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1 Abstract

Dette speciale beskriver hvordan virksomheder bedre kan udnytte digital teknologi til at forbedre interne såvel som eksterne processer. Specialet udformer sig som et komplet strategisk overblik over hvilke forberedelser virksomheder skal have og foretage inden implementering for at være bedst mulig rustet til de implikationer der medfølger. Specialet bevæger sig dernæst over i hvilke muligheder af digital teknologi der er tilgængelig i verden. Derudover vil det strategiske overblik samtidig vise hvor de udvalgte digitale teknologier kan implementeres i virksomheders S&OP afdelinger og hvilke konsekvenser det vil have.

Specialet udfolder sig ved en introduktion til projektet samt emnet. I introduktionen vil undersøgelser fremvises samt resultatet af disse undersøgelser. Dette bliver opfulgt af en dybdegående gennemgang af hvordan litteratur-materialet er fundet, som bruges til at undersøge teorien samt senere til besvarelse af problemstillingen i analysen. Hele specialet kan kategoriseres som et 3-delt projekt. Specialet kommer til at have en problemstilling samt 3 'research questions' som bliver besvaret i løbet af specialet. Disse 3 spørgsmål vil indeholde besvarelser på hvad der kræves af virksomheder før implantation, under implantation og efter implantation af digitale teknologier.

For at gøre specialet mest muligt relevant, så vil der blive benyttet 3 'case Companies'. En ansat i den respektive S&OP afdeling i virksomheden vil blive interviewet og deres virksomhed vil blive brugt som praktisk eksempel for implantation af teorien.

2 Preface

The fourth semester at Aalborg University in Copenhagen is the master's thesis. Here the student must implement all knowledge taught and mastered through the master's study. This master's thesis is divided into six major chapters.

The first chapter of the thesis is the introduction. This chapter suits to illustrate the different assumptions and pre-analysis made prior and during this thesis. This chapter will culminate into a problem statement and research questions to be answered. The second chapter of the thesis includes the literature review of the chosen materials to answer these research questions. The chapter also acts as a framework guidance of how the data and materials were captured and filtered.

The third chapter of the thesis serves as the methodology section. Again, this chapter is a guidance framework of how the methodology of the thesis were formed and provides an overview of the strategy and structure-decisions made in the thesis. The fourth chapter is the theoretical framework. This chapter provides the necessary theory to answer the research questions and are based on the literature findings in the second chapter, literature review.

The fifth chapter is called the Analysis and serves as where the theoretical frameworks of the thesis are applied to the case companies. This includes the frameworks before implementation as well as the chosen digital technologies. The sixth and final major chapter is the discussion section. Here the chosen digital technologies and frameworks as well as the implications and disadvantages are discussed and analyzed. A broader perspective and future predictions will also be presented here to add further relevance to the thesis.

2.1 Acknowledgements

Firstly, I would like to sincerely thank my supervisor Peder Søberg, for helpful assistance and guidance in the beginning with development of the thesis through tips and helpful advises. Thomas Skov Hansen from Hempel, Christian Barbosa-Hartel from Maersk Drilling and Russell Barton from Smith-Nephew also deserves great appreciation for their participation and interviews. Their honesty and contributions raised the validity and reliability of the thesis tremendous.

2.2 Reader's Guide

American English is the language which is preferred in the thesis. For reliability and validity purposes, references to text will be presented throughout the thesis. These references will be illustrated as (Surname, Year) and to check the chosen reference, see chapter 11 named 'Bibliography' for more detailed information of the reference used. In this chapter the publisher's name, title of paper, link, institution etc. can be found.

For ease of navigation and use of the thesis all figures will be presented as figures, regardless of it being a picture, graph, diagram, table etc. The figures will be presented by numbers and are listed in chronological order which means first figure as labeled 1, second is 2 and so on. Quotations by references or statements from interviews is illustrated with cursive text for highlight.

2.3 Limitations and delimitations

In order to provide the best strategy framework for application of digital technologies in S&OP, certain precautions and limitations had to be made. Firstly, the focus of the thesis has been narrowed down to Sales and Operations Planning rather than the whole Supply Chain. This means that strategy frameworks for applications in inventory, procurement, finance, manufacturing plants and marketing will not be in focus and will be minimal featured in this thesis. Furthermore, due to this being a university thesis, there's a page limitation set by Aalborg University. The page limitation is set to 75 pages. This type of constraint means that not all topics and chapters will be equally weighted in terms of text and pages. It has been chosen to shorten the literature review, introduction and methodology chapter to increase to number of pages for the theoretical framework, analysis and discussion chapters.

Another limitation is the lack of quantitative data presented in the thesis. This is due to lack of collaboration with a company. Since it's impossible to extract sensitive data through public channels, there's only qualitative data presented in this thesis.

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3 Introduction

Digitalization. There is no more rapidly spread word within supply chain management these days. The fourth industrial revolution is well underway, and companies are eager to grasp this opportunity and out beat competition and increase market share. The digital era is also contributing to a much faster pace of the markets and organizations are forced to re-evaluate and change their internal and external processes on a regular basis to stay competitive. Since the global markets are constantly changing and rapidly varying in its tendencies, the forecasting and sales of demand and supply are more difficult to predict, and the fluctuations are becoming more unpredictable because of digitalization (McKinsey and Co., 2016).

To minimize these unpredictable demands, reduce errors and increase the performance and delivery of the organization, the company seeks to apply digital models to transform their internal value chains for optimal processes. Buzzwords like Internet of Things, Artificial Intelligence and Machine Learning has been around for decades while new technologies as Blockchain and Cloud Computing are emerging. Despite the facts that these technologies have been available to some extent since the 1960's, organizations are still struggling to implement these digital models and fully explore the potential of the technologies.

The main issue is the lack of information regarding strategies of how to implement these technologies and how the organizations should prepare themselves for this. This paper takes point of departure in global organizations as Hempel, Maersk Drilling and Smith-Nephew to investigate how these firms could apply digital technologies, what would be required and what the implications could be. The thesis furthermore dives into the heart of every supply chain, which is the S&OP department, where many tasks still are performed manually leading to monthly repetition of the same errors.

The purpose of the thesis is thereby to present a complete strategy framework of how to prepare for appliance of digital models, what models to choose and how to handle the implications.

3.1 Background Analysis

The purpose of this first chapter is to illustrate issues and difficulties within the topic of the thesis. This background analysis serves as focus point to ensure that the thesis emphasizes the most relevant and important angles of the overall subject. Through this chapter, 3 interviews with 3 different companies will illustrate inadequacies and obstacles which will determine the guidance and theory of the thesis. This chapter furthermore serves as pre-analysis for the conduction of the problem statement and research questions.

The chapter structure is presented by firstly 3 interviews with respectively Thomas Skov Hansen from Hempel, Christian Hartel-Barbosa from Maersk Drilling and Russell Barton from Smith-Nephew. These participants all hold similar positions within S&OP but in very different environments and industries which will illustrate the different kinds of struggles each industry have in applying digital models in their S&OP. The purpose of the interviews is to illustrate their S&OP setups in each of the companies to better understand where the potential obstacles lays and how to apply the digital models.

The participants of the interviews are as follow:

- Thomas Skov Hansen, Project Manager S&OP, Hempel
- Christian Hartel-Barbosa, Supply Chain Project Manager, Maersk Drilling
- Russell Barton, Supply Chain Director UK & Nordics, Smith-Nephew

The agenda of the interviews are the complete same for each of the 3 interviews. This is to observe if the participants present similarity in their answers. The interviews start off with an introduction to their position within the company and how they operate on a monthly basis and how their S&OP department is set up from end-to-end which means from point of sale to the delivery of products to customers.

Thereby the interviews focused on the cross-functional collaboration in the S&OP departments. This including how the sale collaborated with demand planner, how demand planners collaborated with operations etc. Furthermore, this included how their monthly S&OP meetings were conducted and what were discussed and what actions were taking on these meetings.

Thirdly, the participants were presented with a maturity model framework which they were to point out, within the categories in the matrix, where they saw the company from a scale 1-5. By the conduction of the maturity model, the participants were thereby asked to elaborate on the model and what issues and lacks the department has. This including where they saw the use of artificial intelligence, machine learning, Blockchain, internet of things etc. could be beneficial.

An important task when conducting interviews and trying to formulate a problem statement and research questions is not narrowing the topic down too soon. Not all material the interviews conducted will be used in the background analysis, as this is not relevant at this point. The S&OP setup and the answering of the Maturity Model will therefore not be used until the analysis chapter. The content of the interviews which will be used in the background analysis will therefore be the part where the participants expressed the issues, obstacles and lacks in the departments regarding digital technology.

3.1.1 Hempel

The interview with Thomas Skov Hansen presented a well-established organization with thorough documentation for every process and standard procedures for most tasks. The cross-functional collaboration is present and carried out in the daily obstacles and deadlines, this includes both sales, demand and supply planning as well as the production and warehouse management. The S&OP meetings are held monthly and greatly presented by participants of multiple functions in the S&OP department.

Still, there's multiple issues which are pointed out during the interview. The first one is regarding the sales team. Hempel operates with a project file, updated monthly, containing all the current project they have on tenders. This file is then sent to the demand planners, so the raw materials can be forecasted in case of a tender-win. The problem in this process lays in the calculation of the percentage of likeliness of a tender win.

"As of nature, salespeople are very optimistic in their abilities and sales skills. Naturally they'll make a percentage of winning the case which is to some degree much higher than the actual expectations. This is of cause because of their bonus programs and the way their job is. Nonetheless, the calculation of the percentage is done completely manually and with no statistical data or historical data to support the decision. We're constantly making minor and in rare cases major mistake due to this. We need to bring in more data analysis"

Thomas Skov Hansen is therefore seeking a software tool which could help them determine what percentage the project should have, to minimize the monthly errors and thereby not overstocking or understocking the warehouse.

Another issue is in the demand planning function. Since Hempel is a large global company, it obviously also offers plenty of product varieties to satisfy the customer demands. This large product portfolio makes it harder to forecast correctly and since the products can possess abilities of being seasonal, non-seasonal, infrequent, in-phasing and out-phasing, the forecasting needs to be done manually currently.

Hempel uses SAP APO system for their forecasting. This is a sophisticated demand planning system, but the demand planners of Hempel still need to monthly go through each product to secure that the indicators still are correct, or the parameters are not too high or low.

"This is an extreme time-consuming task which takes us almost a week of work to complete. I would be so much nicer is the computer system could perform like 80% of the easiest tasks, and then we could focus on the last 20% which involved the most critical customers or most revenue or whatever. If a computer could make the same assumptions and decisions as we do, then there would be no point in us doing them"

This statement could indicate that Hempel potentially could benefit from appliance of digital models to automate decision making. Generally, Hempel is very up to date with technology advancement and their S&OP department do consist of functionally ERP systems and they have a cloud in the network system to store important excel sheets, documentation and other relevant data.

Even though, Thomas Skov Hansen thinks that his department could benefit from more technological advancement, he states that this is not a priority now.

"We're not focusing on these issues at the moment to be honest. One thing is that the project priorities are spend on distribution problems at the moment. We're doing a lot of firefighting now because of a difficult market with fears competitors. Another thing is that there no know-how of what technologies which is available today and if there are some easy fixes to make regarding this."

The last statement greatly sums up difficulties which many companies experience. The lack of information. It's impossible to launch a project if there's no knowledge of the models available, the time horizon and price tag.

3.1.2 Maersk Drilling

The second interview was with Christian Hartel-Barbosa from Maersk Drilling, which is a division of Maersk A/S. This interview illustrated to some degree similar difficulties and some new obstacles due to Maersk Drilling being a completely different product provider than Hempel. Maersk Drilling mainly focuses on service and the supply chain of spare parts to the rigs. When dealing with service, one of the busiest departments is the procurement. Documentation of the products, of the bills etc.

"There's documentation for everything you possibly could imaging. Documentation for the bill, documentation for the delivery, for the items, for the hours spend, you name it. These procurement documents are handled manually and can be extremely time consuming. Besides the time spend, many errors occur almost daily. We've been interested in the Blockchain technology, not honestly, we've not come as far as for example Maersk and IBM's project. We just don't have the resources or capacity at the moment."

Clearly Christian sees a major problem in the procurement department and spots the potential of digital technology to reduce personal errors and time resources. The wishes of reducing the manually tasks correlate with the wishes for the Hempel interview with Thomas Skov. Similar to the first interview, they're indicating that there's too many personal errors which are inevitable with the detailed jobs, but automating is wanted.

He also states that Blockchain technology could be the solution but unfortunately the time and resources are not available at the moment to pursue this.

Another topic was the forecasting of the spare parts. Again, similar issues as Hempel, the forecasting is a very manually task and many errors happen. Christian states that Maersk is currently working on improving their sensors on the machines so the need for spare parts will be easier to detect in advance.

"The problem truly is with the critical spare parts which gets broken infrequently and our demand planners had no chance of predicting when this is going to happen. Our ERP system currently helps our demand planner with historical data, but it's nowhere near enough, and I feel like we aren't getting the best results out of all the data and history we have available."

3.1.3 Smith-Nephew

The last interview was with Russell Barton, which is Supply Chain Director for the Nordics and UK. The Nordics are, according to Russell, facing some difficult challenges in which digital technology potentially could be a fit solution. The Nordic countries are struggling with the forecasting and their overall accuracy is lower than the rest of Europe's divisions. This is mainly due to the business they're in and the low volume in Scandinavia. Russel elaborates:

"Our Nordic countries are suffering low forecast accuracies. And the sales data depends on surgeries and hospitals, so with low volume additionally, it's hard to predict the future hence the low accuracy. This amounts in back-order issues and high inventory"

The business of Smith-Nephew is extremely tender based and especially in the Nordic countries, which means that often will the forecast needs to be made even before the client is won. And even if won, the hospital chooses 3 different suppliers for safety reasons, so even then, it's hard to predict how many products the hospitals will need, says Russell.

Then the talks fall in digital technology, Russell admits that the company might have fallen behind during the last decade and their competitors could be ahead technology wise which could potentially mean decrease in market share.

"We are definitely not as far as we want to be regarding technology investments. I know there's plenty of talk of this in top management, but we haven't seen any major changes during the last couple of years"

Russell explains that another big topic is the sharing of information and data transparency throughout the European countries. He wishes to learn more of the best-practises which are performed in high-performing countries like Germany, France and Spain. Each country is working independently and have limited of cross-functional collaboration. Smith-Nephew has a global distribution centre in Baar, Switzerland which are working in aligning the countries and creating this transparency. Yet, the current model is information is sent to Baar and from there transmitted to the rest of the countries. This means that there's still no transparency and the countries are only seeing what Baar is sending.

When asked which specific digital technologies he wanted and what their function in his supply chain should be, he answered:

"I want the decision-making to be primarily from data-driven decisions. Artificial Intelligence and Machine Learning should be able to predict the hardest parts for us as well as suggests decisions which we can acts upon. Furthermore, we need to have a sophisticated could system set up. Both within the Nordic countries of Sweden, Norway, Denmark and Finland, but also at a global scale. Maps and folders in clouds with data to extract and editing."

From these statements, Russell is looking for possibilities within digital technologies as machine learning and cloud computing, which are the globally preferred digital technology for decision-makings and online global storage of data. Lastly, the question from the interviewee was on why there hasn't been any initiatives and projects on this prior? He states that it's easy to focus on this on a theoretical basis, but actually proceed with the idea is difficult. He elaborates with the difficulties of finding a suitable strategy for how to properly implement these technologies.

He states that he has been in contact with multiple consultant firms, but the price tags and the facts that these firms always are looking for applying their best solutions and not the one that's most fitting for the customers.

Many similarities to this interview and the interviews of Hempel and Maersk Drilling. Lack of knowledge and strategy on the topics.

3.2 Survey Analysis

The survey analysis section of the introduction chapter serves to illustrate statements on a global scale. Furthermore, the surveys serve as support to the statements made in the interviews by the three participants. The surveys are presented as second-hand experience. Due to the size of the publisher, the surveys are able to target a much larger audience and can thereby provide a much broader and general interpretation of how the world views digital technologies in S&OP.

The first set of survey analysis is titled “How Big Data and AI are Accelerating Business Transformation” created by New Vantage Partners in 2019. The survey was conducted in collaboration with nearly 65 firms. The survey stated that 91.6% of the asked companies are accelerating in investment in artificial intelligence and big data while only 8.4% are not currently. Furthermore, 87.8% of the asked firms sees the investments as an urgency and 75% supports this state due to fear of disruption in their industry. (NewVantage, 2019).

The 65 firms were then asked which technologies the companies were prioritizing first. 96.4% were investing in artificial intelligence and machine learning, 90.5% invests in Cloud Computing. These were the most popular digital technologies to focus on in 2019. On emerging technologies, blockchain had the focus from 41.7% of the firms. (NewVantage, 2019).

While the investments and focus on digital technologies has been increasing from the same survey in 2017 and 2018, the results of the investments have decreased in 2019, meaning that the 65 firms are getting poorer results from their investments. In 2018, 73.2% of the asked firms said that they were getting measurable results from their investments in Big Data and Artificial Intelligence. That percentage fell to only 62.2% in 2019, meaning that nearly half of the firms are not implementing the digital technologies correctly. (NewVantage, 2019).

These facts are furthermore supported by the percentage of companies finding business adoption of Big Data and Artificial Intelligence a challenge. Here, 77.1% of the asked firms are finding it a challenge to adopt digital technologies in their departments. When asked the reasoning of these challenges, the asked firms pointed 40.3% at lack of organizational alignment, 23.6% cultural resistance, 13.9% understanding data as an asset, 7% executive leadership and 5% technology solutions. (NewVantage, 2019).

These survey results clearly paint a picture that the technology is available, but internal difficulties and human factors are hindering the implementation of digital technologies. This is supported later on in the survey when asked which principles are challenging the firms in becoming data driven. 62.2% said people, 30% said processes and only 7.5% said technology.

Another big survey was conducted from 1. September 2017 – 24. October 2017 and published in the business magazine "The Journal of Business Forecasting" in June 2018. The survey was created by the e-commerce site IBF (Institute of Business Forecasting) which is an online site mainly focusing on forecasting and demand planning in S&OP.

The survey only consisted of one question, but the survey consisted of over 200 professional respondents. The question was "*What are the top technology advancements in the next 7 years that will have the largest impact on forecasting and demand planning?"* The results were as follow in figure 1: (IBF, 2017).

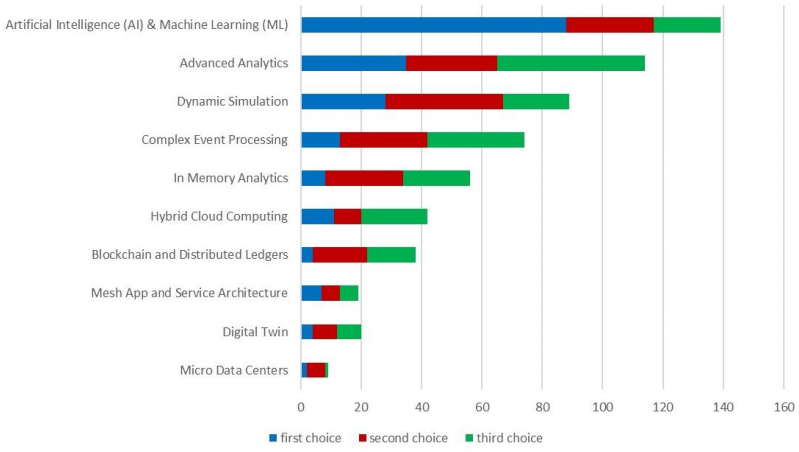

Figure 1 - IBF Survey

The survey clearly illustrates that the artificial intelligence and machine learning are the preferred technology to invest in and is what the global audience of IBF sees as the biggest impact on forecasting and demand planning in 2015. This supports the first survey greatly as artificial intelligence and machine learning being the most important technology to invest in 2019.

The last survey was also at a global scale and counted for over 3000 participants divided in 8 different countries. The survey is created by Kronos Incorporated in The Workforce Institute. The survey illustrates a high rate of the participants believes that working with Artificial Intelligence could improve their everyday-situation and job tasks, yet reasons like lack of transparency, fear and concern are hindering the implementation process.

More than 4 out of 5 (82%) believes that Artificial Intelligence and digital technologies can improve their everyday and this correlates with the previous surveys and interviews. Nearly 1 out of 3 employees (34%) which were participating in the survey are simultaneously fearing that Artificial Intelligence could potentially replace them and their job. Joyce Maroney, executive director at The Workforce Institute at Kronos elaborates to this survey: (Kronos Incorporated, 2018).

"Organizations are making significant investments in benefits, technology, and innovative workplaces, yet employees are working more than ever, and engagement has remained stagnant for decades. While emerging technologies always generate uncertainty, this survey shows employees worldwide share a cautious optimism that artificial intelligence is a promising tool that could pave the way for a game-changing employee experience if it is used to add fairness and eliminate low-value workplace processes and tasks, allowing employees to focus on the parts of their roles that really matter." (Kronos Incorporated, 2018).

As Joyce Maroney states, there's no denying that people in general see digital technologies as the future, but in order to implement this properly and secure maximum efficiency of the invested capital, middle and top management have a tremendous job in explaining and elaborating the technology and the strategy behind it in order to get the lower staff on board.

3.3 Scope of the Thesis

Through the interviews and the surveys, the thesis needs to be narrowed down and scoped for further investigation. Through these interviews it's clear that though artificial intelligence and digital technology have come a long way, there's still many areas of inefficiency and manual errors. The organizations within Hempel, Maersk Drilling and Smith-Nephew still needs more information and guidance to the endless of possibilities digital technology can provide to their organizations. The interviews painted a picture of repeated monthly errors costing both time and resources.

The surveys confirmed and elaborated on the interviews from Hempel, Maersk Drilling and Smith-Nephew. The different surveys illustrated an increasing interest in digital technology and especially artificial intelligence and machine learning, yet at the same time illustrated lack of knowledge on the areas and a general fear of the impacts and consequences of the technology. The survey indicated that almost 70% of the asked participant do not think that their department is even ready for advanced technology investments, mainly due to poor current data collection, lack of collaboration and lack of transparency within the organizations. The scope of the thesis will thereby be an investigation of what is takes to implement advanced digital technology properly and the guidance of how to do it. The thesis will serve as a strategy framework for the organizations consisting of pre-requisites before implementation, current available technology, and their attributes and how they can make the organizations more efficient and the human aspect of the investments and how to manage change.

4 Problem Statement

Internal issues, lack of information and knowledge and missing strategy frameworks are hindering the global companies in fully achieving the benefits of digital technology.

4.1 Research Questions

1. What pre-requisites needs to be addressed before applying digital technology?
2. What digital technology is currently available and what are their attributes?
3. How can the digital technology models improve the current setup in the chosen organizations and what are the possible implications?

5 Literature Review

The chapter of literature review serves the purpose of presenting the processes and procedures which was conducted during the writing of the master thesis. The purpose for exposing the processes and procedures is the obtain reliability and credibility of the articles, books and other references which are used to answer the problem statement and research questions. The literature review must furthermore establish a connection with the theoretical framework of the thesis in terms of why-and how they obtained knowledge are gained and illustrated.

The chapter of literature review serves as a stepped guide of the processes and procedures to enhance the conduction of the thesis. As mentioned above, the chapter will provide linkage and connection to the rest of the chapter throughout the thesis.

The processes and procedures of the literature review is developed by the author himself along with his former study group in the second semester project. The literature review setup development was deemed very successful with high quality of assessment of articles and great credibility and reliability. The setup of literature review has therefore been chosen again for this thesis.

5.1 Literature Review Procedure

To ensure that the literature review of the chosen literature is as credible and reliable as possible, it's important to conduct a structured and efficient research process in order to capture the most relevant literature. (Webster and Watson, 2002). Below the structured strategy for collecting relevant literature material is displayed:

Figure 2 - Literature Review Strategy

The figure illustrates the strategy for this thesis and the literature review. The strategy consists of defining the topics, searching for literature materials through search strings, assess the chosen material through headline assessment, assess the material through the abstract and finally read the full chosen material for complete assessment. It is utterly important that all steps are completed and in the chronological order which is presented above. (Wong *et al*, 2011)

A more complete strategy and search process will give more precise and better search results and thereby better literature materials and finally more and better understanding of the topic. The research strategy takes point of departure in a research-strategy-approach based by *Wong et al* (2011) in the figure below.

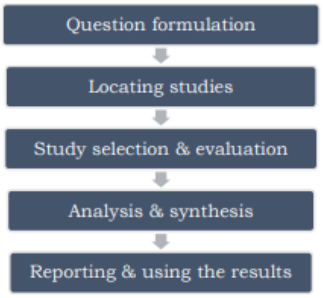

Figure 3 - Research Strategy Approach

The recommendation of the approach of the research by *Wong et al* (2011) can be seen in the figure above. The point is that to overcome the weaknesses and subjectivity in a literature review there must be adopted a systematic and evidence informed approach. This statement and the strategy approach from Wong validate the literature review strategy in figure 3 which is used for this thesis. The detailed description of the systematic literature review approach by Wong et al is as follow:

Question formulation:

This first section is regarding the questions related to the thesis. In this case, this will be the problem statement and research questions. Providing clear and well-established questions will help improve the quality of the literature review. (*Wong et al.*, 2011)

Locating studies:

The first two steps of 'defining the topics' and 'search strings' will be the procedures in locating the relevant studies (figure 3). Beforehand of the literature review the main topics of the thesis are chosen and the problem statement and research questions are therefore based on these pre-chosen topics. The first step of defining the topics is thereby to narrow down the main topics to a more specific definition. The next step is the development and conduction of the search strings. (*Wong et al.*, 2011)

Study selection and evaluation:

The last 3 steps of the strategy approach are step 3, 4 and 5. These steps are similar in procedure and process but contains different aspects and details (Appendix). The different levels of details determine the relevance of the selected studies and their relevance to the main topic and the research questions. Step 3 is the headline assessment and are the minimum of assessment level. Step 4 is the abstract assessment and holds a medium of assessment level and step 5 is the full-read assessment which is the most detailed level of assessment. (*Wong et al.*, 2011)

The reasoning for these 3 steps is to have some time- and resource management of the thesis in order to complete the thesis on deadline. The strategy is narrowing down the literature materials down to only the most relevant ones and thereby the literature giving the most efficiency and productivity to the thesis. (*Wong et al.*, 2011)

Analysis and synthesis:

The section of analysis and synthesis is to comprehend and be analytical with the selected literature material. The materials which are deemed most relevant by the strategy approach is analyzed and compared on a cross-reference with similar materials of same topics.

This procedure is to ensure the most suitable to relevant theoretical framework for the thesis. The analysis and synthesis are being used in chapter 8 called 'Analysis'. (*Wong et al.*, 2011)

Reporting and using the results:

The last section is used for the last parts of the thesis, which is the analysis and discussion chapters (chapter 8 and 9). The purpose of the section is to make use of the theoretical framework and the results founded in the literature review in order to answer the problem statement and research questions.

The figure presents an overview of the processes which are executed throughout the literature review. It is based on the strategy approach illustrated in figure 3 and therefore consists of 5 steps from 1-5. The figure can be viewed in appendix 1. (*Wong et al.*, 2011)

5.1.1 Literature Review Steps

The section seeks to explore in depth each of the 5 steps presented in the figure. This includes an elaboration of how the step was conducted, what it included and what the results from the step was.

First step – Main Topics

As of the latest chapter, Introduction, the problem statement and research questions were formed. These research questions provided foundation for the choosing of the main topics for the thesis and the literature materials. To provide the most credibility and reliability for the thesis, 3 main topics are chosen. The reasoning for multiple topics instead of one, is the diversity and opportunities that multiple topics provide. The 3 main topics which is chosen are the following:

- Digital technologies
- S&OP
- Strategy

These topics are chosen due to the problem statement in lack of knowledge in digital technologies and the implementation possibilities. S&OP are chosen to narrow down the thesis, making it more relevant and in depth. Lastly, the thesis will function as a guidance and framework for implementation of digital technologies and should thereby include strategies.

Second step – Search Strings

Within these 3 main topics which are advertised above, several search strings will be developed to capture the most relevant articles and literature but also to capture as many aspects of the topics as possible. Buzzwords often have multiple terms, for example digital technology can be referred as digitalization, digital models or emerging technology. Therefore, it's important to provide multiple search strings within each main topic to ensure complete capture of these terms.

The search strings will be evaluated based on their hits ratio and how they represent the main topic and their relevance. It's decided that each of the 3 main topics holds equal weight in the importance of the thesis. This means that each main topic will have the same amount of search strings attached.

The search strings will consist of 5 strings each bringing the total search strings to 15 searches. The building of the search strings is by the term of Boolean, meaning that the worlds in the search engine are with * endings and "" phrasings.

Main Topic	Search Strings	Database	Number of Hits
Digital Technologies	Digital Technology OR Digital Models	EBSCOHost	45878
Digital Technologies	Digital Technology OR Digital Models AND "Industry 4.0"	EBSCOHost	1789
Digital Technologies	Digital Technology OR Digital Models AND "Forecast" OR "Demand Planning"	EBSCOHost	699
Digital Technologies	Digital Technology OR Digital Models AND "Artificial Intelligence"	EBSCOHost	2256
Digital Technologies	Digital Technology OR Digital Models AND "S&OP" OR "Sales and Operations Planning"	EBSCOHost	233
S&OP	"S&OP" OR "Sales and Operations Planning"	EBSCOHost	1478
S&OP	"S&OP" OR "Sales and Operations Planning" AND "Organizations" OR "Organisations"	ProQuest	298
S&OP	"S&OP" OR "Sales and Operations Planning" AND "Forecast" OR "Demand Planning"	EBSCOHost	145
S&OP	"S&OP" OR "Sales and Operations Planning" AND "Artificial Intelligence" OR "Machine Learning"	EBSCOHost	56
S&OP	"S&OP" OR "Sales and Operations Planning" AND "Industry 4.0"	EBSCOHost	98
Strategy	"Strategy" AND "Organization" OR "Organisation"	EBSCOHost	60874
Strategy	"Strategy" AND "Industry 4.0" OR "Digital Technology"	EBSCOHost	4569
Strategy	"Strategy" AND "Artificial Intelligence" OR "Machine Learning"	EBSCOHost	897
Strategy	"Strategy" AND "Supply Chain"	ProQuest	148555
Strategy	"Strategy" AND "Forecast" OR "Demand Planning"	EBSCOHost	7896

Figure 4 - Search Strings Results

Third step – Headline Assessment

This is the step where the narrowing of the literature materials begins. A mentioned earlier in this chapter, this is the lightest of assessments and only consist of reading the headline of the article etc. and by the title of the paper conclude whether this literature is fit to be included in the thesis. The conclusion of relevance is based on the relevance towards the main topic and thereby the research questions.

The total number of article and papers founded by the search-engine EBSCOHost and ProQuest was 275,721 hits. Due to time-constrains and limited number of thesis participants, there formed some limitations to the literature review. Only the first 100 articles of each main topic are addressed meaning that only 300 of the possible 275,721 literature will be reviewed. It has been deemed that 100 articles and papers from each topic is enough for the thesis to sustain credible and reliable in terms of search results.

The results for the headline assessment are thereby 69 for Digital Technologies, 41 for S&OP and 78 for Strategy.

Forth step – Abstract Assessment

As mentioned before, step 3, 4 and 5 are very similar in process. The difference in this step is that the headline is not being assessment, but the abstract. The results for this step of the literature review steps are 34 for Digital Technologies, 18 for S&OP and 19 for Strategy.

Fifth step – Full-read Assessment

This is the most intensive assessment and requires a full-read of the chosen article or paper. The literature which have been narrowing down to this step are deemed suitable by the assessment of the headlines and by abstract. The process here is similar to the two previous steps, but somehow different. The purpose is still to assess the materials and decide their relevance to the thesis.

To further improve the credibility and reliability for this specific process, each article or paper will be categorized on a scale from 1 to 5 based on their relevance to the research questions and the likeliness of it being productive in terms of answering them. The figure 5 below presents the matrix which consist of each of the 15 search strings and their remaining articles and their score.

String	1	2	3	4	5
1	4	1	2		
2	3	1	4	4	2
3	2	2	2	3	
4	3	5	1	4	
5	1	2	2	3	
6	2	1	1		
7	1	3	5	4	3
8	4	1	1	4	
9	1	3	1	3	
10	1	5	2		
11	1	3	3	2	
12	4	1	3	5	1
13	3	3	4		
14	1	2	5	3	
15	4	3			

String	1	2	3	4	5
1	4	1	2		
2	3	1	4	4	2
3	2	2	2	3	
4	3	5	1	4	
5	1	2	2	3	
6	2	1	1		
7	1	3	5	4	3
8	4	1	1	4	
9	1	3	1	3	
10	1	5	2		
11	1	3	3	2	
12	4	1	3	5	1
13	3	3	4		
14	1	2	5	3	
15	4	3			

Figure 5 - Score Matrix of Search Strings

The articles and papers which scores 4 or higher on the score are being classified as suitable material and qualifies for usage in terms of answering the research questions. The articles and papers determined valid for further use are

16. This is the final number of literature material chosen and duplicates crossing two main topics have been removed.

6 Theoretical Framework

The newly founded literature in the last chapter 5, literature review can now be used to establish the theoretical framework. This framework serves the analysis and discussion chapters of the thesis. The purpose is to make use of the literature to found theoretical frameworks which can be used to answer the research questions.

Firstly, the chapter provides theory on S&OP in general. This includes both the functions involved as well as the monthly, quarterly and yearly processes of S&OP. Thereby, different types of digital technology will be presented including: Blockchain Technology, Artificial Intelligence, Machine Learning and Could Computing.

Lastly, the chapter presents pre-requisites necessary when implementing the above-mentioned digital technology. The pre-requisites consist of a maturity model, a TOE framework and change management. The sequence of the usage of the theoretical framework will be as presented:

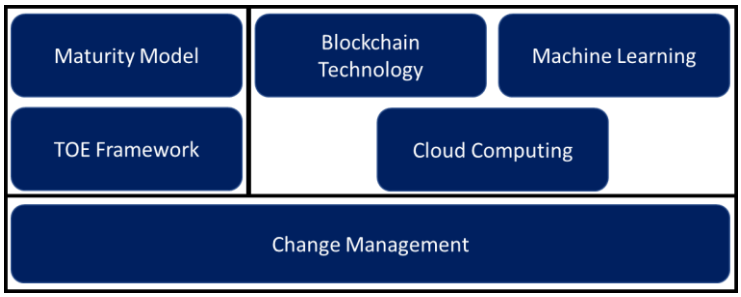

Figure 6 - Strategy Framework

As the figure illustrates, the strategy of the theoretical framework will be usage of the maturity model and TOE framework before appliance of the digital technology. Thereby, the appliance of one or multiple of the digital technologies are applied and simultaneously both before, during and after the implementation, is the change management.

6.1 S&OP

The shortage of S&OP arrives from the term Sales and Operations Planning. The term covers a part of each company and involves multiple function and departments working collaborative together to achieve low inventory, higher sales, great forecast accuracy, and high service level and thereby customer satisfaction. Hence, to achieve a well functioned S&OP department, there must be a well-balance between the supply and inventory of the products and the demands and delivery to the customers. (Chopra and Meindl, 2016).

To be successful in S&OP there needs to be a business plan of the demand and supply of the products which correlates in details and aggregated levels to the certain company. This business plan also needs to be aligned with the overall business strategy of the top management. All functions in an S&OP department are affecting each other. A collaborative marketing division which shares information regular will drive up the forecast accuracy with the demand planners which will provide low inventory and correct safety stocks. This is preventing supply shortage and thereby drive up the service level which will increase the sales numbers. The S&OP department is thereby categorized as a monthly circle with every function affecting each other. (Chopra and Meindl, 2016).

The team members working at a cross-functional level is typically middle management and ranges from demand planners, analyst, sales managers, marketing and operations managers. All these managers can have different agendas and thereby different view on the most optimal S&OP process due to environments, cultures etc.

The sales team are the closest employees to the customers and are mostly in direct contact with them. Sales teams often also have a bonus segment to their contract regarding how many products are sold or how many new customers is acquired. The motivation of the sales managers, regarding the S&OP process, can thereby be influenced by the culture of sales divisions. Sales manager will preferably want the inventory and forecast to be as high as possible in order to always being able to deliver the promised products to the customers. (Wallace T. and Stahl R, 2008).

The operations managers often have a completely different view on the prepared outcome of the S&OP processes. The operations managers are largely in charge of the manufacturing and warehouse management and therefore have a keen concern on the inventory status and budget alignment. The motivation for the operations managers will often be to have enough forecast for the safety stocks but still a general low forecast to secure a low inventory status.

In order to minimize these bias and subjective opinions, S&OP ranges from 1-18 months of mid- and long-term planning to secure alignment with the overall strategy from corporate, finances etc.

The most common setup for S&OP monthly circles is divided into 5 stages. These 5 stages are in chronological order from the beginning of the month onto the end of each month. The 5 stages consist of data gathering, demand planning, supply planning, pre-S&OP meetings and executive S&OP meetings. Depending on specific companies, the process and stages can vary to accommodate the industry or the culture. The following figure 7 presents the different stages of the monthly circle in an S&OP department. (Wallace T. and Stahl R, 2008).

Figure 7 - S&OP monthly circle

The first stage is the data gathering which typically begins during the first couple of days into the new month. Here the sales numbers are gathered and hold up against the forecast, previous months etc. This is also where the KPI and other performance metrics are made in order to validate last month's results.

The second stage is the demand planning part. Here the latest sales data are being analyzed, typically in an ERP system, to calculate the new forecast based in patterns and predictions of the future sales. This process is done by the demand planners and the new forecast is calculated in collaboration with marketing which provides news on products launches, phase-out products etc. With these information's, the statistical forecast of former sales data is mixed with the information from marketing. The gives the current months new forecast. (Wallace T. and Stahl R, 2008).

The third stage of the S&OP monthly circle is the supply planning. With the demand planning teams finalizing the forecast, the supply planning team initiates the calculations of how much raw materials or finished goods will be needed to order from the supplier or manufacturer. This task is often performed by either the demand planning team also or the operations managers because the supply planning must fit into the inventory budget, delivery lead-times etc.

The fourth stage is the pre-S&OP meetings. These meetings are performed when all the data has been analyzed and new calculations have been made. The pre-S&OP meetings are typically then held towards the end of the month. The meeting agendas consist of capacity planning, constrains, scenario planning and news which could hinder to former planning by the demand and supply planning team. The meeting-participants typically consist of middle-management and supply chain managers. (Wallace T. and Stahl R, 2008).

The fifth and final stage of the S&OP monthly circle is the executive S&OP meeting. These meetings are often participated only by top management of the organization which includes division directors, supply chain directors and executive leaders. Here the KPI's of the previous month will be discussed as well as the founding is from the pre-S&OP meeting. From these information's, the new business plan and strategies are discussed and possibly altered to fit the constraints. (Wallace T. and Stahl R, 2008).

6.2 Introduction to Artificial Intelligence

In order to properly investigate the possibilities of digital technology, a general introduction to the field of artificial intelligence is needed. As the name presents, artificial intelligence represents tasks performed by machines which is the opposite of natural intelligence which is performed by animals and humans.

A computer scientist named John McCarthy firstly used the term artificial intelligence in 1956, at a conference in Dartmouth, United States. The definition of artificial intelligence is today spread across various terms and includes any type of automation process to physical robots. (Margaret *et al*, 2018)

Artificial Intelligence has become the center of the next industrial revolution (4.0) and are continuously disrupting new industries and providing new ways of thinking and solutions. Companies and organizations all seek to improve their efficiency and profitability by using artificial intelligence to automate manual tasks or creating opportunities which were not possible before. Artificial Intelligence are still viewed as the recipe for converting all the available consumer data into context and create patterns and conclusions out of data which no human could predict. (DataRobot, 2018). (Hokey Min., 2010)

Artificial Intelligence can be categorized into two sectors. Strong and Weak Artificial Intelligence. Strong artificial intelligence is believing that theoretically the computers will one day develop the same intelligence as humans, including feelings, awareness and conscious. Weak artificial intelligence is that the computers one day will be able to simulate every aspect of the human mind. (DataRobot, 2018).

The following sections of the chapter will present different types of artificial intelligence and their attributes. Blockchain Technology, Machine Learning and Cloud Computing will be presented. All these three digital technologies are overall categorized as artificial intelligence.

6.3 Machine Learning

"A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E".

This definition arrives from Tom M. Mitchell and is an elaboration of the term machine learning. The phrase explains that the purpose of machine learning is basically to get the computers to program themselves. If the computer is programmed to perform automation of a process, the computer will automate the process of automation. While traditionally programming consists of putting data and programming into the computer and receive an output, machine learning is putting in the data and the output desired. The outcome of the machine learning process is thereby a program. (Brownlee, Jason, 2015)

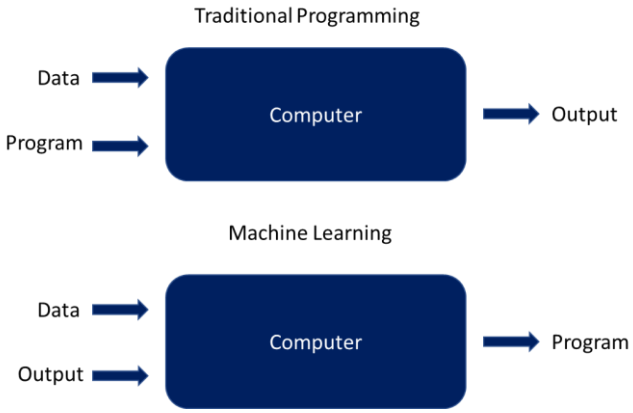

Figure 8 - Traditional programming vs Machine Learning

Machine learning can be grouped into learning fields. These learning fields includes supervised learning, unsupervised learning and semi-supervised learning. Within these categories the learning fields can be further grouped into functions as regression, classification, clustering, decision making and deep learning. Regardless of learning field or function, the machine learning model will always consist of the same three elements. These three elements can be understood as the building framework of the algorithms of machine learning. The three elements of machine learning are: (Brownlee, Jason, 2015)

- Representation
- Evaluation
- Optimization

The representation element of the framework illustrates how to represent knowledge. This can include decision trees, sets of rules, instances, graphical models, neural networks, support vector machines, model ensamples among others.

The second part of the framework is the evaluation. This is the way which the algorithm evaluates candidate programs. This can be accuracy, predictions, likelihood, probability, cost, margin among others.

The last part is the optimization element. This element is the search process and includes combinatorial optimization, convex optimization and constrained optimization. (Brownlee, Jason, 2015)

This is an understanding of the underlying framework of all machine learning algorithms. As mentioned earlier, every machine learning model can be categorized as one of the following four types:

- Supervised learning
- Unsupervised learning
- Semi-supervised learning
- Reinforcement learning

Supervised learning is seen to be the most mature type of machine learning and the most recognized and most commonly used within the business world. Supervised learning is as the name suggests, supervised. This means that the computer is feed training data and the desired output. The most commonly usage of supervised learning is to create new data sets based on old data sets. Supervised learning is the easiest machine learning model to develop. A type of supervised learning is classification, where the model is presented with rules and standards and the model will thereby classify the data sets based on the given rules. (Brownlee, Jason, 2015)

Unsupervised learning does also include the feeding of training data into the computer system, but with unsupervised learning there's no desired output. This means that the algorithm will make use of the presented data and transform it into new data.

A type of unsupervised learning is clustering, where a set of data is presented and the machine learning model unsupervised categorizes the data into clusters based on pattern recognition. (Brownlee, Jason, 2015)

Semi-supervised learning is a combination of both supervised and unsupervised learning. This can be input if training data with only a few rules and desired outputs. The machine learning model will then present the new data based on the given rules and based on pattern recognition.

Reinforced learning is where the machine learning model is receiving rewards from actions made. This is by far the most difficult algorithm to build and the one which is least studied today. (Brownlee, Jason, 2015)

Machine learning model aren't always to right solution and it depends greatly on the individual company and organization. There are four scenarios where machine learning models could be useful according to Jason Brownlee, 2015.

Within the overall types of learning fields there's different types of machine learning models. Due to time restrictions and page limitations, this thesis will only focus on a few of the machine learning models and are focusing on the two largest and most commonly used models: Clustering and Classification.

Clustering is the first machine learning model to be addressed. The main purpose of clustering is to cluster data based on patterns, similarities, functionalities, attributes or characteristics. As mentioned earlier, the clustering model is categorized as unsupervised learning which means that the machine learning model does not require prior knowledge of the data presented to it, in order to operate functionally. Since the model will sort the data based on patterns and similarities, the clustering model is today presented in numerous model types and different algorithm styles. (Baliggan, Gene, 2018).

The clustering model operates without a specific data output required. The clustering can be divided into two major types, hard clustering and soft clustering. Hard clustering consists of labeling data and cluster the data based on the labels. The soft clustering only consists of putting data in clusters based on their degree or percentage of belonging to a certain cluster. (Baliggan, Gene, 2018).

With the clustering of the data, the computer can quickly illustrate areas of improvement and where there's differences. Programming wise, clustering only consist of one phase and the algorithm is thereby considered simple and easy to work with. This is also due to the clustering don't need rules or boundaries since it's unsupervised. (Baliggan, Gene, 2018).

Classification is supervised learning. As the name suggests, the machine learning model will classify the data input into desired output. The classification model will therefore assign data to already existing data classifications or environments. The classification model is supervised because the model uses prior knowledge and experience from old data sets to classify the new data sets. Within the classification model, an algorithm called classifier is used. Basically, the classifier is scoping data by information until the data is completely classified. An example of this could be in the demand planning team of S&OP department. (Baliggan, Gene, 2018).

Based on information given and old data, the classification model will know whether to increase or decrease the forecast. Classification is easier to analyze than clustering since the desired output and rules of the model already is known. Classification algorithms are more in line with decision making and predictions whereas clustering doesn't provide any decisions but merely divide data into larger clusters and groups. (Baliggan, Gene, 2018).

The classification model requires training data and depends greatly on pre-labeling of data in order to function properly. The model is not self-learning and will continue to classify the data in the same manner until told otherwise. As the clustering consists of one phase, the classification model consists of two phases. The first phase of the classification model is a model-learning process. This is where the model is analyzing the training data presented to it. The second phase of the classification model is testing the analytics of the first phase and predicting predefined targets. (Baliggan, Gene, 2018).

In contracts to the clustering, the algorithm and programming of classification is complex and more difficult to develop due to the two phases. Additionally, the model requires tremendous number of predefined labels and boundary conditions since the model is supervised. (Baliggan, Gene, 2018).

6.4 Blockchain Technology

Blockchain Technology is the newest emerging technology with only a decade of history. The technology was invented by a person or a group under the pseudonym 'Satoshi Nakamoto'. Since the birth of the technology, no one has taken credit for the invention and the technology characteristics of Blockchain makes it possible to remain that way. The term Blockchain Technology is best known for its use in the digital cryptocurrency Bitcoin.

In late 2017 Bitcoin was on everyone's mind and the 'bubble' of the stock value of the currency burst in the start of 2018. While the cryptocurrency is one thing, the technology behind it is another, and the technology of Blockchain is definitely striving now and comparisons are made for the technology as when is internet arrived in late 1990's.

> *"The blockchain is an incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value" Don & Alex Tapscott, Blockchain Revolution (2016).*

The blockchain technology is a way to track tremendous amount of data. The data is managed by many computers interlinked in clusters and no data is owned by a single computer or system. The term blockchain is used because of the use of the technology. Block of data (Block) are being protected by a series of other systems using the crypto codes (Chain). Because of the set-up with countless systems interlinked, there's no central governance and no hierarchy of power. It is the definition of a digital demographic society. (Rosic, Ameer, 2016).

The information and tracked data are shared with everyone on an open ledger. This means that everyone in the chain can view all transactions and tracked data, which means that everything is transparent, and no data can be manipulated or changed. (Rosic, Ameer, 2016).

Another feature is the revolutionary way of transacting. The blockchain technology, there's no transaction cost involved in the movement of money, assets of documents from A to B. Furthermore, this is all automatic and safe.

When information, documents or invoices etc. are created and transferred, the transaction is when verified by thousands or millions of other computers and system in the distribution network. (Rosic, Ameer, 2016).

This means that it is impossible to cheat or manipulate in documents because the changes would only exist in your system and not the thousands of other systems.

The decentralization means that there is no central location of information to hack. To hack information of data, you would have to have access to the thousands or millions of systems, at the same time. (Rosic, Ameer, 2016).

The blockchain technology can therefore be categorized into three major pillars. Decentralization, Transparency and Immutability. Today, most of our society and systems are built on centralized systems. This includes services, banks, companies etc. Centralized systems have worked well for centuries, but with the emerging technologies and digitalization, the system starts to illustrate its limitations and vulnerabilities. In most recent times, many larger systems, bank and firms has been attacked by hackers costing them billions of dollars. (Rosic, Ameer, 2016).

Centralized systems store all information and data at one location, meaning that the hackers only need to gain access to one system to succeed. Other examples are software update halting entire systems and it-system shutdowns meaning that entire departments or divisions are incapable of performing their job. (Rosic, Ameer, 2016).

The second pillar is the transparency. The blockchain technology allows your information and data to be private as well as transparent at the same time. The privacy characteristic is showed in the complex cryptography. If a money transaction were to take place, the caption would not be “A sent 10.000 dollars”. The caption would more likely be “43uh43hu64h6h43h228JFJ5485NNF22hyfh3 sent 10.000 dollars”. (Rosic, Ameer, 2016).

In that way the companies and person's identity are hidden and secure for the public, the transaction is viewable for the public and can never be change or altered. With this technology no firm can hide any of their transactions and this could potentially lead to a tremendous reduce in corruption and crime.

The third pillar is the immutability. The term of immutability, in the technology of blockchain, means that once data are entered in the system it can never be deleted or altered. This could potentially mean that no firm or organization could alter company finances before an annual report, Q1 or public announcements. No employee would be able to alter the data in order to receive internal bonus for achievements originally not met. (Rosic, Ameer, 2016).

6.5 Cloud Computing

Cloud Computing arrived in the early 00's and has since then increased in popularity and usage. The term of cloud computing can best be described as an outsourcing service of storage to companies and enterprises as well as private users, hence a model to manage, store and process data online through the internet.

Similarities can be drawn towards electricity supply and heat supply, where the customer doesn't need to fear where the supply comes from, how it's transported or whether there enough storage for the specific customer. The cloud service is often provided by an external service company which maintain and operate the cloud system. The customer thereby pays a monthly or yearly fee and can make use of the software. Often the cloud computing is associated with use of the internet. Hence, the term 'cloud' arrives from the information and data being stored 'at the internet'. (IBM, 2019) (Rouse, Margaret, 2019).

This means that every customer has access to the technology of the service and all its benefits without necessary holding any knowledge of the underlying technology of the service and the servers.

There various forms of cloud computing types. This can be categorized into 3 major areas of cloud computing types: Platform service (PaaS), Infrastructure service (IaaS) and Software service (SaaS). Each of the 3 types consist of increasing complexity and data. Consequently, they can be viewed as layers. (IBM, 2019) (Rouse, Margaret, 2019).

Software as a Service (Saas).

This is the 'lightest' of the 3 cloud computing types and is an on-demand service which means that the application software is pay per use for the users. Software Service runs independently of other platforms and software. Hence, the users of the software can access the applications without the installment on their mobile, pc or other hardware products. The type of products this includes are services as Google Docs and Drive, Microsoft 365, Salesforce and plenty other products in same category. (Barnatt, Christopher, 2019).

The customer segment of Saas can therefore often be categorized as end-users. The cloud service only needs to run one instance while thereby offering the service to multiple customers without increasing cost. This is typically why most of the services have free versions and upgrade opportunities for a fee. The Saas software is completely operated by the service provider. (IBM, 2019) (Rouse, Margaret, 2019).

The benefits of Saas are therefore the cost, since it's a very cheap option and often free, the possibilities of accessing the technology through multiple types of platforms and anywhere in the world. Furthermore, the provider is responsible for updates and the software tools. The problems are Saas can be if the internet browser is poor or the company are experiencing difficulties with the Wi-Fi or internet. (IBM, 2019) (Rouse, Margaret, 2019). (Barnatt, Christopher, 2019).

Platform as a Service (Paas).

Provide environment and tool for creating new online applications.

Platform services are mainly used by developers where the developer can operate in a platform consisting of an operating system, web server and database. This type of environment is also called built-in API and means that the infrastructure is built in and the developers only must worry about the developments and running of the applications and not the underlying server. (IBM, 2019) (Rouse, Margaret, 2019). (Barnatt, Christopher, 2019).

Google has app engine which allows anyone to run, maintain and alter their own application on Google's infrastructure. Microsoft has a similar platform called Azure. The benefits are that the Paas allows users to rapidly develop new application for free or at a low cost.

Such applications can be used both privately and publicly. (IBM, 2019) (Rouse, Margaret, 2019). (Barnatt, Christopher, 2019).

Constrains of Paas is that the developers of the applications are limited to use the providers languages and tools in their infrastructure. There also the risk of vendor locks. The developer of the application can risk being locked with the application to the specific service provider and therefore cannot move it to another. (IBM, 2019) (Rouse, Margaret, 2019).

Infrastructure as a Service (Iaas).

Offers existing applications to be operated on the cloud providers hardware. This means that existing applications can be migrated from the company's data center into the infrastructure provider's server for the benefits of reducing IT expenses. The fundamental unit of the infrastructure is the server. Today servers can both se physical and virtual. Physical servers are individual computers. In contract so can virtual server instances. Virtualization allows users to share one physical server. (Rouse, Margaret, 2019).

Depending on the types of servers involves, Iaas comes in four categories. Firstly, there's the most secure and costly option of the private cloud, which is where a specific number of physical servers are dedicated to one customer. Second, is the dedicated hosting where a customer rents physical server on demand with the cost and number of servers matching their requirement. (IBM, 2019) (Rouse, Margaret, 2019). (Barnatt, Christopher, 2019).

Thirdly, comes hybrid hosting where a mixture of physical servers and virtual servers' instances are rented on demand in order to reduce costs and increase the flexibility. Lastly, is cloud hosting where a customer rents virtual server instances on demand and often on an hourly basis. Multiple companies offer these Iaas solutions including Amazon Web Services and Windows Azure. (IBM, 2019) (Barnatt, Christopher, 2019).

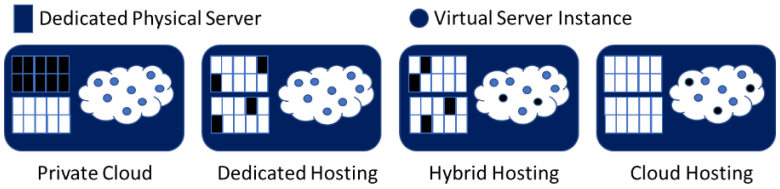

Figure 9 - Cloud Based Servers

6.6 TOE Framework

The term 'TOE Framework' is a shortening of Technology-Organization-Environment Framework. The concept is a theory on an organizational level which illustrates three important elements for a firm to consider before implementing decisions. As the name suggest, these elements are the technologically element, the organization element and the environment element. These three elements are positioned to heavily influence the implementation of innovations and digitalization in organizations. The framework was created by Tornatzky and Fleisher (1990) in their book *'The Processes of Technological Innovation'* where they describe the whole process of innovation, whereas TOE framework is a segment of the process. (Baker, Jeff, 2011).

The Technology Element

The technological element includes all technologies which are deemed to be relevant to the company. This includes both already existing technologies which are in use in the organization as well as available technology which are not currently implemented in the firm. The existing technology of the firm acts as a crucial part of the implementation process of new technology, as the existing sets the bar on how fast the implementation process can undertake and the limitation scope of the project. Innovative technology on the marked also sets an important part as it illustrates possibilities and ways which the firm can evolve and adapt to success in the future. (Baker, Jeff, 2011).

The innovative technologies existing outside the company, can be categorized into three types of technologies: incremental, synthetic or discontinuous changes (Tushmand and Nadler, 1986).

The first type of technology is the incremental creation. This is the type of innovation where the product improves current technology by adding new features or versions to existing technology. From an organizational point of view, these types of investments are the ones which holds the lowest degree of risk associated with implementation. Within typically organizations examples would be upgrades of Microsoft Office package, or upgrade of security or ERP systems. (Baker, Jeff, 2011).

The second type is the synthetic technology. This is categorized as moderate of changes. This is where existing ideas and technologies can be used in an innovative way to produce 'new' technology. An example of this type of innovation could be the introduction of 'Skype'. There no innovations in having conference calls or online meetings, nor is there any innovations in using the internet to communicate. But the combination of having conference calls over the internet by an application was innovative. (Baker, Jeff, 2011).

The third type of technology is the discontinuous change, which is also addressed as 'radical' changes to an organization. These types of changes have significant impact on the companies and includes completely changes of technology and processes. An example of this could be the shifting from local storage of data to cloud computing in the early 2000's. (Baker, Jeff, 2011).

The Organizational Element

The organizational part of the framework includes the organizations characteristics, how the employees interlink with each other, the general internal communication and processes, the structure and size of the firm and resources available among many other elements.

There are multiple ways that these elements impact the decision making of innovative initiatives. Linkage between internal functions in an organization has the effect of promoting innovation. These mechanisms are typically cross-functional teams or communication across different departments and value chains. (Baker, Jeff, 2011).

The organizational structure of the company has been acknowledged to have influence on the adoption process of innovation and the speed of it. Organizations categorized as organic and decentralized has an enhanced possibility of successful adoption of innovations. This is partly due to the structure which emphasize cross-functional teams, equality of responsibilities for the employees and lateral communication. (Baker, Jeff, 2011).

While the organic and decentralized organization structure might be preferable with the adoption phase of innovations, the mechanic and centralized organizations are, according to studies, better in the implementation phase of innovations. This is due to the formal reporting line for the employees and the centralized decision-making. (Baker, Jeff, 2011).

The role of top management also plays a crucial part of the organizations ability to foster innovation. The communication processes from top management needs to support the overall vision and mission of the firm and at the same time promote for innovative changes in the company. The overall strategy needs to involve the use of innovative technologies and the future of the firm needs to embrace technological advancements both internally and externally. (Baker, Jeff, 2011).

The Environmental Element

The environmental part of the framework focuses most on the external context. This includes the industry which the organization is placed in, the technology available to the industry and the service providers and regulatory environments, the company's competitors and the macro-economic factors.

With fierce competition and small market-share per firm, the adoption of technological advancements and innovation increases. The industry, as mentioned above, also has a great impact. With rapidly growing industries like the IT industry or the clothing industry, the companies tend to innovative much more. While slow-paced industries like the cement or painting industry, the trend of innovating is not high. These firms in slow-paced or declining industries will often have more focus on internal efficiency and cost-reduction or investments into new businesses and industries. (Baker, Jeff, 2011).

The innovation initiatives also depend on the service providers of the technology and the labor available in the industry. Many companies could easily implement blockchain technology to some degree in their business, but the demand and availability of software developers within this field is not correlating. Strategy and Management consultants and employees are more available and the organizational structure changes are therefore easier to implement rather than IT innovations. (Baker, Jeff, 2011).

Macro-economic and government elements can also be a tremendous hindering or beneficial factors to the company's possibilities of innovative adoptions. New laws, constraints or policies can produce major changes for firms which could hinder the adoption of innovative ideas. (Baker, Jeff, 2011).

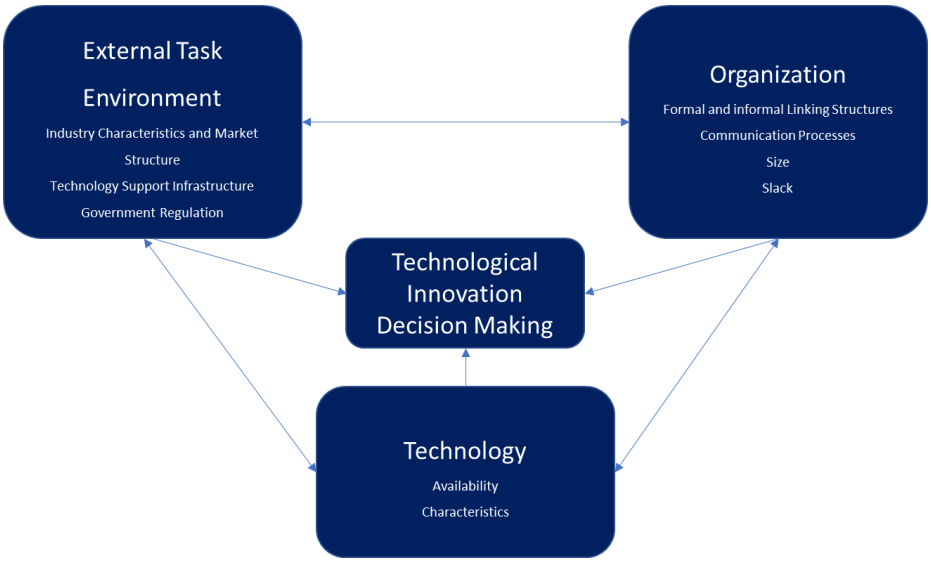

Figure 10 - TOE Framework

6.7 Change Management

Technology is here to stay, and the advancements are only increasing throughout the years. Linear with the increase of modern technology is the importance of proper change management. No matter how sophisticated or advanced the technology is, if the employees doesn't approve and make use of the technology, the investment will always fail to succeed. Digital technologies as artificial intelligence, machine learning and blockchain technology are replacing tasks prior performed manually by employees. These swifts and changes can cause insecurity and fear of unemployment for the staff of any company. (Estaute, 2018).

The complicated task for middle and top management is therefore to implement and apply the digital technology successfully both in the technology aspect as well as the human aspect. There needs to be a proven strategy and alignment throughout the organization to minimize unnecessary changes.

The fear and resistance management and organizations can stay are mainly caused by four factors: (Estaute, 2018).

Loss of job

The fear of losing their job is obviously the primary reason for resistance and fear. The media coverage of artificial intelligence typically covers the theme of robots replacing humans. The unrest of the employees therefore arrives because they'll assume it's a cost-cutting issue and the organization is after salary-savings. (Estaute, 2018).

Fear of the unknown

As the introduction chapter also stated, the topic of digital technology is both well-known and un-known. Many employees know the term of digital technology but doesn't have in-depth knowledge of the technology initiatives presented. This can cause uncertainty of the future, since the employees are unsecure whether the technology implements will benefit them or struggle them. (Estaute, 2018).

Stepping out of comfort zones

Humans are by default pattern people. To have a certain and personal routine in their everyday tasks comforts many people. This goes both in terms of collaboration with other employees and it goes in terms of use of technology. With implementation of new technology, the natural fear comes from the employees being forced to leave their comfort zones and accepting changes. (Estaute, 2018).

Lack of competence

The last of the major factors which can cause resistance are the fear of lacking the necessary competences after the technology implementations. Often will new technology investments require training in the new software and thereby higher qualifications and requirements from the employees than before. (Estaute, 2018).

Fear can arise to whether the employees think they're capable to excel in the new requirements.

Depending on specific companies, certain other topics will arise, and the list can be long. In order to cope with the upcoming fear and possible resistance, the organization and management needs to have a clear strategy and execution plan for both the investment project and the employees in order to succeed. A possible solution to these difficulties is presented in the figure 11 below: (Estaute, 2018).

Figure 11 - Change Management Steps

As the figure illustrates, the solution to handling the fear can be divided into 5 steps.

The first step is breaking the myth. Investment projects regardless of topics are hardly any secret and rumors of the investments will therefore start to spread across the divisions and employees. This is a scenario which can cause fear if not handled properly. The management needs to address the situation to the employees as soon as possible. Communication is key, and the information to the employees needs to address that the digital technologies which will be implemented are not causing a decrease in headcount and the current staff will be properly trained to operate the new system. (Estaute, 2018).

The second step of the process is the preparation of the changes which will occur. The fourth fear factor mentioned above was the concern in lack of competences. These fears can be cleared with proper education and training of the employees. Preparing for changes with investing in the employees with training and courses will higher the likeliness of implementation success. These training modules can consist of webcast training through videos, in-house courses, tests and public speeches from external suppliers of the technology. (Estaute, 2018).

The third step of the strategy is to efficiently communicate the plan to the employees. This has partially been mentioned already above, but this step is also very crucial for the implementation plan.

This step is especially important through the transition phase where the implementation of the technology have already begun. The intensions of the technology investments need to be communicated effectively to each employee. There needs to be an overall message and communication to the staff and possibly individual meetings with the employees as well.

Personal meetings and information sharing can further improve the security of the employee's wellbeing. It's furthermore important that the communication of the project is not only in the beginning of the investment but throughout the installation and within each stage of the process. (Estaute, 2018).

The fourth step of the plan includes taking it one step at the time. Too many changes and alterations within any organization will always cause chaos and panic within the staff. Big investments as digital technology investments must be carried out slowly on step at a time. The organization needs to have a clear implementation strategy outlined and present a clear roadmap for the project.

Dividing the project into minor steps and minor projects will decrease the feeling of being overwhelmed for the employees. This way the employees furthermore can get used to the former step of the project before entering the new stage of the investment. (Estaute, 2018).

The final stage of the strategy for change management is monitoring and improvise. This stage is mainly referring to when the digital technology has been implemented and the installation project is finished. Many assume that change management is mainly focusing on the employee management before implementation, but the aftermath is as equally important.

Technical difficulties, unexpected incidence or staff members failing to perform the tasks which they were trained to can be challenging and cause fear and uncertainty. It's therefore important that the organization continuously monitor the development of the employees and the installed software. If challenges arise, then maybe alterations of the technology need to be made, or the software needs to be changed in order to suit the employee's qualifications more. (Estaute, 2018).

6.8 Maturity Model

Any firm regardless of history and size will most like fail to implement digital technology if the organization isn't ready. Therefore, it is utterly important that the necessary pre-requisites are meet before initiatives on adoption of advanced technology is carried out. One effective way of doing this is evaluating the firm by performing a maturity model.

The maturity model evaluates the employees, processes and infrastructure towards their maturity in terms of implementing new technology. The maturity model is created by Grimson and Pyke (2007) and the overall purpose of this assessment tool is to illuminate how to company is functioning within the core pillars of people, process and technology. As particular tool as this is important to use because organizations often underestimate the consequences of the initiatives and implementations and the impact these changes have on the organization and their employees.

The maturity model implicates that the communication and processes are far more important that the IT tools available. It is recommended to operate with simple excel spreadsheets at first to control the processes and data. This until the processes have become an integrated part of the daily operations in which more advanced software or processes can be introduced. (Grimson and Pyke, 2007).

After the assessment of the maturity model, the next action will be to investigate the answers and the final score in each category. Gaps and identified lacking will be illustrated through this assessment and the actions thereby should be on closing these gaps and improving the overall maturity of the firm.

The maturity model itself is constructed as a 5 x 5 matrix framework consisting of five different dimensions on the x-axe, which is the organization and five maturity stages on the y-axe, which enlighten how advanced the given part of the organization is. The 25 boxes inside the maturity model framework is thereby given a score of 1-5 with 1 being the lowest score and 5 being the highest score. The maturity model framework can be seen in the figure below:

	Stage 1 – No S&OP Processes	Stage 2 - Reactive	Stage3 - Standard	Stage 4 - Advanced	Stage 5 – Proactive
Meetings and Collaboration	Silo Culture, No meetings, No collaboration	Discussed at top level management meetings, focus on financial goals	Staff pre-meetings, executive S&OP meetings, some supplier/customer data	Supplier and customer data incorporated, Suppliers and customers participate in parts of meetings	Event driven meetings supersede scheduled meetings, Real-time access to external data
Organization	No S&OP organization	No formal S&OP function, Components of S&OP are in other positions	S&OP functions is part of other positions: Product manager, supply chain manager	Formal S&OP team, Executive participants	Throughout the organization, S&OP is understood as a tool for optimizing company profit.
Measurements	No measurements	Measure how well operations meets the sales plan	Stage 2 plus: Sales measured on forecast accuracy	Stage 3 plus: New product introduction, S&OP effectiveness	Stage 4 plus: Company profitability
Information Technology	Individual managers keep own spreadsheets, No consolidation of information	Many spreadsheets, some consolidations but done manually	Centralized information, Revenue or operations planning software	Batch process, Revenue and operations optimizing software – link to ERP but not jointly optimized, S&OP workbench	Integrated S&OP optimization software, Full interface with ERP, accounting, forecasting, Real-time solver
S&OP Plan Integration	No formal planning, Operations attempts to meet incoming orders	Sales plan drives operations, Top-down process, and Capacity utilization dynamics ignored.	Some plan integration, Sequential process in one direction only, Bottom-up plans – tempered by business goals.	Plans highly integrated, Concurrent and collaborative process, Constraints applied in both directions	Seamless integration of plans, Process focuses on profit optimization for whole company

Figure 12 - Maturity Model Matrix

Within these 25 boxes, descriptions are made to show what pre-requisites are required in order to qualify for that particular field of maturity. By looking at the next box horizontal on the right, the description can be used as qualification goals for the company in order to achieve the next stage of maturity. An example of this would be if an organization were categorized at stage 3 in the 'organization' category then they would have functions as supply chain manager and product managers. But in order to categorize as stage 4 of organizational maturity, the company would need to have a formal S&OP team with executive participants.

Grimson and Pyke (2007) recommends that the assessment of the maturity model framework is performed by multiple employees within the company to strengthen the reliability and validity of the test. The assessment would be further reliable if the answers came from different functions and departments in the S&OP division.

6.9 Subconclusion

This section served knowledge of the theory necessary to answering the research questions. The literature which was founded in the literature review was framed and exposed for useful information in this chapter. The chapter started with an introduction to theory of S&OP, what it consists of and how the monthly processes are set up. The reasoning for usage of S&OP theory was to support the S&OP processes of Hempel, Maersk Drilling and Smith-Nephew, which is elaborated in the chapter 8, Analysis.

Furthermore, the chapter introduced artificial intelligence and the roots of the technology. From there, digital technologies are explained starting with machine learning and the attributes of clustering and classification.

Blockchain technology were explained with the three pillars of Decentralization, Transparency and Immutability. Next, cloud computing was presented elaborating on the Infrastructure as a service, Platform as a service and Software as a service.

With the artificial intelligence model presented, the chapter ends with pre-requisites in which companies should consider before implementation of the digital technologies. This included a maturity model where the firm can self-check their maturity in the S&OP department and if digital technology should be a priority for the organization.

Furthermore, a TOE framework is presented to in-depth analyze the technology, organization and environment of the company. Lastly, change management theory were elaborated towards handling change, fear and uncertainty.

7 Methodology

The methodology of the thesis serves as a presentation of how the thesis was constructed and the reasoning for academic approach and strategies are explained in depth for the reader to further understand and grasp the thesis. The chapter consist firstly of an illustration of the research onion, thereby an in-depth explanation of the structure of the research onion and the choices made within. This includes the philosophy of the thesis, the approach, the methodology, the strategy and the time horizon in chronological order.

Furthermore, in this chapter, the techniques and methods to collect the necessary data will be illustrated. This is followed by a reliability and validity check of the thesis to ensure the credibility of the recommendations which will be presented in chapter 8. At last, a conclusion for the chapter will sum up the larger context and conclusions.

7.1 Research Design

The reasoning for usage of a research design is the gain structure and produce a solid strategy for completing the analysis of the thesis and thereby answering the research questions. In order to do this properly, the research onion model is used. This model is made by Saunders et al. (2016). The term 'research onion' is because of the structure of the model.

The model consists of 6 'layers' all with different purposes to the thesis and design. The purpose of the research onion is to develop a solid framework and a guided process. Below is illustrated the research onion and its different layers. For better overview, dots in each layer has been made to present the choices made for this thesis.

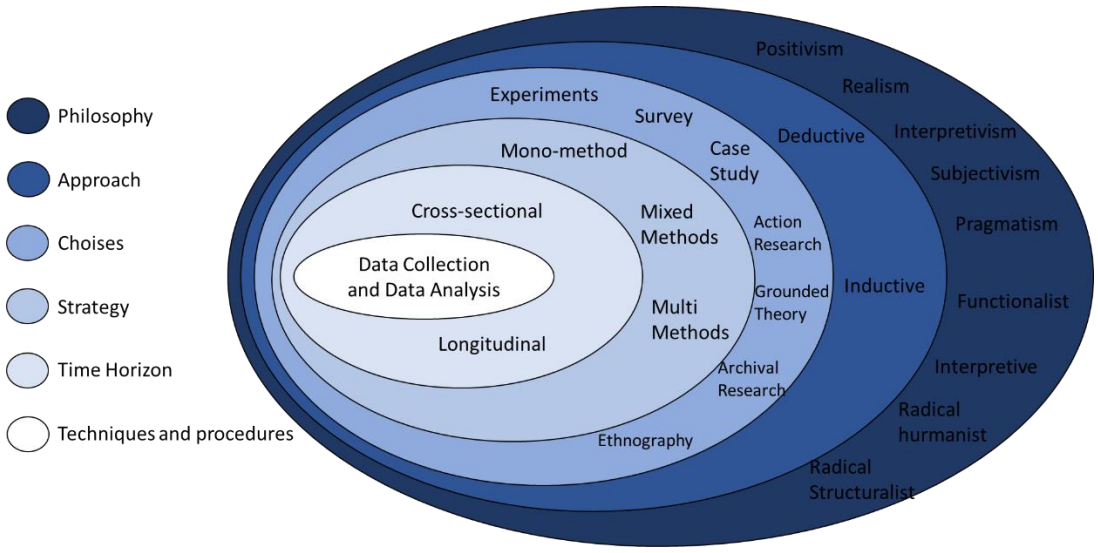

Figure 13 - Research Onion

As described earlier, the research onion model consists of 6 layers for detailed understanding of the research design of the thesis. A notification must be made clear, that the research onion's layers are not in chronological order. It is not necessary to start with the philosophy of the thesis and work its way in and each layer are not meant as entry levels for the next layer. Hence, there's no guidance from the outer layer to the most inner layer.

7.1.1 The Philosophy

The first category which will be addressed is the philosophy of the thesis. This is involving the mind-set of the conduction of the thesis and what kind of approach is used. In this thesis, the philosophy is categorized as a pragmatic approach.

"The pragmatic approach involves using the method which appears best suited to the research problem"

The pragmatism is unfolded by the solutions made in the recommendations. There are no universal solutions which would fit every firm on the globe. Each company requires different solutions and approaches, which means that the methods used to answer the research questions depends on what company is addressed and can therefore vary. The purpose of the thesis is to obtain knowledge and already documented theory and apply it onto chosen firms. The philosophy is also known as 'value-driven' philosophy, as it seeks to fit model and methods onto which perspective and challenges fit the most.

The solutions and recommendations towards Maersk Drilling, Smith & Nephew and Hempel should therefore also be solution oriented with a pragmatic approach.

Another attribution of the pragmatic philosophy is the pragmatism. This means that the thesis can be pragmatic with the solutions. This favors the possibilities of multiple solutions and the possibilities of the recommendations not being complete implementation-ready solutions but merely guidance and strategy solutions. (Saunders *et al.,* 2016). To present multiple solutions in order to best serve each individual company also increases the credibility and validity of the thesis because it allows the notification and accommodation of the differences in each of the chosen firms.

7.1.2 The Approach

The approach of the thesis can best be described as a mixture of both the deductive method and the inductive method. The process of the inductive method is to make observations and from there, conduct theories to explain the observations. The deductive method includes developing a hypothesis based on already founded theory and then designing a research program to test this hypothesis.

This thesis observe issues regarding implementation of digital technologies through interviews, which is an inductive method. Yet, there's no theory developed through these observations. Merely, the interviews are backed by international surveys which serves as theory in this case and that can be interpreted as a deductive method. The thesis aims to build a strategy framework for appliance and guidance of digital technology and that can be placed as an inductive method, as its building new theories on observations.

To fully be an inductive method, the new theory would need to be created on observations and not existing theory. To fully be a deductive method, the theory would need to be tested and not build into new theory. As of this, the thesis leans highly towards being a mostly inductive method, yet remains a mixture.

Additionally, none of the bottom-up nor the top-down approach were used exclusively since both methods were used. In terms of the pragmatic philosophy of the thesis, this correlates.

7.1.3 The Methodology

The methodology of the thesis is a multi-method qualitative. In this thesis the data gathered, consist of interviews with relevant employees within selected companies and surveys conducted by third-party consultancies. These two types of data are both qualitative data, hence, there's a limitation of no presence of quantitative data in this thesis. It's a multi method, since there's multiple types of qualitative data presented in this thesis. The interviews and surveys are two different sources of qualitative data.

The interviews are primary data while the surveys are categorized as secondary data. The advantage of using a multi method methodology is the diversity and variety of data presented which increases the credibility of the data. While the primary data advantages in being very specific addressed to the case and the research questions, the secondary data strives by reducing waste-full time and gives major time-resource savings.

7.1.4 The Strategy

The construction of the thesis is to observe observations through qualitative data, compile relevant theory and literature and try to solve these research questions deriving from the interviews through cases with real companies. Therefore the strategy of the thesis is a case study, because this type of strategy gives room to investigate the different company cases and use the founded theory to apply onto them.

Normally, this type of strategy relies both on qualitative and quantitative data, but in this thesis only qualitative data will be used together with the founded theory and literature to construct valid solutions and recommendations. To achieve this relevant information and literature, the thesis makes use of the available databases provided by Aalborg University, which is ProQuest and EBSCOHost.

7.1.5 The Time Horizon

This thesis, the time horizon can best be described as a cross-sectional time horizon. This is partially due to the limitations of data available, since there's no company collaboration involved and partially due to the limiting time frame sent by the University.

If more time were available, the thesis could have run over multiple periods, which several studies and observations of the impact and consequences of the strategy in the thesis. If those terms were applicable, then the thesis would be categorized as a longitudinal timeline.

The time horizon of the thesis can be boxed into five major sections. Firstly, the research sections. This is where the topic is research and narrowed down. Secondly, the within that chosen topic, the most critical and relevant issues and problems are stated. In the third section, the data is collected. The interviews are made along with the gathering of the articles, papers and other relevant literature.

In the fourth section, the founded literature and articles are analyzed and the data is processed and sorted by relevance. Lastly, the fifth section includes the solutions and recommendations given to the companies as a strategy for implementation of digital technologies.

7.1.6 Data Collection and Data Analysis

As viewed in the research onion model, the layer which is in the center of the model involves the techniques used to obtain and collect the data along with analyzing the collected data for quality literature and high credibility. The techniques which are used in this thesis are deemed relevant and necessary in conducting and answering the problem statement and research questions at the highest level of quality.

Due to the thesis is without any quantitative data, because of the lack of collaboration arrangements, the thesis data solely contains qualitative data which consist of both surveys and multiple interviews with employees with relevant titles and work tasks in terms of thesis topic. This section of the methodology chapter will therefore focus on the two types of qualitative data which has been captured through interviews and surveys.

7.1.6.1 Primary Data

Primary data is categorized as data observed or obtained through first-hand experience. The interviews which are conducted with the employees at Smith-Nephew, Maersk Drilling and Hempel are therefore categorized as primary data since the data were gathered and observed by the author of the thesis.

The following under-section will provide elaboration of what the primary data consist of and how it were obtained.

To conduct the best interviews with highest quality and highest credibility, structure, guidelines and processes needs to be made. Prior to the interviews with the chosen employees, certain criteria's needs to be met. This includes the employee's current knowledge of the topic and interest, their title and position within the company along with their experience and daily job tasks. When the criteria's and structure of the process is established, the search for candidates begin.

The author's network of former student positions, current student positions, former university projects, bachelor projects, friends and business connections is evaluated for potential candidates which through interviews can help shape the thesis and answering the research questions. Through this search process, the following participants are chosen:

- Thomas Skov Hansen, Project Manager S&OP, Hempel
- Christian Hartel-Barbosa, Supply Chain Project Manager, Maersk Drilling
- Russell Barton, Supply Chain Director UK & Nordics, Smith-Nephew

The three interviews were all conducted within 14 days of each other and each of the three interview-sessions lasted 90 minutes in total. The process of the interviews are categorized as both structured and unstructured.

According to Saunders, the true difference between structured and unstructured interviews lays in the questions which the interviewee presents. While the structured questions often leads to direct answers aiming for answering the asked question, the unstructured questions equally often leads to open and descriptive discussions meaning that the participants hold the opportunity to influence the answer and apply subjective opinions to the case. (Saunders *et al.,* 2016)

Since there's only one interview per employee and there's no follow up, the participants are sent an agenda of the topics and exercises which will be performed during the interview. This is to ensure optimal usage of the time available and time for the participants to think of well-formed answers to the questions rather than short-minded or doubtful responses.

Furthermore, the agenda is sent to ensure some sort of structure in the interview. If the interviews follows an unstructured but relevant path, the agenda will guide the interview back on track for the rest of the session.

As mentioned before, unstructured questions and answers can arise and will most often derail from the direct topics, but often provide relevant insides to support the first structured answer or elaborate on subjective matters. The major bias of this kind of approach is that there's only one interview per company and only one interview per participants. Hence, there's no way in telling whether the employee is speaking the truth or misinforming. The information which is given in the interviews therefore has to be hold against theoretical facts and literature material. Nonetheless, it must be assumed that the participants are speaking truthfully during the interviews and their objectivity and reliability is present.

The conduction of the three interviews are very similar, meaning that the base agenda and questions are the same for each employee, but with unstructured questions, new questions can be presented to elaborate on the topic and the interviews can therefore vary after execution. As mentioned, the agenda and base of the interviews are the same for everyone.

First, the interview will start with a formal introduction to the reasoning for the interview and the thesis and research questions, this followed by a presentation of their jobs, responsibility and the company and department. From there, the questions will begin and agenda will be handled in a chronological order, except during derails and unstructured questions in which the order of questions may change due to relevance of the topic.

The employee will answer the questions with objectivity and truthfully and the questions are thereby approach and unbiased statements and subjectivity. Furthermore, the questions for the employee will in no way contain misleading or leading questions which can provoke biased answers.

The chronological order of the questions are constructed with the most general and most approachable questions in the beginning and the most sensitive questions at last. This tactic is used to gain confidence from the participants and therefore raise the credibility of the interview. (Saunders *et al.,* 2016)

For most optimal efficiency during the interviews, the interviews are, with the employee's approval, recorded during the interviews. The reasoning for this action is that is isn't efficient to use valuable time to write quotes and sayings down and the time written could potential be used to answer more questions or go into more detail with the current questions. Furthermore, the recorded sessions can also be used to investigate more detailed in the answers during the interviews. Quotes can be written down peacefully can mumbling and misunderstandings can be listened to multiple times for full understanding.

Additionally, these quotes and answers can be used fully in the thesis to enhance points and context of a certain topic. While not focusing on writing down answers, the interviewee can keep eye contact and engage more with the participant, creating a more trustworthy scene and thereby better answers. The supervisor and censor of the thesis can hereby also see the direct quotes from the interviews which also strengthen the credibility and reliability of the thesis.

There is, however, certain disadvantages connected to recording interview sessions. The employees are answering questions regarding their position and their company which can lead to the participant being too frightened to answer the questions truthfully due to the permeant record a recording is leaving. This is obviously a cause which can hinder the reliability and validity of the interviews.

When listening to the recorded sessions, it's beneficial to conduct some sort of 'key learnings' with the most important elements from the interviews. The key learnings paper will be a summary and a great portion of the interviews will therefore go undocumented. The parts of the interviews which will go undocumented are the ones deemed irrelevant or too derailed for the topic. The important task in conducting the key learnings is to remain unbiased. It's the author of the thesis which choses what quotes is presented, and which goes undocumented.

As this is a university assignment and there's no company collaboration, it's easier to remain unbiased and the author therefore seeks to extract information and answers which can emphasis the different angles of the thesis best.

No statements or documentations have been left out which could change the overall conclusion or misunderstandings and misinterpretations which could twist the words of the employees.

Certain software programs can be used for the most optimal usage of interviews and recorded sessions. Academic approaches to these interpretations could be the software NVivo. Typically, these kind of software programs are used with larger portions of data. Since there's only 3 interviews in this thesis, there' no point in using the system due to time restrictions. There are also other applications focusing on statistical outcomes of data, but this is rejected again due to lack of resources and time restrictions.

7.1.6.2 Secondary Data

This under-section of the chapter serves the secondary data of the thesis. While the interviews are deemed primary data due to the first-hand experience, the survey analysis in the chapter 3 are categorized as secondary data. The data from the surveys is second-hand experience, and there's no telling if the data has been manipulated or twisted to prove a point or highlight an angle which suites the authors of the articles.

The purpose of the surveys analysis is to strengthen the reliability and validity of the statements which the interviews are concluding. While the interviews are made with 3 employees from similar positions, from the same country, the surveys are conducted with thousands of managers and are spread throughout all sectors and countries, greatly increasing the credibility strength of the thesis.

In most cases, surveys are considered to be primary data because the surveys are mostly conducted by the same individuals which needs the answers. As mentioned before, due to lack of resources and time limitations the surveys had to be found through external channels. These surveys are thereby conducted by external consultancy firms which from there are published into articles regarding the topic. The surveys are used because of the large portion of data is contains. The author of this thesis would have no chance of capture these kinds of data.

As mentioned before, there's no telling if the data has been manipulated or if there's a hidden agenda in which the results presented has been altered or change in favor of whichever firms benefit. One could argue that surveys conducted by a consultancy firm typically presents the data from an angle that suits the solutions which the same consultancy firm represents.

7.2 Research Reliability and Validity

For this thesis to be considered relevant and a reliable and valid source of data, the collected data must firstly be deemed reliable and valid. There are certain initiatives which can increase/hinder the reliability and validity of the thesis. These are among others to secure minimal bias in data representation, documents and the recorded meetings. Furthermore, the usage of data triangulation and cross-references are very useful to increase reliability and validity.

For the conducted interviews to be considered reliable and valid, there's multiple considerations both prior to the interview and during. The first factor to consider is whether the employee contains the needed information and knowledge of the topic and the company and whether there're fit for answering the interview questions in terms of answering the research questions. This is ad most important in terms of conducting a decent interview process.

Another crucial task is the ability of maintaining objective during the questions. This is solely on the participants part, and the tricky issue here is that the interviewee can, to a certain point, not tell of the employee is being objective or subjective in his/her opinions. The person interviewing needs to make sure that the employee holds no grudges or are at any discomfort in terms of the topic. If the employee suffers from bad experiences or similar at the department, the interview can derail onto personal statements rather than facts.

From the interviewee's point of perspective, the formulation and pronunciation of the questions is utterly important in terms of getting productive answers. To assume the employee is telling the truth and stating correct facts, there needs to be absolutely no misunderstandings or misleading questions. With all these precautions, the last consideration is the use of data triangulation for optimal reliability and validity and removal of bias factors.

7.2.1 Data Triangulation

The methodology of data triangulation is to compare different sources of data against each other to minimize bias and increasing the reliability and validity of the information presented by the different data sources. Typically, the data triangulation is a comparison of both qualitative and quantitative data. A combination of both qualitative and quantitative data often provides the best data triangulation and thereby the highest reliability and validity of a thesis.

As mentioned before, this thesis is lacking the quantitative data due to lack of collaborating companies. Since there's no quantitative data, the data triangulation process isn't as efficient, and it could be, and the reliability and validity of the thesis is weakened. However, the data triangulation can still be categorized as very useful, since there's multiple types of qualitative data involves which strengthens the process.

The purpose of the data triangulation is furthermore to measure to data in terms of how well they correlate with the answering of the research questions.

The process of data triangulation will be applied in an alternative method during this thesis. Normally, the data triangulation methodology is consisting of a 'triangle' of the quantitative and qualitative data. In this thesis, the data triangulation will consist of three rounds of comparing and measurements.

Firstly, the recorded interviews from the 3 employees at Maersk Drilling, Smith-Nephew and Hempel will be data triangulated and analyzed. Analyzing different data within the same type of qualitative data provides different aspects of the same topic which increases the reliability and validity of the data. Furthermore, the data triangulation of the interviews can be used to highlight differences in either responses, questions or the process in general.

Next, the surveys collected through second-hand experience, are being data triangulated. This is to analyze inequities or flaws in the processes as well as comparing the similarities and ensuring the usefulness of the data provided.

With the two types of qualitative data triangulated, the third data triangulating can begin. This is more in terms of the normal setup of data triangulation. Here the consolidated interviews and the consolidated surveys is being compared and analyzed.

Additionally, the two qualitative data sources are furthermore hold up against the literature materials and theory. This is to strengthen the reliability and the validity even further. The three rounds of data triangulation can be viewed in the figure 14 below:

Figure 14 - Data Triangulation

7.3 Sub conclusion

The chapter of methodology illustrates the methods which were used in terms of securing the reliability and validity of the thesis along with a research design model and strategy for processing the thesis and the used techniques for collecting the data properly. The chapter furthermore illustrated which types of qualitative data were present in the thesis, how the data were collected and how they contribute in answering the problem statement and research questions.

The research design was illustrated by the research onion from Saunders et. al., 2016. Each of the six layers of the research onion have been explain and detailed, including the philosophy of the thesis, the approach, the methodology, the strategy, the time horizon and the data collection method of the thesis.

The philosophy of the thesis was categorized as a pragmatic philosophy due to the use of multiple solutions and using the solutions which fits the companies best individually. The approach of the thesis is a mixture of inductive and deductive methods. The method of the thesis is multi qualitative method, since there's only qualitative data present in the thesis, but multiple sources of qualitative data. The strategy of the thesis consisted of using interviews and surveys as qualitative data and supporting the data with academic articles and literature books.

Lastly, the reliability and validity of the data were tested with the data triangulation to eliminate unwanted bias and increase credibility of the data.

8 Analysis

This chapter seeks to make usage of the theoretical framework from chapter 6 and apply these models and frameworks on chosen company cases. The chapter will be presented by an introduction to the case companies including their products and history along with financials and their S&OP processes on a monthly basis.

From there, the pre-requisites models of the maturity model and TOE framework will be applied to analyse the maturity of the S&OP processes and whether or not, the selected case companies are ready for digital technology implementation. If deemed applicable, the digital technology models of the theory will be applied to the S&OP processes including possible constraints and implications.

8.1 Case Companies

The same companies which were chosen for the interviews in chapter 3 are the same companies which will be used as case companies for the implementation strategy of the theoretical frameworks built in chapter 6. The following description of the S&OP processes for each case company are captured in the interviews respectively. This can cause bias in the credibility of the thesis, as the S&OP processes thereby is portrayed based on the company employee solely. The employee is therefore deemed to have spoken truthfully and remained valid and reliable.

8.1.1 Maersk Drilling

Maersk Drilling is a multinational company which operates in the drilling rig business. The company act as servicer for the oil and gas production companies by providing rigs and drilling equipment. The company is Danish and started as a daughter-company of A. P. Moller – Maersk Group which were stablished in 1972. In 2019, Maersk Drilling became an independent company and were in 2019 introduced on the stock market and NASDAQ.

Maersk Drilling consist of 23 rig fleets spread-out in every continent and ocean. Maersk Drilling are headquartered in Lyngby, Denmark but also have offices in Norway, United Kingdom, Singapore, USA and Ghana. (Maersk Drilling – Annual Report, 2018)

S&OP Process

As Maersk Drilling is a service company and third-party distributer of spare parts, their S&OP process differentiates from the normal theory. Instead of sales numbers coming in each month, Maersk Drilling are measuring the number of service hours spend as well as spare part units sold. The forecast is therefore both on spare parts but also on man-power and availability. Maersk Drilling are also operating with a decentralized approach to the forecasting. The forecast is divided into clients and customers.

The most important clients are handled by the global demand planners, while the less-important clients are handled by the local demand planners. From there, KPI's are updated including service hours, lead-time on spare parts, service levels etc. Through this information, monthly S&OP meetings are held to investigate opportunities for improvement.

8.1.2 Smith-Nephew

Smith & Nephew is a multinational company, originated from England in Hull. Today headquarter is in London, and the company operates in over 120 countries. The company specializes in medical equipment for surgeries and injuries. Smith-Nephew operates in four major divisions: Reconstruction, Trauma, Sports Medicine and Advanced Wound Management.

Reconstruction is hip- and knee implants to replace damaged, worn joints, Trauma is for major injuries as car crashes to stabilise severe fractures and correct bones, Sports Medicine is for minor injuries and surgeries to repair and remove soft tissue and Advanced Would Management be for treatments for difficult wounds. (Smith-Nephew – Annual Report 2018).

S&OP Process

Each region of Smith-Nephew handles the S&OP process different and this thesis takes point of departure in the Nordic region, including Sweden, Norway, Finland and Denmark. The S&OP process start off with the global distribution centre in Baar, Switzerland releases excel spreadsheets with monthly KPI's including forecast accuracy, service levels etc. This information is investigated by the demand planning team and the sales and marketing team. This is done by monthly meetings with each country focusing solely on future forecasting.

After the meetings, the data gets uploaded into their ERP system Logility and Cognos. With the latest month analysed and the future forecast handled, the monthly regional S&OP meetings are held with participation of the supply chain manager, operations manager, demand planner and product manager. Here the KPI's are discussed and what needs to be changed in the future. These keynotes are compiled into a pre-made PowerPoint document which is identical throughout all regions. This document is when viewed by top management on the monthly S&OP meetings.

8.1.3 Hempel

Hempel is a Danish company, founded in 1915 by Jørgen Christian Hempel. The company has it headquarter in Lyngby, Denmark. Today, the company have over 5500 employees spread across 80 countries including production facilities, research and development and sales offices. Hempel supplies painting and coatings to marine, industrial, decorative and yacht markets. Hempel also offers services and consulting for possible customers. (Hempel – Annual Report 2018).

S&OP Process

Hempel follows a monthly circle of S&OP process. The processes differentiate from region to region, and this is based on the European region. The month starts off with the sales numbers uploading into the system from the sales department. This is typically performed the first or second work-day of the month.

The sales team are furthermore updating their 'Tender project file', which is a excel file containing all won, lost and on-going tender cases. The cases won or lost are thereby updated in the ERP system by the demand planning team. This also includes tender projects over 50% likeliness to be won.

From there on, the demand planning team operates on the sales history and are maintaining indicators on items, which is a manually task. Life Cycle Management are performed on items in-order to properly manage the phase-in and phase-out of products. During this period, the monthly KPI's are also handled containing forecast accuracy, service level, inventory status etc.

Medio each month the statistical forecasting begins. This is where each item's forecast is still correlating with the sales history. The items are assigned parameters as moving average 3, 6 or 12 months, seasonal, non-seasonal etc. If there's sudden increase or decrease or new information from marketing or sales, the parameter is changed to accommodate the new information.

8.1.4 Maturity Model

The Maturity Model is part of the pre-requisites necessary in the strategy framework of appliance of digital technology. The companies of Smith-Nephew, Hempel and Maersk Drilling will be tested and evaluated throughout the 25 different levels and fields in the Maturity Model matrix. The maturity model will, along with the TOE framework, provide indications on whether the 3 companies should proceed with the strategy framework or apply their focus and investments elsewhere in their S&OP divisions.

As stated previously in the introduction chapter, the maturity model is developed in participation with the three representing from each company during the interviews. The maturity model will determine their maturity of their S&OP department and their readiness for digital technology. There are certain criteria's which needs to be met in order to be mature enough for digital technology implementations.

These criteria are not hard data based on numbers and statistics but rather on soft data regarding their S&OP set-up, the environments and the processes and people. The following criteria's serves as entry level and the bare minimum for consideration of applying digital technology.

The first criteria are that the company is data driven, meaning that the actions and processes each month are based on data from the customers and suppliers and the sales and forecast are partly based on statistics and history. Throughout the S&OP division, there needs to be cross-functional collaboration among marketing, sale, demand planning, operation and warehouse management.

This means that the data driven decisions from before needs to be evaluated in collaboration with multiple departments. Thirdly, there needs to be a formal S&OP which are having regulatory meetings with multiple stakeholders.

Lastly, the ERP system of the company needs to have a certain degree of sophistication. Ideally, there's a joint ERP system used throughout the organization and on a global scale.

8.1.4.1 Maersk Drilling

Meetings and Collaboration

The first category of meetings and collaboration will be evaluated as stage 3. Maersk Drilling are definitely operating with meetings both pre- and executive S&OP meetings. Yet, the data driven processes aren't as advanced as using supplier and customer data. The suppliers and customers are also not involved in the process.

Organization.

This is a clear stage 4 of the maturity model. There are formal S&OP teams and there's executive participants. The only thing lacking from reaching stage 5, is that these S&OP teams are mostly throughout the Danish and Norwegian organizations and not on a global scale.

Measurements

The measurements of the maturity model are also at a stage 4, as the S&OP departments measures on new product launches, KPI's and general S&OP effectiveness. Reaching stage 5 would require measurements of the overall company profitability, meaning that the KPI's would also include how the measurements of S&OP are affecting the rest of the organization.

Information Technology

The categorization of information technology will be placed between stage 3 and stage 4. Maersk Drilling are running centralized information, and have operating planning software, however, the company uses different ERP systems in each division, and these ERP systems are not properly interlinked to each other.

S&OP Plan Integration

The last category of S&OP Plan integration is at stage 3. There is some degree of plan integration but not highly. Processes are only in one direction and not applied both ways.

Maturity Conclusion

The maturity of Maersk Drilling is between stage 3 and 4 which is barely the minimum requirements for implementation of digital technology. The case company will therefore be included in the strategy framework.

8.1.4.2 Smith-Nephew

Meetings and Collaboration

Smith-Nephew is staged in the first category as between 3 and 4. They are data driven with supplier and customer data to some degree and they have pre- and executive S&OP meetings. However, the supplier and customers are not incorporated in the meetings.

Organization

Stage 5, as there's formal S&OP teams with executive participants, both on a domestic level and on regional and global levels. Furthermore, throughout every organization globally, S&OP is understood as an important tool for optimization.

Measurements.

Another stage 5 categorization. The measurements in the organization is aiming towards overall company profitability. The KPI's are followed through for overall optimization, rather than only regional benefits.

Information Technology.

This is a stage 4 category. The company uses ERP software for revenue and operation optimization and have recently joint their demand planning ERP system globally. Yet, they still use both Logility and Cognos for demand planning, and finance ERP are not joint yet.

S&OP Plan Integration

Placed somewhere between stage 3 and 4 on the last category. There's highly plan integration and a concurrent and collaborative process, but the constraints are not applied in both directions.

Maturity Conclusion

Smith-Nephew averages just above 4 in the maturity model, and the company are therefore deemed ready for the appliance of digital technologies.

8.1.4.3 Hempel

Meetings and Collaboration

Hempel is categorized as stage 3 in meetings and collaboration. Most decisions are made on top management level and then forced down the hierarchy. There's decent collaboration between the regions but no best-practise on a global scale. Each region is working in individual goals diminishing the overall goals.

Organization

The organization status is depending on which region. Overall, the average will be placed at stage 3. Some divisions have formal S&OP while others do not. There's no alignment in the procedure and standard of how the organization should be organized.

Measurements.

This is also stage 3, as the sales are measured on forecast accuracy, and the individual regions do run KPI and monthly measurements. Yet again, the S&OP Effectiveness is not present as these KPI doesn't go cross regions.

Information Technology

The information technology of Hempel will be categorized as stage 4. They've recently introduced a new ERP system and are currently working on linking this system to all the region for total alignment and standardisation. The ERP tool will not, however, be linked to finance, procurement etc. which means stage 5 will not be reached.

S&OP Plan Integration

The last category is stage 3. Again, there is plan integration, but mostly on regional levels and not on a global scale. There's no collaborative processes and the plans for top-down by top management.

Maturity Conclusion

Overall Hempel averages at stage 3 in the maturity model. This means that the company is not ready for digital technology yet and should therefore prioritise other more important matters. Collaboration, transparency and information sharing along with alignment and standardisation should be a higher priority based on the maturity model.

8.1.5 TOE Framework

The second pre-requisites which is recommended for investigation before the initiation of applying digital technologies is the TOE framework. While the maturity model focuses solely on the S&OP organization and their maturity, the TOE framework takes further focus on both internal and external factors. The framework is a three-folded model which details the whole organization, the external environment and the technology available. This framework is necessary for organizations to consider along with the maturity model, as external factors as governments, infrastructure, technology availability etc. also needs to be in line with the investment ideas of the S&OP department.

As it is technology which will be invested in, the technology section of the three selected case companies will be the same and will therefore be addressed here. The technology availability of cloud computing and machine learning are present and there's no fear of the desired technology set-up not being available. Blockchain can be available but due to the lack of years in the market some features of the technology or the developers will not be available.

8.1.5.1 Hempel

Environment.

The industry characteristics of Hempel is a slow-moving market. The industry of painting and coating are not technological advanced and needs for rapid changes and agility of the company are not big. Therefore, there's no fear of the technology investments being out-dated or not functional within many years. There's neither no fear of government regulations nor other macro-factors hindering the implementation of digital technologies in the S&OP department of Hempel.

Organization.

As stated in the maturity model, the communication process in Hempel are not sufficient. The barriers between the regions can become a hindering for the implementation process. The size and economy of the company are great enough for applying larger investments in new technology and there's no fear of consequences for failure and loss of capital.

8.1.5.2 Smith-Nephew

Environment.

The industry characteristics of Smith-Nephew are more rapid moving than with Hempel. The technology advancements of instruments and implant sets in surgery are advancing fast. However, since this is technology investments regarding the S&OP department and not the products itself, there should be no fear of the technology being out-dated or outperformed by competitors. Again, with the products, the government could potentially be a hindering as this industry handles human lives, but since this is regarding the S&OP department, there's no regulations.

Organization.

The communication process is better and more mature at Smith-Nephew than Hempel, and the organisation should therefore be more suited for successful implementation across regions with minimal organizational hindering. The size and economics of Smith-Nephew is also sufficient for larger technology investments without fear of capital loss. The formal organization structure of Smith-Nephew can potentially be a hindering. The company is structured with many 'layers' of management positions and a bottom-up approach can seem difficult with the amount of approvals needed.

8.1.5.3 Maersk Drilling

Environment.

The environment of Maersk Drilling is categorized as a slow-moving market. Again, the government regulation could be a hindering if this was addressing the execution of the oil drilling or the products used at the rigs in the ocean. But this is regarding internal S&OP, so there's no external environmental factors to consider.

Organization.

Former, the organizational structure of Maersk Drilling could be a major hindering, as the company is owned by A. P. Moller Maersk. Any decisions, formerly, would have to goes all the way to the top of Maersk Drilling and then all the way to the top of their owners. Now, Maersk Drilling is an independent company and the formal structure linking in decision making is easier.

The size and economic factors regarding technology investment shouldn't be a hindering as well.

8.2 Appliance of digital technology

The appliance of the digital technologies from the theoretical framework in chapter 6 will be presented and applied in this chapter. The appliance of the digital technology will be addressed to all three case companies, even though Hempel is not categorized as mature enough for implementation. Furthermore, the section will present the appliance of the digital technology on a broader perspective including industries and other functions than S&OP, as production, warehouse, distribution and finance.

8.2.1 Blockchain

Blockchain is the newest emerging technology, and it's therefore still unclear all the beneficial abilities this technology can provide. Certain areas are already being explored as procurement, finance, distribution and logistics. As the technology mature, more functions will benefit from blockchain technology. This section focuses on the benefits in procurement and distribution from the three company's perspective, as well as, in general industries and other functions.

Within both Hempel, Smith-Nephew and Maersk Drilling, the most useful area for blockchain implementation is the procurement department. One of the major benefits from blockchain is the handling of documentations. Today, the procedure of negotiating with a customer of supplier, making the invoices, sending them, getting them returned, proof-read the invoice and actually transfer/receive the cash can be a long process over multiple weeks.

With blockchain technology, companies can form 'smart contracts' in collaborating with their customers or suppliers. Here, the parties involved implement their conditions and terms of the agreements. If the agreements are met from all parties, the smart contracts can self-verify these terms and self-execute the procedure. This is releasing tremendous amount of time resources when handling many customers or handling many transactions within the same customer.

The smart contracts can furthermore be extended to include end-to-end supply chain for the company, which means that not only will the contract be executed automatic, but the rest of the supply chain will receive notification instantly as well.

Furthermore, the blockchain technology will provide transparency and visibility of the supply chain, which means that the purchase good can be traced from supplier to customer ensuing complete authenticity. This is especially useful for companies handling food, beverages, plants and other critical goods. With blockchain technology, is buyer is able to trace the authenticity of the food all the way to the farmer producing the food. This type of transparency will be more and more important as we enter an eco-friendlier world with focus on footprints and waste.

8.2.2 Machine Learning

As the theoretical framework in chapter 6 states, there multiple algorithms and systems of machine learning, and this thesis sets its focus on the entry level approaches of clustering and classification. These digital techniques are useful in almost any industry and organization due to its universal abilities. Therefore, the benefits of clustering and classification can also be used in Hempel, Maersk Drilling and Smith-Nephew. The following section will provide details of the benefits clustering and classification can give to demand planning and sale.

Demand Planning

In Hempel and Smith-Nephew, clustering and classification can be used in various functions in the S&OP department. Firstly, the digital technology can be used to predicts and forecast the future demand more accurately. The classification can be used to set up rules and parameters, which if met, changes the forecast to accommodate the rules. The predefined conditions and parameters serve as limitations in which the classifier can react. This can be extreme beneficial in companies as Hempel, which suffers from a large product portfolio, where it's hard to keep track on all items. The digital model can then be programmed to highlight the biggest changes, if any, or the changes which are made on most important customers.

As stated in the interview, most of the forecast handling are performed manually, which means that the employee manually changes the parameters from moving average 6 months to 3 months etc. With proper rule sets and boundary conditions from the classification tool, the technology can make these changes themselves if taught/programmed correctly. This will release tremendous amount of resources and minimize personal errors.

The classification section can therefore be used to accommodate this task, but in collaboration with the clustering algorithm, the forecast accuracy can improve even further. The clustering algorithm is unsupervised learning, which means that the system learns from previous data. There will always come situations where the forecast is acting beyond the rules set and therefore needs manually handling. With clustering, the system can recognize and identify the patterns made by human interaction and re-use those actions when the same incident happens. In that case, the system will be able to constantly apply more "rules" as the months go on. As the system gets more mature, less resources will be used on the system as it learns from previous actions. (Real Carbonneau *et al.,* 2007)

Another beneficial use of the clustering is the entering of new products in the forecast. Classification can only work with previous training data and can't be used on new products. But the clustering can recognize patterns and function similarities. With clustering algorithm, the system can identify similar products already forecasted and apply these parameters to the new items with no information or data.

Both Hempel and Smith-Nephew have another opportunity for usage of clustering and classification. Both companies are very tender based which means that due to production time and delivery, the products need to be forecasted before the tender case is won. This means that the company needs to predict whether the specific tender case is going to be won or lost. In this case, clustering and classification can be very beneficial as well. By setting up pre-defined rules and boundary conditions of when a tender case needs to be forecasted, the clustering can be used to compare new tender cases to old tender data based on patterns and similarities.

With this technology, the company can instantly detect if the new tender case should be forecasted immediately or not.

Sales

Within sale and marketing, clustering and classification can also be very beneficial. The ability of clustering in finding patterns and recognize similarities can be used when handling new customers and suppliers. The clustering algorithm can detect the functions of the customer and compare to former negotiations with similar customers. This pattern recognition can provide help and assistance for the sales manager in how to approach the negotiation in terms of customers these customers types act and what kind of deals were made previously with similar cases. The same approach goes with trying to win tender cases, clustering can be used to analyse how far the price can be pressed or what demands these customers typically have. That way, the machine learning algorithms can be used for decision making when handling a new customer with no previous data. (Marko Bohanec *et al.,* 2017)

Within Maersk Drilling, many of the previous aspects of sale and forecasting also goes beneficial for this company. In addition, clustering and classification can be used for forecasting spare parts on the oil rigs. Using sensors to detect when a spare part is worn out is one approach, but this partly runs on historic data from previous cases. Clustering can be used when introducing new spare parts with no history available.

8.2.3 Cloud Computing

Cloud Computing is the last digital technology to be applied onto the three case companies. Unlike machine learning techniques and blockchain technology, cloud computing doesn't have a directly impact on the data of the organization. The benefits of cloud computing can't be measured directly in KPI's and monthly accuracy. The benefits of this technology are more on the soft-side and will improve the transparency, collaboration etc. This section therefore provides details of the benefits which cloud computing will bring for the organizations.

The first benefit for Hempel, Smith-Nephew and Maersk Drilling is the cost efficiency which the system will bring.

Unlike the SAP systems which are in-house ERP systems, a cloud-based solution provides such cost savings due to the lack of software investments and computer ownership. The only fee is the activation fee and the monthly subscription fee. Maintenance and upgrade cost will also be kept to a minimum with this solution. Smith-Nephew are already using a cloud-based ERP system in Logility, but Maersk Drilling and Hempel could potentially save capital with cloud computing ERP systems.

Secondly, cloud computing offers great simplification to the three case companies. With a cloud-based solution, every part of the supply chain is accessible through the same platform, improving the transparency and the information-sharing across regions. This is especially something that Hempel would benefit from with the large collaboration issues across regions. Smith-Nephew's current cloud-based solution are also limited to each office i.e. each country. Providing a multinational cloud-based solution would provide them opportunity to share best-practise.

A sophisticated cloud computing solution will also provide flexibility throughout the supply chain. Currently, Smith-Nephew can't access the Logility ERP system when outside of the office. With a complete cloud-based platform (IaaS), the employees would be able to access the ERP system from any location. Furthermore, a cloud-based system serves visibility throughout the supply chain, in that sense, Hempel, Smith-Nephew and Maersk Drilling can observe real-live event happening in their supply chain. This becomes very relevant when dealing with multiregional collaborations, as the regions can interact through the cloud-based solution and work in the same project simultaneously.

8.3 Subconclusion

The chapter of analysis served the applications of the founded theory and strategies from the theoretical framework, chapter 6. The chapter introduced the three selected case companies of Hempel, Smith-Nephew and Maersk Drilling with a short profile intro and a brief intro to their S&OP set-up. From there, the three case companies were measured in maturity of their S&OP departments. The maturity model served the purpose of illustrate the maturity the department has in terms of implementing new digital technology.

Maersk Drilling scored 3.5 in average in the maturity model and was therefore deemed successful for appliance of digital technology. Yet, the barrier was 3.5, meaning that the maturity is at minimum. Smith-nephew proved higher maturity in their S&OP department, as they scored 4.2 in average on the maturity model deeming them suitable for technology investments. The last company of Hempel scored an average of 3 meaning that the company are not ready for digital technology investment, based on the maturity model.

Furthermore, in support of the maturity model, the TOE framework was used to determine the readiness of the companies on more external basis as environmental readiness, global organizational readiness and the availability of the desired technology. This framework proved no major hindering for the three case companies.

Lastly, the appliance of the digital technology was applied to the three companies. This included details of what kind of technologies could be useful and how they would impact the functions. Cloud Computing, Blockchain and Machine Learning were applied onto demand planning, sales and procurement.

This chapter primarily focused on the pre-requisites of the strategy framework for appliance of digital technology, along with the potentially benefits and areas which could improve with the implementation. The implications, disadvantages and considering's of the appliance will be addressed in the discussion, chapter 9.

9 Discussion

This is the last chapter of the thesis. In the discussion chapter, the topics of the thesis will be discussed from other angles and put into perceptive. Firstly, other technologies which have not been selected for this thesis will be discussed. There are plenty of other new technologies available, and some may have positive impact on the three case companies. Secondly, the impacts and disadvantages of the digital technologies will be addressed. This is to highlight the negative impact which can occur when investing in new digital technology.

This thesis has covered the topic of strategic frameworks for appliance of digital technology in the S&OP department. The thesis covered the digital technologies of blockchain, machine learning and cloud computing. While these were determined the most useful digital technologies for Hempel, Smith-Nephew and Maersk Drillings situation, there's many other technologies which are available in today's world. A few of them is Deep Learning and 3D Printing.

3D Printing is the technology which enables companies to produce their own products or materials without the need of suppliers. The potential and benefits of 3D printing is endless, and especially companies like Maersk Drilling can make tremendous usage of 3D printing. 3D printers could potentially be placed at the oil rigs out in the oceans. The developers and engineers could from onshore sent the details to the rig, and the rig could thereby print the spare part needed.

The major hindering right now is the run-time on the machine and the price of production. 3D printing is still much more expensive than metal and moulded plastic. In the future, 3D printing is definitely a potential game changer both for companies and private customers, as this could reduce the need of logistics and distribution dramatically.

As the thesis will state through the theory and analysis, digital technology is overall a tremendous benefit for S&OP, supply chain and companies in general. The potential for technologies is still huge, and with many developments to be unlocked. Though, there is still plenty of implications, disadvantages and possible notifications which needs to be addressed for any organization.

It is not without reason that the companies are recommended to for fill a maturity control of their organization before implementation. The arguably biggest factor to consider is the acquisition cost of the digital technology.

To apply digital technology, involve several expensive steps, which is why the size and revenue of the company are to be considered before appliance. While the hiring of an external consultancy to measure the maturity of the organization can seem expensive, it's nowhere as expensive as a failed technology investment. The future expenses for the investment should also be considered, as the technology will require updates, downtime, configuration etc.

Another important topic for implications is the data quality. The maturity model serves additionally to make sure that the data usage at the company is sufficient for new digital implements. Data outcome are never superior to the data input. Thus, the company needs to be able to handle and analyses their current data before appliance machine learning algorithms. It takes resources and time to sort and analysis the data before input into machine learning models. Furthermore, the data outcome can possibly require additionally resources and time to interpret, depending on the advancement of the technology.

The surveys of the introduction stated that companies were still struggling to interpret and make use of the data available. This will not be easier with machine learning algorithms, which will require educated technicians. Another worry is the performance of the digital technology. There's no telling, whether the technology will perform correctly or experience downtime. The system will properly be loaded with limitations at first, which will require an external technician out to fix it, creating downtown and waste.

As mentioned in the theoretical framework, the better the data input, the better the output. If a company only have 1-2 years of training data, the outcome of the machine learning models could potentially be wrong or misleading. With little data history, even the slightest fluctuations can resolve in major changes in the outcome of the data and thereby the conclusions drawn. Additionally, even with an extensive amount of training data, proving the data wrong can be tricky.

With an advanced and sophisticated software system, the data and programming can be so abstract, that it requires certain people or external people to figure out whether it's programmed wrong or right. It can be difficult to analyse whether the machine have provided the most optimal solution, or something is incorrect. These persons to investigate this are typically the consultants from the consultancy firm installing the software. To call for external assistance each time the machine provided suspicious decisions, or something is wrong is expensive and resource-waste.

10 Conclusion

The objectives of this master thesis were to develop of strategy framework which can be used by companies and organizations as of what pre-requisites needed before implementation, what available options of technology is there and what impacts and consequences does the appliance have on the people and processes. The main purpose of the master thesis was furthermore to fit this strategy framework into an S&OP department within 3 selected case companies.

The introduction of the thesis illustrated issues and problems in the case companies regarding the knowledge and information on digital technology. Thus, many of the monthly tasks were deemed time consuming and artificial intelligence could be interesting but it was never truly investigated. In support of these statements, global surveys indicated fear and employee concern as a great factor of lack of implementation. To overcome these challenges provided by the interviews and the surveys in the introduction, 3 case companies were selected for appliance of the strategy framework of the thesis.

Through the literature review, a sorting model was used to narrow down the potential theory and literature into the most relevant articles and papers. Through all 5 steps, 16 articles and papers were deemed optimal for solving the research questions. This literature was built into a theoretical framework which consisted of a maturity model, TOE framework, machine learning, and cloud computing, blockchain and change management. All this theory was used in the analysis to answer the research questions.

The maturity model deemed all 3 selected case companies as mature enough for appliance of digital technology. Maersk Drilling and Smith-Nephew were deemed very capable while Hempel was on the balance. The maturity was thereby furthermore tested in the TOE framework for possible hindering in technology, organization and environment. From there, clustering and classification were applied to the case companies and their S&OP department. Blockchain and Cloud computing as well.

The strategy framework for appliance of digital technology and thereby also the recommendations of this thesis is the divide the project into 3 major categories; pre-requisites, digital models and consequences. The pre-requisites should consist of a maturity model and a TOE framework. This should be filled out by at least 2-3 employee's all in different positions in the S&OP department. When choosing digital models, they should consider clustering and classification as these are beneficial and are proven to improve many areas of their S&OP department. Blockchain, Cloud Computing and other technologies should also be investigated depending on the company and industry.

Furthermore, change management should be on the agenda throughout the entire project. The handling of the employees is equally as important as the technology. Lastly, the impacts and consequences should be considered, and a possible scenario planning tool could be potential beneficial here.

The research questions of what pre-requisites needs to be addressed before applying digital technology, what digital technology is currently available and what are their attributes and how can digital technology models improve the current setup in the chosen organizations and what are the possible implications, are thereby answered.

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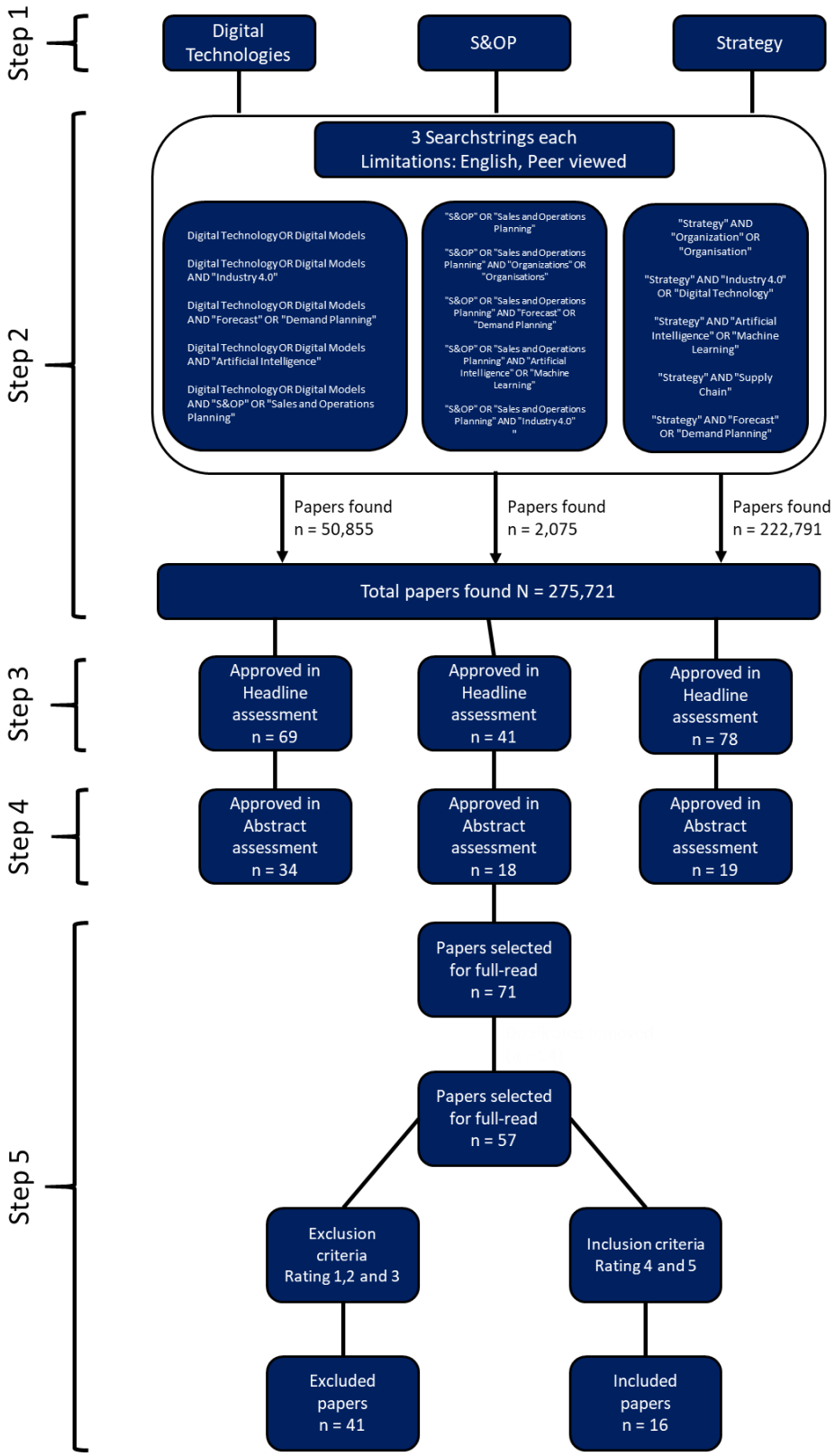
12 Table of Figures

13 Appendix


Step 1
Digital Technologies
S&OP
Strategy
Step 2
3 Searchstrings each
Limitations: English, Peer viewed
Digital Technology OR Digital Models
Digital Technology OR Digital Models AND "Industry 4.0"
Digital Technology OR Digital Models AND "Forecast" OR "Demand Planning"
Digital Technology OR Digital Models AND "Artificial Intelligence"
Digital Technology OR Digital Models AND "S&OP" OR "Sales and Operations Planning"
"S&OP" OR "Sales and Operations Planning"
"S&OP" OR "Sales and Operations Planning" AND "Organizations" OR "Organisations"
"S&OP" OR "Sales and Operations Planning" AND "Forecast" OR "Demand Planning"
"S&OP" OR "Sales and Operations Planning" AND "Artificial Intelligence" OR "Machine Learning"
"S&OP" OR "Sales and Operations Planning" AND "Industry 4.0"
"
"Strategy" AND "Organization" OR "Organisation"
"Strategy" AND "Industry 4.0" OR "Digital Technology"
"Strategy" AND "Artificial Intelligence" OR "Machine Learning"
"Strategy" AND "Supply Chain"
"Strategy" AND "Forecast" OR "Demand Planning"
Papers found n = 50,855
Papers found n = 2,075
Papers found n = 222,791
Total papers found N = 275,721
Step 3
Approved in Headline assessment n = 69
Approved in Headline assessment n = 41
Approved in Headline assessment n = 78
Step 4
Approved in Abstract assessment n = 34
Approved in Abstract assessment n = 18
Approved in Abstract assessment n = 19
Step 5
Papers selected for full-read n = 71
Papers selected for full-read n = 57
Exclusion criteria Rating 1,2 and 3
Inclusion criteria Rating 4 and 5
Excluded papers n = 41
Included papers n = 16