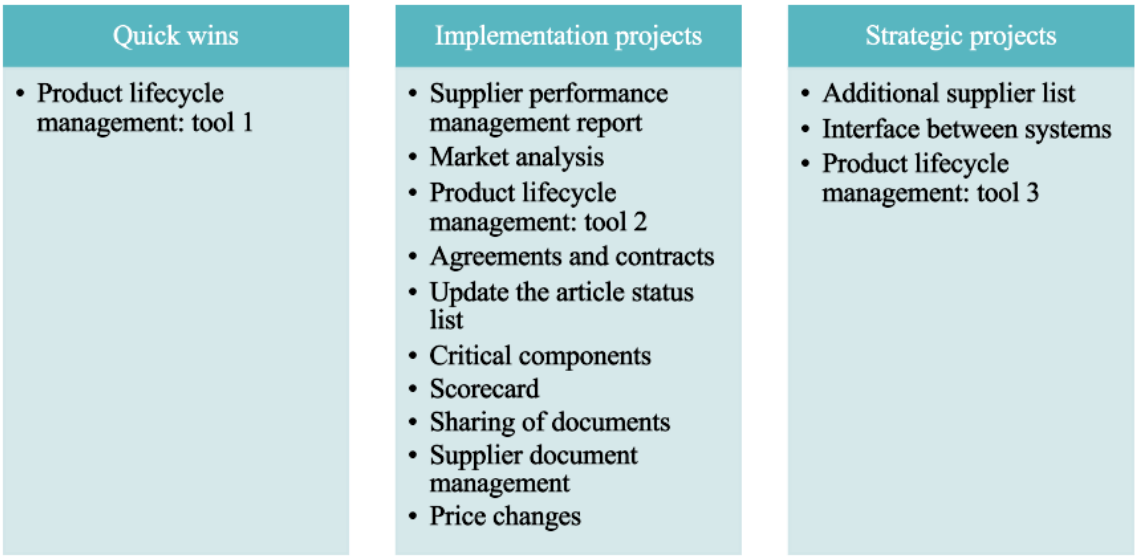

Figure 6.2 The digitalisation projects categorised based on the digitalisation canvas.

6.4 Recommendations for Axis

Based on the authors knowledge of current development projects at Axis, the categorisation derived from the digitalisation canvas and the related literature, a course of action for the digitalisation projects was constructed, see Figure 6.3.

The digital RFQ project is ongoing and different sourcing suites are currently being evaluated. The sourcing suite modules presented in this study should therefore be investigated first. Contact with several system providers have already been established, which will facilitate the gathering of detailed data related to cost and implementation. By assessing the processes and modules early, a sourcing suite with all desired modules and functions could be chosen. PLM tool one could also be implemented early as it is a quick win. The sourcing department should also provide input for the development of the second PLM tool to assure that it will be relevant for their processes and tasks. RPA would be a new technology for the sourcing department and the development project would therefore start from scratch, it is therefore not as urgent as the sourcing suite and PLM tool one and two. The strategic projects are long term projects which will require substantial resources; however, they will have a big impact. It might therefore take a while to allocate the necessary resources to start these projects. The non-investigated processes were not highly prioritised; however, they were identified as processes that could benefit from being digitalised. They should therefore be assessed and explored after the other projects have been investigated.

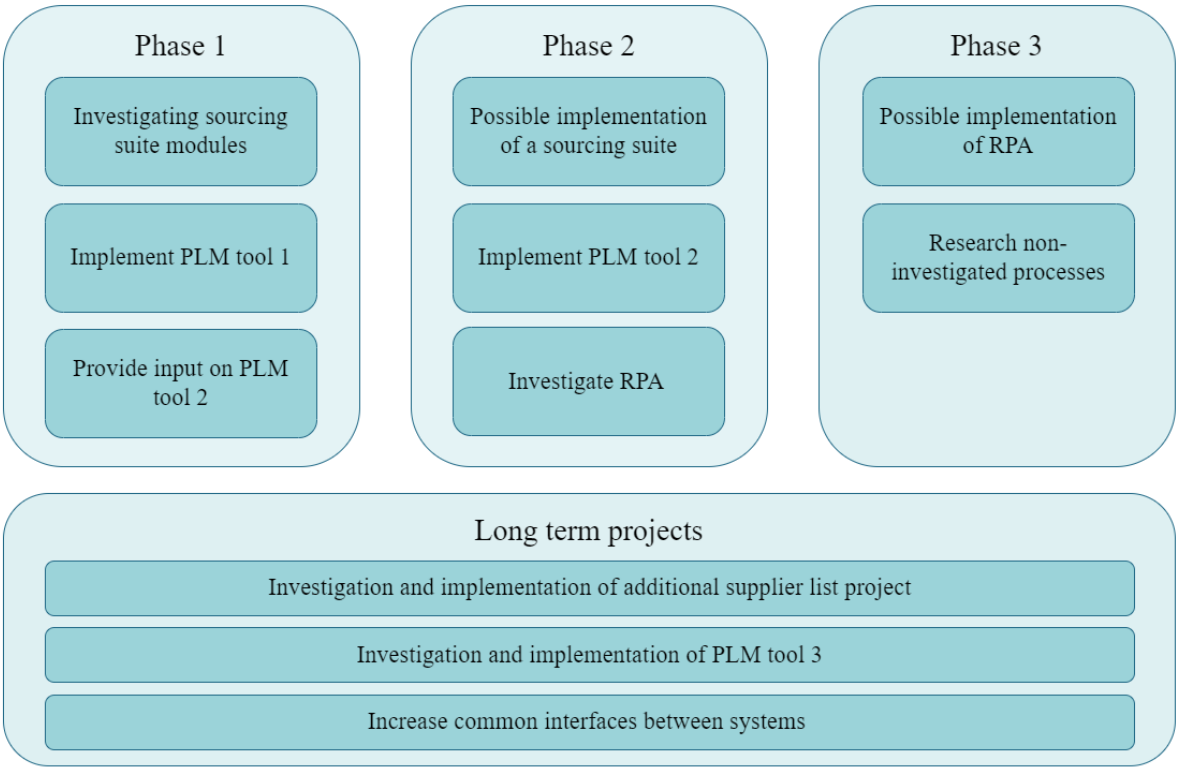

Figure 6.3 Recommended course of action for the digitalisation projects.

6.5 Contribution

The main contribution towards the sourcing department at Axis are the identified processes and the technologies that can be used to digitalise these processes. As Axis is an innovative company, it is relevant that their internal processes are following the same line. Especially since the sourcing department grows as Axis develops. Thereby, the result of the thesis lay a foundation for future digitalisation opportunities within the company. Moreover, the implementation versus effort matrix and the digitalisation canvas provides a categorisation regarding the impact of a specific project and the extent of the implementation. Furthermore, recommendations for how the different projects can proceed has been provided.

The contribution to theory is an analysis on how different technologies can be used in business processes to increase efficiency. The research provides an extensive research on technologies that can be used in different sourcing processes. Furthermore, the thesis provides useful insights into how new technologies develops and generate more efficient processes. Digitalisation is becoming an important tool for companies in order to stay efficient and effective. As digitalisation will continue to become more relevant for businesses in the future, the results from the thesis can be applied for other companies. Even though the thesis is focused on technologies specifically for sourcing processes, some of the recommendations can be applied in other functions as well. As theory was applied to a company case, the research bridges the gap between theory and industry.

6.6 Limitations

There are some limitations to the study which affect the reliability and validity of the thesis. The study only considered one company, which can affect the generalisability of the study. The study's generalisability would have increased if additional cases were investigated. However, there are not many published cases on digitalisation and sourcing, and due to the limited timeframe, it was not considered possible to perform a multiple case study. The timeframe of the thesis led to two further limitations. Firstly, the scope of the thesis only included internal processes at the sourcing department. Processes which involve external partners could therefore have been missed when investigating digitalisation opportunities. Secondly, digitalisation technologies were not investigated for all identified processes, which could have led to quick wins being missed.

Responder biases can also affect the validity of the thesis. Responder bias can occur from the order of the questions, the structure of the survey and questions, etc. Some survey questions were subjective in order to understand and prioritise the identified digitalisation opportunities. However, subjective questions could be interpret differently and therefore led to responder bias. To try and avoid different responder biases the survey were tested and people which were more experienced with making surveys were consulted.

Another limitation was that the authors had no previous experience of working at Axis. Time was therefore needed to understand the organisation, the roles, the connection between different roles, the intranet, etc. This was an imperative base for the identification and understanding of processes which would benefit from digitalisation. In order to reach this

understanding, the supervisors and other employees at Axis were consulted and information collected through interviews.

The final limitation is related to the ongoing Covid-19 pandemic and the restrictions stemming from this. The authors had limited access to the office and all interviews were held virtually. The daily conversations with co-workers which could have led to new aspects and additional ideas, were therefore severely reduced. A workshop with employees at the sourcing department was also considered but deemed unreasonable during the current situation.

6.7 Future research

Future investigation for Axis could be to research if other departments can digitalise some of their processes to decrease non-value adding work. Furthermore, Axis could investigate if some of the recommended technologies could be used at other departments. For example, RPA could possibly be used for other internal processes.

The study has been limited to analyse Axis internal processes. Additional insights could have been gained by performing a multiple case study, in order to compare how the identified sourcing processes are carried out at other companies. Furthermore, research on how sourcing suites are implemented and used in other businesses would deliver a broader perspective to the results of this thesis. This would provide a benchmark on how other companies use a sourcing suite and to which extent this has improved their processes. Additionally, research regarding the other technologies mentioned in this thesis and their long-term impact is of interest.

A more extensive research on how RPA is currently used within companies would have been interesting. The authors have reached out to several consulting firms specialised within this technology but have only received one reply. The reply was obtained at the latter part of writing the thesis. In order to validate this information, further investigation regarding RPA and its usage within the relevant processes is needed. Furthermore, additional research regarding how RPA could be used in general within sourcing processes and in other supply chain operations is of interest. Additionally, as technologies keep evolving and improving, research regarding technologies that can be applied to receive more efficient business processes will continue to be significant in the future.

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Appendices

Appendix A.

Conducted interviews

Table A.1. When and with whom a certain type of interview was conducted.

Date	Role of interviewees	Type of interview
10-02-2021	Process developer sourcing	Unstructured
15-02-2021	Commodity manager	Unstructured
18-02-2021	Commodity manager	Semi-structured
18-02-2021	Project purchaser	Unstructured
22-02-2021	Project purchaser	Semi-structured
25-02-2021	Commodity manager	Semi-structured
26-02-2021	Commodity buyer	Unstructured
01-03-2021	Commodity buyer	Unstructured
02-03-2021	Commodity manager	Semi-structured
04-03-2021	Sourcing engineer	Unstructured
04-03-2021	Project purchaser	Semi-structured

Appendix B.

Interview guides

In this appendix the interview guides used during the interviews seen in Appendix A are presented. The interview guide was the same for all unstructured interviews. The unstructured interviews became the foundation for the semi-structured interview guides. For the semi-structured interviews, the interview guides differ for commodity managers and project purchasers. This was done in order to capture the different processes and activities for each role.

B.1. Unstructured interview guide

- What is your position at Axis?
- Could you please describe the work procedure for your role?
- Do you think something would benefit from being digitalised at the sourcing department?
- Is there something more you think we would benefit from knowing?

B.2. Semi-structured interview guide – commodity manager

Initial questions

- What is your role at Axis?
- What are your main tasks?

Commodity team

- What commodity team are you a part of?
- How do you work within your commodity team?
    - How often do you have meetings with the commodity team?
    - How many people are a part of the commodity team?
    - What departments and roles are a part of the commodity team?

Specifications

- How do you analyse the demand?
- How do you perform a market analysis?
- Which actors are involved in the process?
- Which systems or tools are used in the process?
- What is working well with the current process?
- What could be improved?
- Does this process differ for different products (e.g., routine, strategic, new products etc)?

Supplier selection

- How do you decide if single or dual sourcing should be used?
- How do you create the bidders long list?

    - How are these suppliers identified?
- Do you have a supplier database?
    - How does it work?
    - What information is stored there?
    - For what processes is it used?
- How are the final supplier/suppliers selected?
- How are the documents sent to new suppliers?
- Which actors are involved in the process?
- Which systems or tools are used in the process?
- What is working well with the current process?
- What could be improved?
- Does this process differ for different products (e.g. routine, strategic, new products etc)?

Agreements and contracts

- What is the procedure for supplier negotiations?
- Where are the contracts and agreements stored?
- Can you see when contracts or agreements expire?
- Can you see what type of contract and agreements Axis have with a specific supplier?
- How do you send the contracts to the supplier?
- Which actors are involved in the process?
- Which systems or tools are used in the process?
- What is working well with the current process?
- What could be improved?
- Does this process differ for different products (e.g., routine, strategic, new products etc)?

Follow up and evaluation

- How are the supplier evaluated?
- Which factors are they evaluated on?
- How often is the evaluation performed?
- Does the evaluation differ for different suppliers?
- How do you use the information and evaluation you have on suppliers? (E.g., within risk management, future decisions regarding suppliers etc.)
- How and where is the supplier information updated, in case of changes?
- Do you have any KPIs for the suppliers?
- Which actors are involved in the process?
- Which systems or tools are used in the process?
- What is working well with the current process?
- What could be improved?

Concluding questions

- Do you think something would benefit from being digitalised?
- Is there something more you think we would benefit from knowing?

B.3. Semi-structured interview guide – project purchaser

Initial questions

- What is your position at Axis?
- What are your main tasks?

Start up

- How do you find new suppliers?
- How often are new suppliers used in projects?

Planning

- How do you review product requirements? Do you have any tools?
- How do you identify risks? Do you have any tools?
- How do you identify critical components?
    - How do you find the BOMs?
- What input is used for COGS?
    - How do you find that information?

Execution

- How do you place orders? How often?
    - Sample
    - Tooling
    - Pre-series
    - Test build
- How do update ASL?
    - Does it work well?
- How do you keep in contact with the suppliers during the project?
    - How do you negotiate with suppliers?
- How are the supplier quotes uploaded?
    - Who have access to these documents?
- How do you identify critical/ single source suppliers?
- How do you check if new suppliers have been approved?

Acceptance

- How do you update IFS?
    - What kind of information is updated?
    - How do you receive this information?

Handover & closing

- What kind of information is handed over to Material Supply?
- What does the handover entail?

Concluding questions

- Do you think something would benefit from being digitalised?
- Is there something more you think we would benefit from knowing?

Appendix C.

In this appendix the survey which was sent out to the sourcing department is presented. It contains both the survey questions and graphs of the received answers. Note that the actual survey was created in Microsoft Forms and answered digitally.

C.1. Current systems

This section will include questions regarding current processes.

1. How much time do you spend on a process each time it's performed?

Please only fill in the time it takes to do the process once, as the next question relates to how often the process is performed. The time is measured in a scale from 1-5, where 1=not much time and 5=an excessive amount of time.

If the process is not relevant to your work, please press "not applicable".

	Not applicable	**1**	**2**	**3**	**4**	**5**
Update ASL						
Find/update supplier information stored in the "RFQ Excel file" instead of IFS						
Find information regarding product life management						
Update IFS manually when suppliers change the price						
Find critical components						
Sharing documents with suppliers, both during the supplier qualification and the daily work						
Keep track of which documents that have been sent and received during the supplier qualification						
Finding expiration date and type of supplier agreements						
Use the supplier management performance report (SC-409)						

2. How often is the process performed?

If the process is not relevant to your work, please press "not applicable".

	Not applicable	**Daily**	**Weekly**	**Monthly**	**Quarterly**	**Yearly**
Update ASL						
Find/update supplier information stored in the "RFQ Excel file" instead of IFS						
Find information regarding product life management						
Update IFS manually when suppliers change the price						
Find critical components						
Sharing documents with suppliers, both during the supplier qualification and the daily work						
Keep track of which documents that have been sent and received during the supplier qualification						
Finding expiration date and type of supplier agreements						
Use the supplier management performance report (SC-409)						

3. What's the usability of the current process?

Usability includes the effectiveness, efficiency, error tolerance and overall satisfaction for the user. The usability is measured in a scale from 1-5, where 1=very low usability and 5=very high usability.

If the process is not relevant to your work, please press "not applicable".

	Not applicable	**1**	**2**	**3**	**4**	**5**
Update ASL						
Find/update supplier information stored in the "RFQ Excel file" instead of IFS						
Find information regarding product life management						
Update IFS manually when suppliers change the price						
Find critical components						
Sharing documents with suppliers, both during the supplier qualification and the daily work						
Keep track of which documents that have been sent and received during the supplier qualification						
Finding expiration date and type of supplier agreements						
Use the supplier management performance report (SC-409)						

C.2. Interface between different systems

This section will contain questions regarding interface between the different systems used today.

4. What are the main issues working with multiple systems?

The systems we refer to are those used for sourcing activities, for example Galaxis, IFS, Excel, SpendTool and Windchill etc.

You can choose one or several answers. If you choose other, please specify.

- Human errors
- Time-consuming
- Data from different systems needs to be changed in order to compile information
- Non-integrated systems can lead to non-accurate data
- Need to update the same data in multiple systems
- Other

5. How much would your work tasks benefit from merging some of these systems?

The benefit is measured in a scale from 1-5, where 1=no benefit and 5=high benefit.

	1	**2**	**3**	**4**	**5**

C.3. New systems

This section contains questions regarding systems that could be implemented to support sourcing activities.

6. How much would your work tasks benefit from implementing a market analysis system?

A market analysis system can provide real-time information regarding markets and risks which make it easy to find relevant information for a specific commodity.

The benefit is measured in a scale from 1-5, where 1=no benefit and 5=high benefit.

	1	**2**	**3**	**4**	**5**
Market analysis tool					

7. How much would your work tasks benefit from implementing a system for scorecards?

A scorecard system helps to continuously measure the performance of suppliers. Quantitative measurements such as quality, delivery accuracy etc which can be shared with the supplier on a monthly basis.

The benefit is measured in a scale from 1-5, where 1=no benefit and 5=high benefit.

	1	**2**	**3**	**4**	**5**
Scorecard					

8. How much would your work tasks benefit from implementing a system that would show the current stock at the EMSs?

There is currently no possibility to see the actual stock levels at the EMSs, the only tool is to use demand forecasts.

The benefit is measured in a scale from 1-5, where 1=no benefit and 5=high benefit.

	1	**2**	**3**	**4**	**5**
Stock EMS					

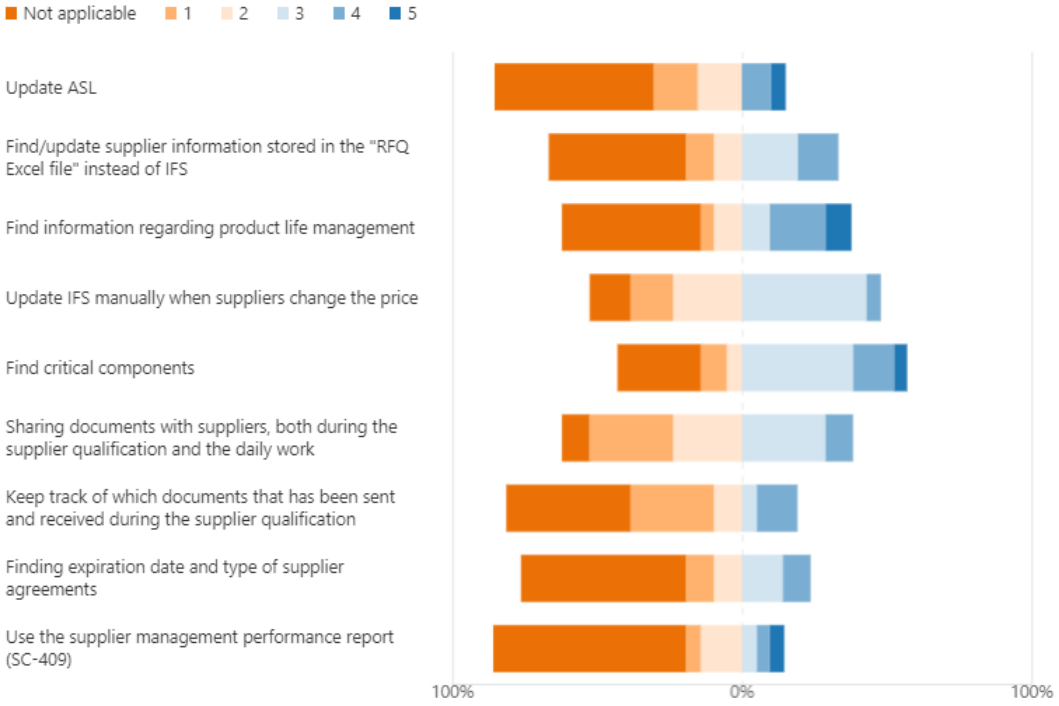
C.4. Additional comments

9. Are there any other processes that would benefit from being digitalised?

C.5 Answers

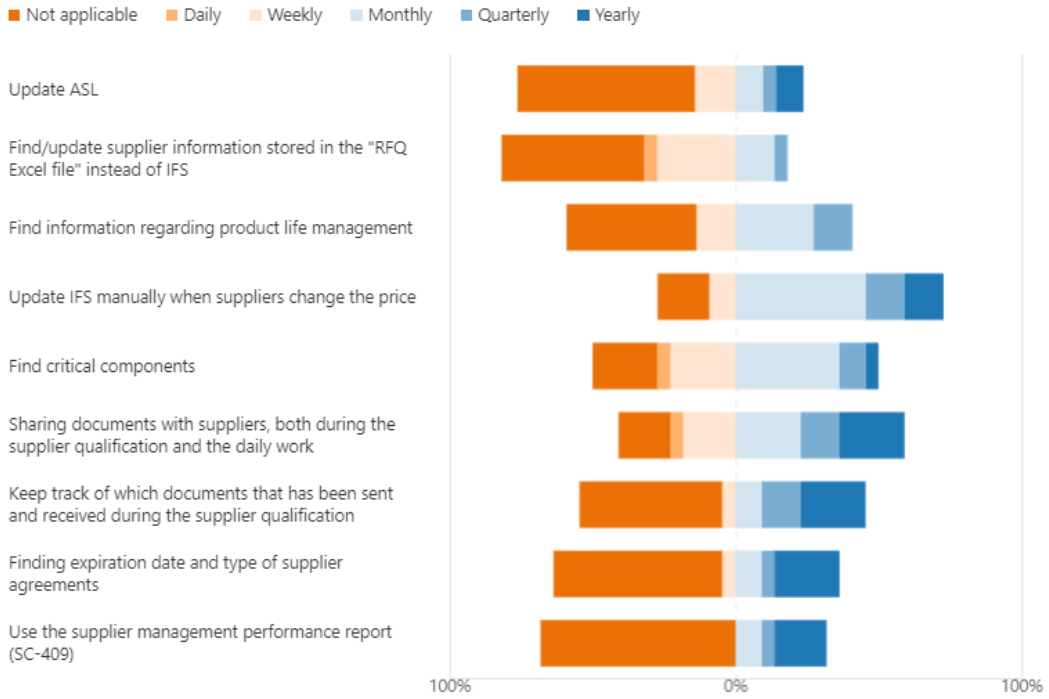
1. How much time do you spend on a process each time it's performed?

More Details



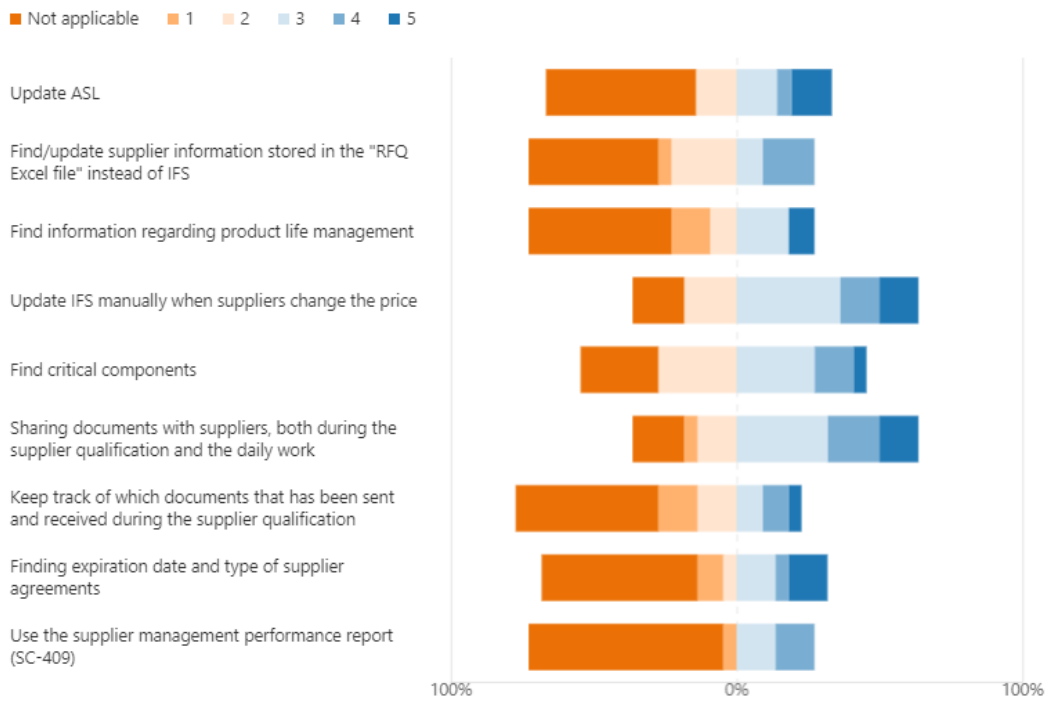
2. How often is the process performed?

More Details



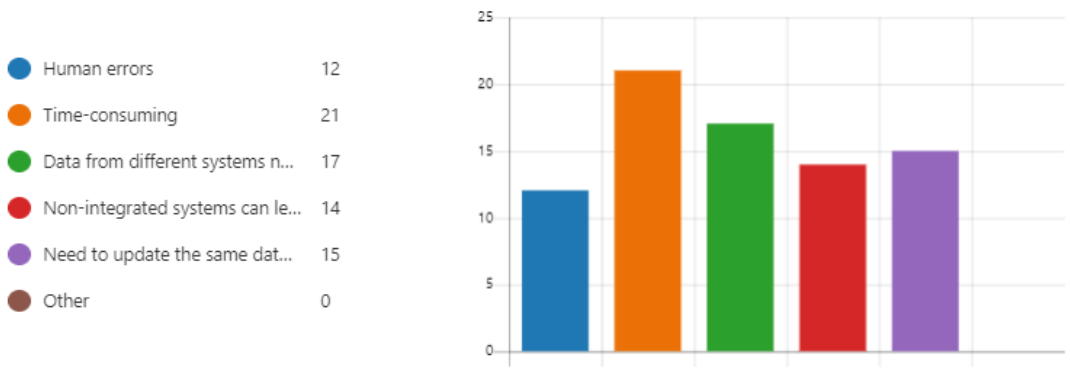
3. What's the usability of the current process?

More Details



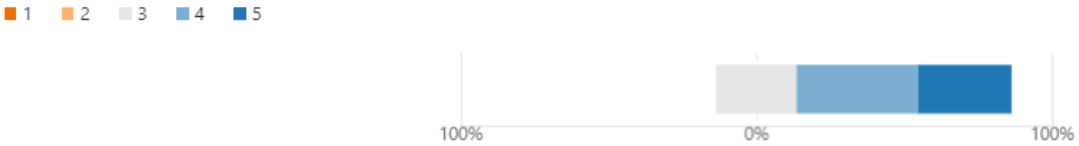
4. What are the main issues working with multiple systems?

More Details



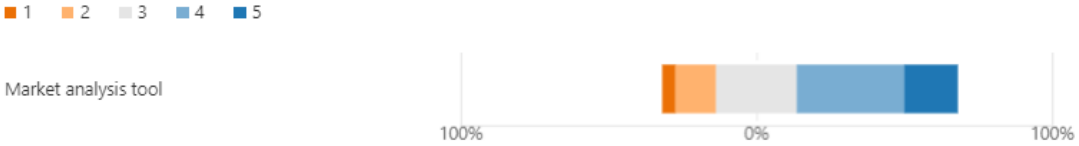
5. How much would your work tasks benefit from merging some of these systems?

More Details



6. How much would your work tasks benefit from implementing a market analysis system?

More Details



7. How much would your work tasks benefit from implementing a system for scorecards?

More Details

8. How much would your work tasks benefit from implementing a system that would show the current stock at the EMSs?

More Details

Appendix D.

New suppliers are assessed and approved through quantitate and qualitative evaluation. This is a part of the new supplier evaluation process, see Figure D.1. In the supplier qualification and general evaluation phase several documents are sent to the supplier, for some of these documents Axis also require material back from the supplier, see Table D.1 and D.2.

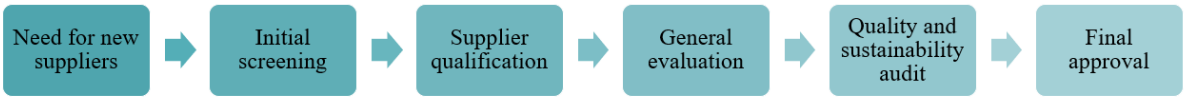


Figure D.1. The new supplier evaluation process.

Table D.1. Documents sent to suppliers during the supplier qualification.

Document	Material back to Axis
Financial evaluation	Yes
Code of conduct	Yes
Supplier information	Yes
Request: ISO certificates (if applicable)	Yes
Budgetary quote (if applicable)	Yes
NDA (if applicable)	Yes
Axis banned/restricted list	No
Material declaration template	No

Table D.2. Documents sent to suppliers during the general evaluation.

Document	Material back to Axis
IPR (if applicable)	Yes
RFQ	Yes
Supplier system setup	Yes
Request: REACH and RoHS statements	Yes
Request: General halogen statement	Yes
SEF template	Yes
General instructions component supplier Axis	No

General production environment requirements	No
General instructions component packaging	No
Contractual agreements (start-up process)	No

Appendix E.

In the Excel file containing the additional supplier list there are multiple sheets with different information. The names of these sheets and the information they contain can be seen in Table E1. The top row represents the sheet names, while the rows below each sheet name represent the name of a column in that sheet.

Table E.1. The Excel sheets within the additional supplier, with corresponding column names.

RFQ	EMS RFQ 2021_Q1	Spendtool 202104-202103
Part no.	Part no.	Component
Description	Description	Description
EMS or supplier	EMS 1a Manufacturer	Part main group
Quote date	EMS 1b Manufacturer	Safety code
Price valid from (date)	EMS 2 Manufacturer	Source type
Price valid to (blank if open ended)	EMS 3a Manufacturer	Date
Manufacturer	EMS 3b Manufacturer	Total spend
Manufacturer number	EMS 4 Manufacturer	2021-04-01
Supplier	EMS 1a USD	2021-05-01
Axis controlled (Yes/No)	EMS 1b USD	2021-06-01
Supplier’s unit price	EMS 2 USD	2021-07-01
Currency	EMS 3a USD	2021-08-01
MOQ (Minimum order quantity)	EMS 3b USD	2021-09-01
SPQ (standard packing quantity)	EMS 4 USD	2021-10-01
Cost in USD	Avg EMS cost	2021-11-01
Lead time (calendar days)	Min EMS cost	2021-12-01
Comment	Max EMS cost	2022-01-01
Added by	Diff (%)	2022-02-01
EMS estimated yearly consumption	EMS 1a Consumption	2022-03-01
	EMS 1b Consumption	
	EMS 2 Consumption	
	EMS 3a Consumption	
	EMS 3b Consumption	
	EMS 4 Consumption	

	Total estimated yearly consumption
	Spendtool 202104-202103
	Turnover, USD (Avg EMS cost)
	Turnover, USD (Min EMS cost)
	Turnover, USD (Max EMS cost)