CHALMERS
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How Digital Technologies will Impact the Procurement Process and Organisation

A study performed in collaboration with SKF Group Purchasing

Master's thesis in the Master's Programme Supply Chain Management

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Gothenburg, Sweden 2018
Report No. E2018:074

MASTER'S THESIS E2018:074

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Chalmers Reproservice
Gothenburg, Sweden 2018

Acknowledgement

This master's thesis has been conducted during the spring semester of 2018 in collaboration with Chalmers University of Technology and SKF Group Purchasing. On the way towards a master's degree within supply chain management at Chalmers University of Technology, the authors have gained assistance and support from people, without whom this thesis would not have been possible.

Primarily, we would like to thank our supervisor at SKF Group Purchasing, Johan Ramström, who has been straightforward with his expectations of this thesis. Except from this, he has also helped us to get in touch with, both internal and external, contacts and interviewees for the thesis. Furthermore, we would like to thank the Strategy & Business Transformation team at SKF Group Purchasing who provided us with valuable input during our workshop. From SKF Group Purchasing, we would also like to thank Anders Löfgren who provided us with information of the structure of the procurement function at SKF.

Secondly, we would like direct a thank you to all contributors to our master thesis for their involvement and inspiration. This involves the interviewees, who helped us understand the concept of digitalisation and its impact, not only on procurement, but also industries as a whole. Also, we would like to say thank you to all students who voluntarily participated in our workshop and for their outside-the-box thinking and dedication.

Finally, we would like to thank Gunnar Stefansson, our supervisor at Chalmers University of Technology, for his guidance regarding the academic report-writing aspect. His advice on how to structure the study has been of great importance during the thesis.

Chalmers University of Technology
Gothenburg 2018-05-17

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Abstract

Digitalisation is the word on everyone's lips today. In a globalised business environment with increased competition, companies need to disrupt their business and processes or get disrupted. This thesis has been conducted in collaboration with SKF, a global market leader in the roller-bearing industry. SKF has, like many other industrial companies, realised that digitalisation potentially could change their entire business model and transform their organisation. Therefore, SKF Group Purchasing is interested in how this will affect procurement. Hence, the purpose of the study has been to analyse how digitalisation will influence the procurement process and organisation at SKF. During the study, current working processes and IT-systems have been disregarded and the focus has been to describe a major step change rather than continuous improvements.

To achieve the purpose, it has been important to first get an understanding of what digitalisation actually is and how the technologies, included in digitalisation, work. Due to the futuristic character of this thesis, it has been challenging to find literature or cases that verify how the technologies will impact procurement. Therefore, the literary study has been complemented by eleven interviews with people specialised, in digitalisation as a whole or, in a specific technology. Additionally, a survey was sent out to the interviewees to complement the results and provide insights for the analysis. During the process, the proposed changes and potential impact has been discussed in workshops with both students and the Strategy & Business Transformation team at SKF Group Purchasing. Students, with basic knowledge in the procurement process and the technologies provided some outside-the-box thinking while the personnel of SKF contributed with insights and a more critical perspective on how digital technologies will affect procurement.

Since the purpose has not been to develop a concept to be implemented in the near future, the most beneficial way to answer the question, how digitalisation will impact procurement, was by creating scenarios. In total, there were four scenarios created, each focusing on an emerging technology. The scenarios are named; *Full Automation* (artificial intelligence and robotic process automation), *Servitization* (Internet of Things), *Blockchain* and *3D-printing*. The first scenario, *Full Automation*, could potentially replace human purchasers and eventually dismount the whole procurement function. *Servitization* could lead to increased planning capabilities and closer relationships with suppliers and customers. The *Blockchain* scenario could disrupt the whole procurement process and enable more transactional business relationships. *3D-printing* could reduce the amount of suppliers and associated call-offs and potentially take over responsibilities from the first tier suppliers.

The digital technologies from the scenarios will change the procurement process and thereby also its role in an organisation. It has been concluded that there is no standalone solution and these technologies will probably all be a part of procurement in the future. Exactly how, is hard to predict and will differ from situation to situation. Probably, digitalisation will first transform the administrative and repetitive tasks to later on innovate strategic assignments. However, before adopting new technologies, it is of high importance to understand them and their business need.

Key words: Digitalisation, Procurement, Artificial Intelligence, Blockchain, Robotic Process Automation, Internet of Things, 3D-Printing, Purchasing

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List of Abbreviations

3D	Three dimensional
AI	Artificial Intelligence
CAD	Computer Aided Design
IoT	Internet of things
IT	Information Technology
MRO	Maintenance repair and operations
MTO	Make to order
NLP	Natural language processing
RPA	Robotic Process Automation
SKF	Svenska Kullagerfabriken
TCO	Total cost of ownership

1 Introduction

This chapter aims to give an introduction to this master thesis. Starting off with a background for the subject and ending up in a motivation of scope and purpose of the study. The purpose is complemented with a few research questions. Further on, delimitations and outline of the thesis are explained.

1.1 Background

Today's industry is rapidly changing. Globalisation has taken its grip during the last decades and distances get shorter, connections get broader and time is ticking faster (Tate, 2013). This has led to increased complexity of the business environment as well as its processes (Arpe, 2012). On a global market with ever increasing competition, the need for quick reaction and adaption has become key factors for success. In combination with increased capacity in terms of data processing, the world is getting more and more digitalised (Averstad, et al., 2017). The fourth industrial revolution, the digital revolution, is only at its pre-stage and there are a lot more to expect (Deloitte LLP, 2017). How these trends and developments will influence the ways of doing business are yet to be discovered.

The journey of digital transformation is often divided into two parts; digitisation and digitalisation (i-SCOOP, 2017). Digitisation is about converting analogue information to digital, something that more or less was covered by the third industrial revolution. Gartner (2018) describes digitalisation as the process of moving to a digital business model, by the use of digital technologies. This enables new revenue and value-producing opportunities. Due to the financial situation in the past decade, many companies have experienced prosperous times and have, therefore, not been forced to change and improve their business models or processes (Magnusson, 2018). This is why digitalisation has not been prioritised until now.

Today, however, digitalisation is the word on everyone's lips (Petersen, 2018) and companies invest heavily in new Information-Technology systems (IT) and innovations to get digitalised. The rationale behind this can be explained by three factors. First of all, the increased complexity, caused by globalisation and technical developments, puts pressure on business process improvements (Averstad, et al., 2017). Using procurement as an example; back in the days this process was depending of a "material man" who decided, without a supporting model, what materials and articles that were needed (Busch 2010). Nowadays, procurement is a supporting function of a business that includes all kinds of buying activities that occurs within a organisation (van Weele, 2014); both in terms of direct and indirect spend. According to Vollmer & Murphy (2017), the subject of procurement has gained interest and importance in the last couple of years, since, in some industries, 65 percent of the total value of a company's products and services can be derived from its suppliers. Having the opportunity to source from countless of suppliers active on a global market as well as on a higher level of detail, the requirements on the actual process and supporting infrastructure is higher than ever (Tate, 2013). For this reason, supporting IT-systems and digital solutions need to be put in place to understand, and to thereby make better decisions based on, all that information (Vollmer & Murphy, 2017).

Secondly, many of the currently existing business processes are too inefficient to handle the increased complexity (Ozel, 2013). Once again looking at the procurement process, it is in many regards unnecessarily time- and resource consuming. There are many steps which in themselves do not contribute with any value, but must be done to secure trust (Murphy, 2017).

All these sub-processes also come with a lead time and usually without any direct transfer to the next process step. In a pre-digitised world, the environmental footprint was also noticeable, considering all the print-outs and documents required (Chin, et al., 2015).

Lastly, the need to stay competitive and stay ahead is of importance to all businesses (Averstad, et al., 2017). While the world is getting smaller, the competition is growing like never before and price is not necessarily the most important aspect anymore (Tate, 2013). To be ahead in adopting new technologies, process development or cost reductions could mean the difference between market lead and bankruptcy. Being an early adopter has never been more important (Averstad, et al., 2017). This does not necessarily mean being the first adopter, there could be benefits with a certain follower's strategy to avoid lock-in effects in an inferior platform or technology (Tremblay, 2017). But, being early heavily increases the possibilities of exploiting a new technology to a company's benefit.

SKF (Svenska kullagerfabriken) can historically be considered an early adopter. The company was founded in the beginning of the 20th century as a result of the invention of the double-row self-aligning ball bearing (SKF, 2018). Now, SKF is a global manufacturing company of high quality roller-bearings for a diverse amount of applications. Manufacturing sites in over 100 different locations as well as presence in 130 countries makes them one of Sweden's biggest companies and a global market leader within their segment. Innovation has always been important for SKF with countless of patents throughout the years. Also, within a globalisation perspective they have been ahead resulting in a fast expansion to other continents and countries (Lindholm, et al., 2011). This thesis has been performed in cooperation with SKF Group Purchasing.

1.2 Motivation of scope

Digitalisation, as identified above, is driven by three main factors when considering market-pull perspectives: increased complexity of the business environment (Arpe, 2012), increased competition/need to be in front of the market (Averstad, et al., 2017) and inefficiency of current processes (Ozel, 2013). There are also technology-push factors such as increased capacity in terms of data processing (Averstad, et al., 2017) as well as increased amount of data generation (Vollmer & Murphy, 2017). IBM states that 90 percent of all data currently existing have been produced during the last two years (Vollmer & Murphy, 2017).

Usage of digital technologies could benefit procurement processes when dealing with the increased amount of data, requirements, complexity and competition (GEP, 2017). The current processes lack efficiency both in terms of time and cost to be able to cope with the upcoming changes and new business environment (Ozel, 2013). There are many unnecessary and non-value adding steps and supporting administration required throughout the processes (Blum, 2018). Digitalisation is happening, and the procurement department needs to be prepared and alert if they want to remain an important function within an organisation (Magnusson, 2018).

SKF is considered to have taken the journey of digitisation and is now working with and looking for the next steps within digitalisation (Ramström, 2018). They are interested in what will happen in the future, what are the new technologies, and how and when can they be applied to make sure that SKF stays in front of their competitors. This thesis will take a closer look on the procurement process and organisation at SKF and how these could be influenced and changed by digitalisation.

However, there are many diverse definitions and understandings about what digitalisation actually is and involves (Ramström, 2018). This should be clarified to set a foundation for further investigations. Additionally, technologies should be identified, that are included in the subject of digitalisation.

The advantages of implementing digital technologies are often associated with savings potential and increased efficiency (Accenture Operations, 2017). Although, that might be possible, it is important to first investigate what business needs there are of implementing a specific technology (Lindstrand, 2018). Otherwise, there is a risk of costly investments and developments, as a result, rather than the savings or the increased efficiency earlier mentioned. Therefore, it is essential to address the right technologies for a company's context and function. Consequentially, it must be identified what technologies, within digitalisation, that can affect procurement and how.

The technologies overall impact and influence on the existing processes and their including steps should be mapped and analysed. It should be described how the new processes will be designed and how they will be executed. Additionally, looking at the organisational factors; the impact on today's employees, their working situation and their roles within the business should be addressed. Digitalisation might not only bring benefits and improvements, there will probably be some negative implications as well. How far development and digitalisation should go, could be an important issue to discuss.

There are also increasing concerns regarding the security, safety and robustness as well as other risks related to storage-, governance- and accessibility of data (Allianz Global Corporate & Specialty, 2016). Digitalisation and its technologies might also influence procurement in a non-beneficial direction or towards a decreased general need of the function (Magnusson, 2018). The digital technologies studied must therefore be analysed in regards to these risks.

1.3 Purpose

The purpose of the master thesis has been to analyse how digitalisation will influence the procurement process and organisation at SKF. The aim has been to identify and explore new technologies within digitalisation, resulting in an evaluation of a few of the most promising technologies and their potential impact on procurement. With this as a foundation, risks and opportunities has been identified and considered for setting a strategic agenda for future scenarios.

The thesis has been performed during the spring semester of 2018 and the results has been delivered in a presentation as well as a written report containing suggestions on what to consider and pursue when it comes to digitalisation of procurement.

1.4 Research questions

To achieve the purpose of the study and enable a deeper understanding there are some underlying questions that have been answered:

1. What is digitalisation?
2. What technologies exist within digitalisation?
3. Which technologies will impact procurement?
    a. How will the procurement processes be affected by these technologies?

b. How will the organisation be affected by these technologies?
c. What are the risks and opportunities with these technologies for procurement?

1.5 Delimitations

This master thesis was limited in terms of both time and scope. First of all, it was mainly focused on process- and organisational changes caused by digitalisation for procurement rather than the whole company. The procurement function was treated on a general level with no special adjustments and considerations to how procurement is organised and functioning at SKF today. Therefore, the specifics of SKF, their routines and activities as well as supporting IT-systems were not taken into consideration. Further on, no focus was on improving or digitising SKF's procurement processes, since this is considered to already have been done. Additionally, smaller improvements and "near-future" solutions were not the focus, but rather major changes and developments representing a step-change for an procurement organisation like SKF's.

The scope was also limited to only cover a selected few of the digital technologies that were considered most interesting and influential. The analysis was also performed on a conceptual level and without deep technical focus. The study was also limited to not consider strategies for implementation of the technologies and concepts.

Due to the width of the topic and scope as well as its futuristic character, the project was limited to qualitative research. Quantitative methods were considered too challenging in regards to available competence and previous cases, and the results would have been insufficient to provide inspiring insights for SKF Group Purchasing as well as to fulfil the purpose.

1.6 Outline

The report has been divided into seven chapters to enable a logical structure and flow of the contents presented. In the introducing chapter, background to the project is presented, ending up in a problem formulation as well as purpose and research questions. Additionally, delimitations with the project are mentioned. Further on, the method of the study, with approach and including steps, is presented in the second chapter. In the third chapter, the theoretical framework is presented to give the reader some knowledge and understanding of the central technologies and concepts within this report. Then, the fourth chapter handles the empirical results received throughout the study from qualitative interviews, workshops as well as a complementary survey. Since the empirical study was of qualitative character, the results are presented in a similar way. In chapter five, the empirical results and literature studied are used for analysis. Four potential scenarios of the future are presented and analysed according to their impact the on procurement process and organisation as well as complementary risks and opportunities. Last but not least, the conclusions are presented in chapter six, followed by a discussion, in chapter seven, regarding interesting topics and future considerations. Proposals for future research are also presented in this chapter.

2 Method

The chapter below will describe the methodology approach of the study as well as all the including parts which build up the method of the conduction of this master thesis. The preparation and literature search will be handled before the major part, of this chapter, will describe the empirical study and the involved methods for this. Finally, the conduction of scenarios for analysis and discussion will be explained.

2.1 Approach

For this thesis, the approach of abductive reasoning was used. Abduction is described by Dubois & Gadde (2002) as a combination of deduction and induction, hence moves between empirics and theory. The approach was chosen due to its free borders and that the iterations suited the project well. Literature was continuously studied while performing empirical studies. This was needed to be able to conduct and understand the interviews, while the interviews gave directions where to look and what to read further. Therefore, the study iterated automatically and became of explorative nature. Additionally, the method approach was of qualitative character, which could be explained as focusing on human factors rather than hard data and information gathering being made in small scale and of describing type (Blomkvist & Hallin, 2015).

The overall methodology approach for this thesis mainly consisted of three parts; literature research, interviews and innovation workshops, as can be described by Figure 2-1 below.

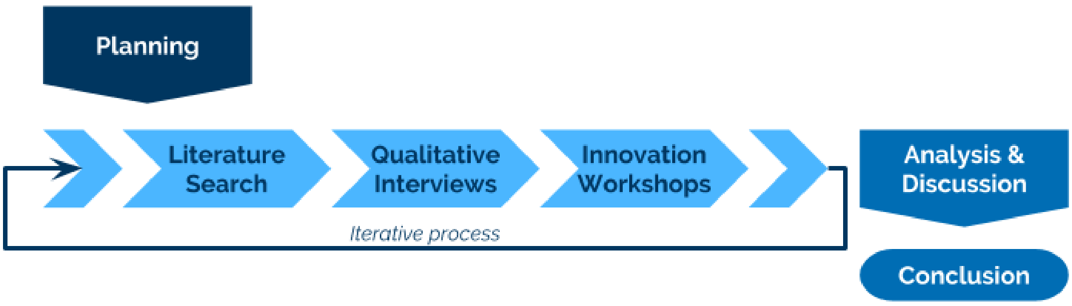

Figure 2-1: Methodology approach.

2.2 Planning

Initially, before starting the actual work, it was important to plan how to approach the subject. Therefore a planning report was made to answer some important questions such as; what is the purpose, what is the objective and how to get there? Another important aspect of the planning report was to define the scope of the thesis and the necessary limitations. To do this, a problem formulation and a time plan were conducted.

To get acquainted with the subject of the thesis, a brief literature study was performed in the planning phase as well. The reason for this was to obtain sufficient knowledge to initiate contact with key interviewees for the project. Due to the futuristic perspective of the thesis, an important issue was how to access accurate information since most literature are either based on historical facts or predictions. Therefore, it was perceived that it would be necessary to conduct interviews with experts in the field of digitalisation, to complement the literature study. Another aspect that was considered is how to achieve a comprehensive view of the subject, which is why the interviewees had different backgrounds, further described in section *2.4.1 Selection of Interviewees*. As mentioned earlier, the thesis was performed in a futuristic perspective, which also is why the interviews were of qualitative form.

2.3 Literature Search

Throughout the project, literature was continuously studied to create a theoretical framework. The aim of the theoretical framework was mainly to obtain suitable and needed knowledge regarding the terms and technologies discussed during the empirical study and to give the reader a brief introduction to the topics and build up towards the rest of the report. Due to the explorative character of the project, theory was continuously gathered in an iterative process, where literature search, qualitative interviews and innovation workshops was performed in parallel or in looped sequences. Initially, there were struggles to identify concepts and areas that needed to be explained in the theoretical framework, why the topics were added over time.

The literary study consisted of scientific papers, reports and other publications, mainly collected through databases provided by the Chalmers Library, as well as Google Scholar. A lot of references were also found through regular web-search and especially consultancies internal web-portals and paper-collections. Search phrases have included *digitalisation, procurement, purchasing, blockchain, artificial intelligence, future trends and technologies* etc. Besides the web, books as well as other physical publications provided by SKF were used.

2.4 Qualitative Interviews

Qualitative interviews were held with "key players" or experts within the digitalisation and procurement subject. The interviewees were of diverse backgrounds, mixing academic and business perspectives, to enable a clear and unbiased picture of the upcoming changes and developments. To get an insight of what SKF was working with at the moment some key players within the organisation was interviewed as well. In total, these interviews were mainly used to get insights about potential solution areas and technologies and their impact on procurement in the future.

2.4.1 Selection of interviewees

As mentioned above it was of importance to get interviewees with varying backgrounds and positions to achieve a comprehensive result of the empirical study. Consultants were chosen to provide information of what is going on right now and what is happening in a near future perspective. Therefore, consultants that were experts within specific technologies as well as consultants with a general view of digitalisation were selected.

The same goes for academy where both specialists, within a specific technology, and people with a wide knowledge base were selected. In general, the interviewees from the academy were chosen to provide a more long term and critical view of the technological development. At SKF, it was first of all necessary to achieve knowledge of how the procurement process and organisation was structured. In addition, information of what digitalisation initiatives there are today was desired, which is why interviewees at a high level, with insights in digitalisation and different parts of the organisation was selected. These digital initiatives can unfortunately not be shared in public. The interviewees representing business were selected in one case due to his/her expertise and knowledge regarding technology usage and in the other case due to his/her broad competence and long experience regarding digital solutions for procurement. All interviewees have been anonymised as requested, but their role and background is shown in Table 2-1.

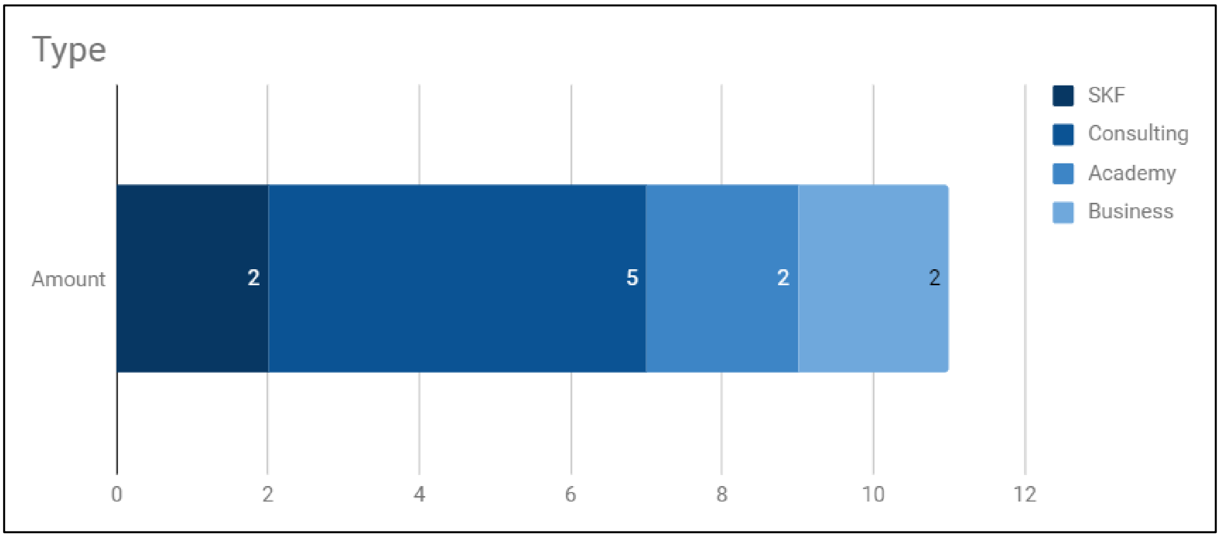

Figure 2-2: Interviewee background.

Table 2-1: Interviewee's roles and background.

Tag	Role	Background	Date
S1	Chief Technology Officer	SKF	7-Feb-2018
C1	Management Consultant within Outsourcing	Consulting	12-Feb-2018
A1	Head of the Information Systems division at the Department of Applied IT, and co-director for the Swedish Center for Digital Innovation	Academy	20-Feb-2018
C2	Strategy analyst within technology	Consulting	26-Feb-2018
A2	Blockchain researcher	Academy	28-Feb-2018
B1	Researcher within ICT	Business	28-Feb-2018
C3	Account Director	Consulting	2-Mar-2018
S2	Manager Business Process Solutions Sales & E-business	SKF	6-Mar-2018
C4	Senior Manager within Procurement Consultancy	Consulting	8-Mar-2018
C5	Consultant specialised in procurement	Consulting	9-Mar-2018
B2	CDO and former CPO	Business	16-Mar-2018

2.4.2 Interview design

To large extent the interviews had the same structure with some adjustments made to match the specialisation of the interviewee. The reason for having the same foundation was to be able to compare the results afterwards in an adequate way. The initial part of all interviews consisted of a brief introduction to the aim of the thesis and what the objective of that specific interview was. Thereafter the reappearing subjects of the interviews was; *what is digitalisation, how will it affect procurement, what technologies will have an impact and in what way?* Of course, interviews with specialists of a specific technology were more focused on that specific technology and its possible effects on procurement.

2.4.3 Performing interviews

The interviews were mainly performed in the form of face-to-face meetings, but due to geographical and sometimes logistical issues, some of the interviews were conducted by phone. 6 out of 11 interviews in total, were held face-to-face and the rest by phone. The structure of the interviews was to some extent predefined, but the interviewee was allowed to change the direction of the interview which led to new questions as well. The interviews were recorded in 10 out of 11 cases, where it was confirmed by the interviewees. In some cases, during the interviews, questions were asked to get previous interviewees' answer validated or questioned. Some interviews were performed to establish background and understanding of the context and did not contribute anything to the empirical study, why these have been excluded from the Table 2-1 and Figure 2-2 provided above.

2.4.4 Summarising the results

Afterwards, with help of the recordings and the notes from the interviews, the key points of each interviewee were registered. This register was used to build a framework where the results were displayed. The objective of this was to achieve an overview of what technologies and what parts of the procurement process and organisation will be affected. The overview was later used to construct the empirical results.

2.4.5 Complementary survey

With all interviews summarised, it became clear that digitalisation will possibly affect procurement in multiple directions. Thereby, it was realised that addressing the question, how digitalisation will affect procurement, preferably would be done by creating scenarios. To get a foundation to build these scenarios upon, a survey was created. The survey included questions regarding, for example, how technologies will be used and to what extent. The questions were formulated to cover all areas of digitalisation in connection to procurement, as discussed during the interviews. Some additional areas of how digitalisation will affect other areas of an organisation and its structure were also included, as these characteristics were expected to be part of the scenarios. The questions were confirmed by the supervisor of the study, before the survey was sent out. All interviewees were asked to answer the survey. The questions and their results are displayed in Appendix A.

The survey unfortunately only received five out of eleven answers, why most of the questions were hard to consider when conducting scenarios since the answers were diverse and did not point in a specific direction. However, some directions were still possible to conclude from the results, complemented by the already performed interviews, as described in section *4.3 Scenario Survey*.

2.5 Innovation Workshops

Alongside, with the above mentioned channels of information gathering, two innovation workshops was planned to be performed with students with technological interest and curiosity as well as employees of SKF Group Purchasing with knowledge and interest within the subject of digitalisation. The aim of the workshops was to complement the qualitative interviews with new angles and ideas from different perspectives.

2.5.1 Workshop with students

The aim of this workshop was to gather a higher quantity of insights from people with or without previous knowledge and to generate "outside-the-box" concept ideas. Further on, it aimed to map the students' understanding of technology-trends and gather thoughts on the topic from the students' perspective. This was meant to expand the horizon of possible solution areas and give further input to be discussed during the qualitative interviews. Ten students within the subject of engineering participated, all with knowledge and interest in technology. The educational backgrounds of the participants are displayed in Figure 2-3.

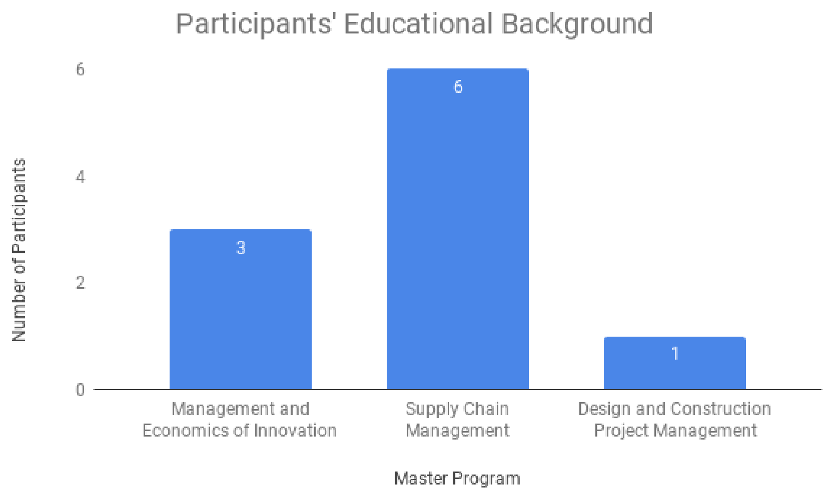

Figure 2-3: Educational background of the participants of the student workshop.

Structure and design

The workshop was planned to take about an hour, but ended up close to 1,5 hours. First of all, the purpose of the workshop was introduced along with the overall purpose of the project. A brief introduction to the topic of procurement was given, just to make sure that all the participants knew what was meant when using the term procurement. A short introduction to the topic of digitalisation was also given, as well as a more detailed but yet brief walk-through of the blockchain-technology. Blockchain was especially chosen since many students might not be familiar with this concept, an assumption that was proved right considering that some of the participants had not heard the term before.

The actual workshop mainly consisted of two parts; Brainwalk and Progressive Abstraction. Before encountering these methods, the basic rules of brainstorming (IDEO, 2018) were introduced, to give the students the mind set and framework for the challenges to come.

Brainwalk

This method is basically a rotating mind-mapping technique (Friessnig & Karre, 2016). The students were divided in three groups, each given a flipchart and some coloured markers. At each flipchart, a question was already written and the groups were asked to brainstorm around these questions, building mind-maps on the charts. After a set of a few minutes, the groups circulated to the next flipchart and were asked to continue to brainstorm on the question and comments added by the previous group. This was iterated until the groups came back to their original chart. Through this method, all groups collected their thoughts on all questions but were also given the opportunity to build on the other's ideas and expand the mind-map. When all was finished, the groups briefly presented their charts and what the main take-outs was from each one of them. The questions asked on the flipcharts were; *what can we do with IoT-data*, *how can AI change the way of working* and *what are potential usage areas for blockchain*.

Progressive Abstraction

The second part of the workshop consisted of the method known as progressive abstraction. This technique aims to define problems by varying the level of abstraction (Friessnig & Karre, 2016). It is common that the wrong questions are being asked, making it impossible to understand the root causes. This method helps to reach a proper problem definition and was actually used for the initial parts of this project, where background and motivation of scope was used to conduct purpose and research questions.

During the workshop, the students were once again divided in their groups. At each flipchart, a problem was written and their task was to conduct answers and/or solutions for this. The next step was to identify the essential part within these answers, i.e. what was the most important aspect or answer. Lastly, the essential part was used to conduct a new question or problem. These steps were then iterated during a few minutes or until a sufficient level of abstraction was reached. The results were then discussed with all participants, as the groups presented their outcomes. The procedure can be explained by the example given in Figure 2-4 below. The initial questions used for this activity was; *why is procurement needed, why is digitalisation needed* and *what are the risks with digitalisation*.

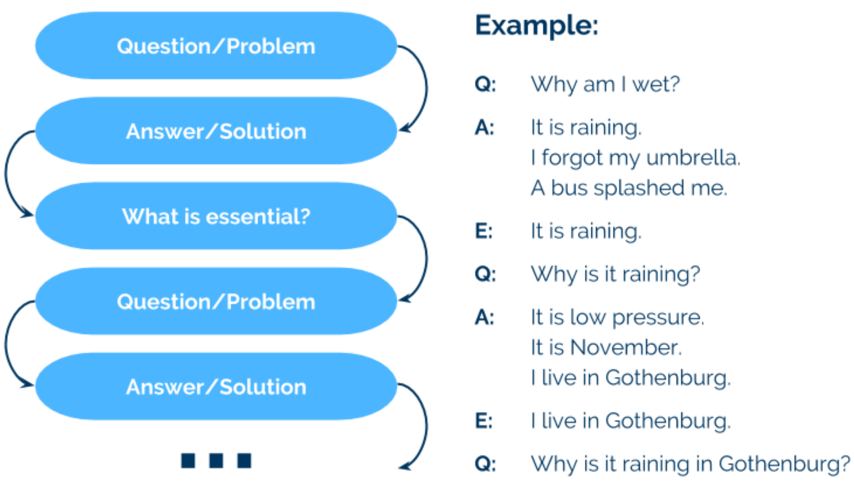

Figure 2-4: Example of Progressive Abstraction. Q = question; A = answer(s); E = essential part.

Usage

The outcomes of the workshop was used as a complement to the results provided by the interviews, see section *2.3 Qualitative Interviews*. The key objective was to gain the students' perspective and their understanding of the topics targeted within this thesis. The workshop also contributed with some new angles and ideas, further, explained in section *4.2 Workshops.*

2.5.2 Workshop with SKF

This workshop was performed later on in the project's timeframe and in connection to a pre-presentation of the results collected so far in the project. The employees of SKF Group Purchasing's Strategy & Business Transformation team were participating, counting up to 15-20 people. The aim of this workshop was to get the purchasing team's input in regards to the presented results considering viable technologies for procurement. A few of the technologies was selected by the team and the workshop was simply designed around those. The team was divided in four groups, corresponding to one technology each, and was asked to brainstorm around the topics however they preferred, for example considering advantages and disadvantages, potential usage for procurement, impact on organisations and processes etc.

The usage of this workshop was similar to the student workshop, where the insights and angles complemented the results provided from the interviews. The objective was, however, also to get feedback on the results presented. This was given through questions and discussion during the presentation as well as the following workshop. The key outcomes of the workshop are further explained in section *4.2 Workshops*.

2.6 Analysis and Discussion

After the theoretical and empirical study, the results were analysed and discussed to prepare for a summarising conclusion of the study. The selected technologies and their scenarios were analysed according to a set-up framework and discussed regarding their future potential, using the insights provided through the empirical study.

2.6.1 Creating scenarios

The results from the survey and the summarised interviews were used to decide how many scenarios to create and what to include in those. Since none of the scenarios are supposed to be used in a near future perspective, it was necessary to first of all set the scene. The intention of this was to describe how procurement will look like if today's rate of progress continues, see section *5.1 Setting the scene*. All technologies included in this section are technologies that to some extent already are used in the organisation. In cooperation with our supervisor at SKF Group Purchasing, Johan Ramström, four different scenarios were conducted and aligned with the interests of SKF. All of them focused on what one specific technology could offer procurement when used to its maximum. The rationale for this was to describe different directions of development and look at "end-points", to enable understanding about potential effects. The four scenarios are; full automation (focusing on AI and RPA), blockchain, servitization (focusing on IoT) and 3D-printing, and are all further described in chapter *5. Scenario Analysis*.

2.6.2 Analysis of scenarios

Analysing the scenarios was done by using information obtained from interviews in combination with studied literature. The purpose of the analysis was to find out how the scenarios will affect the procurement process and its different organisations. Focusing on the process, the aim was to see how the different steps would be affected by technologies. With this as a basis, it was possible to see how the organisation would be affected as well. Altogether, this generated some possible opportunities and risks that each one of the scenarios provides. The scenario analysis is found in chapter *5. Scenario Analysis*.

2.6.3 Conclusion and discussion

The analysis was summarised in a conclusion containing the key take-outs and reconnecting to the research questions. Additionally, some potential directions of the future role of procurement, as derived from the analysis, are stated. Last but not least, a few especially interesting points as well as considerations to what is needed from SKF to be prepared and ready to pursue these opportunities, were discussed and suggestions for further research were presented.

3 Theoretical Framework

This chapter, which is based on literature, aims to provide a theoretical foundation of procurement, digitalisation and the technologies further evaluated in chapter *5. Scenario Analysis*. However, there will at first be an explanation of what procurement is, what different processes there are and how SKF's procurement organisation is structured. Thereafter, the expression digitalisation will be defined including a brief description of the technologies frequently mentioned within digitalisation. Lastly, the most promising of those technologies, for procurement, are described to prepare the reader and provide understanding for the scenarios in chapter *5. Scenario Analysis*.

3.1 Procurement

Procurement is a supporting function of a business and covers the processes of all types of buying that occurs within a company (van Weele, 2014); whether it is direct or indirect spend. The subject of procurement has gained importance in the last couple of years due to realisation of the great savings potential within spend. According to Vollmer & Murphy (2017), 65 percent of the total value of a company's products and services can be derived from its suppliers. The strategic importance of well-functioning procurement is therefore increasing (Accenture Operations, 2017).

Procurement is often confused with purchasing and sometimes other terms such as sourcing or supply management. However, van Weele (2014) argues that these terms are interchangeable while many others claim the opposite. Procurement could be seen as the more overarching function, which purchasing is a part of (Purchasing Insight Ltd, 2018). According to the definition given by Purchasing Insight Ltd (2018), procurement involves the more strategic activities, such as supplier evaluation and negotiation, as well as the more operational activities required to order and receive goods. Purchasing on the other hand only covers the operational part (Purchasing Insight Ltd, 2018) and can, according to Lim (2014), be described as the transactional function of procurement. However, there are no common definitions of the two terms and they are used differently by different companies and in different environments. The following section aims to describe procurement, its processes and role in an organisation as well as explain procurement from the perspective of SKF.

3.1.1 The Procurement Process

Alike the definition of procurement, there are a lot of different descriptions of the procurement process and many companies are using their own versions. The process described by van Weele (2014) involves six steps according to Figure 3-1 below. The first three steps belong to strategic sourcing, while the last three refer to the order function and operational part. The steps according to van Weele (2014) will be described briefly below.

i. *Determining specification*
The process is initiated by a purchasing requisition i.e. something need to be bought. This requisition must be specified in a correct way to enable a future purchase. Here one must answer some questions regarding if it is a product or a service that is sought and what functional and technical requirements is needed.

ii. *Selecting supplier*
Based on the specification, the supplier base of potential providers must be evaluated and narrowed down according to aspects such as delivery lead time, price, quality as well as corporate social responsibility and location of origin. After this assessment, a selection can be made.

iii. *Negotiation and Contracting*
This involves conducting negotiations in order to establish an agreement upon terms that in a best case scenario is beneficial for both parts and is ending up in a legally binding contract. The contract sometimes works as the bridge between strategic sourcing and operational buying, which is why it should establish the kind of relationship between the buyer and seller.

iv. *Ordering*
In this step the ordering and handling routines are set up and developed, if the supplier is a new acquaintance. When the routines are set, the actual placement of purchase orders can be done.

v. *Expediting and evaluation*
This means monitoring and controlling the order to secure the supply. Typically, this means sending several documents between the buyer and seller such as shipping bill and goods receipt.

vi. *Follow-up and evaluation*
The last step involves rating and ranking the supplier as well as keeping all files up to date. It should be determined whether or not to continue source from the chosen supplier or what to change and develop.

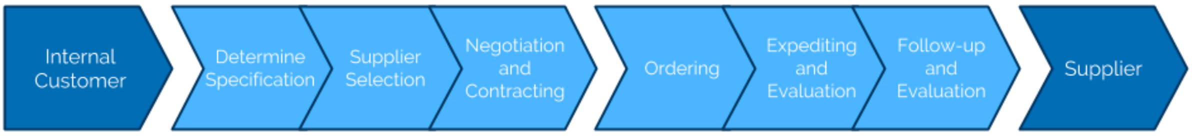

Figure 3-1: The Purchasing Process according to van Weele (2014).

The process explained above has further been developed to an extended purchasing process model, as by Figure 3-2 below. The extended model was conducted to better fit the needs of companies (van Weele, 2014). In this model, there are three phases; source, purchase and pay, each with several steps. The source-phase is more of strategic importance and involves a handful of analysis as well as the processes of evaluation, negotiation and selection of supplier. The last step is contracting, which connects sourcing to the next phase. This phase is the more operational purchase phase, which involves requisition, ordering and goods receiving. When all is finished, the invoice can be sent and payment performed, which is the pay-phase. The lower part i.e. the second part of the model is the so called purchase-to-pay process. These process steps are repeated for every regular purchase, while the source-phase is usually only done for new purchase needs. That is why the source-phase is of strategic importance while the purchase-to-pay is more administrative, operational and typically involves set up routines.

Figure 3-2: Extended purchasing process model according to van Weele (2014).

According to the definition regarding the difference between procurement and purchasing given by Purchasing Insight Ltd (2018), procurement would cover the whole processes described by van Weele (2014) in Figure 3-1 and Figure 3-2 above. Purchasing on the other hand, would according to this definition only cover the second and more operational part of both the process models.

Procurement process at SKF

SKF, as many other companies, have their own procurement process; see Figure 3-3 below. This process has two cycles, one strategic and one operational, as well as a connecting block consisting of contract and supplier relationship management (SKF Group Purchasing, 2018). In contrast to the definition provided by Purchasing Insight Ltd (2018), SKF use the term procurement for the operational part, while purchasing is the wider concept covering procurement as well as the strategic part. Besides the confusion regarding how the terms are used, the steps themselves are more or less the same as in the models described by van Weele (2014).

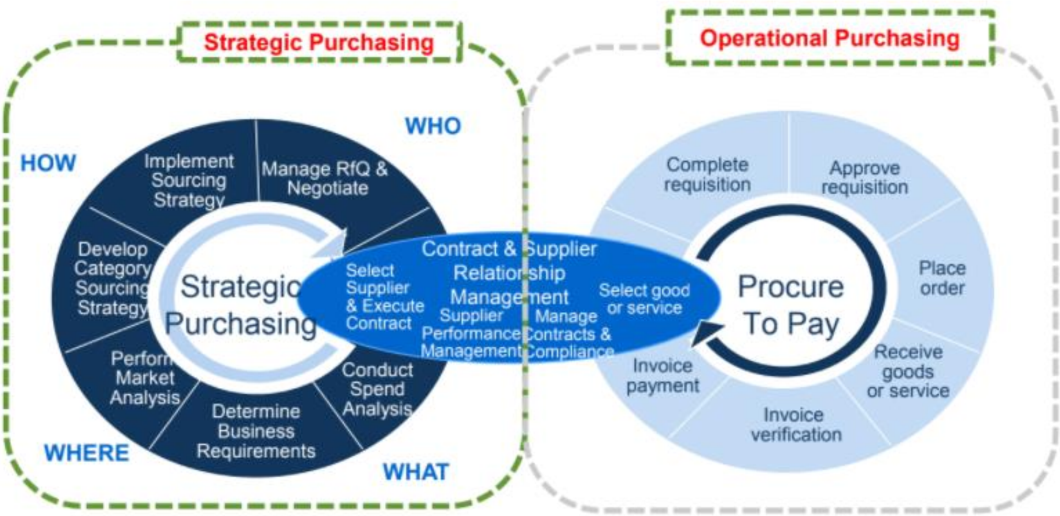

Figure 3-3: The Purchasing Process according to SKF Group Purchasing (2018).

Under the headline of strategic purchasing there are two different processes used at SKF; either the 3-step process of *sourcing* or either the 7-step process of *strategic sourcing* (SKF Group Purchasing, 2018). In short, the sourcing process is used when the specification and supplier base are known and there is a clear understanding of the stakeholder needs. For this process, a category strategy should also be present. The strategic sourcing process, on the other hand, should be used when the supplier base is unstructured and the market is unknown, without known best practices within the category. This process should be used when there are benefits cross business areas and/or business units. The 3- and 7-step processes are shown in Figure 3-4 below.

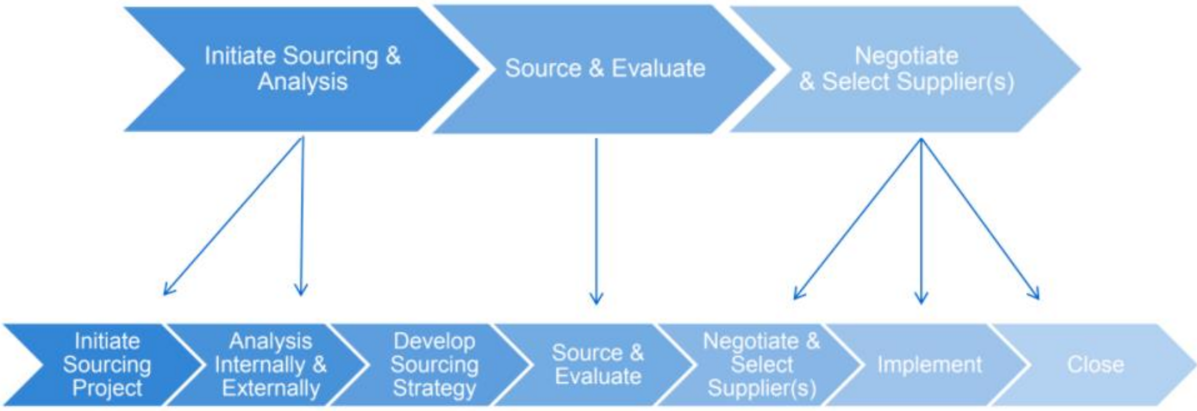

Figure 3-4: Sourcing and Strategic Sourcing according to SKF Group Purchasing (2018).

The General Procurement Process

For the purpose of this paper, a joint model has been conducted to explain the procurement process to be analysed. Inspiration has been taken from the two processes provided by van Weele (2014) as well as the process used by SKF and they have been combined to create a general description of the procurement process. This model will be used for describing a general procurement process and act as foundation for future analysis and empirical studies.

The procurement process, as described in Figure 3-5, consist of three main phases, very much like the one used within SKF (see Figure 3-3). For this model, the left cycle is called *strategic sourcing* and is linked to the right cycle, *request to pay*, by contracting and supplier relationships management. The definitions used for procurement and purchasing respectively are also shown in the bottom of the model.

Strategic sourcing consists of four steps; determine specification, evaluate supplier base, supplier selection and negotiation. These steps are very similar to the ones used by van Weele and still covering the details of the SKF-process. The steps are conducted to enable an easier analysis and avoid getting stuck on details.

The *request-to-pay* cycle is described more in detail with six steps; purchase requisition, quotation, purchase order, goods receipt, 3-way matching and payment. The steps are more or less self-explaining due to their names, except perhaps the 3-way matching. This means comparing the documents of the purchase order, the goods receipt and the invoice to make sure that their information, regarding product, quantity and price, are matching. If so, the invoice can be paid, and the request-to-pay loop is finished.

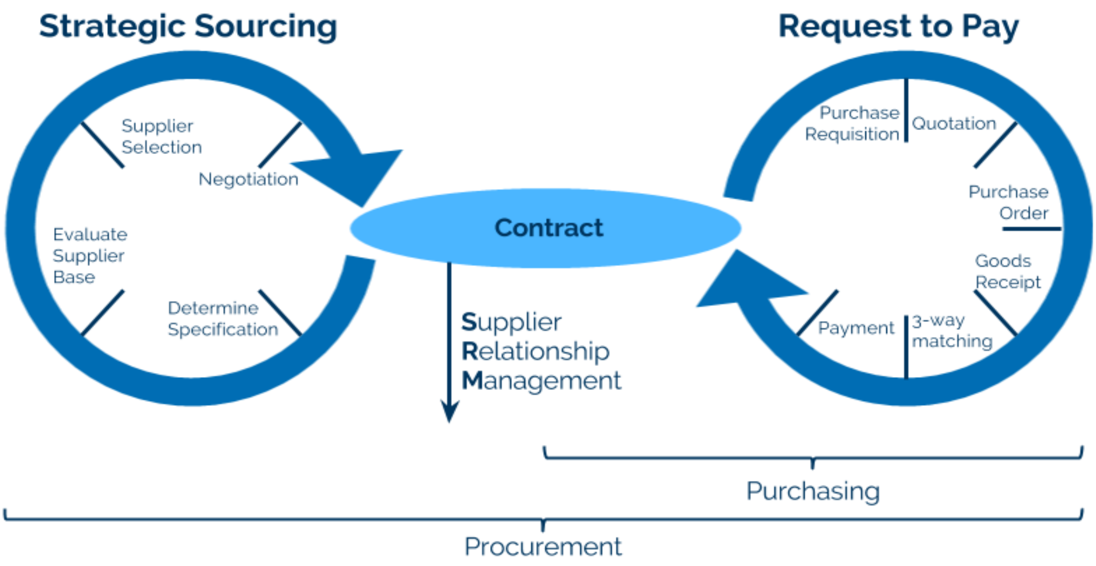

Figure 3-5: The General Procurement Process.

3.1.2 Procurement's role in and organisation

The role of procurement within an organisation has traditionally been of non-strategic importance (Vollmer & Murphy, 2017). This can be explained by the famous value chain model by Porter (1985). In this model, procurement is described as a supporting activity. The supporting activities have traditionally been addressed as areas which do not contribute to value directly and therefore holds potential for major cost reductions (Magnusson, 2018). In other words, these activities should only be as cost-efficient as possible. Magnusson (2018) argues that Porter is to blame for the role that procurement plays in most organisations today. The value chain model has been adopted by many companies and academic institutions, educating millions of professionals to address procurement as suggested by Porter. The result is that procurement is only seen as something that should be cost-efficient rather than being of strategic importance. Procurement's involvement in research and development is for instance absent in many organisations, where it could have substantial benefits to be carried in early on (Vollmer & Murphy, 2017). Imagine a new product development where the team present their final design concept and are being told by procurement that one of the parts needed cannot be sourced from any existing supplier, making their last months of work to be in vain.

Procurement at SKF

Procurement at SKF is driven by categories (Löfgren, 2018). Category management is a procurement methodology where items are bundled together, to consolidate purchasing agreements and maximise savings (Webb, 2015). Category management centralises procurement and leverage economies of scale.

At SKF, procurement lies organisationally under *Bearing Operations*, which is one of SKF's business areas (Löfgren, 2018). The CPO reports directly to the President of Bearing Operations. Procurement is in itself built up by the areas of: *Bearing Operations, Automotive & Aerospace, Indirect Material & CAPEX* and *Industrial Units*. Under these main areas, there are several more material- and cluster-specific subareas, for example for raw materials or product-families, as can be seen in Figure 3-6 below. The power of the procurement organisation lies within the category structure and their management. Local purchasers, at production sites, mainly follow the set-up strategy for the category. Almost all negotiations with new suppliers and new contracts are handled centrally through the category, but sometimes new negotiations for single purchases could be handled by the local teams. Regarding transactional and daily purchases against already settled contracts, these call-offs are made by the local supply-chain teams at the factories. The procurement department handles, in essence, the strategic purchasing wheel on a group-, category- and sometimes local level, while supply chain handles the procure to pay-wheel for all the regular transactions (ibid).

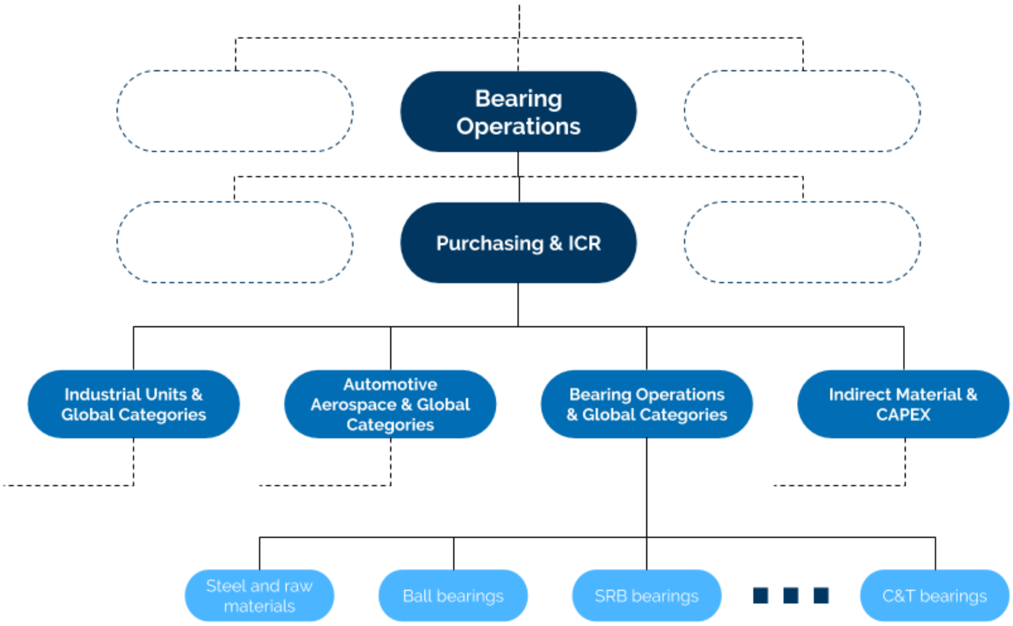

Figure 3-6: Organisational structure of SKF's procurement categories (Löfgren, 2018).

The overall procurement organisation at SKF is centralised and more is done on category- and group level (Löfgren, 2018). Just recently, the function of sourcing IT-solutions has been moved to belong to SKF Group Purchasing instead of SKF IT. The Group Purchasing department is a rather new instalment and prior to this, most procurement was handled locally by the factories. This development simplifies the processes and brings certain economies of scale.

Löfgren (2018) emphasises the importance of local competitive sourcing for SKF. There are two fundamental strategic rules followed when developing sourcing strategies at SKF; first to have regional suppliers near the production sites and second to use dual-sourcing to obtain flexibility and avoid dependence on single suppliers.

3.2 Digitalisation

In a report conducted by Qvartz and Microsoft (Averstad, et al., 2017), 20 major Swedish companies were interviewed regarding how they believe that digitalisation will impact their business. What can be concluded by the report is that the transformation towards a digital business has become of top management's priority for a wide range of businesses and that most companies still are at an early stage in this transformation. The latter is due to the economic situation that has been present during the last decades (Magnusson, 2018). Companies have not experienced the need to move towards digitalisation because their organisations have delivered good results anyway, considering the economic situation. During the last years there are some examples of new companies, with a more digitalised approach, that have been game changers for already matured businesses. Uber has changed how we travel by taxi (Stone, 2017), Airbnb has changed the way we travel (Marcotte, 2017) and Amazon has moved into, and changing, more and more businesses during the past couple of years (Kline, 2016). Their predecessors are now trying to stop the growth of these companies by legal actions because they are simply too far behind to compete with them. This is a major reason why companies today have such a high priority for digital transformation; they do not want to be left behind (Averstad, et al., 2017).

Digitalisation expects to have, as for many other areas, a large impact on procurement. The cost of running procurement is estimated to be reduced by as much as 40-60 percent (Accenture Operations, 2017). Moreover, the reduction of spend is expected to be about 15-30 percent (Vollmer & Murphy, 2017). However, these results will not be achievable tomorrow, it is important to use technologies in an adequate way and make sure that the organisational structure will follow. Furthermore, other parts of the organisation may change during the journey of digital transformation, which may lead to the procurement department having a different role in the future organisation. The digital transformation of a company can be divided into four areas; engaging customers, empowering employees, transforming your products or services and optimising operations (Averstad, et al., 2017). Since the aim of this thesis is to explore the effect on procurement it is mainly the latter, optimising operations, that is relevant in this case. To explain this further the question of what digitalisation actually is first needs to be answered.

3.2.1 What is Digitalisation?

Digitalisation has its origin in the word *digit* which in turn has its origin in the Latin word digitus. Digitus actually means finger, so the phrase is based on the old habit of counting with your fingers (Dictionary.com, 2018). What digital refers to is to represent something by using numbers. Digitalisation and digitisation is two phrases that is often being used interchangeably used, but actually have different meanings. Digitisation is basically converting analogue data into digital data. Examples of digitisation are how books have turned into e-books or how CDs has turned into MP3-files (Heimbuch, 2010). In other words, digitising is making analogue information readable for a computer i.e. converting it to 1's and 0's. Digitalisation is something entirely different although digitising is an important first step. Gartner (2018) defines digitalisation as *"the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business"*. This reveals that digitalisation also includes how digitised data is used to create business value and how it will change the organisation.

3.2.2 What technologies exist within digitalisation?

Digitalisation includes a vast amount of technologies. Below there is a list of some of them, including a brief description. The ones relevant for this paper will be further explained in sections *3.3 Internet of Things - 3.6 3D-printing*.

- *Blockchain* – A network platform, based on cryptology, enabling safe peer-to-peer transaction without any need of trust between peers (Christidis & Devetsikiotis, 2016). The technology also enables traceability of transactions all the way to the networks origin which brings transparency to the network. All information of the transactions is stored decentralised in the distributed ledger and is available to all users in the network. Today it is mostly used for cryptocurrencies such as Bitcoin, Ether etc.

- *Artificial Intelligence (AI)* – Using algorithms to enable computers to understand what data is relevant and using that data to make autonomous decisions. The expression artificial includes sub technologies such as machine learning, deep learning and natural language processing. By using these, a computer can understand for example images and written text / voice. *Cognitive computing* is a term often confused or used interchangeably with AI, but is just an initiative by IBM where the goal is to achieve a computer that think and behaves as a human being (Kelly, 2015).

- *Robot Process Automation (RPA)* – By algorithms making computers perform tasks autonomously that originally requires human workskill. RPA is similar to AI but is only used for routine task while AI has a wider range of usage areas due to its ability to self-learn (Accenture Operations, 2017).

- *Internet of Things (IoT)* – This technology provides connectivity between computers and physical objects. This is done by placing sensors on the physical objects to retrieve data (Gubbi, et al., 2013). These sensors could for example provide information about an object which is starting to get worn out. By providing this information the production will know about this before it actually breaks and therefore it can be replaced before it happens.

- *Big Data* – Due to the increasing amount of data that is provided by digitisation and IoT, enables new functions and new automation opportunities (Gartner, 2018f). Also it is important to analyse what data is necessary and what quality the incoming data actually is of.

- *Augmented Reality and Virtual Reality (AR and VR)* – AR is basically putting virtual objects in the real life environment (Gartner, 2018d). With VR you can walk around in an entirely virtual environment (Gartner, 2018e). If we look at a factory for example, AR can be used to place a virtual model of a machine in the factory to see how it fits while VR can be used to walk around in a virtual model of the factory before it has been built.

- *5G* – The fifth generation of mobile network. Will probably be able to transfer data in up to 10-20 gigabit per second (Thors, 2017). The main advantage is that there will be a lot more frequencies available for mobile network which means that it will be possible to connect a lot more devices. This will be a requirement for full implementation of internet of things.

- *3D-printing* - With 3D-printing, it is possible to print out three dimensional models from CAD-files. This technology might disrupt the way a supply chain works today. For example, suppliers might stop selling components and start sell CAD-files instead to let SKF manufacture the product by themselves (Magnusson, 2018).

All these technologies do not seem relevant for the field of procurement. In a survey, conducted by Vollmer & Machholz (2017), CPOs from various companies was asked what the five most important priorities for procurement in 2017 were. The results, displayed in Figure 3-7 below, indicate the importance of Big Data as well as Internet of things. Noticeable here is that the question is asked specifically for the year 2017 and not for the future, which affects the results.

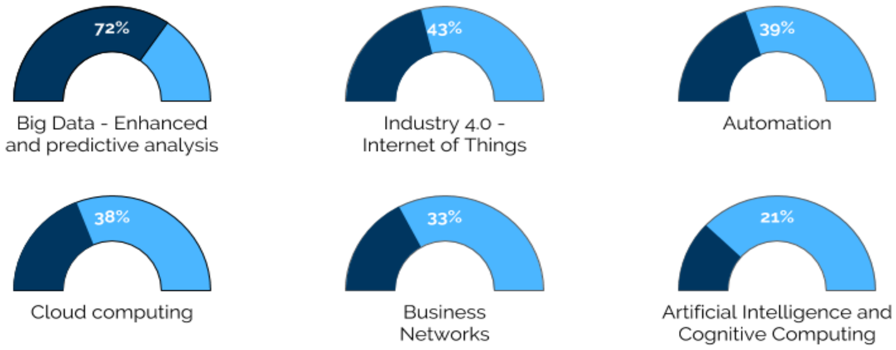

Figure 3-7: Results from CPO survey 2017 - Top priorities for procurement (Vollmer & Murphy, 2017).

Except for these technologies others like Blockchain, 3D-printing, Augmented Reality are mentioned. Another interesting aspect of this result is that Big Data and IoT will be the foundation for technologies such as AI (Cook, 2018) and robotics, which is why it is reasonable to understand why these technologies was most prioritised for 2017. Furthermore, this reasoning indicates the connection between these technologies, in other words, to be able to achieve the full potential of one technology you need to use other technologies as well. For this thesis, the focus is on the technologies that would change the way of working within procurement compared to today. For example, cloud computing, is performing the same computations as today but in a cloud. 5G allows upscaling of activities already performed today. Instead of focusing on these, the ones which are expected to be game changers, for procurement, are put into the spotlight. These were selected in coherence with the supervisor of the thesis. The selected technologies are; 3D-printing, IoT, AI (including RPA) and Blockchain. These four technologies are described in the following sections.

3.3 Internet of Things

Internet of things (IoT) is an expression that often is misinterpreted or misused. The common mistake is that people believe that IoT-equipment makes physical objects perform tasks such as opening garage door when you arrive or making coffee when the alarm clock goes off in the morning. Although, IoT enables these kinds of actions, the technology itself does not perform the tasks. What the technology does is that it connects physical objects with each other and to the internet by using sensors and/or processors (Xia, et al., 2012).

3.3.1 Background

The term Internet of things was coined by Kevin Ashton in 1999 (Gubbi, et al., 2013) in a presentation at Procter and Gamble. The context was of Radio Frequency Identification (RFID) impact in a supply chain (Gubbi, et al., 2013). IoT, in general, uses many different old technologies, such as temperature sensors, RFID and barcodes. What the IoT technology provides is the connection to internet. By doing this, it enables multiple automatic functions. Since then, IoT use cases, that involves everything from optimising heavy industries to automatising the home environment, has been performed (Gubbi, et al., 2013). Also, IoT enables new functionalities for other emerging technologies, where blockchain is an example. To put RFID tags on objects enables tracking and tracing within the supply chain and in combination with blockchain technology it would be certain that the information is valid (Christidis & Devetsikiotis, 2016). In 2013 there were about 9 billion IoT-objects; in 2020 it is estimated to be approximately 24 billion objects (Gubbi, et al., 2013).

3.3.2 Definition

Gubbi, et al. (2013) argues that the definition made by Kevin Ashton, in 1999, still is valid even though the usage of the technology has changed. It is defined as a computers possibility to sense information without any human interference. In other words, objects are automatically communicating directly to a computer. Noticeable is that, what the computer does with the information is not included in the definition of IoT.

3.3.3 Functionality

To describe how IoT works an example for a agricultural production system will be used (Lee, et al., 2013). In this example the IoT-service is used to monitor the environment surrounding the crops, for example humidity sensors, temperature sensors and pH-sensor. These sensors will operate day and night and automatically send data to a database in almost real time, see Figure 3-8. However, this type of monitoring of production systems use cases can be applied for various industries (Lee, et al., 2013). The data provided by these sensors can be used to, for example; forecast of the future based on historical data, quick responses based on real time information, deciding what type of crop that is most beneficial to grow and so on.

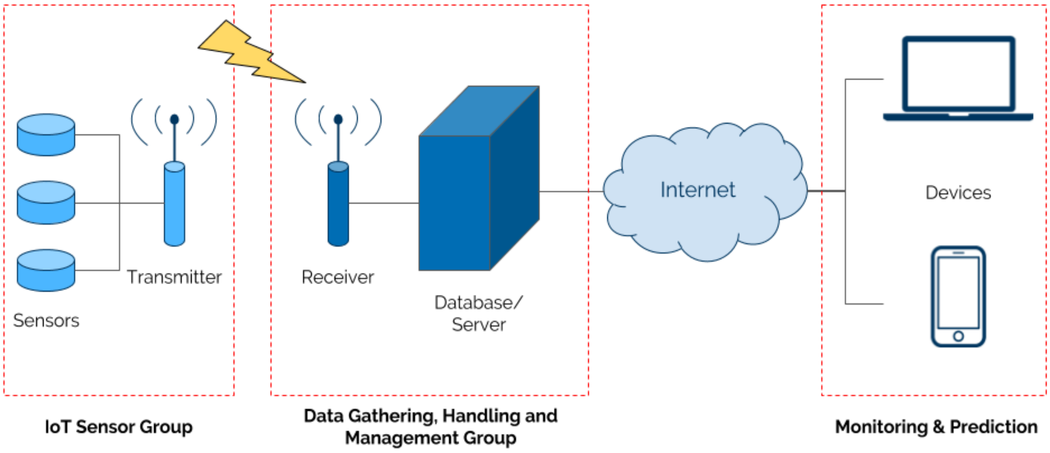

Figure 3-8: Schematic view of IoT (Lee, et al., 2013).

3.3.4 Advantages and Disadvantages

One advantage of IoT is the possibility to retrieve real time information. This feature has a lot of different applications, especially within supply chain. The ability to monitoring goods location in real time makes companies planning process easier (Christidis & Devetsikiotis, 2016). By including the sensor data in program codes the sensor data indirectly has the possibility to trigger autonomous responses based on what information that the sensor provides.

IoT is also, in many cases, an important gateway for other technologies. IoT-data has some important features that other technologies have use of. One example is how RFID tags has the possibility to provide an identification of goods (Lindman, 2018), which is necessary for blockchain technology when its purpose is tracking goods back to its origin in a supply chain (Christidis & Devetsikiotis, 2016). Another example is how historic IoT-data can be used for machine learning to be able to predict the future (Abu Alsheikh, et al., 2014). This paper also emphasises that machine learning can be used to sort out what IoT-data to retrieve. This is an example of how the different technologies benefit each other.

Servitization, moving from an entirely product based organisation towards selling services instead, is a trend in many businesses and industries today. For industries IoT-sensors is, to large extent, an enabler for this. Sensors have the capability to sense that machines, or components of a machine, are starting to get worn out (GE Digital, 2017). With IoT, these sensors would communicate this to a database, and by signalling this, the company would be able to replace, or perform maintenance service before the machine, or component, breaks down. The philosophy behind this is that the data, provided by IoT-sensors, can provide service opportunities that might be as valuable as the product itself (Rymaszewska, et al., 2017).

The amount of data in the world has increased dramatically over the last couple of years; in fact 90 percent of all existing data has been created during the last two years (Vollmer & Murphy, 2017). As mentioned earlier, it is estimated that by 2020 there will be 24 billion devices connected to the internet (Gubbi, et al., 2013). Therefore, the need of servers and highly capable systems will be needed. Also, a lot of the data will be of bad quality, so the importance of data management will increase (Vollmer & Murphy, 2017). In an IoT-environment the quality of the data becomes even more important, since the data will trigger automatic functions. If the quality of the data in unsatisfactory, the actions triggered by the data will be the wrong ones. Or as Nielsen (2018) and Petersen (2018) expresses it, garbage in equal garbage out.

An important aspect of IoT data is also how to protect it (Persaud, 2017). Lindstrand (2018) addresses this, and means that hackers changing the data could have dramatic consequences since the data controls functions. Since, companies to larger extent than ever before are dependant of data, the motive for hacking increase and thereby also the need of data security.

Lastly, there is the question of who should have the right of sharing and using the IoT-data. Think about a car for example, when the engine can let us know exactly what needs to be replaced. Will it be the car manufacturer, the driver, the insurance company or the workshop that owns the data? This is an important aspect in for industries (Knight, 2017), and selling data might become a part of the companies' business models (Magnusson, 2018).

3.4 Artificial Intelligence and Robotic Process Automation

According to a CPO survey by Vollmer & Machholz (2017), see Figure 3-7, where 211 participants ranked the five most important priorities within procurement in 2017, the topic of Big Data, Enhanced and Predictive Analytics followed by Internet of Things and Industry 4.0 got the highest rank with 72 respective 43 percent. Artificial Intelligence (AI) only got 22 percent and a fifth place. There are two ways to interpret this information, either that AI is not that prioritised for procurement or either that AI is more of a futuristic approach while Big Data and IoT are already here.

3.4.1 Background and definition

The term *artificial intelligence* (AI) was first used by John McCarthy at the Dartmouth Conference in 1956 (Garnham, 1988), when he defined it as the development of machines that *"behave as though they were intelligent"* (Ertel, 2011a). Prior to this, pioneers like Alan Turing, Kurt Gödel and Alonso Church laid the foundations for the subject, however there were no computers present at the time and it would take until the 1950s to create computers with sufficient power to simulate simple human thinking (Ertel, 2011a). The Dartmouth Conference can be considered the birth of AI. Here, Newell and Simon first introduced their Logic Theorist, which automatically could prove theorems and therefore showed that computers could not only deal with numbers but with symbols. McCarthy, as previously mentioned, also introduced a programming language, LISP, for this purpose, to process symbolic structures. With this, programs were capable of modifying themselves (ibid).

The definition of AI provided by McCarthy soon seemed to be too narrow, since it only implies machines to act as though they were intelligent and not as being able to solve difficult practical problems (Ertel, 2011a). Turing used the example of chess to describe intelligence and problem solving abilities (Copeland, 2018), as a computer in theory could play chess by searching through all available moves, but effectively needs human intuition considering the vast amount of possibilities. In coherence with this additional complexity, AI can nowadays be defined, as by the Encyclopaedia Britannica, as *"the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings"* (Copeland, 2018). But as the computational capabilities increase all the time, one could also use a more time-resistant definition as provided by Rich, et al. (2009); *"AI is the study of how to make computers do things which, at the moment, people do better*". This definition will always be up to date, independent of technological developments and improvements. The chess example is for instance no longer part of AI, considering the definition by Rich, et al., since it nowadays exist computers that play chess better than most humans (Ertel, 2011a). For the purpose of this study, the definition of AI provided by Gartner (2018a) will be used, since it is up to date and targets a few key objectives of AI as well as what differentiates it from RPA. First of all, the below given definition involves the capability of learning, which implies the topic of machine learning to be a core part of AI. This is further confirmed by Techopedia (2018). Another important aspect of AI, provided by Gartner (2018a), is that it enables replacement of humans in non-routine tasks. This is the crossroad where RPA and AI break apart. RPA is focused on automation of routine tasks, while non-routine tasks require a higher level of intelligence, why it is within the scope of AI. With that said, the line between pure AI and pure RPA is still very much like a grey-zone and it is sometimes very hard to distinguish the two technologies. Pure RPA tends to be ruled-based and have structured data, while pure AI tends to be based on judgement and have more unstructured data (Accenture Operations, 2017). The definition of AI provided by Gartner (2018a) is given below.

> *"**Artificial intelligence** is technology that appears to emulate human performance typically by learning, coming to its own conclusions, appearing to understand complex content, engaging in natural dialogs with people, enhancing human cognitive performance (also known as cognitive computing) or replacing people on execution of non-routine tasks."* (Gartner, 2018a).

Garnham (1988) describes AI as the study of intelligent behaviour and that its goals are to understand the human intelligence and to produce useful machines. The first one of these goals has a rather psychological aim and might not be of the same value for industry. This implies that the subject can be studied with completely different objectives and scope, and AI is often divided into the areas psychology or computer science (ibid). For this research, the more practical aim is assumed, since this is the part where artificial intelligence could improve and influence business processes such as procurement. Due to this potential of cost savings, reduction of human errors and human efforts etc., in combination with the fascination of understanding and replicating human behaviour, the research field of AI have been popular throughout the years and especially during the current era of digitalisation.

3.4.2 Functionality

From the definition stated above, a few key points within AI can be identified: the ability to learn, coming to conclusions, engage in dialogues and enhance cognitive performance. To explain how this would function on a conceptual level, explaining the function of a agent would be a good start. Within computer science, a software agent is a program which uses input data from a user to create output data (Ertel, 2011a). This could for instance be a simple mathematical calculation, where input is transformed to output. This agent is based on interaction with a user. On the other hand, within robotics, a hardware agent is a robot or machine equipped with sensors and actuators with which it perceives its surroundings and carries out actions depending on changes within the environment. These are the two most basic versions of agents. Other forms of agents are reflex agents (that only can react to input), agents with memory (that can include the past in their decisions as well), cost-based agents (that aims to minimise cost of decisions in the long term) and learning agents (that can learn from given examples and feedback of their performance) (ibid).

When problems are becoming too complex for a single agent to solve, they can cooperate in creation of a knowledge-based system (Ertel, 2011a). This system separates the knowledge from the agents and stores it in a knowledge base. The programs can then use the knowledge stored through an inference mechanism, thus the program in itself does not need to store all data on its own. Knowledge is gathered in the base through various sources such as databases, experts, knowledge engineers as well as learning systems. The execution program simply obtains the knowledge from the base, which is gathered from many different sources, and uses it to interact with the user. This separation provides opportunities to more easily swop knowledge base if necessary, instead of programming a new system (ibid). The concept of a knowledge-based system is visualised in Figure 3-9 below.

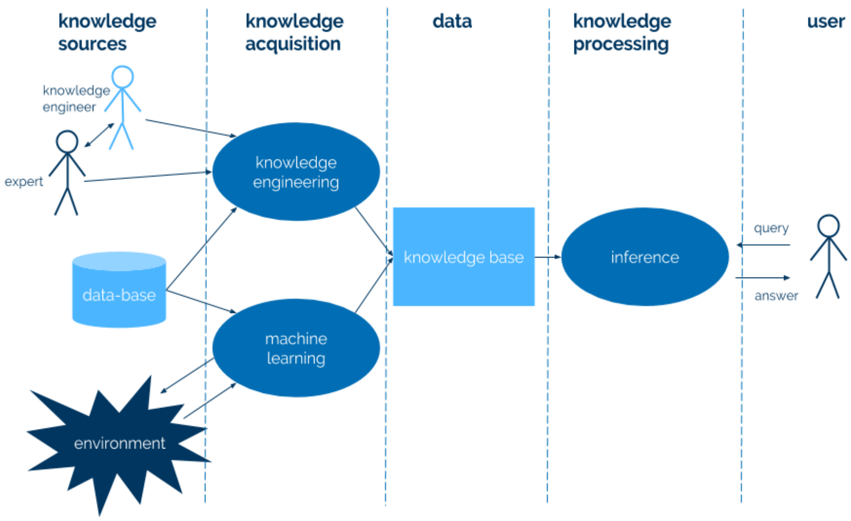

Figure 3-9: A conceptual model of a knowledge-based system (Ertel, 2011a).

Inference
The knowledge-based system could also be called a distributed agent system or multi-agent system, since there are several agents collaborating while specialised in a specific task (Ertel, 2011a). To further explain it all, three essential parts will be described; inference, machine learning and knowledge engineering, starting off with the *inference* connecting the knowledge base and the user. The inference process is usually handled by some kind of software agent and may nowadays contain text-, voice- or image recognition, which are key areas for the subject of AI. The core of this process is to understand the user and get knowledge from the base. According to Russell & Norvig (2016), an inference agent typically does three things when called upon. First of all it tells the knowledge base what it perceives from the user interaction. This typically means understanding language in some way and then transforming it so that the knowledge base understands it. Secondly, it asks the knowledge base what action should be made. Lastly, the agent tells what action was chosen and then executes the action (i.e. reply to the user) (ibid).

The possibilities for interaction with users have been improved throughout the years. There are now many examples of *chatbots*, which are boosted with artificial intelligence and the ability to sort out and understand written text (Ertel, 2011a). This feature is called natural language processing (NLP) and involves trying to mimic human conversations as well as understanding complex content (Nguyen, 2017). There are also simpler chatbots, which only react to simple commands. This kind of chatbot is more of a classic software agent responding to input with output following a predefined set of rules.

The next step of this bot-development has been the voice recognition. Nowadays there are many highly developed services, among them iPhone's Siri and Amazon's Alexa, but the technique in itself is nothing new (Geitgey, 2016). The issue is to achieve a high accuracy of the speech recognition, which becomes extra challenging considering that people talk differently in terms of speed, pronunciation and loudness etc.. According to Geitgey (2016), the difference between 95 percent accuracy and 99 percent accuracy means the difference between "annoyingly unreliable and incredibly useful". Text recognition use NLP to understand the written text and voice recognition do that as well. But first of all, the sound waves have to be transformed into data points, and then these data points need to be matched with words. Voice recognition is therefore far more complex and problematic.

Another type of inference-mechanism is image-recognition. There are currently well-functioning face recognition agents for example for Samsung-phones. Like with voice recognition, one issue is to translate the images into data points in an efficient way. Similar to all kinds of recognition is that they are hard to program (Carlsson, 2016). It is very difficult to program a computer to be able to identify a zebra in a picture, for instance. It is too complex to set up the required rules. Instead, image recognition is usually constructed with help from machine learning (which will be further explained below). Instead of setting rules of how a zebra look like, the program gets feed with thousands of pictures, where some are of zebras. The program is told which pictures actually are zebras and through this technique of quick repetition, the computer learns to generalise and build a framework of what is and what is not a zebra. Through every iteration, the accuracy becomes better (ibid).

Machine learning
M*achine learning* is handled by the learning agent. Machine learning is often referred to as a subject in itself but is more of a building block of artificial intelligence. Machine learning is

defined by Mitchell (1997) as *"the study of computer algorithms that improve automatically through experience"*. With this background the learning agent can be further explained. As with human learning, the agent needs some kind of explanation to start off (Ertel, 2011b). This is usually in the form of training data, for example pictures of zebras in image recognition. The training data consist of examples which outcomes are predefined, whether it for instance would be a classification or recognition task. The training data act as foundation and framework for the agent's future analysis. After being feed with this data, the agent start evaluating and determining the input/observations in regards to the predefined features to be considered. The outcome is generated and stored as a data point, added to the training data points. The more data points gathered the better accuracy for determination. In other words, the algorithm gets better and better by every new point collected (ibid). The concept of a learning agent is explained by Figure 3-10 below. The learning agent gives the AI the ability to learn, as is one of its core parts.

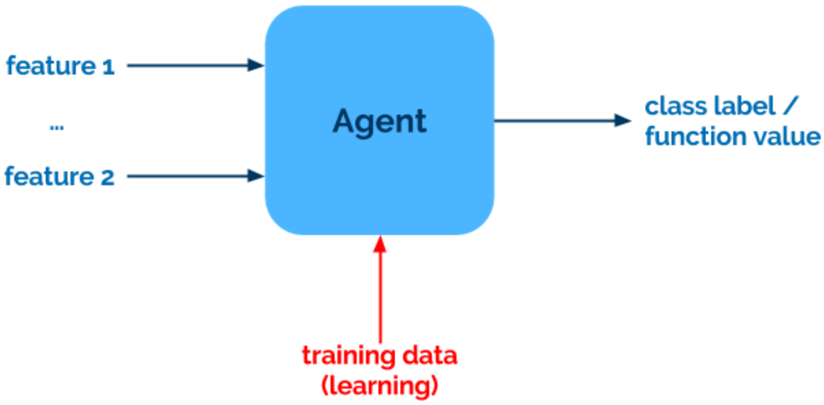

Figure 3-10: A conceptual model of learning agent (Ertel, 2011b).

Case Study: Alpha GO and machine learning

Maybe the most famous example of AI in present time is the AlphaGo. This was the first computer program to defeat the world champion in a game of Go (DeepMind, 2017a). Go is an ancient game from China where two players place either black or white stones on a board with 19 x 19 lines. To win, a player needs to capture the opponent's stones or surround empty spaces to mark territory. The board has over 10^{170} possible configurations, making it far more complex than a game of chess. That is more positions than the amount of atoms known in the whole universe. This huge complexity means that Go primarily is played through intuition and feel, making it far more difficult to program. The traditional approach of conducting a search tree, to check all possible positions, would not work in this case (ibid).

AlphaGo uses a combination of an advanced tree search and deep learning, through something called *deep neural networks* (Silver, et al., 2016). These deep neural networks consist of 12 layers with millions of "neuron"-connections and are used to reduce the breadth and depth of the search tree. The first neural network is the value network which is used to evaluate positions and predict the winner of the game. The other one is the policy network, which is used to decide actions and select the next move (ibid).

For AlphaGo to learn to play Go, the neural networks were first of all trained by 30 million moves played by human experts (Hassabis, 2016). The next step was to let AlphaGo discover new strategies by itself, by playing thousands of games between its neural networks. This was a form of reinforcement learning, or trial-and-error approach, which helped AlphaGo to develop and adjust its connections in the neural networks. In October, 2015, AlphaGo played its first official match against the European Go-champion and beat him 5 games to 0 (Hassabis, 2016). Later, in March 2016, AlphaGo beat the world champion, Lee Sedol, with 4 games to 1 (DeepMind, 2017a).

A few months after the success of AlphaGo, the new and improved AlphaGo Zero entered the spotlights. The unique thing about Zero is that it did not get any initial training from thousands of games played by professionals, as its predecessor did (DeepMind, 2017b). Zero simply learned how to play by itself and only got the basic rules as input. Reinforcement learning is used to update the neural networks continuously, resulting in a steep learning curve through the iterations. AlphaGo Zero is not constrained by the limits of human knowledge, why this technique quickly beat its predecessor. Zero also combines the policy- and value networks of AlphaGo into one network, enabling a more efficient training (ibid). AlphaGo Zero challenges the current paradigm of supervised machine learning (Perez, 2017) as well as gives the expression *"learning by doing"* a whole new authority. According to the paper written by the team behind AlphaGo Zero, it shows *"it is possible to train to superhuman level, without human examples or guidance, given no knowledge of the domain beyond basic rules"* (Silver, et al., 2017).

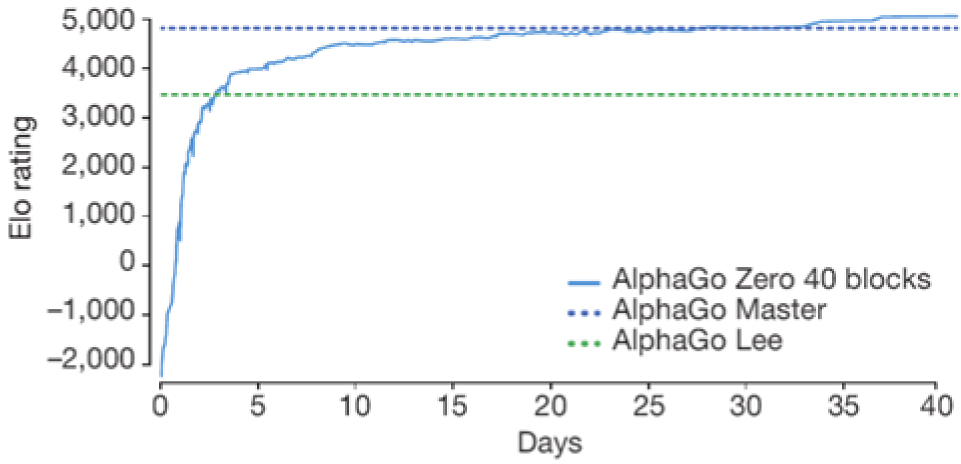

Figure 3-11: The learning curve of AlphaGo Zero (Silver, et al., 2017).

Knowledge engineering
Knowledge engineering is the process of creating the foundation and setting up the knowledge base (Russell & Norvig, 2016). A knowledge engineer investigates a particular domain and learns what the most important concepts are. He/she then creates a formal representation of the objects and relations within the domain. The process typically involves identifying the task to be solved by the knowledge base and then acquiring the relevant information/knowledge required for the base. This part can be performed in collaboration with experts in the field. When the knowledge has been assembled, a relevant vocabulary is to be chosen, that simplifies and expresses the important concepts and objects in the domain. Then the vocabulary gets encoded and then there is room for testing. The test involves posting queries to the inference procedure and get responses, testing if the vocabulary, encoding and knowledge are rightly set up. The knowledge engineering process is typically iterated until a suitable solution is working sufficiently (ibid). The knowledge base assembles more knowledge from the machine learning procedure as well as earns better understanding of how to interact through the inference procedure. The knowledge base is a simple explanation of

how many artificial intelligence tools and programs are working currently, but is merely an example and does not cover all parts/alternatives of AI.

3.4.3 Advantages and disadvantages

When addressing the advantages of artificial intelligence, the potential application areas usually are presented. Looking at digital assistants, medical diagnosis and fraud detection, these are all good examples that will benefit companies, individuals and society in many ways (Rao & Verweij, 2017). However, the real advantages with AI lie in the effects.

AI may reduce the required human involvement, especially within repetitive tasks, saving both time and money (Guszcza, 2018). The error rate can be heavily reduced with the use of AI and RPA (Goldberg, 2017), however, it cannot be reduced completely - machines will also make mistakes, just as humans. AI can rather easily be improved though (Brynjolfsson & McAfee, 2017), and once it becomes better, it never returns to its previous state of knowledge. AI-solutions are also consistent when presented with the same data. Maybe the biggest advantage of them all is that AI/RPA-solutions do not need sleep, rest or even food and can just continue to work unhindered (Daisy, 2017). This means astonishing productivity and time savings, if compared to a human employee performing a repetitive task (Guszcza, 2018).

Looking at the disadvantages of AI/RPA-solutions, the most common concerns are about cost (Goldberg, 2017). New technologies are often times costly to implement, but can potentially achieve a lot of savings if used efficiently. Another issue is the cyber-security, which have arisen recently as an important topic (Baccala, et al., 2018). Companies and people may not feel safe with putting more and more of their trust to digital solutions, considering hacker-attacks and the always present risk of a computer or database crashing. In connection to this, there are always some concerns about whether or not humans should develop these kinds of robotic solutions (The Drum, 2016). Robots taking over the world have been the story of many science fiction movies during the years. Even though the majority do not see this development as a risk, the concern is still present by many individuals.

There is a risk that humans are becoming too dependent on AI (Gilster, 2017). Similar to a company being dependent one individual’s competence, AI may lead to loss of knowledge of how to do things manually (Blum, 2018). For example, consider an invoice process which already today is done automatically by a system-solution. What if the system broke down and invoices had to be sent manually, but no one within the company longer possesses the knowledge to do this.

Brynjolfsson & McAfee (2017), emphasise that the main concern regarding AI today is that it knows more than it can tell. This creates something like a “black box”, where input is transformed into output without proper transparency and understanding of the transformation process. Humans do not understand how the AI works and what it does, but are still expected to trust it. This leads to three risks, according to Brynjolfsson & McAfee (2017). First of all, that training data, that is given to the AI initially, might imply rules without the intent of the designer. For example, when a system helps to determine applicants for a job and the training data consists of decisions made by recruiters in the past, the data set might involve ethnic or gender biases, unintended by the recruiters. Secondly, AI-systems deal with statistical rather than literal truths, making it hard to prove that the system will work in all cases. Third, and last, there is a risk considering the “black box” when the system makes mistakes (which it will do). It becomes very hard to examine and determine the cause of the error as well as correcting it, when there is no full understanding of the system itself. Brynjolfsson & McAfee (2017) conclude, however, that these risks and flaws with AI also represent the human behaviour. *"After all, we humans, too, have biases, make mistakes, and have trouble explaining truthfully how we arrived at a particular decision."* Brynjolfsson & McAfee (2017) state.

Last but not least, there are major concerns that AI will make people unemployed (Baccala, et al., 2018). As the systems are becoming better and better they can potentially replace humans more efficiently. But AI is not about removing jobs, it is about transforming them. Humans will not be replaced by machines, but rather have to learn how to work in cooperation with them. As Baccala, et al. (2018) put it, *"AI will impact employers before it impacts employment"*, meaning that the way of working will be changed before. Brynjolfsson & McAfee (2017) address this as well, stating that *"AI won't replace managers, but managers who use AI will replace those who don't"*.

3.4.4 Related concepts

The following section will explain a few related concepts and their connection and potential differences to AI. This to clarify the terms and enable understanding.

Robotic Process Automation
RPA is by some considered a topic in its own while it by others is described simply as algorithms. According to (Wright, et al., 2017), RPA is computer-coded and rule-based automation of processes that replace humans performing repetitive tasks. More importantly, RPA is not robots that walk and talk. Similarly, Accenture Operations (2017), differentiate between AI and RPA, saying that RPA tends to have structured data and to be rule-based while AI have unstructured data and is judgement-based. The line in between the two concepts is, however, pretty vague, and combinations, or blended technologies, might be most common (Accenture Operations, 2017). A pure RPA might therefore be compared to the previous example of a simple chatbot. While a AI-boosted chatbot use NLP to understand more or less every conversation, a simple chatbot simply answers to key phrases according to a predefined set of rules. This simple chatbot would in essence be a RPA-solution, since the task probably has to be rather routine if it is possible to pre-program responses to the specific inquiry. RPA could therefore be considered as being the "easy version" of AI, where simpler tasks are dealt with (Willcocks, 2016). Even though there are differences between the two concepts, there are no fundamental differences rationalising covering a separate section regarding RPA, even though the concept is important and elemental for the overall project.

Cognitive computing
Cognitive computing is commonly mistaken for being something completely different than artificial intelligence. But cognitive computing is not a subject of its own, but rather a synonym to AI (i-SCOOP, 2018). The term was first introduced by IBM, in an attempt to separate their solutions from the (in many times truly) misunderstood concept of AI (Kelly, 2015). IBM emphasise that cognitive computing programs do not aim to mimic humans and will never be truly autonomous, but rather reason with arguments and give recommendations. In essence, however, this is nothing different from what is being covered by the concept of artificial intelligence (i-SCOOP, 2018).

According to Hoffenberg (2016), the difference between the two notions is that an AI system would tell the user a course of action, based on its analysis, while a cognitive computing system would provide material to enable the user to make the decision, i.e. decision support. This, however, can still be interpreted as a marketing trick from IBM's side to gain recognition and ensure that their "cognitive computing" solutions will not make decisions on their own.

3.5 Blockchain

Various technology magazines print articles with headlines such as; "Blockchain is the most disruptive technology in decades" (Mearian, 2018a) or "Blockchain is this year's buzzword" (Busby, 2018). Unfortunately, most of them fail to explain how or why. Today more and more businesses and industries are investing into blockchain technology (Mearian, 2018b). Even though there are some issues and uncertainty about how it actually can be applied there are a lot of companies, especially within the financial sector, that are investing a lot in this technology. In this section blockchain and its underlying functionality will be explained and defined. Furthermore, the advantages and disadvantages will be mentioned.

3.5.1 Background

The blockchain technology was firstly mentioned in 1991 in an article by Stuart Haber and W. Scott Stornetta, published in Journal of Cryptologi, named "How to time-stamp a digital document" (Narayanan, et al., 2016). At this time the name blockchain was not used instead it was just called as a cryptographically secured chain of blocks. A blockchain concept was developed first in 2008 by Satoshi Nakamoto, also known as the founder of the cryptocurrency Bitcoin (Baghla, 2017). It should be mentioned that Satoshi Nakamoto is not a known actual person; it is an alias which belongs to either one person or a group of persons. Bitcoin was founded due to mistrust in banks due to the worldwide financial crisis aiming to eliminating intermediaries in transactions. In other words, only the specific user would have access to the Bitcoins and the banks, or any other third party, would not be involved in transactions at all. The actual usage of the blockchain today are mostly connected to different cryptocurrencies, but the potential benefits of applying the technology for different industries and businesses are expected to be considerable (Busby, 2018).

3.5.2 Definition

According to Gartner (2018b), blockchain is defined as value exchange transactions, recorded in a distributed ledger, which are sequentially stored into blocks. Each block is linked to the previous block, which builds the chain. This creates an immutable peer-to-peer network, based on cryptography and consensus mechanisms. The blockchain network's behaviour is possible to customise to suit different implementations.

3.5.3 Functionality and characteristics

How a blockchain works can vary a lot depending on what its purpose is. However, to be a blockchain ecosystem there are four logical components that must be included (Neocapita, 2018):

1. A node application
2. A shared ledger
3. A consensus algorithm
4. A virtual machine

A node application means that all users that want to connect to the network will need an application to be able to do so (Neocapita, 2018). This application need to be specific for the network for which it enables a connection.

The shared ledger is available for all users that are running the node applications (Neocapita, 2018). The ledger is distributed among the users and consists of all transactions made in the network all the way back to when the network was created. Each transaction is visible for all users.

The consensus algorithm is what ensures the security in the blockchain (Neocapita, 2018). It decides which blocks that is valid and which ones that are not. There are some different consensus algorithms but they all have in common that it uses computer power to decide what block that is correct by solving some mathematical/cryptological problem.

Lastly, there is a need of a virtual machine (VM) (Neocapita, 2018). The virtual machine is included in each user's node application. The VM is isolated from the blockchain in the sense that the code running in VM does not have access to the rest of the network (Tanner Jr, 2016). It is this virtual machine that understands how the blockchain functions and how i should act in different situations.

How it works

The description of how blockchain works is to large extent based upon how Bitcoins blockchain system works. In general, the function is similar but there are some differences, especially regarding for different types of blockchains and how to reach consensus for those, as described further below. A blockchain is basically information stored in decentralised blocks (Christidis & Devetsikiotis, 2016). While it does not sound that alluring it in fact differs a lot from how information is used and stored. If a company wants to share information with another company today, both parts would end up with one copy each stored in their own servers. With blockchain, the information is stored in the network (e.g. in the blockchain) and will be available for other actors in the network (Christidis & Devetsikiotis, 2016). It might seem insecure at first, but the truth is actually the opposite. The information in each block is protected by a password or key as it is called. For Bitcoin, it is actually two keys one public and private and these are the only keys to the information stored in the block. The rationale behind this is that the public key is used for others to validate the information in the other block. The public key is also used as the recipient address which means that all users remain anonymous. Therefore, all actors in the network will be able to visualise the information stored in the blocks through the public key. The private key is used to send transactions (Christidis & Devetsikiotis, 2016). Also, all transactions of information or cryptocurrencies are noted in a distributed ledger. The distributed ledger contains information about all transactions ever performed in the blockchain and it is available for all parties in the blockchain. Furthermore, this leads to the fact that it is only one version of the truth and that information is stored in the distributed ledger.

Another important aspect to mention is that each block is linked to the previous blocks (Christidis & Devetsikiotis, 2016). To explain this further an example is provided. Imagine that Company A receives raw material from Company B and uses it to produce a component for Company C. The information in the block available for Company C would consist of where and when it is produced (Company A) and also where the raw material comes from (Company B). This part is expected to enable end-to-end visibility in supply chain in a new way. Kempe, et al. (2017) discusses this aspect regarding a food supply chain. One example provided in the report is for fishing. A photograph taken of a recently captured fish could instantly publish the location, where the photo is taken, in the blockchain. This information will follow the fish along the steps of the supply chain (Kempe et al, 2017). Each block consists of two things; firstly, there is the asset which was transferred in the block, secondly it is a time-stamp, which is named hash, of the prior block, see Figure 3-12. Since that block contains the hash of the block before that it means that it is possible to track each asset all the way back to its origin. The information from previous blocks are impossible to change without notifying other parts in the network since it will create a new block and thereby a new hash (Christidis & Devetsikiotis, 2016).

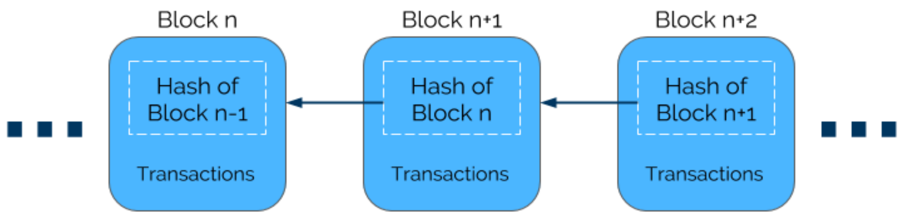

Figure 3-12: Blockchain structure (Christidis & Devetsikiotis, 2016).

Instead of having a bank confirming your account balance, the blockchain will track all previous transactions in the chain to confirm your balance (Christidis & Devetsikiotis, 2016). By doing this the blockchain itself has the possibility to authorise the transactions without any influence from an intermediary. This is how the blockchain enables strict peer-to-peer (P2P) transactions (Christidis & Devetsikiotis, 2016). This means that all transactions always will be traceable in the blockchain and also that it is impossible to commit fraud by performing the same transaction multiple times (Christidis & Devetsikiotis, 2016). The double spending issue, as it is called, is most easily explained with an example. Let us say that Alice are going to buy one product from Bob and one product from Chris and that the price of both products are 5 BTC and Alice only have 5 BTC. In previous systems Alice would have been able to first buy the product from Bob and then from Chris by changing the time of the transaction. This means that Alice would get both products but only paid for one. What the blockchain does is that it places all transactions in chronological order by making the computers in the network solve a mathematical problem (in case of Bitcoin) to verify the transaction (Christidis & Devetsikiotis, 2016). This is what is called the consensus mechanism. There are several variants of this, but Bitcoin's Proof-of-Work is a common example. When the mathematical problem is solved a block is created with a time-stamp or hash as mentioned earlier. To solve this mathematical problem, a lot of data processing capacity is required, and creating a block today takes approximately 10 minutes. This is actually what is called Bitcoin mining (Christidis & Devetsikiotis, 2016). Today you can distribute some of your data processing capacity to Bitcoin miners and get paid in Bitcoins. Due to the capacity requirements, so called mining pools are created, where Bitcoin miners sit in groups allocating all their computer capacity to Bitcoin mining (Parker, 2015).

Types of blockchains

Until today there are four types of blockchains that is most frequently discussed. Those are; public blockchain, private blockchain, semi-private blockchain and lastly the consortium blockchain (Dobson, 2018). Although, especially, the last two are quite similar, there are some differences which are described below. Blockchains can also be divided into permissioned and permissionless (Andersson, 2018a). In permissioned blockchains, the owner(s) can control who has access to the network, while in permissionless blockchains there is a need for consensus algorithms to ensure the history of transactions (Andersson, 2018a).

Private blockchain

A private blockchain is used within one organisation (Buterin, 2015). This means that the organisation itself decides what rules that should be applied for the blockchain and how it should be structured. Some likely applications for this type of blockchains are internal auditing and database management.

Public blockchain

This type is available to the public, or at least to all using the node application (Dobson, 2018). All users have the possibility to be a part of reaching consensus. The users agree upon the terms set in the network and all transactions are visible for everyone. This is the type of blockchain that are used for most cryptocurrencies.

Consortium blockchain

A consortium blockchain functions in a similar way as a private blockchain, but instead of having a single organisation as a decision making unit it is a consortium where multiple companies rules the blockchain to benefit all (Buterin, 2015). One example of this could be financial institutions where maybe 20 different companies create a blockchain to send transactions to each other. This type of blockchain often has a type of voting consensus where for example 15 out of 20 stakeholders must confirm the transactions to ensure its validity.

Semi-private blockchain

This type is in many aspects similar to a consortium blockchain, but to some extent also similar to a public blockchain (Dobson, 2018). In a semi-private blockchain companies has not, in contrast to a consortium blockchain, created the blockchain for everyone's benefit. The blockchain is, in this case, created by one organisation. This organisation set up the terms for the blockchain and all users that fulfil these terms may enter the blockchain network. This type of blockchain is most common for business-to-business situations.

Consensus mechanisms

Consensus mechanisms are designed for blockchain-networks to be able to verify transactions by itself (Christidis & Devetsikiotis, 2016). Often, the type of blockchain and its purpose is decisive when choosing what consensus mechanism that is needed. Public blockchains (permissionless) uses more complex algorithms to be able to verify the validity of transactions while private or consortiums (permissioned) often uses voting or other rather easy targets (Buterin, 2015).

Proof-of-Work

For the Bitcoin blockchain the algorithm is named Proof-of-Work (Nakamoto, 2008). This algorithm is designed in a way that makes the blockchain unhackable. The blockchain is programmed to verify the longest branch of blocks. Therefore, to hack the blockchain one have to not only change the information in the desired block, but will also need to mine all blocks in front of that block to actually change the information in the blockchain. For each block the hacker will need more computer power than the entire network altogether to have higher probability to solve the block. Nakamoto (2008) describes it by using equation (1) below.

$$q_z = \begin{cases} 1 & if p < q \\ \left(\frac{q}{p}\right)^z & if\ p > q \end{cases} \qquad (1)$$

Where q_z is the probability that the hacker is able to change the information z blocks back in the blockchain and making the blockchain believe this information is correct. q is the probability that the hacker solves this block and p is the probability that the honest version becomes the truth (Nakamoto, 2008). Although, the risk of the hacker solving the first block is very small it is in contrast to changing the information a couple of block back, very big due to the exponential decreasing probability, see equation (1) above. Since, the Bitcoin network by an estimation consist of about 100 000 miners (Parker, 2015), it is possible to imagine how unlikely it is that one hacker, or even a group of a thousand hackers would succeed in changing the information in a block. The miner whose computer actually solves the puzzle gets rewarded in Bitcoins. To ensure the security the mathematical issue is updated continuously so that it will take about 10 minutes to solve it (Christidis & Devetsikiotis, 2016). This is also the factor that limits the amount of transactions of Bitcoin and what makes the Bitcoin transactions relatively expensive. The fact that it takes about 10 minutes, using computational power from about 100 000 miners, points out the amount of computational power, and thereby energy consumption, that is needed.

Proof-of-Stake

The purpose of Proof-of-Stake is to reduce the need of external resources for the system (Poelstra, 2014). While Proof-of-Work, uses computational power to verify transactions, proof-of-stake uses a cryptocurrency. Instead of renting out computer power, the user can rent out some cryptocurrency. Some of these users, which rented out some of their cryptocurrency, will be randomly selected to approve the new extension of the blockchain. If more than 50 percent of those confirm the transaction, a new block is created (ibid).

These two, most commonly found in literature, consensus mechanisms for public blockchains and this is how the technology eliminates the need of trust between the users. For the other types of blockchains, there are alternative ways to achieve consensus (Bagila, 2017). For consortiums it is common that a certain percentage of the participating organisations verify the transactions (Buterin, 2015). For permissioned blockchains, the need of a trustless system does not exist in the same way. Compared to public blockchains, these ones requires less computing and is therefore more easily to scale up (Bagila, 2017). Example of permissioned blockchain concepts is Practical Byzantine Fault Tolerance (PBFT), which is a voting mechanism. In this case you must reduce the false, or byzantine, nodes to a set tolerance, to verify a transaction.

Smart contracts

Smart contracts are not really a contract in its original definition. . Smart contracts are able to work with a blockchain a can example be used to trigger a transaction in the blockchain if all necessary terms are fulfilled (Christidis & Devetsikiotis, 2016). As an example it could be used to pay commission to salesmen. When sales are confirmed the smart contract automatically can trigger a commission payment in the blockchain. In difference to already existing automation mechanisms, smart contracts accesses information from all actors in the network which mean, that the contract could be triggered by external information. This is what is sometimes called the second generation of blockchain technology. Ethereum, which is the blockchain platform for the cryptocurrency Ether (ETH), allows this technology. One way this can be used is as a capital fund, which The DAO (Decentralized Autonomus Organization) is an example of (Waters, 2016). They initiated an open source project where users were allowed to create smart contracts. They were, by doing this, able to create earnings of 150 million USD in a less than a month.

Other ways to use this technology is to monitor IoT-sensor data (Christidis & Devetsikiotis, 2016). When these sensors provide data that are predefined in the code, the smart contract can be triggered to perform a required task. In other words, smart contracts in combination with IoT-sensors allow automatic blockchain transactions based on sensor data.

3.5.4 Advantages and disadvantages

By studying the blockchain technology it is possible to realise the potential impact it could have in most industries. Today, actual use cases of blockchain are still rare and the issue of upscaling the blockchain is still considerable (Maltaverne, 2017). To achieve possible winnings of implementing such technology it is of high importance to get the other actors in the supply chain to invest in it as well. An internal blockchain for just one company would have some benefits but, compared to the potential benefits of the technology, it would be unnecessary. Therefore, the need of a close relationship towards suppliers will be important to get them to join the network. Otherwise, the suppliers will not be motivated to share information and realise the importance and winnings of implementing the technology (Kaipia & Hartiala, 2006). Thereafter, since all information in the blockchain is reliable, the relationship will not be as important (Christidis & Devetsikiotis, 2016).

However, there are four main areas where blockchain technology would improve the performance for supply chain compared to today’s technology. These areas are; trust, security, transparency and transactions (Williams, 2017). Due to the security in the blockchain it is not possible to falsify the information in a block without it being noticed (Loop, 2016). This would make the trust matter between actors irrelevant since they all know that the information is reliable (Christidis & Devetsikiotis, 2016). Therefore, it is also possible to follow the blocks upstream in the chain to find the origin of the raw material for the end product (Maltaverne, 2017). As mentioned earlier, this information would be 100 percent reliable.

The security, in the Bitcoin network, is heavily depending on the pair of keys (public and private) that each user in the network is handed (Christidis & Devetsikiotis, 2016). These keys are cryptically designed passwords that so far not have been possible to hack. One issue with the system for Bitcoins, is that if a private key is lost then the Bitcoin, belonging to that key would be unable to use. In other words, these Bitcoins would be lost forever. Since the maximum number of Bitcoin is fixed to 21.4 million, this means that it will be fewer Bitcoins in total. Since the amount of Bitcoins is fixed and the people investing in Bitcoin is varying a lot, the currency (e.g most cryptocurrencies) experiences unreliable volatility. Therefore it seems unlikely that this type of tokenisation of assets would be used for industrial applications in the short term future. Due to the anonymity in the network, public key is impossible to connect to certain person; there are a lot of crimes connected to these cryptocurrencies. For example, both weapons and narcotics are sold over the internet, by using cryptocurrencies (Bloomberg, 2017).

Regarding transactions, blockchain enables immediate transactions in just a few seconds (instead of a couple of days, as with today’s intermediaries) which make it possible for actors to make decision upon real-time based information (Byström, 2016). Today, due to the issues with upscaling the process the transaction costs are relatively high, but in the future transaction cost in a peer-to-peer system could be eliminated (Gupta, 2017). In other words, it would be almost free to make payments all over the world within seconds. Also, all transactions would get a specific ID (hash) stored in the distributed ledger. In other words, all transactions of either payments or information would be available to all actors in the blockchain network at all times (Maltaverne, 2017).

One issue, heavily discussed regarding blockchain technology, is the upscaling potential (Maltaverne, 2017). As mentioned earlier the technology, especially for public blockchains, is dependant of heavy computations (Poelstra, 2014). Blockchain could therefore have a negative impact on the environment, considering the energy consumption needed for data processing (Reed, 2017). The amount of transactions per second that is possible today will not be enough if most companies started using the technology. This is because of the consensus mechanisms, which is crucial for the technology. How to achieve trustless consensus in an easier way, will be an important research question for companies using the technology.

3.6 3D-printing

3D-printing is a technology with potential to disrupt current supply chains and industrial manufacturing. In this section, the concept will be briefly described in terms of background, functionality and advantages and disadvantages.

3.6.1 Background and definition

3D-printing as a concept is rather straightforward (Horvath, 2014). A three-dimensional object is "printed" through iterations of adding layers of material, in the same way as a brick wall is built. The term additive manufacturing is often used interchangeably to 3D-printing. The technique can be found in nature, as for example when seashells and sandstone are being produced. When sandstone erodes by rain or wind, material is subtracted from the object. In a similar way, 3D-printing often add more material than needed, why some have to be removed afterwards to form the object. The concept of 3D-printing is really nothing new, but a modern and digital adaption of nature's own process (ibid). Gartner (2018g) defines 3D-printing as an additive technique that uses a device to create physical objects from a digital model.

3.6.2 Functionality

A modern 3D-printer starts off with a computer model of the object to be printed (Horvath, 2014), in many cases CAD-files (Computer-Aided-Design). The model controls a robotic device that places the layers of the material accordingly. There are generally three methods of additive manufacturing; using powder, using a vat of liquid or using filament such as plastic. The filament-version is the simplest one and this method only places material where it is needed. The powder-version can be used for more complex designs as well as metallic constructions. Current 3D-printing techniques take at least a few hours to print simple objects (ibid).

3.6.3 Advantages and disadvantages

3D-printing can be used to create objects and structures that previously have been impossible to make with traditional manufacturing techniques (Bhadeshia, 2016). The technique also offers low-weight solutions for special components and applications, such as for aircrafts, where lowering weight helps save fuel and reduces CO2-emissions (White, 2015).

Considering the long lead time of a 3D-printer, it is probably not the best manufacturing option when a lot of simple components are required (Horvath, 2014). The technique is not yet mature enough to cope with mass production. However, considering the use of computer models, every single print-out can basically be customised, enabling a mass customisation of products. This will prove beneficial in case of product development processes and 3D-printing can be used for rapid prototyping.

3D-printing offers manufacturing on demand and decentralisation of production (White, 2015). This will save transportation and logistics costs. The storage space needed could also be reduced. In case of spare parts, these kinds of components usually have to be offered many years after the transaction, taking up a lot of space. These replacement parts could be printed on demand instead.

The use of 3D-printing will also create a certain focus on the designs and the intellectual property rights related to these (White, 2015). The value of the product will potentially be in the design, why the licenses of CAD-files might be more important than the actual products.

The 3D-printing technique usually enables shorter set-up times compared to traditional manufacturing (Horvath, 2014). At the same time, scrap material can in many cases be reduced while also combining several components into one, enabling bigger modules. However, the current 3D-printers are pretty expensive, resulting in huge investment costs for industrial applications.

4 Empirical Results

The empirical study consisted to most extent of interviews from various experts within the field of digitalisation in general but also some experts within specific technologies or areas. To get some younger minds and also achieve outside-the-box thinking, a workshop with students was held. Additionally, a similar workshop was held with employees of SKF Group Purchasing, where the so far established results and analysis were discussed. The results of the study are presented below and will be further analysed in chapter *5. Scenario Analysis*.

4.1 Interviews

The main part of the empirical study consisted of qualitative interviews with several experts within the subject of digitalisation and from diverse backgrounds. 11 interviews were held in total and details about the backgrounds of the interviewees and how they were selected can be found in section *2.4 Qualitative Interviews*. All interviews were held during 2018. The abbreviations used are described by Table 2-1, where C stands for consultant; S for SKF etc. The result from the interviews will be summarised in accordance to the research questions, where the important aspects from the interviews will be mentioned respectively.

4.1.1 What is digitalisation?

Digitalisation is the word on everyone's lips, but not that many know what it actually means (C1). According to (A1) digitalisation is divided in two dependent parts; increasing efficiency and changing business models. C4 stresses that digitalisation in one perspective is a natural next step but in another perspective it is disruptively changing the direction of the next steps with new technologies. S1 takes it one step further and means that companies will have to start from a blank paper and rethink their organisation and business models. The change of operating models means that there will be roles and responsibilities, within companies, that do not exist today (C2).

Probably, in the near future, digitalisation will mostly be about automatising processes (C1). Thereafter, it will become more and more of strategic importance. C5 addresses that the actual effects of digital transformation is hard to predict and states that the thing we can be most certain about is that the predictions made today most likely will be wrong.

4.1.2 Which technologies will impact procurement and how?

The technologies included in the subject of digitalisation are identified and described in the theoretical framework. However, during the interviews, the question regarding which technologies will impact procurement was raised. In some cases, this was discussed according to the interviewees understanding and knowledge and in some cases; specific questions were asked regarding specific technologies. This section will give a brief summary of the technologies that were mentioned and how these could influence procurement according to the interviewees. A representation of the mentioned technologies is given by Figure 4-1 below.

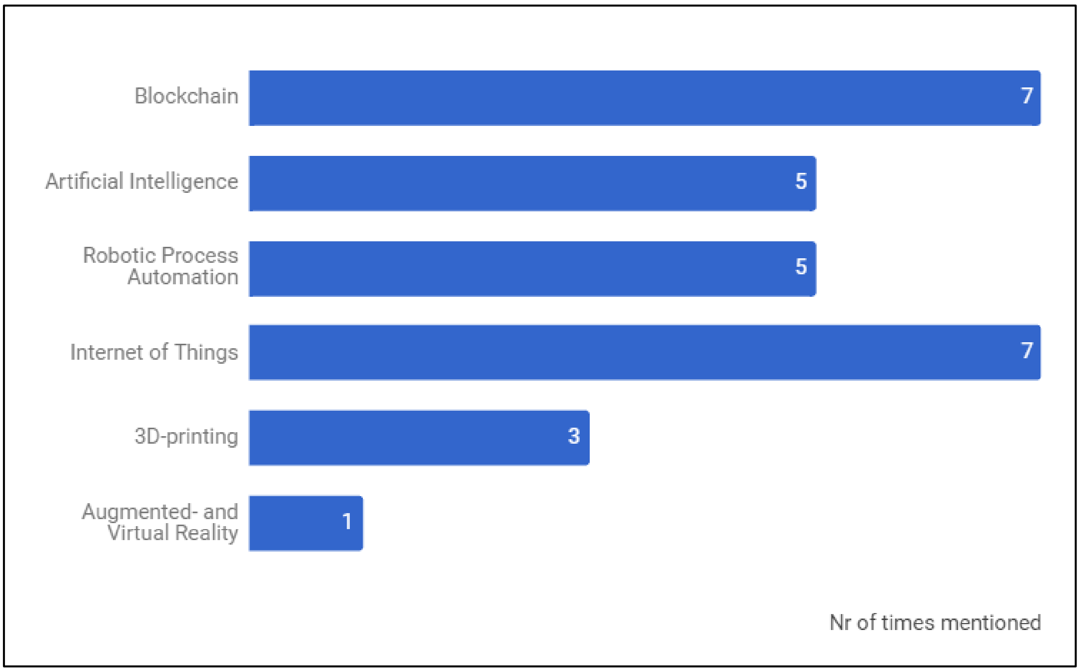

Figure 4-1: Overview of topics discussed during the interviews.

Blockchain

Blockchain was the technology which was mentioned most times during the interviews. The topic is rather new and exciting, why it is on many lips nowadays and there is a lot of fuzz regarding its possibilities. A1 as well as B1 talk of blockchain as a new paradigm and see its upcoming breakthrough as a revolution bigger than internet. Blockchain creates entirely new business opportunities and whole new ecosystems (C3).

A1 argues that blockchain technology will only be necessary when there is an intermediary that cannot be trusted. If both parts trust the intermediary, blockchain is too ineffective and costly. C4 is on the same track and explains that it is important to identify the needs of blockchain, and why a company should use it, before considering an implementation. This opinion is also phrased by A2.

The benefits of blockchain is according to C1 that it provides safety and ensures that data is stored in a reliable way, while all parts of the network will have access to all data simultaneously and in real time. This has a lot of potential effects, for example regarding tracking and tracing, document handling and invoicing. A1 states that for procurement and SKF, blockchain will provide the opportunity to ensure where and how products are made. With the help of blockchain, this kind of information can be found as easy as on Google (C3). C2 mainly sees blockchain as an interesting infrastructure and enabler of many other technologies and applications.

B1 explains the potential benefit of using blockchain technology to reduce the lead times within the value flow. Today, when a product is sent, there is usually 30-90 days before the payment is expiring. This creates a lot of friction in the economic system and results in low liquidity for the sellers. With blockchain, the value flow and the supply flow can be parallel and payment could potentially be done when a product is received (ibid).

From a business perspective, public blockchains are not that interesting but there is certain demand for private blockchains within a company or within a supply chain (C2). The aim of these setups would be to create transparency and traceability. A1 and B1 on the other hand, argues that private blockchain solutions are not really blockchains but regular databases. A2 thinks there are going to be combinations, and see potential with semi-private and consortium blockchains. The important part is to identify what SKF would need from a blockchain-solution. B1 argues that consortiums lead corruption and eventually cartels. Instead of collaborating with the network, the actors try to keep information secret in between themselves.

Many raised the topic of smart contracts and how these can be used on a blockchain to execute processes and transactions (C2). Smart contracts could create new ways of working and transactions could be registered between peer-to-peer (C4). C1 sees great potential in smart contracts and their ability to confirm transactions automatically.

Artificial Intelligence and Robotic Process Automation
AI and RPA are two concepts closely related. In many cases they target the same areas and issues, why they are put together in this section. The difference between the two subjects are described in section *3.2.3 Artificial Intelligence and Robotic Process Automation*.

C5 talks about the possibility to use AI/RPA to reduce administrative tasks, but also to gain better insights regarding the supply chain through visualisation and optimisation. These insights can support decision making and conduct early warning systems in case of delivery disturbances. The main thing, however, is to use the technologies to automatise the transactional processes within procurement. In the request-to-pay cycle, there are already some cases where 85 percent is automatised (C5). C2 is on the same page and suggest that RPA-solutions could be used for every process that occupies a lot of time but where the employee does not need to think when executing. RPA is considered to be a slow-moving technology but at the same time being a good starting point for companies initiating their journey of digitalisation (C2). C1 support this and says that basically all parts within the request-to-pay cycle, from purchase order to payment, could be automatised. Human efforts and errors could be reduced, resulting in time and cost reductions for simple processes like invoicing (C1). B2 takes the 3-way matching process as an excellent example of potential for automation within operational procurement. There is also large potential internally, for example simple tasks as approving travel expenses and notifying when there is discrepancies in the data (C1).

For strategic sourcing, digital technologies can be used to scan the market for new suppliers and to earn knowledge about how the market is evolving (C5). AI has the potential to expand the funnel of potential suppliers without increasing the costs (A1). The amount of possible suppliers will probably increase by a factor of ten and the purchase specifications will probably depend on more complex terms than only delivery time and price. C2 suggest that AI could monitor and scan data in real time as it is being collected as well as bundle and use that information to express recommendations and support decision making through virtual agents, such as chatbots. C1 points out this as well and raise the issue with unreliable incoming data. In time, however, the data quality will be better and the AI-applications will become smarter and thereby be able to perform more complex analysis and eventually be connected to benchmarking databases (C1). C1 also sees potential for risk-analysis to be made by AI-solutions.

Digital technologies might also be used to efficiently monitor contracts and keep track of trade agreements with different countries (C5). C1 also sees great potential for contract management processes, where a lot of effort is needed to follow up and handle all suppliers. Purchasers would also need to optimise the entirety as well as use digital tools to gain information regarding competitors and the market (C5).

Altogether, the interviews agree that RPA will be used for transactional and operational procurement while the AI-solutions can be used to make strategic decisions or at least contribute with supporting information for decisions. As a beginning, digitalisation will mostly be about making processes autonomous to thereby decrease the need of human workforce (C1). A1 predicts that AI will reduce the manpower needed by approximately 10 percent. This will happen for procurement as well as for other functions and other departments of SKF (C1), thereafter, digitalisation will become of more strategic importance.

Internet of Things

IoT is one of the technologies that will have the highest impact on future processes and how to run a company according to B2. Both A1 and C1 see IoT as the enabler for further digitalisation. The main reason is that IoT provides data, which other technologies can use. A1 thinks that in some cases, the data will be more valuable than the actual products. The important question to answer is what a company like SKF could do with the data they collect through IoT-solutions (A1). One well-established application for IoT is track and trace of products within a supply chain (C1). C4 notes that IoT can be used to obtain more efficient production lines and production planning, but might also be used as another criteria to take into consideration when selecting suppliers, i.e. whether the supplier use IoT or not. B2 states that IoT can enable full transparency and visibility in every single step of a production, where an employee, via a mobile app, can access and handle vast amounts of data in real time. IoT can also significantly reduce the error rate related to planning activities (B2). A2 also suggests that IoT could solve one of the issues with blockchain by enabling a digital connection to physical things. This proposes another issue of who should have access to and own the data. Ramström (2018) thinks that the race for the data will determine the fate of many companies. The bottleneck will be the internal organisations ability to adapt to the world of IoT (A1).

A majority of the interviewees points out that digital technologies will enable a move towards a service based organisation, instead of the product based organisation that is most common today (A1). With IoT-technology bearings will be able to notify when they are starting to get worn out which leads to a possibility to optimise maintenance, repair and operations (MRO). This is also confirmed by S1.

3D-printing

The idea of 3D-printing is very exciting according to C5. It could potentially be so, that everyone has a 3D-printer at home, being able to print anything. This would remove the supply chain entirely and be extra beneficial for spare parts and aftermarket (C5). C5 talks about five classic models for differentiation; *speed, innovation, low cost, flexibility and customisation*. Traditionally, a company would choose one of these strategies to differentiate themselves from their competitors, but now, due to digitalisation and as an example 3D-printing, a company can achieve both speed and high customisation. A1 stresses that 3D-printing may change the role of procurement completely, focusing on purchasing the right CAD-models rather than the right components.

Augmented- and Virtual Reality
A1 thinks that the technology of AR/VR only will become relevant for procurement if it does not become fully autonomous. The technology is efficient for visualisation purposes and when an employee needs to deal with large amounts of data (A1). C5 sees great potential in using AR/VR for product development processes, where virtual prototypes could be created and shared with suppliers in an earlier state, potentially affecting procurement to become more of an integrator.

4.1.3 Risks with digitalisation

Regarding risks, the most common concern for the interviewees were about cyber security. Since companies get more and more dependant of data, the potential damage that can be caused by hacker-attacks increases, which C5 relates to Hollywood-movies on cinemas. The availability of data, as mentioned before, creates new business opportunities (A1). For those opportunities to be profitable, it is important that the quality of the data is adequate (C1). If the quality of the data is low, decisions will be made on wrongful information.

Disregarding risks related to data security there are other issues of digitalisation to consider. One risk, according to C4, is that companies invest at a too early stage in new technologies. It is fundamental to understand the technology and the business need of the technology before investing and implementing (A2). C2 gives an example where an AI is implemented and no one actually knows how it works. In that scenario the AI becomes a “black box” and the traceability of the data is lost. C2 stresses the importance of how the functionality of the systems is depending on how organisations adapt to them, this is further described in section *3.2.3 Artificial Intelligence and Robotic Process Automation*. On the same track, how well human and automatised solutions would be able to interact and work alongside each other is a factor to consider as well (C4).

4.1.4 Impact on organisations

According to A1, digitalisation will lead to radical transformation of organisations. When tasks get automatised and new business occurs, it will be important to adapt the organisation to the new preferences. It is not only internally the organisation will change; digitalisation will also affect the relationships towards other stakeholders in the supply chain (S1).

Internal
Internally, the interview objects had two separate theories of how the organisation will change due to digitalisation. The most common perception was that the organisation will remain as one but move towards being project-based rather than the more common function-based. Thereby the organisation will consist of cross-functional teams with people with different competences (S1). C1 agrees with this and also points out that the manpower will be reduced and the focus of employees will be more towards strategic decisions rather than operational.

On the other hand both C5 and A1 mean that the trend today is that big companies, such as SKF, split up i smaller companies. S2 means that it is most likely that there will be some combination of the two end-points, where smaller, high-skilled companies will do projects together in a network. What all interviewees agree upon is that organisations need to be agile and to be able to respond to the radical changes that digitalisation lead to. The drive for internal change is, according to B2, the will of becoming better and preparing for a future with increased competition.

External
According to the majority of the interviewees, the importance of partnership will increase. Amongst these are C1 and C4. Contradictory to this, at least from a procurement perspective, is that digital technologies will help to find more available potential suppliers. Probably, the amount of possible suppliers will increase with a factor ten (A1). One issue is that, to get technologies to perform at their highest potential, there will be need of sharing data between stakeholders. C3 states that a system is only as good as the number stakeholders participating. A1, also addresses the potential of platform models, and compares this to how just-in-time transformed industries, but on steroids. S1 stresses the importance of alignment amongst actors in supply chains as well as within organisation. C1 agrees with this and states that stakeholders will need to find common grounds and objectives instead of just focusing on optimising their own result. External change is driven by pressure from market development as well as requests from suppliers and customer, according to B2.

Procurement's role
What role procurement will play in a digitalised company covers a wide spectrum of alternatives according to the performed interviews. A1 expects that there is a risk that supporting functions such as procurement will disappear. Amongst others, C4 means that procurement's role will become more important than ever. However, the role will change and there will be a need of high competence staff and flexibility within the function. An important factor, according to many interviewees, is that procurement will need to be more involved in research and development. This is mentioned by A1, S1 as well as by C5. C5 also stresses that purchasers will need knowledge about the entire supply chain. This will be necessary when making strategic decisions, for example what countries to source from.

B2 stresses that the important thing for procurement organisations is to define the value propositions of the future and how they can add value to the company in this setting. This evaluation may be extra important for organisations driven by category management, such as SKF (B2). Further on, B2 says there is going to be three key elements of the future procurement organisation; supplier relations, risk management and ensuring a sustainable supply chain.

A future scenario for procurement could be to work more as an integrator, or collaborator (B2). This is supported by C5. The chief *procurement* officer might become the chief *collaboration* officer, focusing on connecting suppliers with internal lines of business (B2). This vision of procurement being brand ambassadors rather than buyers is one way of how procurement and its employees need to redefine their purpose and organisational set-up for the future (B2). B2 is anyway very clear that procurement will not disappear as a function, but the function will most likely transform a lot in the upcoming years.

4.2 Workshops

The results from both the workshops will be presented in the section below. Since the workshops followed a little bit different structure than the interviews and were performed to complement the insights from the interviewees, only the key take-outs and important points will be presented, as they contributed to the study. However, the complete results of the workshops are found in Appendix B-D.

4.2.1 Workshop with students

The student workshop followed a little bit different structure than the interviews and the key points derived for the session will therefore be summarised a little bit differently. First some general observations regarding digitalisation and procurement will be brought up and then the three main technology-areas (blockchain, AI and IoT) will be summarised respectively. The key points summarised below are the ones most different to the results from the interviews and which are bringing some new light to the subject. For the whole result, see Appendix B and C.

General

According to the students, procurement is needed because a company cannot do everything by themselves as well as a tool for reducing costs. The main drive for this structure, is that companies want to achieve economies of scale and therefore need to specialise their business. The chase for economies of scale would according to A1 lose its purpose when digitalisation hits for real. In a digitalised world, the economies of scale will make no difference, why the structure of many big companies is wrong. The era of pursuing economies of scale is over and businesses need to adapt and find new ways of being competitive in a digitalised and globalised business environment.

The workshop concluded that digitalisation is needed for companies to stay competitive, which is crucial for keeping the jobs and employments locally. Digitalisation is a way for developed countries to compete in the same league as the emerging economies when it comes to cost efficiency.

One of many risks with digitalisation that the workshop identified, is that it changes the how competence is valued. The fact that digitalisation is changing the way of working and the competences needed is well known, but it would also change the value of an employee's specific competence. If needed competence could be obtained through a platform-solution or an ecosystem, the employee's knowledge would not be enough reason to keep them employed. Other types of competence will be of higher importance, such as being able to quickly learn new things, collaboration abilities and so on.

Blockchain

Blockchain was the concept that the students had least knowledge about. Many struggled understanding the use of it and some questioned the need for it. Before the workshop, the students were given a brief introduction to the technology and its functionality, but it was obvious that this concept was less well-known than IoT for instance.

The most interesting take-outs regarding blockchain was that the students saw less need for relationships and even contracts. The idea was that blockchain would enable a distributed platform for all kinds of interaction and transaction, why partnership and well developed contracts would lose its purpose. Through a blockchain, a set of prerequisites would determine the entry and permission to certain information as well as business transactions. Everything could be handled through the blockchain and no human interaction would be needed.

Artificial Intelligence

Artificial Intelligence-tools could not only be used to prevent failure modes and mistakes but also to correct common mistakes. Take purchase ordering for example. In many situations, there must be humans who place the orders or at least confirm the orders. From time to time, mistakes appear like ordering 100 units instead of 10, or ordering 24 packs of water instead of 24 bottles. These human errors happen, but AI can help and scan orders to make sure that the order lines are within the scope.

The workshop also suggested that AI could be used for more advanced trend spotting. For example scanning the price fluctuations of oil and how that would influence long-distance shipping of raw materials to one of the existing suppliers, leading to delayed production schedules why a new supplier will be selected for the upcoming weeks of delivery. This kind of second-cause analytics is tightly connected to risk management. Risk management regarding supply chain is a topic nowadays and a lot of systems appear on the market, which could help in detecting and preventing several types of catastrophes.

Internet of Things
The students touched upon many of the points discussed during the interviews and read about in literature. One important insight regarding the usage of IoT-data was that the sensor data also can be used to learn more about the customer and how they use and treat the product. This information could be used to design more specific propositions and services for the specific customer and also get first-hand information about potential improvements in product design and development. This data could directly be of use for a procurement department which is involved in innovation early on and instantly can check for new materials etc. as well as push the suppliers in the right direction much earlier.

Interaction between the components in themselves were also something brought up during the workshop. For example if a bearing is about to be worn out, it can connect to the other bearings in the machine and/or plant to see if any of them might also need to be replaced soon, why a joint order could be beneficial. Basically, if the bearings could talk to each other, they could coordinate orders to simplify logistics and transportation to the plant.

4.2.2 Workshop with SKF

The workshop with employees of SKF Group Purchasing was mainly about four topics/technologies; AI and RPA, servitization enabled by IoT, blockchain and 3D-printing. The topics were chosen by the team after the overall results from the interviews were presented. The section below will highlight the key take-outs from this workshop. The complete results from the workshop can be found in Appendix D.

AI/RPA
The employees discussed these technologies from an angle where they could be used to automatise most of the processes and activities of procurement. Their approach was to list pros and cons with this development and discuss around these. The advantages involved creating better guidance for purchasers, transactional efficiency as well as reducing human factor and time spent on manual tasks. This would lead to time savings while also increase the standardisation. However, it was discussed how increased standardisation of processes will limit the innovation capabilities.

The disadvantages involved increased dependence on system-solutions and losing control and flexibility in terms of error handling/reporting and adapting to market trends. They also addressed issues with security and legal requirements, if systems handle many of the current activities.

The discussion mainly resulted in two questions. First of all, whether or not to be an early adopter of new technologies within this area, considering lock-in effects and fear of missing out and being too late. Secondly, the question if there is something as going too far with automatisation. The team agreed that 100 percent automation probably will not be possible, but where the limit is or should be, is really hard to predict.

Servitization enabled by IoT

Data collected through IoT-solutions and sensors attached to the products could potentially be used to sell services to customers instead of physical products. This development would be very interesting for SKF, according to the participants. This discussion evolved around already known areas of use and potential usage areas for a company like SKF. It was concluded that there is going to be a lot of competition regarding access to the IoT-data as well as the ownership of the data and the service network. A question that was discussed was also how far a company like SKF should go and whether it would be smart to still deliver products rather than services in some contexts. It was proposed; however, that SKF still would be tied to a product and that roller-bearings essentially is the core of SKF's business. If servitization would be developed, there might be a need for changing the core business.

Blockchain

Blockchain was the least known of the technologies and topics, why the discussion mainly was about what blockchain could be used for. The usage areas of payments, invoice management and dealing with customs clearance and sanctions were addresses. The term obligation management was mentioned as when contracts are conducted and there are several obligations that both parties need to fulfil. Many of these obligations, however, gets transferred up-stream in the supply chain and blockchain technology could be used to track these obligations more efficiently. In conclusion, blockchain could be used for every case where it is important to always be able to trust the data, according to the participants.

It was also suggested that blockchain might lead to increased importance of partnerships and strategic sourcing activities, especially when setting up a blockchain solution. However, the transactional parts of procurement will probably not be as reliant on close collaborations. The employees also questioned whether innovation capabilities could be used as a factor when using blockchain to select a supplier for instance.

3D-printing

This technology was discussed in regards to its potential benefits and drawbacks as well as areas of use. The team suggested that 3D-printing would not fit mass production of bearings, but rather be used for customised or special variants and tools used within manufacturing. There are some limitations with raw material that need to be considered when using 3D-printing and there might also be higher total cost of ownership than traditional sourcing. The usage of 3D-printers would, however, mean less work for the purchasers, as they do not need to order countless of spare parts etc. This development would also create a make-or-buy decision in terms of designs, as SKF potentially could start to design their needed components by themselves using CAD.

To summarise, the main take-out is that as long as the speed for mass production is faster than 3D-printing techniques, 3D-printing would only be beneficial for special components. But if 3D-printing is faster, this would lead to completely customised products and offerings for each individual customer, matching their respective needs.

4.3 Scenario Survey

In addition to the interviews, a complementary survey was sent out to the participants. The objective was to obtain some guidelines for the conduction of scenarios for the analysis, see chapter *5. Scenario Analysis*. The construction of the survey is described in section *2.4.5 Complementary survey*.

The overall results from the survey are collected in Appendix A. The key take-outs and directions extracted from this survey are summarised below.

a. *Partnerships will continue to be important*
   Partnerships with suppliers and customers will develop and be more important than ever, which all respondents agree upon.

b. *Automatisation will have increased impact*
   The survey shows that automatisation will be possible for all parts of the procurement process, but mostly for the request-to-pay processes. A majority believes that about 60-80 percent of these tasks will be performed autonomously. For strategic sourcing and contract management the results are too incoherent to make a conclusion.

c. *IoT-data will be used to improve and optimise production planning*
   All survey responders believe that IoT-data will to high, or very high, extent be used to optimise production planning. To be more specific 60 percent believes that it will be used to very high extent, and the remaining 40 percent believe it will be used to high extent.

d. *Organisations will be more project-based*
   Even though there is a outlier in the responses, saying that it is very unlikely that SKF will have a more project-based organisation, all remaining answers indicate that this is likely or very likely.

e. *IoT-data will be used to sell services*
   80 percent of all respondents argue that IoT-data to very high extent will be used to sell services. It should be mentioned that the remaining person means that this will only be used to low extent. Based on this it is possible to conclude that the IoT-data probably will be used to sell services.

f. *The value propositions of SKF will to 61-80 percent be service-oriented*
   That SKF will move more towards service-based value propositions is probable according to all responses. However, to what extent the value proposition will be service based, varies a bit in the results. The majority believes that it will probably be about 61-80 percent and all responses indicate that it will be at least 40 percent of the value proposition.

g. *Organisations and companies will collaborate through ecosystems*
   When it comes to non-core companies the lion's share means that it will obtained through ecosystems. Amongst the other responses there are some who say that it will be outsourced and one claims that it will be obtained through platforms.

h. *SKF will adopt a blockchain-solution*
   In 2025, all respondents believe that blockchain is in some way likely to be used at SKF in some way. However, the results are, quite evenly, spread out regarding this question between 40 and 100 percent. Regarding what type of blockchain that SKF will use, the consortium alternative is the most popular answer, but since the answers for this question are too diverse, it is not possible to make conclusions entirely based upon this.

5 Scenario Analysis

To analyse how the different technologies will impact procurement, its process and organisation, four scenarios were created. In this chapter these four are described and evaluated, based on interviews, workshops and literature. The analysis combines empirical results with theory as well as self-conducted thoughts and ideas. After first setting the scene, all four scenarios are handled according to the same structure. First of all, the scenario and its fundamentals are described briefly. After that, the impacts on the procurement process and organisation are examined, followed by tables consisting of the opportunities and risks within each scenario and its central technology.

5.1 Setting the scene

There are a few characteristics that probably will influence a company like SKF, non-regarding other technological developments and improvements. These characteristics are mostly accessible already and to some extent already present in industry. These will formulate the foundation for the scenario analysis and will be described below.

Companies have already taken the journey of digitisation, where physical documents and information have been put into IT-systems and ERP-systems. Therefore, most of the procurement activities are supported and handled through some kind of system or software. Some physical documents, goods receipt for instance, may still exist down at the shopfloor-level, but the majority is digital. This pre-step of digitalisation is assumed to be standard for the purpose of this analysis.

Other aspects are the availability of Big Data and well-functioning storage of the same in data bases. The amount of data generated during the last few years is remarkable and this is expected to increase further. All of this data can be considered as a prerequisite for more or less all digital technologies, as they use this data as input. In connection to this, the capabilities of data storage and processing is also important and a prerequisite for the development of most digital technologies. Big Data and handling of the same does not in itself contribute with any value, if not used and assessed in the right way by other digital technologies.

Most of the operational parts of procurement are already, or will be, improved and eventually optimised. More or less the full request-to-pay cycle can be automatised, which means that little time and human effort is spent on these processes. The strategic sourcing will then occupy most of the purchasers time, but these processes will be done very similar to today. Since partnerships will continue to be important for the company, a lot of effort will be put on the contract management part, maintaining good relations and collaborations. Strategic sourcing will be assisted of AI to find suppliers and evaluate them by some criterias before human workforce gets involved at all. Based on historical data, the AI will be able to determine what specific factors to compare when evaluating suppliers. In this base-scenario, humans will still make the final decision of what supplier to use, but alternatives will be automatically provided by help from digital technologies.

IoT is being used by placing sensors on the bearings delivered to customers. The data these sensors collect are mainly used for setting more accurate and reliable production plans, predicting maintenance and replacements at the customers' sites. The more reliable production plan cooperates well with the highly automated ordering process. By having more accurate forecasts, the purchase needs and requisitions for the suppliers will be more reliable in the long-term planning as well.

5.2 Scenario 1: Full automation (AI/RPA)

In this scenario, the technologies of AI and RPA are fully developed and can be used to optimise, improve and automate more or less everything. The algorithms are smarter and more powerful than before, machine learning have been improved so that programs truly develop themselves in high pace and the inference-mechanisms of text-, voice- and image recognition are near 100 percent accurate. Human behaviour, performance and judgement can be accurately mimicked and in some circumstances even out-performed.

For a company like SKF, this development has led to full automatisation of processes and activities within all parts of the organisation, including procurement. Administrative and operational tasks are solely done by AI/RPA-solutions and strategic tasks are heavily supported as well. AI does not only contribute with decision basis, but may also make decisions that previously only humans were trusted to do. This is the future where computers can do everything that humans allow them to do and the sky is the limit. This development is supported by the interviewees, but the time-horizon is hard to predict.

5.2.1 Procurement Process and Organisation

In a scenario of full automatisation, the procurement process will more or less be the same as before, see Figure 5-1. However, since AI and RPA are used to automate everything, only a few steps remain for the purchasers. Taking a look at strategic sourcing, it is essentially only the negotiation part that cannot be done by AI. Negotiation builds on interaction between individuals and often involves emotions, why humans still out-perform machines in these situations (Morgan, 2017). Otherwise, the process is the same, but the steps will be performed by AI-solutions. There might still be a need for human confirmation, when specifications are to be determined. This as a safety-feature, so that there will not be initiated sourcing projects for non-required needs or with unrealistic specifications. This confirmation, however, will probably not be necessary after some time (GEP, 2017).

Looking at the request-to-pay cycle, similarly to specification determination, there might be a certain need for human confirmation of purchase orders. The employees of SKF Group Purchasing argue that humans, to some extent, need to maintain in control due to legal and security requirements. The cycle in itself will also become “smaller” since its importance will be reduced.

With most parts of the two cycles being automatic, the effort will be on maintaining relationships with the suppliers and manage contracting (C1). When the procurement department do not need to deal with administrative and operational tasks, they can focus on the strategic parts of procurement, i.e. develop the category strategies, empower negotiations and develop collaborations with key suppliers (B2). This development will make procurement earn a spot around the strategy table, as it holds potential for both major savings as well as business developments (C1).

This scenario creates a reduced need of a procurement function and may, in a company like SKF, result in that procurement as a function will be removed as speculated by A1. AI’s ability to take over almost every task in the procurement process, performed by the procurement staff today, leads to the fact that a lot of procurement competence will be unnecessary. The remaining tasks will be negotiation and maintaining relationships, and these might be performed by teams specialised in this rather than by procurement personnel, as supported by A1. There is also an opportunity that those tasks will be handled by external partners specialised within these areas. In this case, the existing procurement staff would be spread out in other functions, such as R&D and business strategy, where procurement competence is asked for (A1; C5; S1). It is further suggested by B2 and C5 that procurement will become more of an integrator, where the purchasers connect suppliers with internal organisational functions rather than being buyers. In a scenario of automation, where the traditional tasks are taken over by computers, this might be the direction of development. Procurement could handle all the contracts and supplier relations as well as connect the right functions and people, hence making the chief *procurement* officer the chief *collaboration* officer (B2).

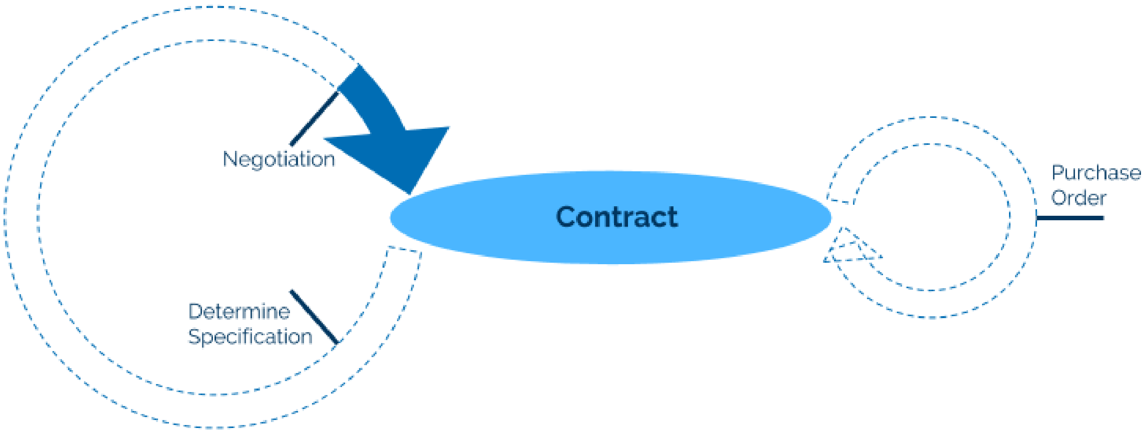

Figure 5-1: The Procurement Process in Scenario 1 - Full automation. For original, see Figure 3-5.

5.2.2 Opportunities and Risks

Table 5-1: Opportunities of Scenario 1 - Full Automation.

Opportunities	
Increased involvement in R&D	
Causes: • Higher productivity and reduced errors through automation give purchasers time to spare for other activities (Goldberg, 2017; Guszcza, 2018). • Procurement competence could benefit early-stage product developments (A1; C5; S1).	Treatment: • Make sure that knowledge about suppliers is included in R&D decisions or include purchasers in product developments (S1 2018).
Increased focus on strategic activities	
Causes: • Higher productivity and reduced errors through automation give purchasers time to spare for other activities (Goldberg, 2017; Guszcza, 2018).	Treatment: • Emphasise the strategic importance of procurement decisions (Vollmer & Murphy, 2017). • Illustrate the knowledge held by procurement

• Procurement have increased strategic impact through possible spend reductions and supplier relationship management (C1).	(Vollmer & Murphy, 2017).
Get closer to suppliers and improve partnerships	
Causes: • Most of the procurement activities are not reliant on human involvement anymore, enabling a higher focus on relationships (Guszcza, 2018; B2). • Human communication is still important for negotiation and supplier relationships management (C1).	Treatment: • Specialise procurement towards being experts in negotiation and relationships management.

Table 5-2: Risks of Scenario 1 - Full Automation.

Risks	
Loss of process competence	
Causes: • Automation reduces the value of current competence and replaces employees (Baccala, et al., 2018). • Knowledge of how to do things manually is not needed (C2). • New kind of competence is required, which might not be available within the workforce (Baccala, et al., 2018).	Treatment: • Work with competence development and education to match new requirements. • Document how the systems work and stay informed and updated of the underlying functionality and decision variables used by AI/RPA-solutions, to avoid creating a "black box" (C2).
Data security & Hacking	
Causes: • Everything is generating increasing amounts of data (Vollmer & Murphy, 2017). • In this scenario everything is stored digitally, without physical copies.	Treatment: • Establish security systems and use encryption. • Employ knowledgeable people (A1). • Use warning systems to point out variations in data (C5). • Work with reliable system providers.
Trust issues	
Causes: • People can be resistant to digital developments (The Drum, 2016). • People do not understand the technology and the increased complexity (Brynjolfsson & McAfee, 2017). • The systems are not transparent and appear as a "black box" (Brynjolfsson & McAfee, 2017). • Lack of control of the systems (Brynjolfsson & McAfee, 2017).	Treatment: • Create understanding and trust through smaller pilots. • Educate staff how the technology works - try to open up the "black box" (C2). • Change management.

5.3 Scenario 2: Servitization (IoT)

It was widely agreed upon, by many of the interviewed experts, that IoT-data will be used to move towards a more service-based rather than product-based company. This means that SKF will leverage the data provided by the sensors and adapt their value propositions accordingly, creating a company that truly delivers uptime rather than roller bearings. In this scenario, it is assumed that these opportunities have been maxed out and that SKF deliver almost 100 percent of its sales within services. Most likely, the suppliers of SKF will also move in the same direction which means that the machines used in SKF's production also will provide data and thereby service opportunities to SKF's suppliers. In other words, SKF will not only sell services to a larger extent, they will also buy services to a larger extent.

The focus areas for R&D will be; what data each bearing can provide, how to use it and how to secure that the data is of good quality. The mechanical features of the bearings will of course still be of importance, but not as prioritised as today. Noticeable is that a sensor placed on a bearing, in a production flow, will be able to retrieve information about the status of other components in the production and not only about the bearing itself. However, this works both ways and the machine, which the bearing is placed in, might be able to provide information about the bearing. The strategic importance of who possesses the right to retrieve and use IoT-information will be crucial.

5.3.1 Procurement Process and Organisation

When IoT-data is used to sell services, more or less all customers are contracted through prescriptions or service agreements. This in combination with the forecasting opportunities provided by the sensor data enables a company like SKF to have a smooth and accurate production plan (Lee, et al., 2013). When it comes to direct material, it can automatically be ordered following the sequence and production plan constructed by the data from the customers. Therefore, the purchase requisition, quotation and purchase ordering can be performed automatically, at least for standard components from regular suppliers. Looking at indirect material, as explained above, the suppliers probably sell services as well, resulting in automatic ordering/replenishment of these kinds of products. The request-to-pay cycle will therefore start at the goods receipt-activity. Except for this, the procurement process will look the same in this scenario as can be seen in Figure 5-2.

The service-development will lead to stable cash flows, both in terms of income as well as cost (Marks, et al., 2017). When selling services, there is usually a fee dependent on time units rather than actual products delivered. This will smoothen out the revenue-streams. Simultaneously, the costs will be more stable as well, especially for indirect material.

When selling services instead of products, the production plan will be smoother and more accurately follow the demand, as explained above. This will result in lower stock levels. The balance sheet will then lose some weight. However, since SKF are selling services, the ownership of the bearings, placed at customers, will belong to SKF instead of their customers. This will impact the balance sheet in the opposite direction. On the other hand, if the suppliers are working in the same way, all fixed assets in terms of machines etc. will be removed from SKF's balance sheet. The workshop with SKF concluded that in this scenario, someone still has to be tied to the physical products, even though the products might be moved upstream in the supply chain. The change from selling products to selling services might also influence the core-business, which needs to be considered when evaluating this transformation, according to the employees of SKF as well as A1.

In this scenario, contracts will be more important. Since suppliers provide services rather than products, a higher amount of total spend will be in terms of service agreements. Therefore, it will be important to negotiate good contracts (Vendrell-Herrero, et al., 2017). It will also be more important to maintain the relationships with the suppliers, since service agreements create certain lock-in effects (Marks, et al., 2017). When supplies are bought solely as products, it is easy to play competitors against each other as well as swop supplier whenever it suits. When tied up into a service agreement, however, changing the supplier is far more difficult why it is essential to maintain good relations and have a balanced dependence between each other (Vendrell-Herrero, et al., 2017). Traditionally, the buyer has the edge in the supplier-buyer-power situation, but with servitization this power will move towards the supplier (Marks, et al., 2017).

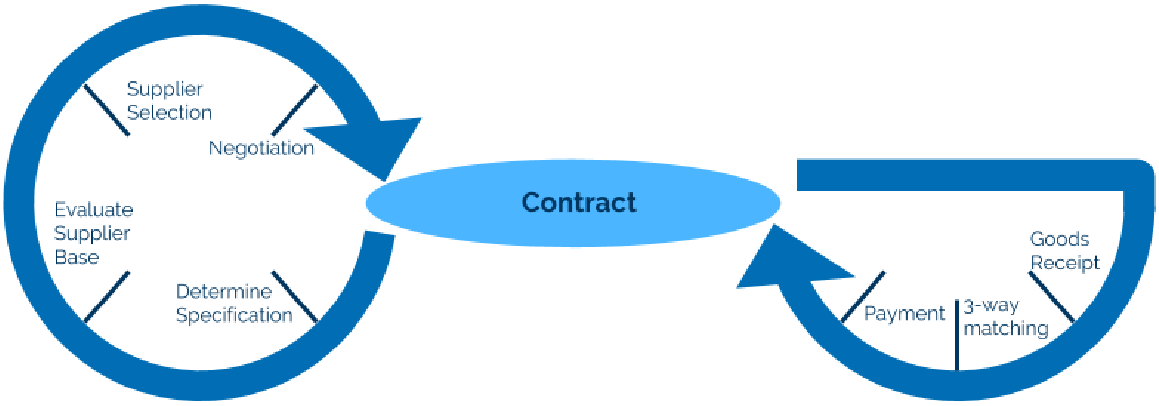

Figure 5-2: The Procurement Process in Scenario 2 - Servitization. For original, see Figure 3-5.

5.3.2 Opportunities and Risks

Table 5-3: Opportunities of Scenario 2 - Servitization.

Opportunities	
Improve cost control	
Causes: • The original price includes more costs than just the price of the product. For example costs associated with maintenance and repair are included (Marks, et al., 2017).	Treatment: • Long term thinking in negotiation. • Focus on new, more complex aspects when negotiating, looking more at the bigger picture (Putters, 2018).
Get closer to suppliers and improve partnerships	
Causes: • Parties need to trust each other to be able to share data from production for example (Vendrell-Herrero, et al., 2017). • Lock-in effects through service agreements make parties want to focus on and develop their relationship further (Marks, et al., 2017).	Treatment: • Integrate systems and processes with suppliers to enable full transparency (Marks, et al., 2017). • Create incentives for suppliers to deliver long term results (Marks, et al., 2017).
Improved and more accurate forecasting	
Causes: • Access to real time information from products (Lee, et al., 2013). • Gaining control and "ownership" of incoming	Treatment: • Enable and boost predictive analytics.

orders. • Reduced amount of emergency orders.	

Table 5-4: Risks of Scenario 2 - Servitization.

Risks	
Increased dependence of certain suppliers	
Causes: • All machines are bought as services, giving full transparency and access of information towards the suppliers. • Lock-in effects and high exit barriers (Korte, 2015).	Treatment: • Create incentives to perform better and develop continuously (Marks, et al., 2017). • Balance the power-situation, make the suppliers as dependent (Vendrell-Herrero, et al., 2017).
Suppliers do not perform as good anymore, become slow and lazy	
Causes: • Suppliers feel "safe" due to long lasting contracts and agreements (Korte, 2015). • Lack of motivation for suppliers to improve and develop, since the performance level is not rewarded (Gallant, 2013).	Treatment: • Increase pressure on supplier performance (Marks, et al., 2017). • Create incentives for collaborative improvements.
Reduced control of machines, their maintenance and breakdowns	
Causes: • A machine and its data are owned by the provider rather than the company using it.	Treatment: • Track and register maintenance and stops, both historical and planned in near future. • Clarify responsibility and actions, in case of unplanned stops, in the contract.
Non-synchronised maintenance, leading to increased downtime	
Causes: • Maintenance, repair and operations will be provided by several suppliers, based on IoT-data. • Needs appear independently of each other. • Suppliers aim to optimise their own services.	Treatment: • Track and register maintenance and stops, both historical and planned in near future. • Facilitate cooperation between suppliers to coordinate maintenance and other stops.

5.4 Scenario 3: Blockchain

By studying the survey results and literature, it is possible to conclude that blockchain will, most likely, be a part of SKF's organisation in the future. While blockchain can be used to secure data internally in a private blockchain, the focus of this section will be on how a blockchain can be used externally which is more essential to the procurement process and organisation (B1). Since a public blockchain where everyone possibly could get information of transactions between companies seem rather unlikely, this scenario investigates the use of a semi-private or consortium type of blockchain where identities are anonymous. Instead of known identities, previous performance and service features are transparently displayed within the network.

In this scenario, there will be full transparency between SKF and all its suppliers and customers. Thereby, the information of each product and its different components could be traced all the way back to its origin. The dependency of a good relationship towards suppliers is not as important as before when the supplier has entered the blockchain platform. In this scenario monetary transactions as well as information transactions will be made by the use of blockchain technology. Due to the decentralised ledger, all suppliers will be able to visualise transactions between SKF and other stakeholders. This will lead to increased competition between suppliers. Included in the blockchain network there will be, except for the suppliers, the customers. This means that not only SKF, but also its customers, will be able to trace all parts of the bearing back to its origin.

Smart contracts allow the blockchain to act automatically (Mohan, et al., 2018). By the use of smart contracts, transactions could automatically be sent when the terms of the contract are fulfilled. In this scenario, smart contracts can be used for diverse application areas and would be the natural choice for optimising traditionally time-consuming back-and-forth processes (GEP, 2017). Since blockchain enables access to data from all users, smart contracts can act upon information from multiple parties of the network.

5.4.1 Procurement Process and Organisation

This blockchain-scenario will rather drastically change the procurement process, see Figure 5-3. First of all, since there is no need of trust amongst actors (Lopez, 2017), the technology enables strategic-sourcing cycle to be of less importance. However, when setting up a network, partnerships may be of extra importance, but in case of consortium or semi-private blockchains, suppliers will enter the blockchain if they get permissioned by the owners (Buterin, 2015), or if they fulfil the prerequisites (Dobson, 2018). The supplier base can therefore be built automatically or by carefully selected partners. The issue will be to reach a critical mass of users on the blockchain, as confirmed by C3. A blockchain can be compared to a platform in this case, and a platform without users is worthless while a crowded platform attracts even more users (Magnusson & Nilsson, 2014). The more users there are, the bigger the network effects. However, consider SKF having a blockchain in place which has reached the critical mass of suppliers in this case, then the supplier base is already present on the blockchain. After a specification of a purchase has been determined by a purchaser, this criteria provides prerequisites for a smart contract (Mohan, et al., 2018). Any supplier on the blockchain can apply for the contract, if they fulfil the prerequisites. The best available suppliers are then chosen automatically, considering various factors, and are presented as a short list to the purchaser. This will lead to increased competition between suppliers and thereby an improved negotiation position for SKF. The final decision is then taken by humans, which more accurately can take outside factors into consideration, such as innovative capabilities. There is no need for back-and-forth negotiations, since the bidding is made through the smart contracts (GEP, 2017).

The request-to-pay cycle will be affected similarly as the strategic sourcing. The purchase need is identified and formulated as a purchase requisition. Then the smart contracts execute the requisition and let suppliers quote according to the set up formulas. A purchase order is proposed and chosen by the operational buyer. This order is automatically stored in the ledger, making it available to the involved actors on the blockchain (Mohan, et al., 2018). Similarly, when the goods are received, this receipt gets stored on the ledger. Since both these documents are present on the ledger, they can be matched directly and initiate a smart contract performing the payment instantly, without any need for sending invoice or doing the 3-way matching (GEP, 2018). Blockchain technology will make the request-to-pay cycle a lot more efficient and simpler. The smart contracts will also heavily reduce the lead times for the procurement activities with back-and-forth characters (Mohan, et al., 2018). At the same time, liquidity of companies gets affected as payment now is received instantly and without the traditional 30-90 days of invoice expiration (B1).

Having a blockchain-solution in place, there is less need for close relationships to the suppliers or customers, as suggested by Maltaverne (2017) and the workshop with students. A company is either part of the blockchain or not and every purchase is determined by automatic bidding processes through the smart contracts, with full transparency. The relationships will become more transactional as a result, since it does not matter for a company like SKF if it is supplier A or supplier B that gets the deal, knowing it will anyway be the best applicant (Christidis & Devetsikiotis, 2016).

There will be a lot of focus on the infrastructure in a blockchain-scenario, as trust in technology is required (Christidis & Devetsikiotis, 2016). That means building, maintaining and providing attractive solutions to obtain users in terms of both suppliers and customers. Procurement will be handled by the infrastructure rather than the procurement team, why the technology and functionality will be essential to maintain business. As one of the benefits with blockchain is that it does not require any trust in between the users, it does, however, require trust in the technology (Christidis & Devetsikiotis, 2016), which may pose a problem when approached by a conservative company that prefer to put their trust in people.

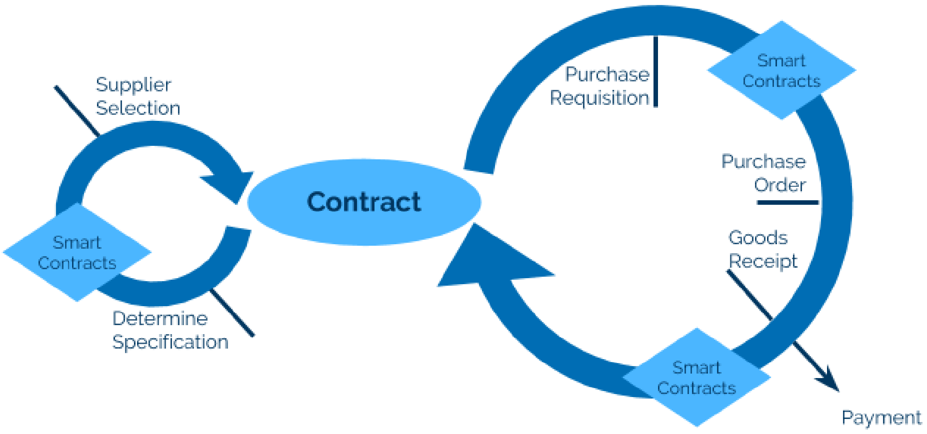

Figure 5-3: The Procurement Process in Scenario 3 - Blockchain. For original, see Figure 3-5.

5.4.2 Opportunities and Risks

Table 5-5: Opportunities of Scenario 3 - Blockchain.

Opportunities	
Expanding the funnel, expanding the supplier base	
Causes: • Reliability towards suppliers (Loop, 2016) because of: ○ The immutable distributed ledger. ○ It is impossible to provide false information.	Treatment: • Try to focus less on historical relationships. • Set up clear prerequisites and expectations.

○ Full transparency towards supplier and customers. ○ Provide guarantees of origins.	
Improve negotiation position	
Causes: • All suppliers are equals since there is no knowledge of what suppliers are being negotiated with. • To be a part of the network all suppliers must fulfil the set up terms (Dobson, 2018). • Increased competition on the supplier market (Mohan, et al., 2018).	Treatment: • Put more pressure on suppliers for price, lead time and/or other wanted aspects.
Improved risk management provides a possibility for procurement to act earlier	
Causes: • Early warning systems for all involved actors (C5). • Access to reliable and trusted real-time information (Maltaverne, 2017).	Treatment: • Leverage/exploit shared information to predict risks.

Table 5-6: Risks of Scenario 3 - Blockchain.

Risks	
To not reach a critical mass of users and achieve network effects	
Causes: • Supplier hesitancy to enter a network with full transparency towards competitors (Christidis & Devetsikiotis, 2016). • Suppliers might not realise what the benefits the technology provides which leads to hesitancy to join the network (A2; C4).	Treatment: • Educate suppliers what blockchain is, and what advantages it leads to for them. In other words, create incentives. • SKF could invest in blockchain for their suppliers. • Follower's strategy, adopt someone else's blockchain (C4).
Suppliers are not as committed to SKF	
Causes: • Not as important with partnerships, as no trust in needed in between the buyer and seller (Lopez, 2017).	Treatment: • Create incentives for delivering results (Marks, et al., 2017).
Developing blockchain-solution without knowledge of business need	
Causes: • Intermediaries are trusted (A1). • Wrong context can lead to no clear benefits for suppliers and stakeholders (A2).	Treatment: • Examine/monitor technology development before investing (A2). • Investigate the opportunity to adopt someone else's blockchain (C4).
Lock-in effects when adopting someone else's blockchain	
Causes: • High investments/configurations to enter - feel like they need to stay (Maltaverne,	Treatment: • Examine/monitor technology development before investing (A2).

2017). • Problematic exit procedures. All data of previous transactions will remain in the ledger. • Lack of alternatives.	

5.5 Scenario 4: 3D-printing

The last scenario involves the usage of 3D-printers. The technology of additive manufacturing is on a rise and many companies are exploring the potential (GEP, 2017). In this scenario, the 3D-printing techniques are highly developed to ensure fast production of almost every application/component with high quality and low error rate. However, the relatively advanced commodity of roller-bearings is expected to be too complex for the 3D-printing technology considering lubrication etc. This opinion is backed by the employees of SKF Group Purchasing. It is also important, for a company like SKF, to keep control of intellectual property. This means that a company like SKF will use 3D-printing to provide their manufacturing facilities with components of both direct- and indirect character. There would be 3D-printers at all factories, printing all required components for production and just-in-time. The printers would be flexible in terms of settings and can work fast and autonomous without any special monitoring. There would be reduced need for suppliers of special components and variations, but rather an increased supply of raw materials and eventually CAD-models (A1).

5.5.1 Procurement Process and Organisation

When printing most of the components at the production sites, the need for raw materials increase while the orders for components will decrease. When SKF can print whatever variant of guide ring they like, they do not need the current suppliers providing guide rings. The suppliers providing raw material, however, will be of higher importance and partnerships should probably be developed with these key suppliers. This will lead to a decreased number of total suppliers, simplifying the supplier base and, as a consequence, the contract management (GEP, 2017). The procurement process will be more or less the same though (see Figure 5-4 below), but the need for and effort put on supplier relationship management will decrease. This will make it all much simpler to manage. It will also be easier to have an overview of the total spend.

The reduced amount of suppliers for special components will also lead to decreased amount of call-offs made during the operational procurement, as supported by the workshop with SKF. This will influence the local supply chain teams at the production sites. Their overall work situation will be simplified due to smaller amount of incoming flows of supply.

By the use of 3D-printers, SKF could use more of a make-to-order approach (MTO), meaning that manufacturing is initiated first after a customer order has been received (Weller, et al., 2015). With shorter lead times of production and reduced material waste, as a consequence of 3D-printing, the MTO-approach could be used more, eventually resulting in lower stock levels and capital cost (GEP, 2017). The employees with SKF discussed that if the production speed of 3D-printing is as fast as today's assembly lines, as suggested in this scenario, this will enable mass customisation rather than mass production. SKF could then potentially offer specialised roller-bearings for every customer.

When 3D-printers are used, the focal company will take over responsibilities that their suppliers previously had (GEP, 2017). SKF would have control of a bigger part of the value chain. However, this means that their previous suppliers of components lack responsibilities, since production now is taken over by the 3D-printers of SKF. Suppliers might then be pushed towards a certain design focus, putting all their efforts at designing new CAD-files for components which they can sell to SKF. This development will influence procurement, as they increasingly have to deal with licensing and intellectual property of these design models (GEP, 2017). The alternative is that SKF start doing these developments by their own and in connection to product development. This would be the optimal version of early supplier involvement, resulting, however, in that the previous suppliers have no role to play in the supply chain. In this case, 3D-printing will completely remove the middlemen of first tier suppliers.

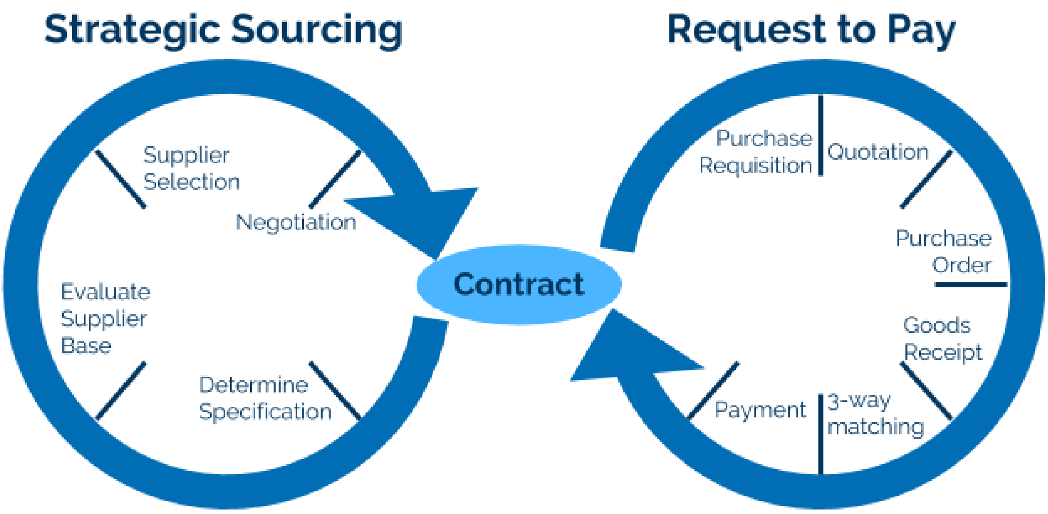

Figure 5-4: The Procurement Process in Scenario 4 - 3D-printing. For original, see Figure 3-5.

5.5.2 Opportunities and Risks

Table 5-7: Opportunities of Scenario 4 - 3D-printing.

Opportunities	
Simplify supplier base and reducing transaction costs	
Causes: • Not as many components, more raw material (GEP, 2017).	Treatment: • Focus on relationships/partnerships. • Get rid of unnecessary suppliers.
Get suppliers involved in R&D to create compatibility with SKF's products and leverage rapid prototyping	
Causes: • Suppliers provide CAD-files. • Easier to change/update designs compared to finished components. • Easier to test designs in real case environments due to 3D-printing.	Treatment: • Important to address ownership of intellectual property (GEP, 2017). • Maintain dialogue with suppliers.

Table 5-8: Risks of Scenario 4 - 3D-printing.

Risks	
Dependence of raw-material suppliers	
Causes: • Reduced amount of components and increased need of raw materials (GEP, 2017). • Raw material suppliers cover a bigger portion of the total spend.	Treatment: • Use multiple suppliers, at least dual sourcing to keep some leverage towards suppliers (van Weele, 2014).
Suppliers selling the same designs to multiple customers	
Causes: • Issues related to intellectual property (GEP, 2017).	Treatment: • Important to handle those issues in the contracts. • Create incentives for suppliers to “stay loyal”.

6 Conclusions

Digitalisation means transformation of business models by the use of digital technologies and is a force that is approaching. Potentially, this will disrupt all parts of business and organisations. The force will first hit the operational and administrative parts of business and further on impact the strategic parts. Companies will need to rethink how they are structured and functioned to be able to compete in a digitalised world. Digitalisation involves several digital technologies, where AI/RPA, blockchain, IoT and 3D-printing are considered to be the most interesting and influential for the procurement function and organisation. These technologies create four potential scenarios of future developments. However, it is concluded that there is no standalone solution and that a combination of these technologies is most plausible. A combination of technologies will probably have a greater impact on procurement than the presented scenarios.

The scenario analysis provided some key insights. *Full Automation*, might result in a deconstruction of the procurement function since most tasks will be automated. *Servitization* will increase the importance of the business relationships and enable better planning capabilities than today. The usage of *Blockchain* technology will enable more transactional relationships in between parties while creating an increased focus on infrastructure. Smart contracts will disrupt the procurement process with its self-execution. *3D-printing* will reduce the supplier base and thereby the amount of call-offs made. The responsibilities of first tier suppliers will somewhat be taken over by the focal company.

In a digitalised future the role of the procurement function will have to adjust to stay important. Already today, there are examples of procurement processes that are automated to large extents, eliminating the need of some parts of the traditional procurement functions. It can be concluded that procurement will have a changed role with more of a strategic focus and potentially also be involved in R&D. Looking even further ahead, with an even higher level of automation, the question whether a separate procurement function is needed at all will appear. Therefore, it will be crucial for procurement to stay alert and quickly adapt to what the digital technologies offer, to keep its relevance as a function.

Supplier relationships will continue to be important in the future, the study concludes. Three out of four scenarios propose an increased need and opportunity for close partnerships with suppliers. As many digital technologies are depending on increased amounts of shared data in between the parties, the bonds will naturally grow tighter.

The study concludes, that digital technologies will impact employees and their working situation before they impact employment, i.e. replace humans. Digitalisation will change the competences needed and humans must learn to work in collaboration with and supported by technology. As humans lose control of processes and decisions, there will be an increased need for personnel that understand technology to avoid black-box effects.

Companies are not recommended to digitalise their business just for the sake of digitalisation. Considering the investment and development costs, there has to be a clear business need and context before implementing a digital technology. Companies should reconsider, before adopting something new that create lock-in effects and without a clear business motive.

7 Discussion

The following chapter will address a few topics of discussion, which were considered to be interesting. The topics are both questions arisen from workshops and interviews as well as concerns discovered when performing the analysis. The last paragraphs will cover the need for future research related to the topic of this study.

What is plausible?
The scenarios developed in chapter *5. Scenario Analysis* were all designed to challenge today's processes. Therefore, each one of them was structured to answer the question, what happens if the technology is implemented to its maximum? Regarding 3D-printing today, due to its production time, it is mostly used for manufacturing customised products in smaller quantities and, to some extent, spare parts. A question was raised, if it ever will be possible to use 3D-printing for mass production, and thereby achieve mass customisation? And what effect would it have on the TCO? Could complex products such as roller-bearings be produced solely by 3D-printers? Most likely, 3D-printing will become more efficient and thereby increase its usage areas, but exactly to what extent is hard to predict. However, having 3D-printers as the core-manufacturing technique does not seem plausible in the upcoming decade.

Based on the survey, it is likely that blockchain technology will be a part of SKF's organisation, already by 2025. An important issue to address, is whether SKF should develop a platform themselves or if it is better to join an existing blockchain platform? Regardless of which, SKF will be dependent of having other actors joining the network. In a scenario where SKF develop a blockchain, there is a risk that other actors' benefits of joining the network will be reduced. Strength comes in numbers, and the stakeholders joining the network need to have a certain amount of customers present there as well and solely SKF might not be enough. If SKF would decide to create a blockchain the most plausible solution would be to develop a consortium, where a network with a sufficient amount of users could be obtained, see section *3.2.4 Blockchain*. The issue of where to draw the line of who should be allowed access to the network is crucial. This is where the benefits of a semi-private blockchain appear, see section *3.2.4 Blockchain*. In this case, other issues become of importance; should competitors be allowed to enter and is it possible to stop them? What becomes obvious when discussing blockchain is that, it is fundamental to figure out the business need and what type of blockchain to use. First then, it is possible to decide if SKF should make or buy a blockchain platform.

How far should we go?
When considering digital technologies, the maxed out scenarios as presented in the analysis might not be applicable. The employees of SKF Group Purchasing raised several concerns regarding the realism of the scenarios. For instance, an automation of hundred or close to hundred percent might not be plausible at all. This creates another question - how far should automation go? Automation will have a certain impact on employment, that is for sure, and employees cooperating with AI/RPA will to some extent lose control of the processes and decision making. Soon enough, a computer will run the company, performing all operational tasks, making all decisions and so on. Maybe there is a limit, or a line, where automation should stop? Maybe an automation of above 80 percent of all processes will mean that the humans have no control of their own company? When considering digital investments, this should be kept in mind, what is desirable and what is not. Just because some features and functionality exist do not mean that they should be used and adopted.

With increasing amounts of data provided by IoT-sensors, the possibility to move towards servitization appears. In this scenario it is important to ask, the same question as for automation, how far should servitization go? Is it better to sell services than products, and to what level? When does services or maintenance become core-business instead of roller-bearings? There seem to be a common understanding that servitization is good and beneficial for a company like SKF, but this utopia should be challenged and confronted. Additionally, the working environment in SKF's own manufacturing sites would be affected, when everything in the factory is owned by suppliers. The suppliers want to sell as much services as possible, based on the data that their machines provide. The suppliers could potentially know more about SKF's manufacturing process than SKF themselves, making them lose control of their own production.

An important issue that will emerge is who should own the data? A sensor, placed on a bearing, will be able to sense that something else is wrong in a production system. Should SKF in that case be able to sell a service to fix that error, when the broken component is not owned by SKF? In this case, the quality of the sensor becomes so important, that a lot of industries to some extent might change their core business to focus more on the sensors rather than the products. Another possible direction is that the rights of the data will be owned by the factory where the component is placed. This would decrease the motivation of servitization, but also make it easier to organise the MROs for the factory in question.

Being early adopter vs. follower

The question should be raised, whether or not to be an early adopter when it comes to digital technologies. It could prove beneficial to be in the frontline, if the right technology and/or platform is adopted. However, the first projects and initiatives are seldom the right ones, in other words, the soldiers in the frontline die first in combat. Adopting the wrong or inferior technology/platform can be devastating, as lock-in effects often are strong in case of these solutions. Heavy investments and complex implementations make the pit deeper and it becomes harder to get out. At the same time, a company have to be early to obtain competitive advantages and possibilities to stay ahead. If a company does not start to dig, how can it find the treasure?

However, neither being too early nor being too late seem like appropriate strategies. Perhaps the middle way is once again the golden way. A company could use a follower's strategy, i.e. being early but not being first. When following and observing the leaders, the mistakes and traps can be avoided while the right technologies and systems can be adopted early on.

One issue with the industrial market when it comes to adoption of new technologies and systems is that the network is very complex with many layers and connections. In case of SKF, for an implementation of blockchain to be beneficial, the suppliers, customers and other stakeholders has to be on similar technical level to be able to adopt and use a blockchain. SKF's level of digitalisation does not matter if a supplier cannot cope with it. All stakeholders have to be on similar level, considering technical developments, for digitalisation to create value.

Role of procurement

The role of procurement within an organisation has been on the agenda throughout the whole study. Different voices and scenarios tell different stories but one thing is for certain: the role of procurement will change. Procurement and its importance as a function could be strengthened, for instance by more involvement in R&D and strategy. It could also shift focus and become more of integrators or innovation partners. However, there are also indications that procurement, as it is right now, will not be needed in a future organisation. As digital technologies take over more and more parts of procurement's current activities, what use is there of a procurement function? This poses an important question for all procurement departments in big organisations. Should procurement prepare for doom and be dismounted and potentially removed as a function or should it rise up and fight and make itself important and essential in future organisations?

Related to this discussion, is the concept of category management. As this procurement strategy has not been in focus in this thesis, the knowledge and understanding is too vague to address the question in a trustworthy manner. However, a company should think about the future of digitalisation and how the procurement function might look in this scenario and then evaluate how their current strategy (in case of SKF, category management) fits into this picture. Category management is a way to simplify procurement and obtain economies of scale. In a digitalised world, economies of scale will not be of the same importance and advanced technology could handle every single item independently, or at least categorise them in more efficient and cheap ways. When digitalisation hits for real, category management might become a legacy.

Future research

As the study has been limited to focus solely on the procurement function, some aspects may have been missed or overlooked. Digitalisation will probably influence the whole organisation simultaneously which means that some changes related to marketing could possibly affect how procurement is done as well. This kind of second cause effects have not been considered in this master thesis, as procurement has been the central function. The implications digitalisation have on procurement might also influence other parts of the organisation, such as supply chain, which have not been within the scope as well. Similarly, the focus has been on SKF, while many of the digital technologies impact the whole supply chain of both suppliers and customers. This calls for future research discovering the impact of digitalisation on the organisation and supply chain of a company like SKF, rather than a specific function. Even though this research will become broad and complex, the connections and interdependencies covered will be of higher relevance than to extract procurement and analyse it by itself.

This thesis, briefly touches the subject of how today's category managed procurement function will be affected by digitalisation. Digitalisation is to a high degree based on an aligned procurement function, why there are some contradictories with category management. Category management does the opposite by enabling separate procurement categories to work differently to some extent. Investigating where, and if, these two poles meet or if one overrides the other, would be of interest for procurement organisations in general. Analysing the role of category management in a digitalised future would be valuable for companies such as SKF. By focusing more on the current procurement organisation, it would be possible to create more specific and realistic scenarios.

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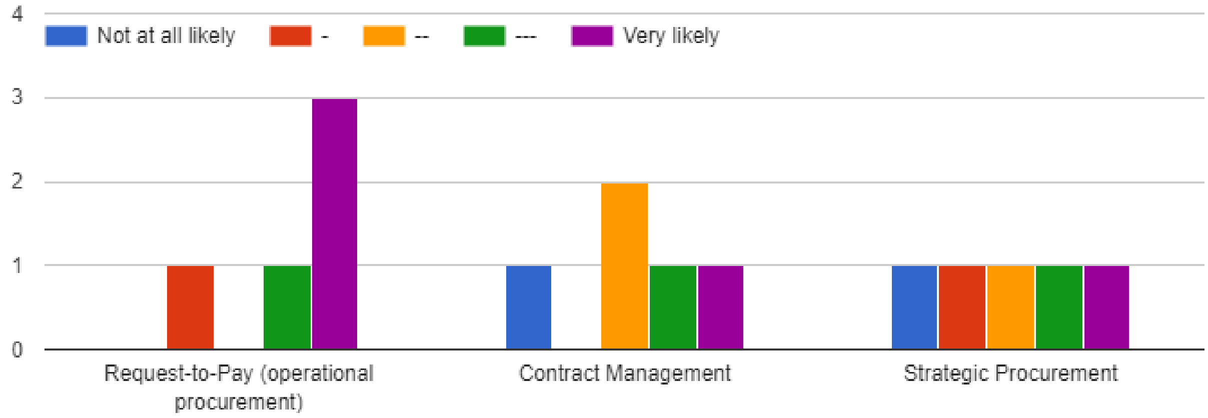
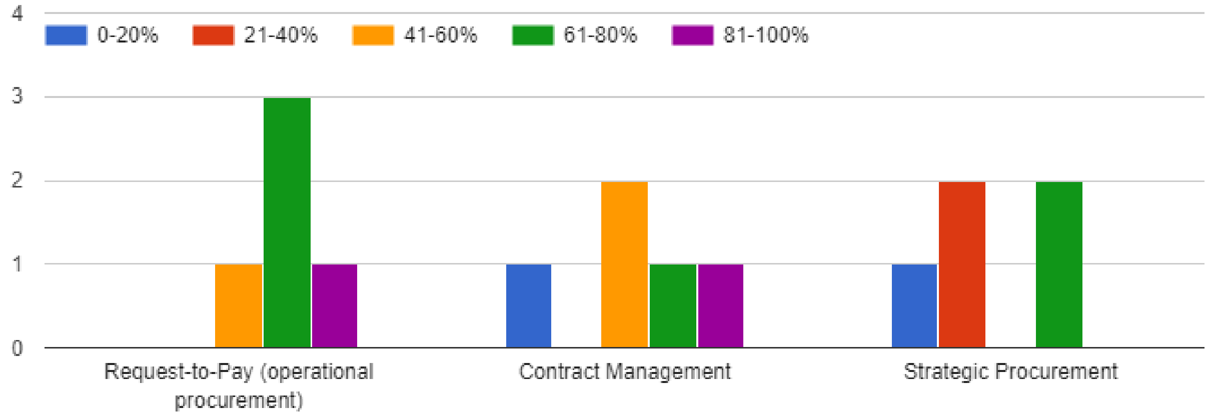
Appendices

Appendix A: Scenario Survey and Results

Consider today's development of AI/RPA-solutions. How likely is it that ... will be automatized?

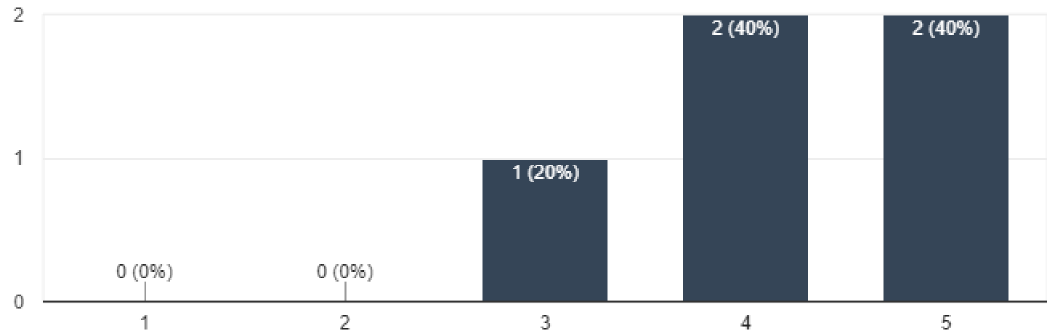


To what extent might ... be automatized?



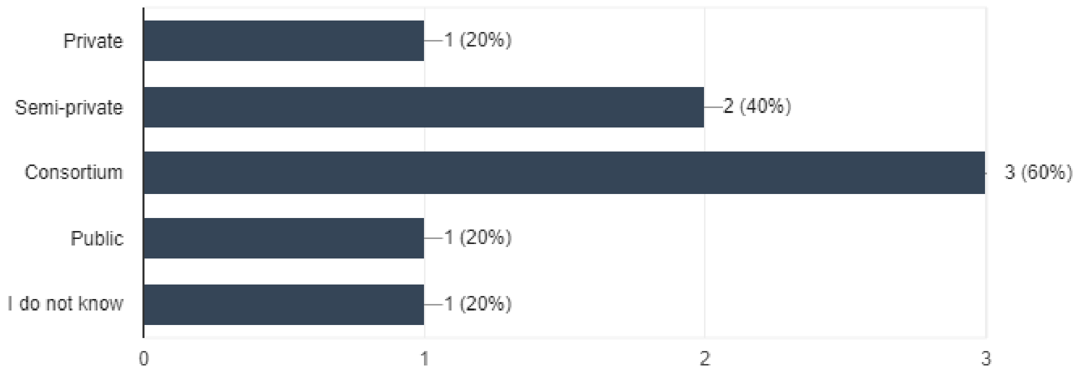
Consider today's development of blockchain-technology. How likely is it that a company like SKF would use blockchain in 2025?

5 responses

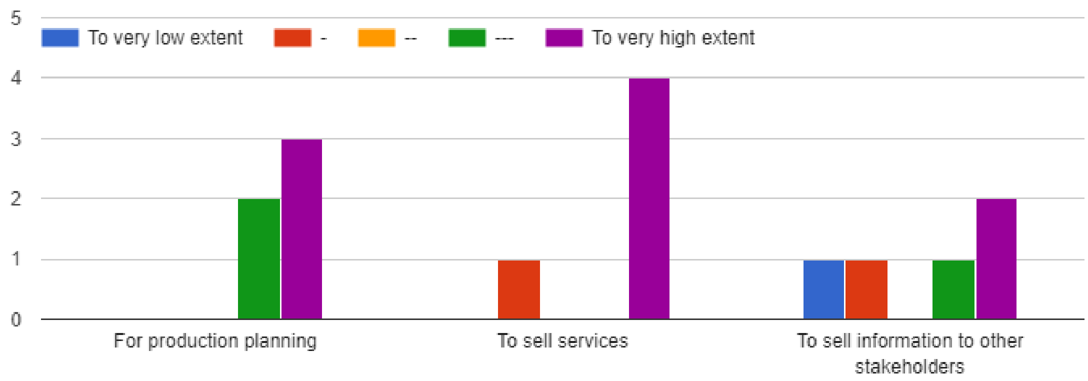


If blockchain will be used. What type is most likely?

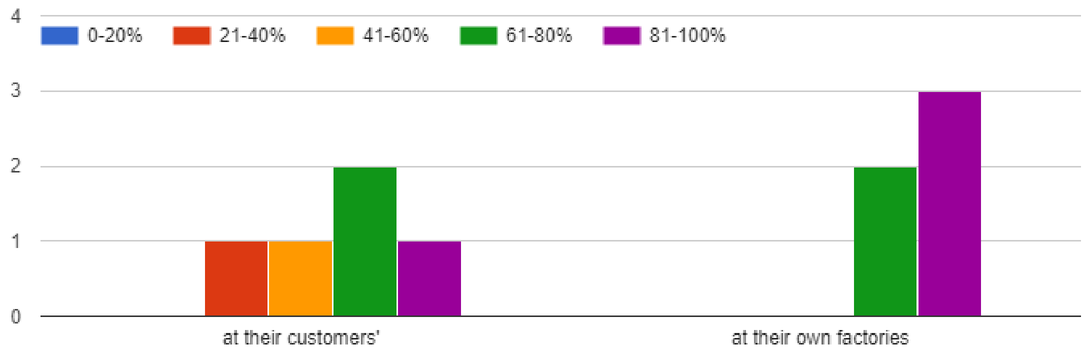
5 responses



To what extent will IoT-data be used ...

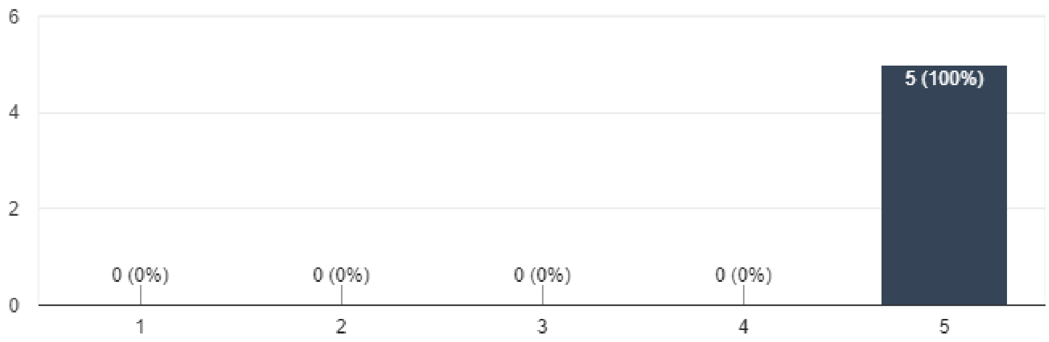


How likely is it that SKF would use 3D-printing ...?



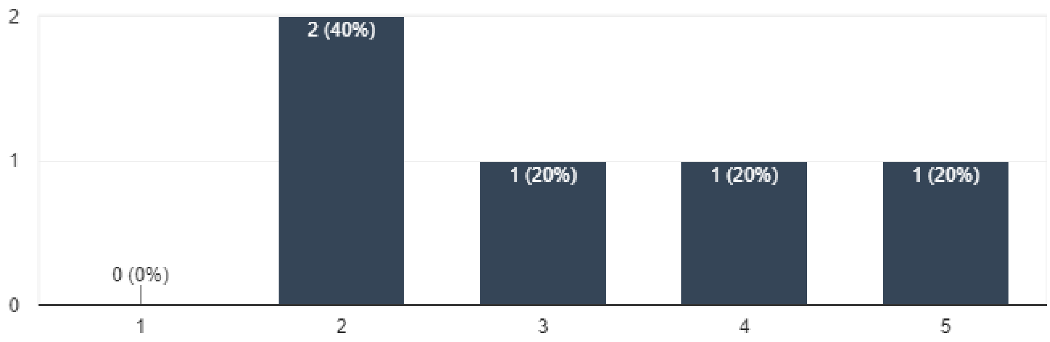
For a company like SKF, how important will partnerships with suppliers and customers be in 2025?

5 responses



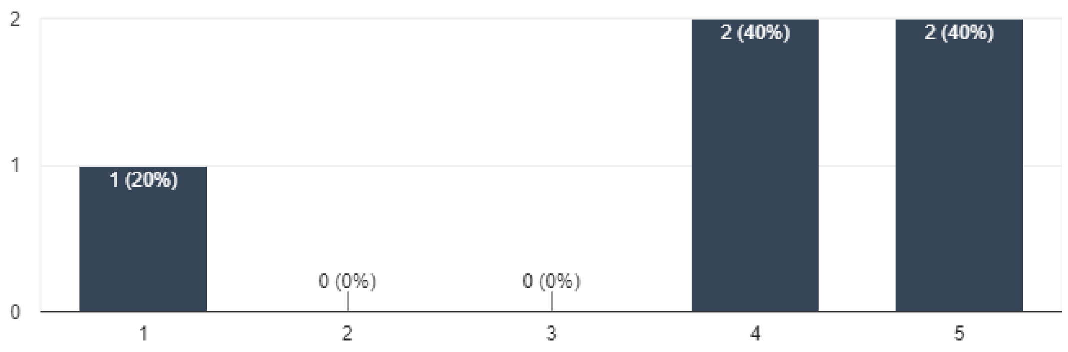
How likely is it that organisations like SKF will split up in smaller companies (business fragmentation)?

5 responses



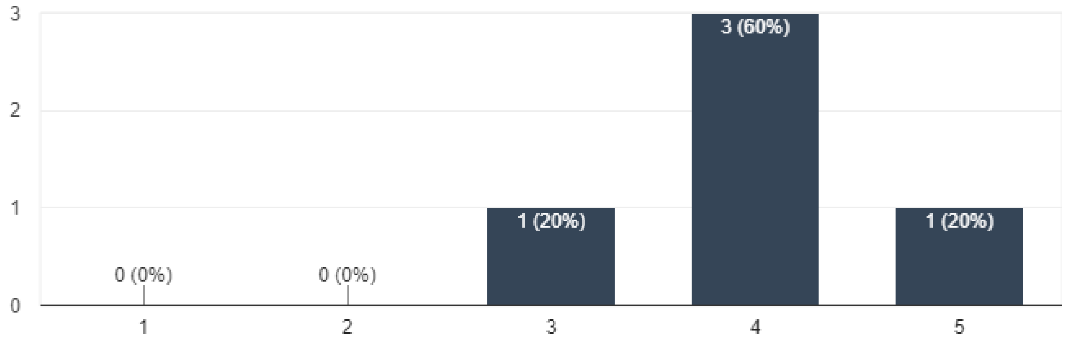
How likely is it that SKF will remain as one, but move towards a project-based organisation?

5 responses



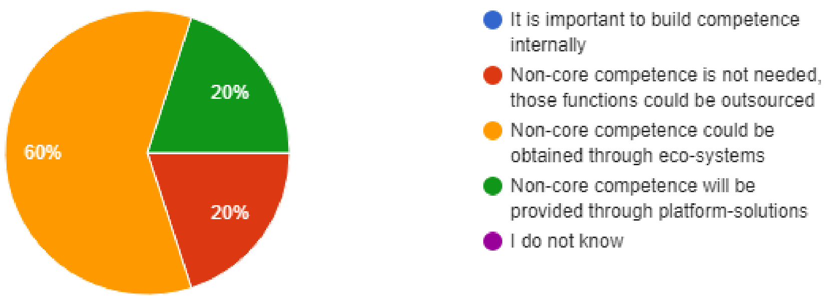
To what extent do you believe that SKF would be service/product based in their value propositions?

5 responses



In a future organisation, what scenario is most likely considering non-core competence?

5 responses



Appendix B: Results from workshop with students

What can we do with IoT-data?		How can AI change the way of working?		What are potential usage areas for blockchain?	
Real time data		Adapt individuals schedule after performance		Finance & banking	Crypto-currencies
Don't need to save data		Predict optimal purchasing	Time and quantity		Ditributed ledger
Track/prevent emissions		Adjust desk, lighting and temperature automatically			Faster transactions
Interaction between components	Optimise performance, Manage risks	The computer has started up when you arrive at work			Safer transactions
Big Data-sets		Coffee is ready when waking up			Eliminates the need for banks
Quality Check		Better decisions that are based on data	Consistent decisions		No need for banks exchanging currencies
Automatised ordering			Less errors	Purchasing	Sourcing - tracking
Status (in maintenance is required)			Objective decisions		No counterfeit
Monitor how the products are used at the customers'	Optimise Product		Save money and time		Lower threshold
Connectivity		Learn how much to transport (weight, quantity)	ICA fruit - know which fruit it is		No relations needed
Industry 4.0		Correct common mistakes e.g fel beställningar		Does not need to trust single actor because you trust the system/the chain	Ex. Uber, Bonsai
Just-in-time	Door-opening	Automatic purchasing	Reduce dependence of workforce	Marketing	"We are transparent"
Buy food		Trend spotting	Reduce speculation		Track product all the way from source
Automatise prodution lines	Machine Communication		Less individual judgement	Logistics	Communication
Send new when something happens to the first one			Set-prices		Incoterms
Transport connected to cities	Optimise Routing		Customized offerings		Ownership
Real time Mainenance decisions			Better negotiation (BATNA)		Insurance
Collect info earlier in the process	Customised Offerings	Better forecasts	Reduced stock		Laws
Discover variations in production behaviour			Increase reactivity and proactivity		Transparency
Directed marketing		Automatic customer support			Remove forwarder (hire carrier directly, not for example DHL)
		Self-driving	Running 24/7	Contracts	Validation
			"Stock along the road"		Objective
			Optimise system		Less need of contracts
		Less admin/monotone work			Insights regarding previous contracts

Appendix C: Progressive abstraction-results from workshop with students

Progressive Abstractions		
Q: Why is procurement needed?	**Q: Why is digitalisation needed?**	**Q: What are the risks with digitalisation?**
A: Reduce costs	A: Stay relevant (companies)	A: Dependence of technologi
A: Collect competence/specialise	A: Improve efficiency	A: Hacking
A: Centralise for control	A: Speed	A: Independence of human knowledge
A: We need material/raw material/services	E: Competitiveness	A: Forget how things are being done
A: Don't want to produce on our own		A: Changing the way of work - competence looses its value
E: Don't want to produce on our own	Q: Why stay competitive?	E: Knowledge
	A: The society is based on capitalism	
Q: Why not do it ourselves	A: To keep our jobs (in sweden)	Q: Why do we need knowledge?
A: We can't	A: Keep/improve wellfare	A: Solving problems
A: Others are better	E: Quality of life	A: Understanding
A: More cost effective		A: Predict and se patterns
A: Distribute risk	Q: What is quality of life?	A: Improve
E: Companies are specialised	A: Health	E: Development
	A: To eat	
Q: Why are companies specialised	A: Enjoy	Q: Why do we need development?
A: Scarce resources	A: Treat yourself	A: Not to be bored / being idle
A: Economies of Scale	A: Social coexistence	A: Increased expectations and demands
E: To be competitive	A: Acceptability	A: Reduced amount of resources
	A: Stimulance	A: Survival
Q: Why should we be competitive	E: Being well	E: Survival
A: Make money / profit		
A: To survive		Q: How to survive
A: To grow/develop		A: Trust
E: Companies need to survive and thrive		A: Community
		A: Being better than competitors
		A: Development
		E: Profit / Thrive

Appendix D: Results from workshop with SKF

	AI/RPA	Servification	Blockchain	3D-printing
Pros:	Guidance: source, contract, P2P	Machine and Maintenance	Obligation management (Cascade of certs) - Audits	Not for mass production of bearings
	Transaction efficiency	In hands of suppliers	Payments and invoice management	Fits for one peice production, customized, tools, solution factories
	Reduce human factor = standard	Changed realtionship - stronger partnerships, how far should we go?	Sanctions	Maintenance - Speed
	Reduce manual tasks - increase "strategy" task and increase servitization	Today mostly IT - IBM, SAP and MS	Customs clearence and data recovery	Limitations with raw material
	Data quality improve	Competition - who will own the service network		Less work for purchasing, to buy spare parts
Cons:	Error handling/reporting	Possibility to additional services		TCO?
	Security - cloud vs. on premise, hacks			CAD producer vs. manufacturer (Make or Buy)
	Legal requirements			
	Long time until everyone are at the same level			
	Dependence (knowledge)			
	Flexibility - market trends, technology			
	Too late adopter - Monday example			
Is there a too far?				