Fit for Purpose Tactical Production Planning

a context-based view on sales and operations planning

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ON SALES AND OPERATIONS PLANNING

BY
JESPER HEMDRUP KRISTENSEN

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AALBORG UNIVERSITY
DENMARK

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A CONTEXT-BASED VIEW ON SALES AND OPERATIONS PLANNING

by

Jesper Hemdrup Kristensen

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Dissertation submitted on the 28th of August 2018

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PhD supervisor:	Prof. Brian Vejrum Wæhrens Aalborg University
Co-PhD supervisor:	Prof. Charles Møller Aalborg University
PhD committee:	Associate Professor Iskra Dukovska-Popovska (chair.) Aalborg University
	Professor Mats Johansson Chalmers University of Technology
	Professor Jan Björnson Holmström Aalto University School of Science
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CV

Jesper Hemdrup Kristensen is from Dybvad in Nordjylland, Denmark. He studied at Aalborg University, where he completed a B.Sc. degree in Global Business Engineering in 2013, followed by an M.Sc. degree in Operations and Supply Chain Management in 2015. Since then, he has been a PhD student at the Department of Materials and Production at Aalborg University, where his research on fit-for-purpose tactical production planning is part of the Manufacturing Academy Denmark (MADE) project, funded by the Innovation Fund Denmark.

ENGLISH SUMMARY

All companies need to coordinate their activities to ensure the optimal use of resources and fulfilment of customer needs. Since the 1950's management practices have advocated closing the gap between functions in the company, to ensure that the company work in unison towards the same goals. Consequently, tactical planning became the process that unified sales and capacity plans on a medium-term planning horizon (i.e. 3-24 months). To ease the tactical planning efforts, the process Sales and Operations Planning (S&OP) was developed to facilitate tactical planning in balancing supply and demand. The process consists of a series of steps that brings together decision-makers to ensure the alignment of the organisation's plans so that the functions of the company follow the same strategic goals. The S&OP process and benefits hereof have been investigated and documented for years, i.e. through best practice cases. However, recently researchers and practitioners alike report difficulties in reaching a high performing process, despite these best practices. This indicates that what might work for one company is not necessarily a fit for other companies.

According to the contingency theory, there is no one best way to organise a company. Rather, it is about achieving a fit with the internal- and external context of the organisation. This research expands and supports this view, by examining how the S&OP process should be designed for different companies, and further, how this should be done in practice. For these reasons the research question posed for the thesis is:

How can S&OP reach high performance, through the optimal design of the process, and implementation and maturation of S&OP?

To answer this, the thesis is divided into two parts. The first part investigates how different contexts affect the S&OP design and resulting performance benefits. The second part investigates how to implement and/or mature the S&OP process, to ensure that the design of the S&OP process fits the context of the company and ensure that the continuous development of the process is aligned with the context.

To do so, mixed methods have been applied. Both parts take a point of departure in the findings on the topic in current literature, both from academic and practitioner sources. These are then further researched using case study approaches such as embedded case studies, multiple case studies and action research.

The result of the first part of the study was that a large part of the current sources from academia and practitioners did provide information on how the S&OP process is affected by context, albeit often not always explicitly. The derived effect was that some context areas (industry, dynamic complexity, detail complexity and organisational characteristics) clearly affected the optimal design of S&OP, while

other context areas (firm size, manufacturing strategy and hierarchical planning framework) should be considered as well, due to their implications for the tactical planning. Empirical studies further found that the strategic decision area of capacity extension should be considered on the tactical horizon if; there are discrete changes in the demand, the workforce is flexible, and inventory cost is high relative to the cost of production assets. In addition, the use of Advanced Planning and Scheduling systems for tactical planning were found to not only be beneficial for companies with a mature planning process, as it also supported the assessment of the production set-up on a tactical horizon for immature planning processes. Lastly, it was found that S&OP need to be designed in accordance with the processes and systems in the company, as the interfaces are critical to the success of the company.

For the second part, two approaches were needed, one for the new adopters of S&OP, and one for the companies already using S&OP, but in need of reassessing their S&OP design. Therefore, a greenfield approach was developed, in form of an implementation plan for S&OP, this was derived based on the findings from the first part of the study, supported by literature findings. This included the added element "S&OP roadmap", which is designed to provide insights towards the desired development of the S&OP design, according to the contexts of the company. A brownfield approach was further proposed, which used insights from an end-to-end assessment of the planning processes in a global industry leading OEM. Here, it was found that the series of workshops and tools used was instrumental in identifying the misfits in the S&OP design. The mechanisms hereof were explored in order to propose a method to identify misfits and redesign projects for an existing S&OP process.

As a result, this study provides guidelines for known contextual effects on the S&OP design and performance. It further discusses areas in need for further studies, before we are able to make a full contingency approach towards designing S&OP for different contexts. To assist in this process, the study proposes methods for the assessment of the S&OP design in relation to the context, in a greenfield- and brownfield approach. Both strive to guide companies towards a fit between S&OP design and context.

DANSK RESUME

Alle virksomheder har behov for at koordinere deres aktiviteter for at sikre en optimal brug af ressourcer og opfyldelse af kundebehov. Siden 1950'erne har ledelsespraksis forsøgt at lukke kløften mellem funktioner i virksomheden for at sikre, at virksomheden arbejder sammen om de samme mål. Taktisk planlægning blev den proces, som skulle forene salg og kapacitetsplanlægning på en mellemlang planlægningshorisont (dvs. 3-24 måneder). For at lette den taktiske planlægnings indsats blev processen Sales and Operations Planning (S&OP) udviklet til at balancere udbud og efterspørgsel. Processen er en række trin, der bringer beslutningstagere sammen for at sikre, at organisationens planer er tilpasset, og virksomhedens funktioner følger de samme strategiske mål. S&OP processen og fordele heraf er blevet undersøgt og dokumenteret i årevis og er veldokumenteret i best practice eksempler. I nyere tid rapporterer både forskere og praktikere vanskeligheder med at nå en højtydende proces på trods af disse best practices. Dette tyder på, at det der virker for en virksomhed, ikke nødvendigvis passer til andre virksomheder.

Ifølge contingency teorien er der ingen bedste måde at organisere en virksomhed på. Det handler snarere om at opnå en passende organisering mellem organisationens processer og den interne- og eksterne kontekst. Denne forskning udforsker denne opfattelse af, hvordan S&OP processen skal udformes forskelligt for forskellige virksomheder, og yderligere hvordan dette skal gøres i praksis. Af disse grunde er følgende forskningsspørgsmål blevet stillet til afhandlingen:

Hvordan kan S&OP opnå gode præstationer gennem den optimale udformning af processen og implementering samt modning af S&OP processen?

For at besvare dette er afhandlingen opdelt i to dele. Den første er afsat til at undersøge, hvordan forskellige kontekster påvirker S&OP design og den resulterende performance. Den anden del er rettet mod, hvordan man implementerer og/eller modner S&OP processen for at undersøge, hvordan man sikrer, at designet af S&OP processen passer til virksomhedens kontekst og sikrer, at den fortsatte udvikling af processen er i overensstemmelse med konteksten.

For at gøre det er flere metoder blevet anvendt. Begge dele tager udgangspunkt i resultater fra litteraturen, både fra akademiske og praktiserende kilder. Disse udbygges derefter yderligere ved anvendelse af casestudier, såsom embedded casestudier, multiple casestudier og action research.

Resultatet af studiets første del var at en stor del af de nuværende kilder fra den akademiske og praktiserende verden gav oplysninger om, hvordan S&OP processen er påvirket af kontekst, men ikke altid eksplicit. Den afledte virkning viste sig at være, at nogle kontekster (industri, dynamisk kompleksitet, detaljeret kompleksitet og

organisatoriske egenskaber) klart påvirker det optimale design af S&OP, mens andre kontekster (virksomhedsstørrelse, produktionsstrategi og hierarkisk planlægningsramme) også bør overvejes, på grund af deres konsekvenser for den taktiske planlægning. Endvidere viste empiriske undersøgelser at det strategiske beslutningsområde for kapacitetsudvidelse bør overvejes på den taktiske horisont, hvis der er diskrete ændringer i efterspørgslen, arbejdsstyrken er fleksibel, og lageromkostningerne er relativt høje i forhold til omkostningerne for produktionsaktiverne. Derudover blev det konstateret, at brugen af Advanced Planning and Scheduling systemer til taktisk planlægning ikke kun er til gavn for virksomheder med en moden planlægningsproces, da det også kan understøtte vurderingen af produktionsopsætningen på en taktisk horisont for virksomheder med en umoden planlægningsproces. Yderligere er den positivt korreleret med planlægningens kompleksitet. Til sidst blev det konstateret, at S&OP skal udformes i overensstemmelse med de processer og systemer, der findes i virksomheden, da grænsefladerne er kritiske for virksomhedens succes.

For den anden del blev det konstateret, at der var brug for to tilgange; en til de virksomheder der skal til at implementere S&OP, og en for de virksomheder der allerede bruger S&OP, men har brug for at revurdere deres S&OP design. Derfor blev der udviklet en greenfield tilgang, i form af en implementerings-plan for S&OP, der er udledt ud fra resultaterne fra første del af studiet, understøttet af resultater fra literaturen. Dette omfattede det supplerende element "S&OP roadmap", som giver indsigt i den ønskede udvikling af S&OP designet i forhold til virksomhedens processer og systemer. Der blev også foreslået en brownfield tilgang, som anvendte resultaterne fra en komplet vurdering af planlægningsprocessen i en global industriledende OEM. Her blev det konstateret, at serien af workshops og værktøjer der var brugt, var med til at identificere elementer af dårligt passende S&OP designs. Mekanismerne til dette blev udforsket for at foreslå en metode til identifikation af dårlig tilpasning og forslag til redesign projekter for den eksisterende S&OP proces.

Som konklusion, så udformer dette studie retningslinjer for kendte kontekstuelle virkninger på S&OP designet, samt forslag til områder der har behov for yderligere undersøgelser (hvoraf der er mange), før vi er i stand til at udarbejde en fuldstændig kontekst baseret guide til at designe S&OP til forskellige kontekster. For at guide denne proces foreslår studiet metoder til vurderingen af S&OP designet i forhold til konteksten, i en greenfield og brownfield tilgang. Begge har til hensigt at lede virksomheder mod et passende S&OP design, som kan hjælpe virksomhederne med at opnå en højtydende S&OP proces.

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I would like to thank my family and friends for their support, and for offering so many opportunities for recreation, so I did not fade away into my studies. Last but not least, I would like to thank my wife for her support during my studies. When my studies reached a rough part, you always offered support, you were there when I needed sparring and you were there to celebrate the victories. All of this you accomplished in a period where we truly settled our family, we bought our house, got engaged, married, added to our family (our lovely dog Elton), and are expecting the arrival of yet another family member.

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Paper 3. Asmussen, J.N., Kristensen, J., Steger-Jensen, K. and Wæhrens, B.V. (2018), ”When to integrate strategic and tactical decisions? Introduction of an asset/inventory ratio guiding fit for purpose production planning”, *International Journal of Physical Distribution and Logistics Management,* Vol. 48, No. 5, pp. 545-568.

Paper 4. Kristensen, J., Asmussen, J.N. and Wæhrens, B.V. (2018), ”A context-based study of Advanced Planning and Scheduling (APS) for tactical planning”. An improved version of the conference article presented at: *2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Singapore, Singapore.*

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CHAPTER 1. INTRODUCTION

Tactical production planning and especially Sales and Operations Planning (S&OP) is built on existing management practices, which have been advocated since the 1950s (Ducker, 1955). Here, it is strongly advocated for management to focus on closing the gap between functions in a company and managing the 'great divides' between supply and demand (Tate et al., 2015). As the operational plans, such as the sales-, financial- and operational plan, are focussed on fulfilling diverse objectives that once scrutinized, is found to be mutually exclusive, hence creating a variety of suboptimal plans, that hinders the business in achieving their full potential.

The tactical production planning serves to balance future supply and demand, while the S&OP process enables this balance by bridging the gap between sales and operations. However, one of the drawbacks found is that there is no one best way of doing S&OP (Jonsson and Holmström, 2016) and that S&OP is in need of being tailored to the different needs and contingencies (Sousa and Voss, 2009). This is the basis of this thesis and will be the connecting thread throughout the research projects.

This chapter introduces the topics covered in the thesis. The first section will elaborate on the research theme; tactical production planning through the Sales and Operations Planning (S&OP) process. This is followed by an empirical motivation, based on a Danish manufacturing context which highlights the challenges that lead to the research objectives of the study. Lastly, an overview of the structure of the thesis is presented to guide the reader through the remainder of the thesis.

1.1. RESEARCH THEME

The theme, tactical production planning, originate from the separation of production planning decision areas, which are found in traditional planning frameworks, such as the Materials Planning and Control (MPC) framework (Jacobs et al., 2011) and Hierarchical Production Planning (HHP) framework (Miller, 2001). The planning frameworks serve as guides towards organizing, planning and scheduling the production activities at manufacturing companies. While the frameworks have existed since the 1960's (E.g. Anthony, 1965), the practice presumably has existed for longer. The approach to production planning has matured through the years, for instance with the introduction of the Enterprise Resource Planning (ERP) systems. The frameworks divide the planning decisions into three levels, which have commonly been labelled strategic-, tactical- and operational planning, see Figure 1.1.

The *highest* level, strategic planning, decides on the long-term plans and how to achieve the strategic objectives of the firm. Here, the decision areas are related to the assets of the company, i.e. the number, location and size of factories, stores and/or suppliers (Anthony, 1965). These decisions are commonly taken on a time horizon of

two to five years, and often longer, as decisions on this time horizon are evaluated based on financial measures such as return on investment (ROI). Within strategic planning, research focuses on different strategies, such as make-to-order or make-to-stock (Olhager et al., 2001), outsourcing approach (Slepniov and Wæhrens, 2008), the design of the global footprint of the company (Ferdows et al., 2016) and the how to prioritise the strategic objectives of the company (Slack, 1994).

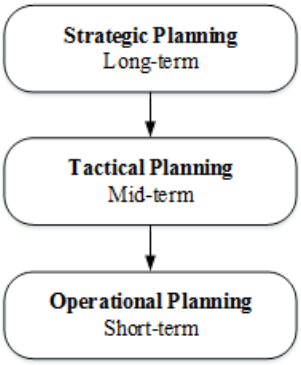

Figure 1.1. Production planning hierarchy and the time horizons.

The *medium* level, tactical planning (also known as aggregated planning), is focused on mid-term plans typically on a two-months to two-year time horizon. Historically, the medium-term plans have been focused on budgeting (Anthony, 1965), however, through the years it has gained traction as an essential process for resource allocation and resource utilization. Tactical planning is working within the frames set by the strategic planning, namely the given assets, and is planning areas such as workforce, inventory, capacity allocation to product groups, sourcing assignments and transport lanes with the objective of ensuring enough supply to match the future demand. While strategic planning is setting the overall frame of the company, then it is the task of the tactical planning to best utilize the given frame. Tactical planning, therefore, encompasses demand management, which focuses on providing an accurate forecast for the future demand of the company, which is then used for the planning of the capacity and production levels. Tactical planning has gained tremendous traction in practice and academia as the plan which balances supply and demand. For a supply chain perspective, this is for instance seen as an approach for handling the Forrester effect (Lee et al., 1997), where a longer perspective is used to avoid the short-term fluctuations. The tactical planning process, labelled the Sales and Operations Planning (S&OP) process, has been advocated as the process to facilitate efficient tactical planning, which originates from America in the 1980's (Ling and Goddard, 1988).

The *lowest* level, operational planning, is focused on short-term plans with a time horizon ranging from hourly or weekly up to one year. But, while the time horizon can stretch for longer periods, the focus is on the daily execution. The task here is to

execute the production plan as efficient as possible, e.g. through scheduling of work processes (Jacobs et al., 2011).

The planning hierarchy, as illustrated in Figure 1.1, illustrates the progression of planning activities. The strategic planning's goal is to achieve a strategic direction, through investments in assets and strategic priorities. The tactical planning is constrained by the frames set by the strategic planning, and its goal is to match future demand with capacity. The operational plan is then constrained by the tactical planning, and its objective is to execute the production in the most efficient way.

The focus area of this research project is on the tactical planning, while it is acknowledged that tactical planning is a part of this bigger picture. The recent trends in both practice and academia emphasise tactical planning as an approach to handle contemporary trends. It serves as a process to facilitate governance of demand forecast, product phase-in and phase-out, and capacity management. In addition, it creates a one-shared plan across functions and entities, it is used to conduct scenario planning, facilitate risk assessments, as well as aligning the strategic direction throughout the organisation.

The S&OP process is used to facilitate the tactical planning and is often described as a five-step process, as depicted in Figure 1.2. The process is running on a monthly calendar, meaning that it is a cyclic process, which is conducted once every month. The five steps consist of three preliminary processes, which can be conducted sequentially with inputs from one another, or independent of each other and reconciliated afterwards. The three steps are the product review, demand review and supply review, responsible for updating product introduction and phase-out plans, demand forecasts and capacity plans, respectively, for each month's reconciliation.

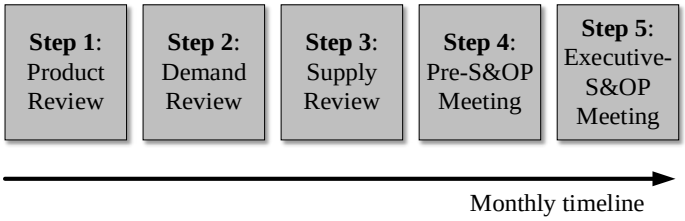

Figure 1.2. An illustration of the S&OP process.

The reconciliation serves to balance the supply and demand while finding the issues from all areas of the organization regarding the ability to supply or sell the products in focus. These issues are handled at the two subsequent meetings, the pre-S&OP meeting and executive-S&OP meeting. The first serve to address the issues which can be handled by the middle management without the need of involvement from the top management, while the second resolves or makes plans for issues that require top management attention, as well as, signing of the final plan that is to be executed.

The adoption of S&OP has been linked to various performance gains, such as increased profit margins, revenue, forecast accuracy, service levels and lowered inventory levels (Bower, 2006; Muzumdar and Fontanella, 2007; Wagner et al., 2014). However, a common mistake is to believe that a company receives these benefits just by implementing an S&OP process. In practice, the process needs to be matured, in order to achieve the higher performance gains (Grimson and Pyke, 2007). For this reason, various maturity models have been proposed, describing paths to higher performance (Cacere et al., 2009; Danese et al., 2017; Grimson and Pyke, 2007; Wagner et al., 2014). The maturity models offer descriptive insights towards how S&OP is conducted at different stages of maturity. These maturity models have gained a lot of attention, as they are linked to improved operational performance. While a recent study has investigated how the design changes during the transition between maturity steps (Danese et al., 2017), it did not account for whether the design changes were due to contextual fitting, or if it was simply following the prescribed maturity models. More studies are needed in this area to investigate the link between the S&OP maturity and –design.

Another stream of literature is focusing on using S&OP for different purposes, mostly concerned with fitting S&OP for different industries. Dreyer et al. (2018), Ivert et al. (2015A) and Noroozi and Wikner (2017) are all examples of studies focusing on tailoring the design of the S&OP process to the needs of different industries, retail, food manufacturers and process industries, respectively. This stream of literature does not entirely disregard the aspect of maturity, but in these studies, performance is linked to the achievement of a fit-for-purpose S&OP, which takes the contingencies of the different industries into account when designing the S&OP process. These studies have been focused on a single industry or manufacturing type and do not account for the variety of context dimensions highlighted in the literature (e.g. Thomé et al., 2012; Paper 2). As a result, the area is in need of unifying research, and guidelines for assessing the S&OP design fit.

While the theme fit-for-purpose S&OP design remains the primary focus area of this research, the thesis further deals with the themes of implementing and maturing S&OP. All of these themes seemingly lead to higher operational performance, and none of them can be disregarded when striving for higher performance. According to Jonsson and Holmström (2016), the ability to explain how the different aspects of the S&OP performance lead to performance benefits will enable companies to design S&OP process specific to their purpose, with the least amount of wasted resource.

The concept of the S&OP process has been synthesized using the framework seen in Figure 1.3 (Ivert et al., 2015A; Thomé et al., 2012). The framework illustrates that S&OP has a horizontal part, where inputs into the process are transformed into outcomes, informs of operational plans. In addition, there is also a vertical part, where the business plans and corporate strategy is transformed into operations through the S&OP process. For this thesis, the S&OP design encompasses, to some degree, all of

the elements. The S&OP process and set-up hereof is found within the "structure and process" box. However, it can influence and is dependent on the links with strategic and operational plans (vertical) and the type and nature of the inputs and outcome (horizontal).

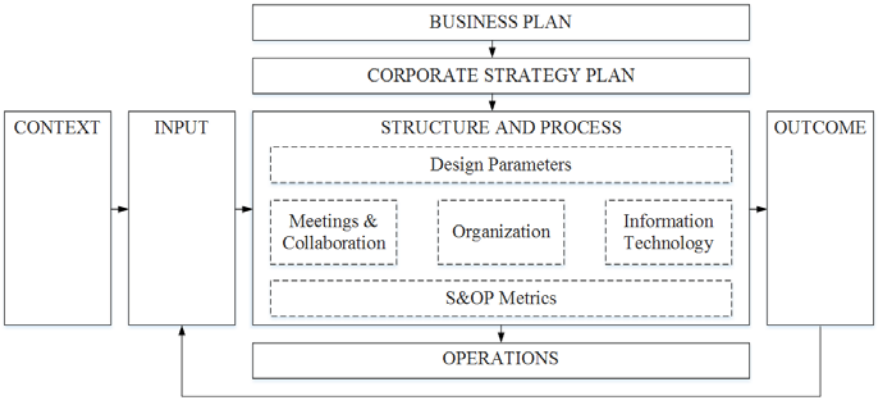

Figure 1.3. S&OP framework (adopted from Ivert et al. (2015A) and Thomé et al. (2012)).

In short, S&OP facilitates tactical planning and it is in need for fit-for-purpose research on S&OP design, to ensure the highest performance possible. This thesis considers S&OP design to consist of the design and organisation of the S&OP process (i.e. Structure and Process in Figure 1.3), as well as the linkages from strategic planning to operational planning, and the inputs that are transformed to outcome through the S&OP process.

1.2. EMPIRICAL MOTIVATION

Empirically, it is a priority for Danish manufacturing companies to ensure that their S&OP process delivers high performance. However, if reviewing the current state of S&OP adoption and challenges in a Danish industry context, then two survey studies express a bleak reality. The first study investigates the quality and use of the S&OP process within Danish companies and they found that while 80 percent of the companies did have a formal or unformal S&OP process. However, only eight percent of these reported that they to a large extent were satisfied with the result of the S&OP process, and as much as 50 percent was only satisfied to a small extent (Scholte and Thomsen, 2016). In the second study, they found that the share of companies working with S&OP has gone from 56 percent in 2013 to 86 percent in 2017. The study examined S&OP practices according to four dimensions: People, process, structure and technology. They asked companies on a five-point scale ranging from fully adopted practice to far from adopted practice, on how well they performed in the four

dimensions. The result of the study is illustrated in Figure 1.4 (Lund and Raun, 2017; Lund, 2017).

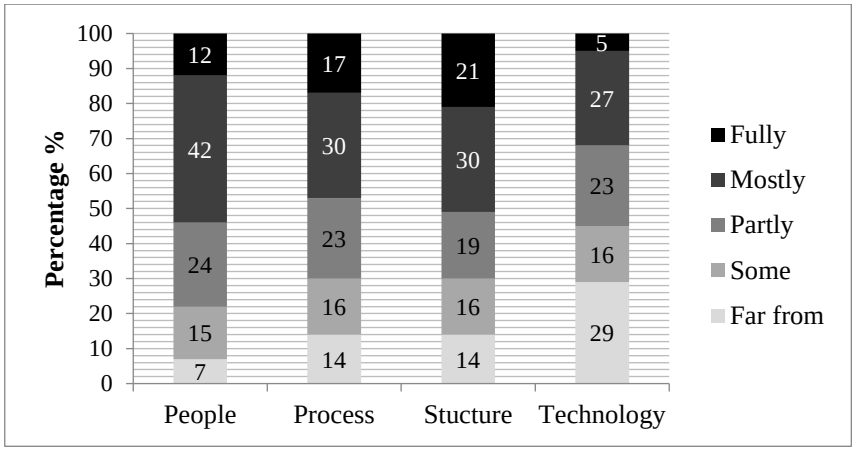

Figure 1.4. S&OP practice in Denmark (Lund and Raun, 2017)

As seen in the figure, Danish companies are performing best within the *People* category, while performing worst in the *Technology* category. However, across the board, almost half the Danish companies have only partly adopted S&OP practices, leaving a major gap for performance improvements to be found.

The experience of not getting the full benefits from the S&OP process was also reflected in the companies collaborating in the research project. Two companies have participated in the research conducted, both of them are large Danish companies, with a global production and sales network. Some general characteristics of the company are found in Table 1.1.

Table 1.1. Characteristics of Case A and Case B.

		Case A	**Case B**
Characteristics	**Revenue (2017)**	100.000-50.000 mil./DKK*	50.000-25.000 mil./DKK*
	Employees (2017)	25.000*	20.000*
	S&OP practiced since	2014	2009
	S&OP practice	Immature	Mature

* Approximate values due to confidentiality.

As seen in the table, then the two cases represent contrasting S&OP maturities, as one have been practising S&OP since 2009, while the second initiated S&OP in 2014, close to the start of the research project, which began in 2015.

Case A, who served as the primary case company, implemented S&OP to improve the performance of the company. However, the company experienced challenges in implementing a well-functioning S&OP process. One reason they expressed, was the high degree of complexity, as they rely on a large number of external suppliers, as well as owning a number of tiers and multiple sites in their supply chain, which makes the overall supply chain planning complex. In addition to this, their business is characterized by project sales, meaning that changes in demand are often discrete and have a high volume impact. As a result of the complex supply chain, multiple production facilities and suppliers have to deliver components to the same project with a critical accurate timing element, therefore, the company saw S&OP as a key process for orchestrating the supply chain. Additionally, due to the uncertainty involved in the project sales, they envision that S&OP could help them to align supply and demand, or at least prepare and assess the flexibility in the supply chain.

Case B, who served as a secondary case, was used to test ideas and share experience between the two cases. The case has been working with S&OP since 2009 and has a fairly mature S&OP process (E.g. see Paper 1). They too face a high degree of complexity, stemming from having multiple product groups, with a variety of demand scenarios (box-sales and project sales), different resource requirements, different transport solutions, as well as also owning a multi-tier supply chain.

These two cases served as the outset for initiating the research objectives, and for investigating S&OP.

1.3. RESEARCH OBJECTIVES

The research builds on the theme of tactical production planning, namely the S&OP process. The research investigates how to reach high S&OP performance, by investigating how design impacts S&OP, and additionally, how this can be used when implementing and maturing S&OP. Therefore, the overall research question is:

Main research question: *How can S&OP reach high performance, through the optimal design of the process, and implementation and maturation of S&OP?*

This research question investigates two avenues of S&OP. First, the link between S&OP design and performance needs to be investigated, as well as knowledge about how to design S&OP for different contexts. Second, while the link between S&OP performance and maturity has been established, the process of implementing and maturing S&OP is characterized by descriptive maturity models, with limited prescriptive value and guidelines. Additionally, it lacks the element of design-fit, as it recommends generic designs and generic processes. To overcome these gaps, and answer the main research question, the following three secondary research questions are formulated:

Secondary research question 1: *How does S&OP design-fit influence S&OP performance?*

Secondary research question 2: *What is known about S&OP design-fit and how does it affect S&OP performance?*

Secondary research question 3: *What is known about S&OP implementation and maturation?*

The main research objective is answered through three steps, related to each of the secondary research questions. First, it is investigated how S&OP performance is dependent on design-fit. Second, S&OP design is investigated for what is known, and how it impacts performance. This leads to the next step, where it is investigated how this knowledge can be included in the S&OP implementation and maturation knowledge, as both seek the goal of reaching the highest possible performance, and thus needs to be combined to answer the main research question.

1.4. POSITIONING

To position the research project, then the research uses a contingency-based research perspective, to investigate how to design S&OP in different contexts to achieve the highest performance. This is a design approach, related to how to achieve a competitive advantage through S&OP (Barney, 1995; Jonsson and Holmström, 2016).

Multiple authors have already suggested that S&OP is not a *one-size-fits-all* approach (e.g. Godsell et al., 2010), however, how to design the S&OP process to achieve a design-fit is not answered. Sousa and Voss (2008) applied a contingency theory lens, and found that most operations management practices, similar to S&OP, started by being driven by best practices, however, as they matured several examples of difficult and failed implementation efforts would emerge, as described in an S&OP context by Bower (2005), Lapide (2004A) and Piechule (2008), which according to Sousa and Voss (2008) is due to the fact that the practice is not fitting the contingencies of the company trying to implement it. Contingency theory is the theoretical lens to view this direction (Donaldson, 2001), it argues that there is no one best way to design an organisation, and is focused on finding a "fit" between the organisation and the contingencies (Lawrence and Lorsch, 1967).

Within the S&OP domain, this direction is clearly present, for instance, Jonsson and Holmström (2016) calls for analysing how S&OP generates outcomes in different contexts, using a Context, Intervention, Mechanism and Outcome (CIMO) approach. The CIMO approach closely resembles the approach of contingency research and is used for creating practically relevant research on how an outcome is created given certain contextual factors. For example, in this thesis, the hypothesis is that if the S&OP design matches the context of the company, then it can become a competitive

advantage. Paper 2 address how this fits into the current literature of S&OP and it illustrates that there is an increasing focus on context-related S&OP research (See Figure 1.5).

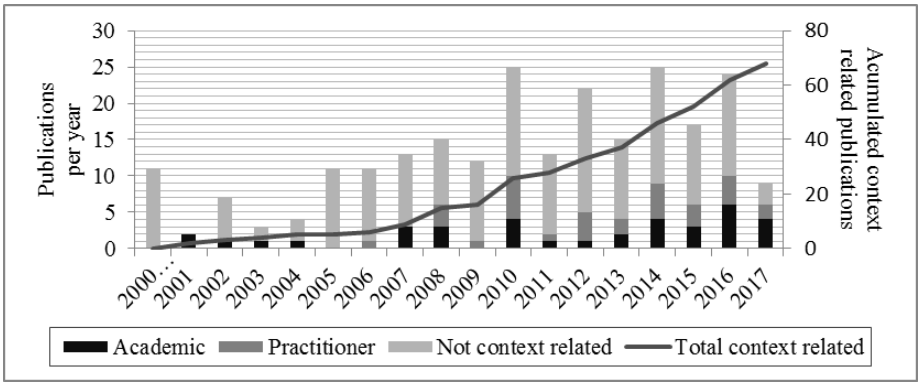

Figure 1.5. S&OP papers according to the year of publication, context relation and outlet type (Source: Paper 2).

This research is further expanding this research agenda, by putting forward new knowledge on context-related S&OP. This is done, first, by unifying a research agenda drawing on the previous research within the area. Second, by researching questions that for academic and practice are relevant.

Moreover, the current body of research on how to implement S&OP is to a high degree driven by practitioners and is dominated by conceptual studies (See Figure 1.6). This study reviews the current state of the art and proposes two methods for including the context-related S&OP research, when implementing and maturing S&OP, for companies with and without an existing S&OP process, respectively.

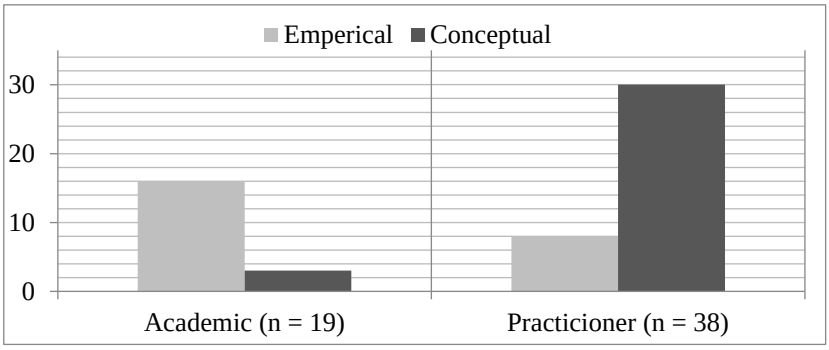

Figure 1.6. Studies on implementing S&OP (Data source: Paper 5)

1.5. STRUCTURE OF THE THESIS

The structure of the thesis is divided into seven chapters. An illustration of the progression of the chapters, as well as a short description of each chapter, is found in Table 1.2.

Table 1.2. Overview of the chapters in the thesis.

Chapter 1. Introduction
This chapter serves as an introduction to the research theme, tactical production planning, as well as introducing the empirical motivation and research objectives.
Chapter 2. Research design
The research approach describes how the research process was designed, which methods were used, and how they were linked.
Chapter 3. Research summary
The research summary presents the selected papers and highlights the methods, contributions and linkages from each paper towards the research objectives.
Chapter 4. S&OP design
This chapter answers the secondary research question on what is known about S&OP design, and how it affects S&OP performance.
Chapter 5. S&OP implementation
This chapter brings the knowledge about designing S&OP into the context of the implementation and maturation process of S&OP.
Chapter 6. Design approach for Sales and Operations Planning
This chapter presents novel research on how to include an assessment of design-fit at either a new S&OP adoption or as a reassessment of a running S&OP process.
Chapter 7. Conclusion
The conclusion section summaries the entire research project, and concludes on the results by answering the main research question. In addition, it assesses the limitations of the studies and proposes areas for future research.

The next section is dedicated to the research approach, and how the research was designed to answer the research questions posed.

CHAPTER 2. RESEARCH DESIGN

The question of how to optimally design and implement S&OP has value for both academia and practice, and this chapter will outline how these questions can be answered, and the methods used to investigate them. The question calls for empirical research, as in-depth knowledge is needed to understand the complexity of the S&OP set-up and be able to claim causality between variables. Parts of the research are anchored deeply in industrial practice, and multiple research methods are used throughout the research project. This chapter will go through the research position, the framework for guiding the research design and different research questions, the methods used for the research, and finally, the empirical foundation for the research.

2.1. RESEARCH APPROACH

Starting at the holistic level, then the research takes a system view, which "… *looks at reality as consisting of fact-filled systems structures in the objective reality and of subjective opinions of such structures, which are treated as facts as well."* (Arbnor and Bjerke, 2009, p. 39). With the systems view, it is acknowledged that a phenomenon can only be explained and understood in its context. The system view sees the whole, as being larger than the sum of its part, meaning that there are synergies between the different parts (Arbnor and Bjerke, 2009). As fitting for a system view, the research uses multiple methods, which gives different views on the issue at hand, while focusing on exploration.

My research project can be characterised as an exploratory study, where the research questions for the papers were developed, through the interaction with the case company and by investigating the current academic literature. The case insights were used for gaining knowledge of the practical problems, one could argue that it is this exploratory study which resulted in the research objective. The explorative study takes a grounded theory approach, from the 'Straussian' school, which contrary to the "Glasserian' school builds on a prior understanding, experience and knowledge of the topic (Glaser and Strauss, 2017). For this reason, an abductive research process is used (Kovács and Spens, 2005), which will be expanded in the following sub-section.

2.1.1. PHILOSOPHICAL RESEARCH POSITION

The research paradigm serves to explain the authors view on the world, here, multiple competing epistemological views are present, which are concerned with what should be considered acceptable knowledge. The views range from positivism to constructivism. For the positivist, the world is external to the individual, which in essence focus on the observable that can be verified and generalized (Bryman and

Bell, 2003). Constructivism, on the other hand, sees that actions are dictated and specific to the situation, and the specific circumstances (Croom, 2009).

The view of this research project is neither pure positivistic nor pure constructivist, it adopts a view in-between referred to as *critical realism* (Bhaskar, 1986; Guba and Lincoln, 1994). According to Coughlan et al. (2016), this view seeks to solve problems, by understanding the mechanisms. This type of research is relevant, as it seeks to solve the issues faced by operations and supply chain management practitioners. As in the research objective, critical realism sees context as essential to understanding activities and under which conditions they take place. Here, a phenomenon is viewed together with the context, as they are seen as interconnected.

This leads us to the abductive research process, which is used in this research project. In this approach, data is collected at the same time as theory is developed (Dubois and Gadde, 2002), a knowledge development process which is also found in research approaches such as design science (Holmström et al., 2009) and action research (Coughlan and Coghlan, 2002). The abductive research process is depicted in Figure 2.1, the process starts (1) once a deviation is spotted, but to identify deviations a prior theoretical knowledge is needed (0). Following this is a process of (2) theory matching, which seeks to find a new matching framework or extending the theoretical knowledge. The goal is to obtain new knowledge and build on theory (3). This further adds to a practical solution, through an application of the conclusion (4).

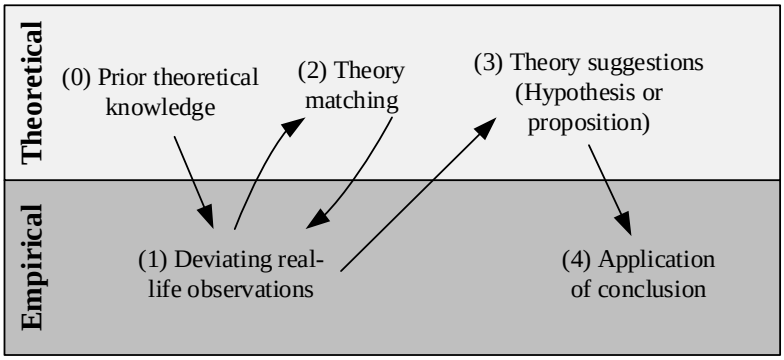

Figure 2.1. Abductive research process (Kovács and Spens, 2005, p. 139)

While the abductive research process is said to start once a deviation is spotted, then, in practice, a researcher can also introduce a new element, framework or apply another theory to an already existing phenomenon, and in that way seek deviations (Kovács and Spens, 2005). In this research, the abductive research process focuses on the theoretical knowledge of tactical production planning, namely S&OP. While the concept of contingency-based research is imposed to investigate how this affects our knowledge of S&OP.

2.1.2. BALANCING PRACTICAL AND ACADEMIC RELEVANCE

The research approach's goal is to achieve practical relevance while also providing a theoretical contribution. This area has been widely discussed in academia, see for instance: Boer et al. (2015), Ellinger and Chapman (2016), Stentoft and Rajkumar (2018) and Toffel (2016). The approach is to make contributions towards both areas, by building theory to the state-of-the-art research, as well as providing practically relevant implications.

To be practically relevant, it has been argued that research has to have the potential to *improve the decision making* of managers (Toffel et al., 2016). More granularly, Nicolai and Seidl (2010) have developed eight forms of practical relevance, as illustrated in Figure 2.2.

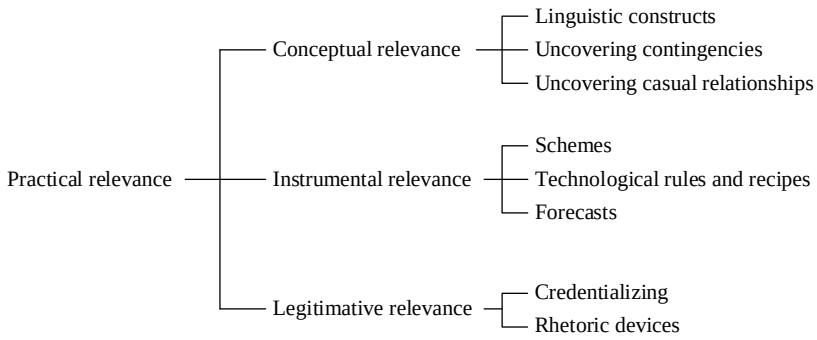

Figure 2.2. Practical relevant research (Nicolai and Seidl, 2010)

Here, practical relevance can be seen as *conceptual relevance* which can be relevant for creating linguistic constructs (concepts), and which can enhance how we think and talk about a subject. Moreover, it can uncover contingencies and/or causal relationships, which affects how we understand the phenomenon and helps explain why certain actions lead to certain outcomes. Practical relevance can also be seen as *instrumental relevance*, which includes schemes, which help to define decision variables (such as checklists or matrices). In addition, it can provide technological rules and recipes which guide practitioners towards different decisions. Additionally, it can be in the form of forecasts which predict future development. The last form of practical relevance is *legitimative relevance*, which can be credentializing and/or rhetoric devices, which refer to the use of an adequate jargon using vocabulary combining theory and practice, or by referring to relevant studies justifying the course of action. This research project predominantly contributes to *conceptual relevance*, however, through the studies *legimative relevance* is present.

In order to achieve practical relevance, the researcher has worked as a practitioner at one of the case companies, getting hands-on experience with the research topic,

changing the role from an observer to an actor. This approach ensures that the gaps which can be identified in academia are likewise a worthwhile gap to investigate for practice (Toffel, 2016). Another approach that has been used, is to co-author with a practitioner, as this can both provide insights to proprietary data, but also give a nuanced interpretation of the findings from the views of a pragmatic (Toffel, 2016). In addition, writing for cross-over journals has been done (Toffel, 2016); an example is Asmussen et al. (2016) which is published in the Danish magazine *Effektivitet*, which is targeting practitioners.

Representing a realist, believing that scientific theories represent reality and that they are getting closer to reality over time (Boer et al., 2015), then making a theoretical contribution depends either on the ability to be *consensus-shifting* or *consensus-creating*. The former refers to the ability to shift the academic community from one accepted position to another, while the latter refers to the ability to create consensus on a topic where there previous did not exist any. While the majority of the research conducted offer consensus-creating contributions, by answering previously unanswered research questions, or providing new insights on the relationship between variables. In addition, some elements of consensus-creating are found in the research, for instance supporting the argument that S&OP needs to be designed for each company, and how implementation practices should include S&OP design aspects. The next subsection is explaining the philosophical research position and the research paradigm on which the research is conducted.

2.2. RESEARCH FRAMEWORK

This section introduces the research framework and the logic behind the appended papers. In total five papers are appended in this research, each aimed at contributing to the secondary research questions. The progression of papers and research questions is illustrated in Figure 2.3. This section explains the progression and linkages between research questions and papers, while section 2.3 explains the methods applied in the different papers.

The first phase of the research project focused on linking S&OP design (i.e. design fit) to S&OP performance. To do so, a multiple embedded cases study was conducted at Case B. The goal was theory building (Voss, 2009), with the theoretical goal being both consensus-creating and -shifting (Boer et al., 2015), to change the discourse in academia from assessing S&OP performance solely as being dependent on maturity, to being dependent on both maturity and design fit. The practical relevance is mainly conceptual relevance (Nicolai and Seidl, 2010), through the identification of contingencies and causal relationships.

The second phase of the research project, focus on investigating what is known about how to design the S&OP process. The first part of this, i.e. paper 2, consists of a literature review focusing on context-based S&OP research. Here, the goal is to find

areas in which the contingencies affect how S&OP should be designed, and also how this ultimately affects S&OP performance. Secondly, the paper identifies areas for further research, which are areas which have an impact, while not being fully investigated. Due to the significant number of areas, it has only been in scope to investigate two of the areas found in the literature, namely when to use hierarchical or integrated production planning, i.e. paper 3, and how and when Advanced Planning and Scheduling (APS) modules support the tactical planning, i.e. paper 4. For paper 3, an action research approach was used at Case A. The goal was theory building (Voss, 2009), while the theoretical goal was consensus-creating (Boer et al., 2015), as the current academic discourse was discussing the benefits of the one or the other approach. The practical relevance is of both conceptual and instrumental relevance (Nicolai and Seidl, 2010), as it both identifies contingencies and causal relationships, but can also be used for practitioners to guide when to decide on either the hierarchical or the monolithic approach. Paper 4 is extending the action research study to multiple embedded cases and is challenging the theoretical perception of when APS modules can be of use to tactical planning, as well as why so few companies achieve high &OP maturity. For these reasons is the goal of the paper theory building (Voss, 2009), while the theoretical goal is a mix of consensus-shifting and -creating (Boer et al., 2015), as extends current theory on when APS modules are applicable while challenging its role in maturing S&OP. The practical relevance is here also of both conceptual and instrumental relevance (Nicolai and Seidl, 2010), as it identifies contingencies and causal relationships, and can also be used for practitioners to guide when to use APS modules for tactical planning.

The third phase of the research project investigates the current approaches to implementing and maturing S&OP. The paper 5 investigates this through a literature review, here, the paper (Kristensen and Wæhrens, 2017) provided some insights into the maturity models. The paper investigates different phases of S&OP implementation and what is known and where there are worthwhile gaps in the literature. Its main purpose is to inform the fourth and final phase of the research.

The fourth and final phase of the research combines the findings from the three previous phases, and conceptualise and operationalise the findings, in order to create a framework for how to design and implement S&OP in a greenfield set-up, for companies with no existing S&OP process, and a brownfield approach to redesigning S&OP for companies with an existing S&OP process. This will be found in Chapter 6 of the thesis, and the goal is theory building which serves to propose a new method. The practical relevance is instrumental relevance (Nicolai and Seidl, 2010), as it provides guidelines for how to design, implement and mature S&OP. The theoretical contribution is consensus-creating as it brings together the knowledge in academia to provide a unified proposal to address this issue. The last step is to conclude on the main research question and discuss perspectives for future research.

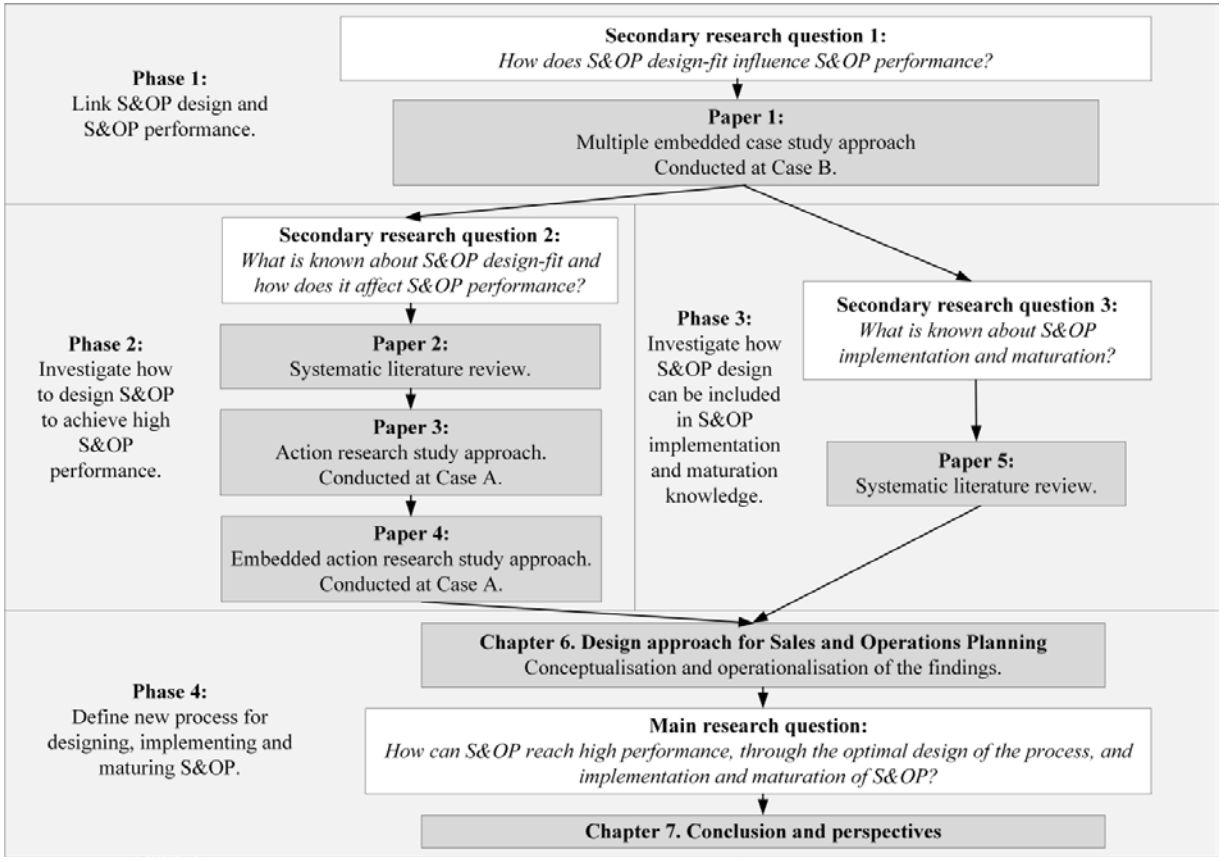

Figure *2.3. Research framework and progression.*

During the PhD study, another 12 publications have been authored or co-authored, but is not part of the final PhD thesis, while they have been used for inputs to various parts of the PhD they are not directly related to the objective of the PhD thesis. The publications are listed here:

- Asmussen, J.N., Kristensen, J. and Wæhrens, B.V. (2018), "Cost estimation accuracy in supply chain design: The role of decision-making complexity and management attention", *International Journal of Physical Distribution and Logistics Management*, Accepted for publication.
- Kristensen, J., Asmussen, J.N. and Wæhrens, B.V. (2017), "The Link Between the Use of Advanced Planning and Scheduling (APS) Modules and Factory Context", *2017 International Conference on: Industrial Engineering and Engineering Management (IEEM) proceedings*, Singapore, pp. 634-638.
- Asmussen, J.N., Kristensen, J. and Wæhrens, B.V. (2017), "Outsourcing of production: The value of volume flexibility", *LogForum*, Vol. 14, No. 4, pp. 73-83.
- Kristensen, J. and Wæhrens, B. (2017), "Sales and Operations Planning (S&OP) maturity models: A critical assessment of maturity models", *NOFOMA 2017: The 29th NOFOMA conference "Taking on great challenges"*. Hellström D., Kembro J. and Bodnar, H (eds.), Lund University, Sweden. pp. 73-74.
- Asmussen, J.N., Kristensen, J., Steger-Jensen, K. and Wæhrens, B.V. (2017), "Integrated Capacity and Production Planning: Including supply chain flexibility and capital investments", *NOFOMA 2017: The 29th NOFOMA conference "Taking on great challenges"*. Hellström D., Kembro J. and Bodnar, H (eds.), Lund University, Sweden. pp. 28-43.
- Kristensen, J. and Wæhrens, B.V. (2017), "Implementing and maturing Sales and Operations Planning: A literature review and agenda for future research", *2017 EurOMA Conference*, Edinburgh, United Kingdom.
- Asmussen, J.N., Kristensen, J. and Wæhrens, B.V. (2017), "The Link Between Supply Chain Design Decision-Making and Supply Chain Complexity: An Embedded Case Study", *Advances in Production Management Systems. The Path to Intelligent, Collaborative and Sustainable Manufacturing*, Lödding H., Riedel R., Thoben K.D., von Cieminski, G. and Kiritsis, D. (eds), Hamburg, Germany, pp.. 11-19.
- Asmussen, J.N., Kristensen, J., Kristensen, T.B. and Wæhrensen, B.V. (2016), "Comparing Cost Of New Supply Chain Designs Under Uncertainty: An Empirical Study Of Challenges And New Opportunities", *POMS World Conference*, pp. 1-9
- Kristensen, J., Gubi, E. and Wæhrens, B.V. (2016), "Assessing Sales and Operations Planning (S&OP) for project selling companies", *2016 EurOMA Conference, Trondheim*, Norway, p. 65.

- Asmussen, J.N., Kristensen, J. and Wæhrens, B.V. (2016), "Supply Chain Costing: Beslutningsunderstøttelse for nye forsyningskonstellationer", In: *Produktion og styring: Perspektiver på økonomistyringen*¸Bukh, P.N. and Kristensen, T.B. (eds)m Djøf / Jurist- og Økonomforbundet, pp.. 259-275.
- Asmussen, J.N., Kristensen, J., Toldbod, T. and Wæhrens, B.V. (2016), *Supply Chain Costing*. Aalborg: Center for Industriel Produktion, Aalborg Universitet, pp. 1-39.
- Asmussen, J.N., Kristensen, J. and Wæhrens, B.V. (2015), "Fra risikostyring til resiliens i forsyningskæden", *Effektivitet*, Vol. 4, pp. 8-12.

2.3. APPLIED RESEARCH METHODS

The next section will go through the research methods that were used in the five papers appended to the thesis. Two types of studies were made, systematic literature reviews and case studies. The two following subsections will discuss two methods.

2.3.1. SYSTEMATIC LITERATURE REVIEW

The literature review is essential to research projects, as they give legitimacy to the research conducted, as well as clarifying existing contributions, gaps in the literature and the researchability of the studies (Croom, 2009). While literature reviews inform research, then a systematic literature reviews have a different purpose, according to Denyer and Tranfield (2009, p. 671): "A systematic review should not be regarded as a literature review in the traditional sense, but as a self-contained research project in itself that explores a clearly specific question, usually derived from a policy or practice problem, using existing studies". As such, both studies stem from the first research phase, to further investigates the problem that was acknowledged in Paper 1.

Conducting a systematic literature review requires a choice of either having a low number of studies with a coherent research position or having a large number of studies with differences in their research position, which challenges the research synthesis (Durach et al., 2017). Within S&OP research this is an essential question, as there are many ideas to what S&OP is. S&OP is traditionally said to have a time horizon at least as long as the longest supply- or demand lead-time, however, some studies refer to S&OP for processes that have a significantly shorter time horizon. However, in this case, it was decided to include studies with a wide set of views on S&OP, as these often reflected the most on the contingencies, for instance, the contextual reasons for shorter time horizons, which is essential to the study. Hence, the unit of analysis is S&OP or one of its adopted synonyms (From Paper 2, p. 23):

- "sales operations and inventory planning (SIOP);
- integrated business planning (IBP);

- profit, sales and operations planning;
- supply chain sales and operations planning;
- sales/production sales and operations planning;
- global sales and operations planning;
- executive sales and operations planning; and
- demand and supply integration (DSI)"

As discrepancies in the definition and use exists even within the different labels, then the literature review further serves to create a common view on S&OP context and design, and a common agenda for further research. However, the two studies, Paper 2 and 5 have different scopes. In Paper 2, papers which contributes to knowledge on when the context has an impact on S&OP design is investigated, while for Paper 5 it is papers contributing to how S&OP is implemented and matured. The assessment criteria for the quality of the literature reviews have been adopted by Denyer and Tranfield (2009): Transparency, inclusivity, explanatory and heuristics.

In order to enhance *transparency* of the study, a theoretical framework was designed for both studies to guide the research (Rycroft-Malone et al., 2012). This framework was additionally used to design the research protocols (Durach et al., 2017) to be used both to explain how the study would be conducted, as well as for the coding of the findings.

For the *inclusivity*, the argument from Pawson (2006) was used, as he argues that if the literature adds something of relevance to our understanding of the phenomenon, then it should be included, if the findings are trustworthy. This is reflected in the exclusion criteria, which starts by asking if the study is related to S&OP, as a preliminary screening after reading the abstract. Second, duplicating studies are removed, as multiple databases were used. Third and finally, the papers are assessed for relevance to the topic, i.e. context- or implementation relevant, for paper 2 and 4, respectively.

For the *explanatory* criteria, then this relates to the ability to synthesise the findings. In essence, "… the synthesis provides a feasible explanation of the study findings rather than a replicable explanation… synthesis involves the process of bringing the pieces from individual texts together to make a whole that should be more than the sum of the parts" (Denyer and Tranfield, 2009, p. 680). Both papers synthesise the current knowledge and arrange them into frameworks on how they affect design and implementation, respectively. In addition, they argue for which gaps in the literature should be investigated.

For the *heuristics* criteria, then this relates to the ability to provide guides or rules for decision-makers to use (Denyer and Transfield, 2009). While neither of the papers provides any detailed solutions, as too many gaps were present, both offers significant insights towards how contexts affect the S&OP design and thereby performance, and

how implementation and maturation of S&OP are improving S&OP performance. In addition, they both serve as guides for further research.

2.3.2. CASE STUDIES

Case research is consistently reported to be needed in operations and supply chain management research (Jonsson and Holmström, 2016; Stentoft and Rajkumar, 2018). Case studies are reported to be powerful in the extension of theory and development of new theory (Eisenhardt, 1989, Meredith, 1998, Voss et al., 2002; Yin, 2014). The case study papers in the thesis are classified using three forms of case studies:

- Paper 1: An embedded case study.
- Paper 3: An action research study.
- Paper 4: An embedded action research study.

Paper 1 is an embedded case study, where the researcher served as an observer investigating a phenomenon from a distance. For paper 3 and 4, the researchers were involved in collection data, as well as designing and implementing a solution. The two methods, case studies and action research are different in nature, and the use thereof will be explained in separate sections.

Case study

The case study appended to the thesis (Paper 1), is an exploratory and theory building case study (Voss, 2009). Exploratory as it seeks to justify that the research topic is of interest to academics and practitioners, and theory building as it focuses on identifying linkages between the S&OP performance and the S&OP context, -design and –maturity.

While it is fairly well described in the literature, that S&OP performance is dependent on S&OP maturity (See Chapter 1, Introduction). However, based on the experience from the interaction with the case company, it was the hypothesis, that while S&OP maturity was indeed important, the S&OP design was not applicable to all companies and dependent on the context of the company. To investigate this, the Case B was used, as it provided a unique opportunity to investigate if S&OP design-fit indeed did affect S&OP performance. The research framework used for Paper 1 is depicted in Figure 2.4.

The research question for the paper is: “What is the link between the S&OP design and the context fit of the case, and its effect on the S&OP performance?” (Paper 1, p. 2). The case study design used in Case B used an embedded case study approach, as the case had three different business units, which each had an S&OP process that was identical in relation to S&OP design and –maturity. Hence, these two variables remained the same across cases. However, the three cases represented two different contexts, hence it could be explored if the S&OP performance differed for the two

context, and the in-depth knowledge allowed for relational inference (Meredith, 1998) on whether this was due to a misfit between S&OP design and context.

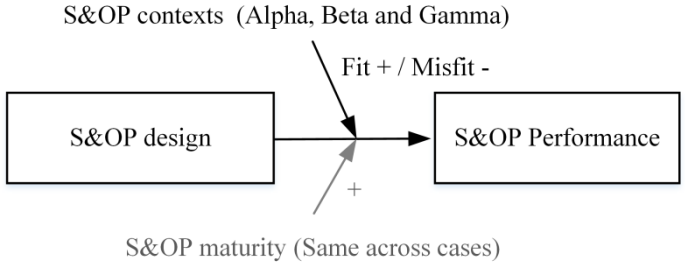

Figure 2.4. Conceptual research framework (From Paper 1).

The data was collected through semi-structured interviews, review of internal documents and performance data, this allowed for triangulating the findings, as the same questions were asked multiple respondents, as well as verified using documents and data (Voss et al., 2002). The semi-structured interviews focused on process owners from the different business units and areas of the S&OP process and had two rounds. In the first round of interviews, the focus was on the design and the performance, while the second round focused on assessing the design fit between the S&OP process and the context. The collected documents were mainly process descriptions, agendas for meetings and performance reports. The performance data were collected through quantitative data from the companies ERP-system.

Action research

A key characteristic that distinguishes action research is that the researcher takes action (Gummesson, 2000). As a result, the researchers are not merely observing a phenomenon, but use the case as an experiment. In this case, action research is ideal, as while positivistic research is "context-free" then action research is embedded in the context of the company (Coughlan and Coghlan, 2009). However, this brings certain requirements for the selection of cases, as the goal of this research is to test the effect of context on the researched phenomenon. For Paper 4, a theoretical sampling approach is needed (Voss et al., 2002), here, cases are selected based on known elements, i.e. different levels of planning maturity, and complexity, which are of interest to the study.

For paper 3, the context is in focus as well, as the objective of the paper "…is to inductively show how the characteristics of the production system and the planning environment influence the difference in performance between hierarchical and monolithic planning." (Paper 3, p. 4). However, while the study is an action research study, it involves a second part, where the developed mixed-integer-linear-programming (MILP) model is used for testing the effect of changing different variables. For paper 4, the goal is to investigate how context affects the use and contribution of the APS modules (I.e. the MILP models). Here, the exploratory study

is looking at four factories, with a different mix of planning maturities and planning complexities.

The action research studies started in 2015 and ended in 2017, thus enabling longitudinal studies on how the APS modules were used in the different factories (Åhlström and Karlsson, 2009). For the data collection, a team-based approach was used (Baskerville and Wood-Harper, 1996), one researcher was primarily concerned with the development of the MILP models, while another researcher focused on the planning processes, and how the APS modules supported this.

To assess the quality of the action research studies, Levin (2003) proposes four criteria; participation, real-life problems, joint-meaning construction and workable solutions. Regarding the participation, then the two researchers were directly involved with the case company, in two different departments (the supply chain planning department and the process excellence department). The real-life problem was identified through the knowledge obtained during the collaboration, and it was therefore decided to make a study (Paper 3) which served a practical purpose, namely to optimize the tactical planning for the factories. To make it academically relevant, hence serving as the dual goal (Gummesson, 2000), it was decided to test how the context affected the performance of the developed model (Paper 3). The joint-meaning construction was created through several iterations of model development, where the model was presented and tested against previous plans and gave high face validity. The last criteria, workable solutions, is best illustrated by the second study (Paper 4), where the company was so satisfied with the developed MILP model, that it was desired to develop similar models for other factories. Again, to make both a practical goal and an academic goal, the researchers participated in the selection of the cases based on previously known differences in context. While there were not infinite possibilities for case selection, four cases were found that represented different contextual cases.

CHAPTER 3. RESEARCH SUMMARY

The thesis is a collection of papers, which are appended to the thesis. In the research summary chapter, a summary of each individual paper is presented, as well as the research question or objective of each paper (See table 3.1).

Table 3.1. Summary of the five appended papers.

Paper 1: Assessing the design fit of Sales & Operations Planning (S&OP): An embedded case study
Research question: *"What is the link between the S&OP design and the context fit of the case, and its effect on the S&OP performance?"* **Method**: An embedded case study. **Summary:** The research uses embedded cases to explore the link between S&OP design fit and its effect on S&OP performance. The study proves that the S&OP performance is dependent on the design-fit, as well as the maturity to reach high performance, once and for all proving there is no one-size-fits-all S&OP process, and that the process needs to be designed to fit the context of the company. **Linkages:** • **Paper 2**: As it finds a relationship between the S&OP design and the performance. It calls for further studies on what can be said about S&OP designed for different contexts. • **Paper 5 and Chapter 6**: While the maturity in the case was high, it revealed that there was a design misfit. This calls for a reassessment of the S&OP design, which is one of the linkages to the brownfield approach in chapter 6.
Paper 2: Context-based sales and operations planning (S&OP) research: A literature review and future agenda
Research questions: *RQ1. "How does the S&OP literature contribute to our knowledge on how S&OP design and performance is affected by context?"* *RQ2. "What are future areas for context-based S&OP research?"* **Method:** A systematic literature review.

Summary:

The review finds that the following context areas have an effect on the S&OP design: Industry type, dynamic complexity, detail complexity, firm size, manufacturing strategy, hierarchical production planning, and organizational characteristics. While these areas have different effects on the S&OP design, several areas are in need of further research, and our knowledge of how to design S&OP according to context is lacking.

Linkages:

- **Paper 3**: While the systematic literature review revealed a number of areas in need of further research, it also highlighted the limited studies on the linkages in the hierarchical planning framework. For this reason, this study serves to investigate the link between strategic and tactical planning.
- **Paper 4**: The literature study found that APS modules were beneficial in some contexts, but it was not revealed how it affected performance through its usage, which was one of the research goals of this study.
- **Chapter 6**: The literature review collects a range of findings on how different contexts affect the S&OP design. This has been summarised in the guides for how to design S&OP as a greenfield approach, or for areas to be aware of in the redesign brownfield approach.

Paper 3: When to integrate strategic and tactical decisions? Introduction of an asset/inventory ratio guiding fit for purpose production planning

Research objective:

"To investigate under what conditions monolithic planning improves performance relative to hierarchical planning."

Method: An action research study.

Summary:

The research uses an action research approach to develop an Advanced Planning and Scheduling (APS) module to improve the tactical planning for the case company. The academic objective is to investigate under which contingencies that monolithic planning, integrating tactical and strategic decision, is performing better than a hierarchical production planning approach. It is found that a low A/I ratio, high demand fluctuation and high demand fluctuation is all linked to a better performance of the monolithic planning approach.

Linkages:

- **Paper 4**: The APS module designed for one factory is in paper 4 spread to multiple factories, and is a direct extension of the research conducted for paper 3.

- **Chapter 6**: To propositions towards when to integrate strategic and tactical decisions is used to inform both the greenfield- and brownfield approach.

Paper 4: A context-based study of Advanced Planning and Scheduling (APS) for tactical planning

Research questions:

RQ1: "How is the frequency of use of an APS module affected by factory context?"

RQ2: "How is the contribution of an APS module affected by factory context?"

Method: An embedded action research.

Summary:

The paper uses an embedded action research approach, to develop APS modules for tactical planning in four different factories in one OEM. This was done in order to investigate the contribution and frequency of use of the APS modules, as well as how the contingencies factory planning maturity and factory planning complexity affect this. The paper finds that APS modules are contributing companies with low planning maturity for configuring the production system set-up, while contribution companies with high planning maturity through optimization and scenario planning. For companies with a medium planning maturity, the contribution is low, as the performance difference is low, and the aim of the planning is not high enough to use scenario planning. For the frequency of use, it is found that for low planning maturity, the module is used seldom, while frequent for high planning maturities. In addition, it is found that complexity moderates the contribution and frequency of use.

Linkages:

- **Chapter 6**: The propositions towards deciding if an APS module is beneficial are used to inform both the greenfield- and brownfield approach.

Paper 5: The approach for implementing and maturing Sales and Operations Planning (S&OP)

Research question:

"How should S&OP be implemented and matured, and what are the areas for future research?"

Method: A systematic literature review.

Summary:

The review finds that the implementation of S&OP can be divided into three phases: Initial project planning, project operationalisation, and maturation. The paper finds that while an abundance of guidelines covering the area, there are few that are empirically tested. For the maturation, the models are descriptive and do not account for e.g. S&OP design or how context, in general, affects the implementation and maturation process. The knowledge of the mechanisms aiding in implementing S&OP is not known, and there is a need for empirically grounded studies.

Linkages:

- **Chapter 6**: The implementation literature study is covering the groundwork of the conceptual study for the greenfield approach, as well as informing the study on the brownfield approach.

Chapter 6: Design approach for Sales and Operations Planning (S&OP)

Main research question:

How can S&OP reach high performance, through the optimal design of the process, and implementation and maturation of S&OP?

Method: Conceptual and grounded in case findings.

Summary:

The chapter proposes how S&OP performance is developed through incremental maturity increase, while design-fit reassessments are in need of larger changes and create discrete performance jumps. For empirical reasons, a conceptual approach is made on how S&OP design can be included in the implementation of S&OP in a greenfield set-up, without and existing S&OP process. The insights from the case company additionally support the creation of an approach for reassessing the S&OP design in a brownfield set-up, with an already existing S&OP process.

CHAPTER 4. S&OP DESIGN

This chapter has three parts. In the first part, the link between S&OP and operational performance is examined. The second part goes through the elements in the S&OP design, and lastly, the third part investigates how contextual areas affect the S&OP designs and its ability to generate positive performance outcomes. The chapter provides insights from paper 1, 2, 3 and 4, however, for the full contribution of the papers are found in the appended papers.

4.1. S&OP'S LINK TO OPERATIONAL PERFORMANCE

Supply chain management is defined as "*the integration of key business processes from the end user to the original supplier, who provides products, services and information that add value for customers and other stakeholders*" (Lambert and Cooper, 2000). This integration of supply chain partners and cross-functionally within a company is proven to lead to better performance for the company and supply chain (Stank et al., 1999; Ellinger, 2000; Pagell, 2004; Gimenez and Ventura, 2005; Lynch and Whicker, 2008; Daugherty et al., 2009; Flynn et al., 2010). While the integration can happen without the involvement of S&OP, then S&OP is a process created to facilitate integration and alignment across functions and supply chain partners.

The S&OP goals can be grouped into various categories; alignment and integration, operational improvements, single perspective improvements, better trade-offs and enhanced end results (Thomé et al., 2012). These goals are often linked and their accomplishment starts with considerations related to the alignment and integration. S&OP has most often been linked to the balancing of supply and demand, this involves the integration and alignment of multiple functions, and in some instances even multiple supply chain partners. The S&OP process and the increased complexity of multiple partners makes the reconfiguration of the S&OP process difficult, which in the end can affect the flexibility and operational performance in the long run (Wæhrens et al., 2015)

The goal of matching future supply with future demand is illustrated in Figure 4.1, this figure was used internally in Case A to promote S&OP. Here, it is illustrated that a mismatch has negative consequences on the cost performance. In the case of demand being lower than supply, the consequence would be excess inventory, lower capacity utilization and even risk of obsolete inventory. In the case of demand being higher than supply, it would mean that the company would have to expedite orders through the supply chain using expensive airfreight even on heavy components. As a result longer lead times would appear which in their case could result in liquidated damages. Hence, one of the goals of S&OP in Case A was to balance supply and demand, and through this, minimize the cost throughout the supply chain.

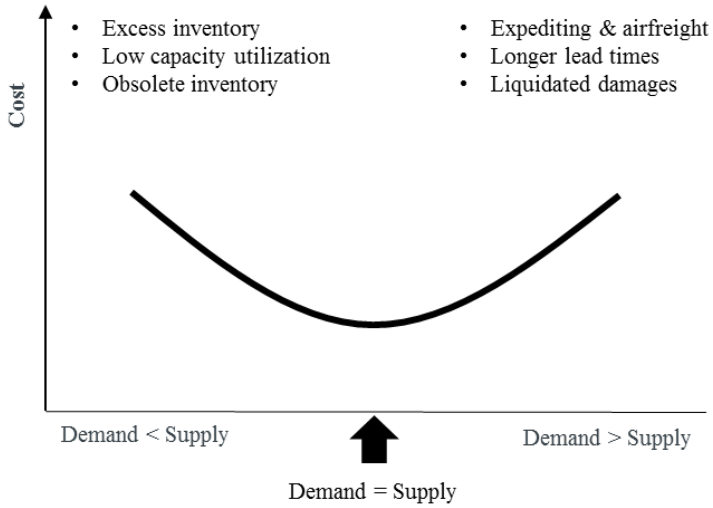

Figure 4.1. Balancing of supply and demand.

Besides the cost benefits of balancing supply and demand, then the alignment with customers is used to ensure delivery performance (and avoid being affected by bullwhip), while alignment with suppliers ensures availability of resources (Oliva and Watson, 2011). S&OP also affects forecast accuracy, either through customer transmitted forecasts, or by making the governance of the forecast transparent, so owners put more effort into transmitting reliable forecasts.

An anecdote from Case A provides additional reasons for why S&OP is needed, here it was a fear (not proven), from the operations department, that the sales department submit forecasts that are higher than the realistic sales, to ensure availability of products to sell. On the other hand, the sales department feared (again, not proven) that the production department made a production plan with fewer than forecasted products, to keep inventory low. These behaviours, if not mitigated, would lead to a vicious cycle of misinformation. Here, the S&OP process is a step toward mitigating these behaviours, as better forecasting leads to better service levels, lower inventory levels and higher capacity utilization (Wagner et al., 2014; Muzumdar and Fontanella, 2006; Bower, 2006). This, in the end, affects the financial performance through increased revenue and profit margins (Muzumdar and Fontanella, 2006).

Besides these operational and quantifiable performance improvements, then S&OP is seen as the top management's tool for handling on the business, as it is a forum for taking aggregated decisions affecting the entire company. In addition, it has the purpose of not only aligning the company horizontally (between functions), but also

vertically, as it is an approach for ensuring a connection between the strategy of the company, and the plans of the company.

4.2. THE S&OP DESIGN

The S&OP process is illustrated in the five-step process, illustrated in Figure 1.2., and S&OP as a whole has been synthesized using the framework seen in Figure 1.3. In the thesis, the S&OP design consists of the design and organisation of the S&OP process (i.e. Structure and Process in Figure 1.3), the linkages from strategic planning to operational planning, and the inputs that are transformed to outcome through the S&OP process (as written in the introduction). To give more insight towards the design and organisation of the S&OP process then the S&OP 'structure and process' part includes five areas, these are (Ivert et al., 2015A):

- **Design parameters:** This refers to the details of the S&OP set-up, such as the length of the planning horizon, the frequency of meetings, the aggregation levels, the planning objects, etc.
- **Meetings and collaboration:** This refers to the human-effectiveness, and the set-up of the planning steps (i.e. the five-step approach seen in Figure 1.2), and the linkages between them. In addition, this also involves the monthly calendar and the agendas for the meetings.
- **Organization:** This refers to the governance aspects of S&OP, as well as the organizational design. One aspect is whether it is an independent department, or located in the operations or sales areas, or even as a support function in a matrix organisation. It further involves governance aspects, as to who has the ownership of the different processes, if it is anchored by the CEO or other places. Finally, it involves the organizational and individual skill-levels for S&OP.
- **Information technology:** This refers to the information and data flow, as well as the tools and systems used. This ranges from Excel tools to wide-ranging Enterprise Resource Planning (ERP) systems, and Advanced Planning and Scheduling (APS) systems used for optimization or scenario planning.
- **S&OP metrics:** This refers to the performance metrics designed for supporting the S&OP process in assessing the effectiveness of its actions. As well as, assessing the efficiency of the S&OP process.

In essence, S&OP metrics have little to do with how the S&OP process is designed. However, they can be used to guide and improve the S&OP process. For this thesis, the S&OP metrics are not considered an essential part of the S&OP design, however, it is acknowledged that different S&OP processes should likely be measured using different S&OP metrics (e.g. See Hulthén et al. (2016)). The next part provides insights into the S&OP design of the case companies.

Case A

The S&OP design at Case A, Figure 4.2, is a monthly process, facilitated by an S&OP department, located in the sales department of the organization. The process starts at the left in the figure, where a product review is used for inputs to both the supply chain assessment (upper part) and demand assessment (lower part). These two represent a parallel flow. The product review provides input on phase-in- and phase-out plans for products, as well as ensuring that changed components are reflected in the supply and demand plans. For the supply chain assessment, a forecast of available capacity is sent from strategic suppliers, as well as a forecast for capacity at own facilities. This is finally signed-off by the Chief Operating Officer at the supply chain assessment meeting. For the demand assessment, the sales in the key account pipeline are included, as well as the forecast from the sales regions. This is then discussed and signed-off by the Chief Sales Officer at the demand assessment meeting.

The two processes (supply chain- and demand assessment) lead to a pre-S&OP meeting where the forecast and capacity are discussed and balanced with the help of a Total Landed Cost (TLC) tool, to investigate the cost of the final plan, and provided scenarios. The recommendations from here are transmitted to the executive-S&OP meeting, where decisions are taken on the final plan.

These meetings are further used for discussing the value chain risk management, the status of strategic deployment initiatives (i.e. improvement projects) and performance Key Performance Indicators. The output of the process is a production plan for the next two years, as well as a sales implementation plan suggesting which sales activities should be in focus. In addition, the output is input to a financial forecast, which ultimately is used for budgeting. The output is also an input to a global footprint process discussing how the supply chain should look in the future. In the end, the plans are communicated to the sales business units and production business units, to ensure that they act according to the plan that has been signed-off.

Case B

The S&OP design of Case B can be seen in Figure 4.3, and the design of the three sub-processes (product-, supply- and demand review) can be found in the Appendix of Paper 1. Case B's S&OP process is also monthly, but contrary to Case A, it follows a sequential flow of the sub-processes. It is also facilitated by an S&OP department, however, for Case B this department is located in the operations area of the organisation. In addition, the S&OP process is parsed into three processes, which are identical in design (This is further expanded upon in Paper 1).

The first part of the design is a demand review. Here, a statistical forecast generated through their SAP APO system is sent to the regional sales department, who can give manual inputs to the forecast or choose not to, however, once they have submitted the forecast, they have committed themselves to the forecast. This is discussed in the demand review meeting, where also the performance of the demand related Key Performance Indicators are assessed. If there are any conflicts it is escalated to the pre-S&OP meetings. In addition, the signed-off demand plan is sent to the executive-S&OP meeting and to the product- and supply review meetings.

The product review meeting is the second step, for this process, there are three inputs: First, the product roadmap, which is provided by a different and ongoing process that manages product development, and is used for introducing new products and phasing-out old products. Second, is the demand plan, which is assessed in order to check if the sales business units are selling the agreed upon mix of products. Third, a segment/region alignment is providing input, which is a process for ensuring alignment between the product development segments and the sales regions. The product review ensures that the mixes of products are absorbed correctly through the supply chain, to assess the stock points, and to assess if sales are following the product roadmap plan. If there are any escalations, this is submitted to the pre-S&OP meeting. The signed-off plans are sent to the executive-S&OP meeting and to the supply review meeting.

The supply review meetings follow a process where the demand and product review plans are sent to the SAP APO system, which provides a production plan, and flags potential supply- and/or capacity shortages. This is then sent to the production planners at each factory, who can give inputs on why there are shortages, and what can be done to elevate these. In addition, the supply review meeting receives inputs from a Control Tower process, which weekly asses the performance and suggestions for improvements and issues are discussed in the supply review meetings. If there are any escalations, this is submitted to the pre-S&OP meeting. In addition, the signed-off plans are sent to the executive-S&OP meeting.

The pre-S&OP meeting is facilitated by the S&OP department, and involves relevant participants, according to the escalations submitted. Here, escalations are resolved. However, by default, decisions exceeding a cost impact on a predefined value are further escalated to the executive-S&OP meeting, but with a recommendation for which action to take. The executive-S&OP meeting discusses the plans, makes decisions on escalations and are in charge of communicating the plans.

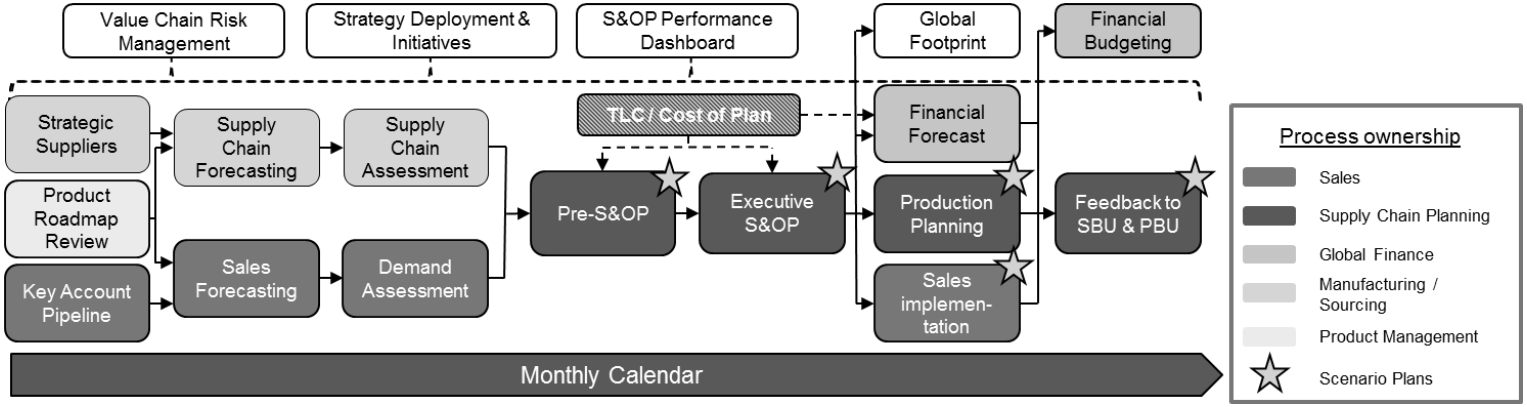

Figure 4.2. Illustration of the S&OP process at Case A.

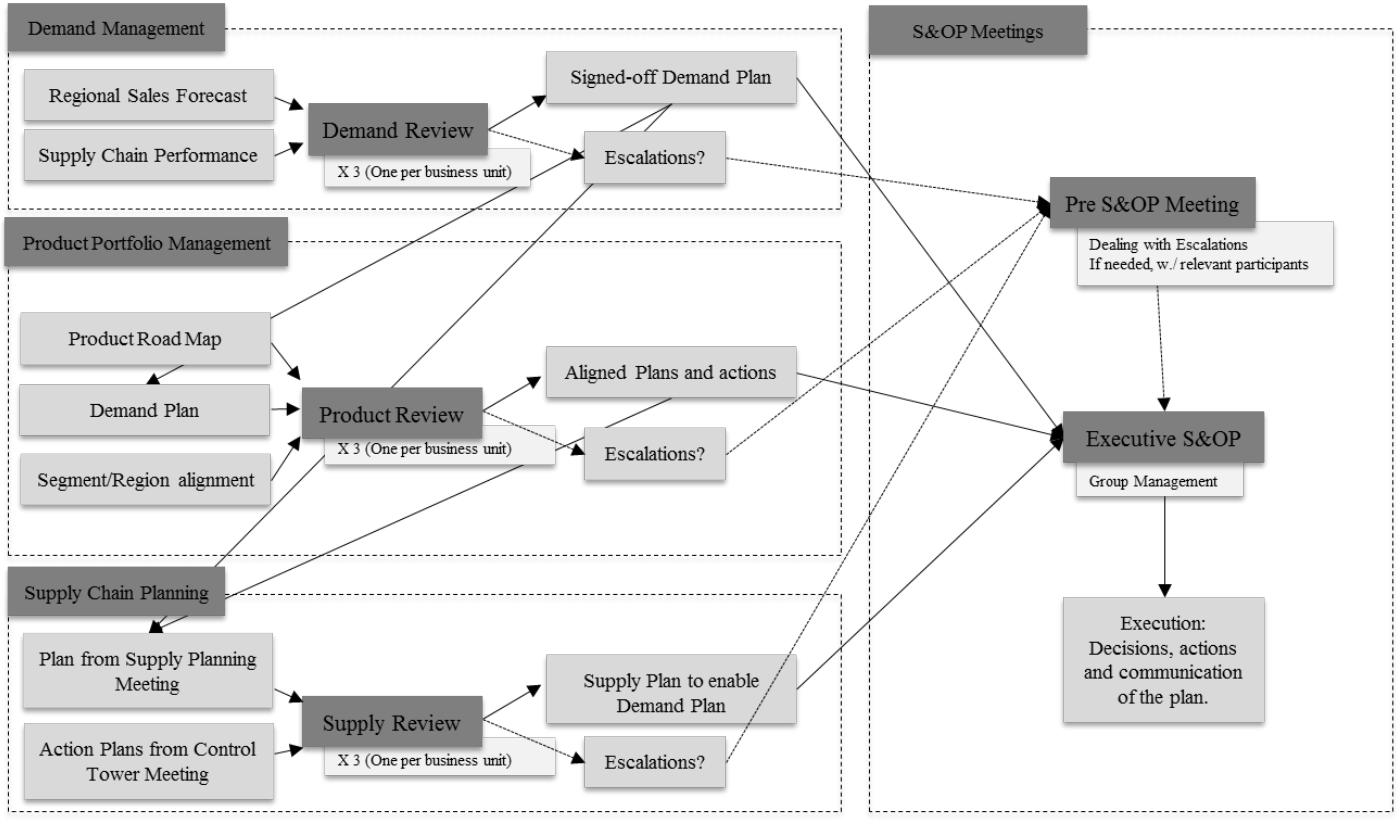

Figure 4.3. Illustration of the S&OP process at Case B (Source: Paper 1).

4.3. DESIGN-FIT AND CONTEXTUAL PARAMETERS

Paper 1 asked the question: "*What is the link between the S&OP design and the context fit of the case, and its effect on the S&OP performance?"* The paper found that a variety of studies have linked S&OP performance to the degree of maturity achieved (e.g. Wagner et al., 2014) and while numerous papers investigated S&OP design for different industries, then no studies had made a link between S&OP design fit and S&OP performance, or found any empirical evidence that the S&OP design, in fact, hindered the achievement of the performance benefit. The question is related to contingency-based research, where Sousa and Voss (2008) found limitations in our ability to explain the relationship between the adoption of best practices and the associated performance outcome.

Paper 1 had, as previously explained, a unique case setting, as it investigated three embedded cases, with the unit of analysis being the business unit. Here, as illustrated in Figure 4.4, did each business unit follow the same S&OP process, with the same design and maturity, but with varying task and market characteristics. Thus, it was possible to assess three different S&OP processes, while ensuring that all processes had the same design and maturity, however, two different contexts were investigated.

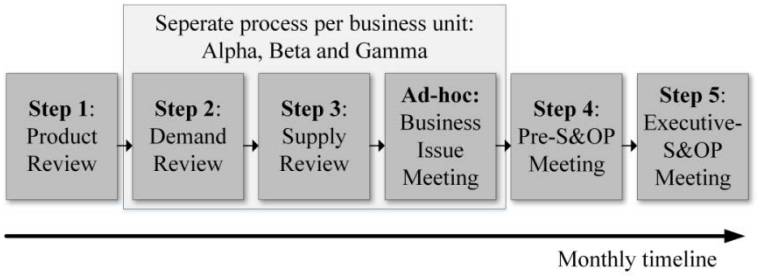

Figure 4.4. Research setting of Paper 1 (Source: Paper 1).

The study found that one of the cases performed significantly below the other two cases, in terms of forecast accuracy and delivery performance (which was the only performance measures investigated). During the review of the context, it was found that the context of this case was different in terms of *industry*, *dynamic complexity* and *manufacturing strategy*. The case operated in a project sales industry, contrary to the other cases which were box sales. As a result, the demand was more volatile and followed a make-to-order principle. Consequently, the performance of that case was lower than the others, for reasons which could be uncovered once the context was assessed. As recommended in the literature, the specific context required an entirely

different design, as forecasting was not set-up to properly assess the project pipeline. In this case, the usage of the Customer Relation Management system would ideally be used to assess the entire pipeline on a tactical time horizon (Voss, 2012; Bhattacharrya, 2014). In addition, the rest of the organisation used a make-to-stock manufacturing strategy, therefore the manufacturing units in the supply chain were set-up with inventory as a buffer. However, for the project sales business, the products sold was highly customised, and consequently, the inventory buffer could not be used to adjust the volatility in demand. According to Olhager et al. (2001), then the buffer strategy that fits this context should be a capacity buffering approach. As a result, Paper 1 makes two propositions:

"P1: S&OP performance is dependent on both S&OP maturity and S&OP design.

P2: S&OP performance gains through S&OP design fit is in need of reassessment."

The first proposition is illustrated in Figure 4.5 and it is the first study to be able to assess S&OP performance based on the degree of design fit. The result gives a contingency-based view on how to reach high S&OP performance. The second proposition state that S&OP design fit is in need of reassessment (i.e. step-changes or larger project changes). This was found, as it was evident that the design aspects of S&OP are clearly interdependent with multiple areas, meaning that changes in one area are affecting other areas. This is similar to what is proposed by Danese et al. (2017) who found that the design elements that are changed when making changes in an established (mature) S&OP process, are multiple and happening at once. A practical implication of this is that companies have to assess the S&OP design to try to match it with the context of the company, similar to how Ivert et al. (2015B) and Dreyer et al. (2018) have assessed the S&OP needs for different industries.

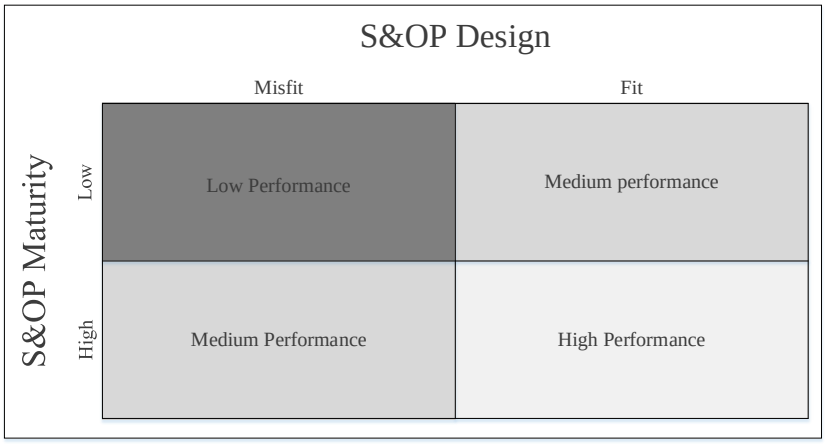

Figure 4.5. Propositions on the link between S&OP design, maturity and performance (Source: Paper 1).

After having linked S&OP performance and S&OP design fit, the next parts of the research focused on investigating how to design S&OP according to the context. The starting point was a literature review (Paper 2). The literature review investigates what is known about how S&OP design and performance is affected by a certain context, as well as problematizing future areas in need of research.

That study reviewed 68 articles and found that S&OP design has been linked to the following contextual areas: Industry, dynamic complexity, detail complexity, firm size, manufacturing strategy, hierarchical planning framework and organisational characteristics. However, through these studies, it was only found that four of these areas (industry, dynamic complexity, detail complexity and organisational characteristics) affected the S&OP design. However, based on the literature it was argued why the remaining three areas (firm size, manufacturing strategy and hierarchical planning framework) should affect the S&OP design. The implications of Paper 2, was a series of descriptions on how S&OP design was affected by context, these findings have been used in Table 6.1, in Chapter 6, to provide normative suggestions on how to design S&OP according to different contextual variables.

As a result of the study, multiple areas in need of further research were problematized (Paper 2):

- Industry studies
- Organisational studies
- Complexity studies
- System and process studies

To focus the research, the Papers 3 and 4 are focussing on the system and process studies, as it was found in the literature review, that no studies had explicitly researched S&OP as a part of a planning system, with processes that are linked and stretch further than to the tactical planning area. The lack of studies in this area is alarming, as planning hierarchies and systems dates back to the introduction of planning frameworks in the 1960's (Anthony, 1965), and is evident in S&OP textbooks (Jacobs et al., 2011; Wallace and Stahl, 2008). To contribute to the elimination of the gap in relation to the linkages between strategic-, tactical- and operational planning, and how context might affect this, Paper 3 investigates when to integrate strategic decisions into the tactical planning process.

In Paper 3, the strategic decision areas in questions are related to capacity expansion, where Bradley and Arntzen (1999) argues that monolithic planning is needed, to fully make use of the flexibility of the capacity, and thereby, achieve better results. Monolithic planning is the simultaneous decision of strategic and tactical decision areas, contrary to the hierarchical approach where decision are taken sequentially and set the frame for the subsequent decision (Vogel et al., 2017). The gap in the literature relates to the questions of whether or not the benefits of monolithic planning outweigh

the drawbacks, as well as the industrial applicability of the monolithic approach (Kanyalkar and Adil, 2005; Vogel et al., 2017). This is investigated for the separation of strategic and tactical decisions, which has major implications for the design of the S&OP process, which is a product of a hierarchical separation of decision areas (Jacobs et al., 2011). The research focuses on how different contextual contingencies might affect whether a monolithic or hierarchical approach should be used. To investigate this, the A/I ratio is introduced, which is a ratio describing the relative importance of the cost of production assets to the cost of holding inventory. The paper uses an action research approach to develop a mixed integer linear programming (MILP) model, fitting one factory belonging to Case A. The MILP model is subsequently tested for a range of context variables; A/I ratio, demand scenarios, and workforce flexibility. As a result of the study, Paper 3 makes three propositions, which are illustrated in Figure 4.6:

"*P1: The benefit of integrating strategic investment decisions on a tactical horizon is negatively correlated with the A/I ratio.*

P2: The benefit of integrating strategic investment decisions on a tactical horizon is positively correlated with workforce flexibility.

P3: The benefit of integrating strategic investment decisions on a tactical horizon is positively correlated with demand fluctuations."

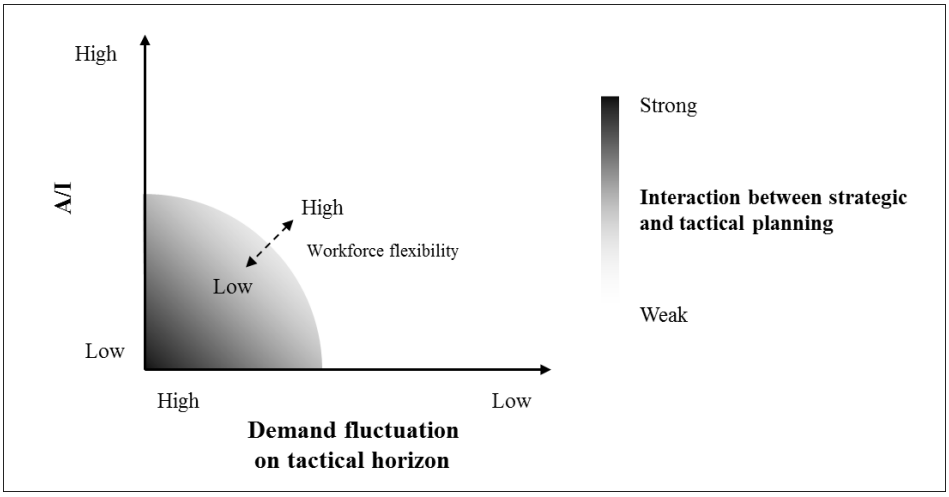

Figure 4.6. The interaction between strategic and tactical planning (Source: Paper 3).

The first proposition substantiates the A/I ratio, as it finds that if inventory cost is dominant relative to production assets, then including capacity expansion decision areas into the tactical planning gives a better performance. While if production assets

are dominant relative to inventory cost, then including capacity expansion provides no added benefits for the tactical planning optimisation. As for the second proposition, it was found that the benefits of integrating decision areas were positively correlated with workforce flexibility, so the benefits of integrating the decisions were only amplified if adding a flexible workforce. For the third proposition, it was found that these benefits would only occur if the company experienced demand fluctuations, for example, rise and fall or seasonality in demand. If the demand was stable, it would not trigger any capacity extension, hence, including the strategic decision areas in the tactical planning would not change the performance.

One of the central arguments for separating strategic and tactical decision areas are the investment period, as an investment often is justified on a time horizon longer than the tactical time horizon (Kanyalkar and Adil, 2005). However, in this study, it was found that given the right contingencies, the pay-back period of these investments was often less than the planning horizon (i.e. less than two years), as a consequence, none or low residual risk exists in making these decisions. The implications for the S&OP design is that if there is a low A/I ration, high workforce flexibility and high demand fluctuations, then S&OP should incorporate decisions of capacity investments in order to find an optimal production plan, as this can give several operational benefits in terms of lowered costs.

Paper 4 followed up on the system and process studies proposed in Paper 2. But the purpose of Paper 4 was to investigate when to use Advanced Planning and Scheduling systems in S&OP. An APS module uses an optimisation algorithm to assist the planning by transforming a set of inputs into an optimised plan based on the criteria in the module (Hvolby and Steger-Jensen, 2010). It is a complex process, with a trade-off between system complexity and real-life applicability. On one hand, if too many decision variables are introduced, the APS module becomes too complex to solve. On the contrary, if too few decision variables are included, then it loses its resemblance to the real-life scenario. Perhaps for this reason, is the adoption of APS in S&OP lacking, especially in a Danish context it is found that technology is the largest gap towards getting more advanced (Lund and Raun, 2017). APS has been researched in an S&OP context with promising results (e.g. Darmawan et al. 2018; Fachini et al., 2018). Ivert and Jonsson (2014) already asked the question; *when should APS be used in S&OP?* They found that the company needs to have strong technical competencies, as one of the drawbacks of APS is that the decisions leading to the end result are not transparent, therefore if the decision makers do not know the mechanisms leading to the result, then they are unwilling to trust the system. They further find that organisational and individual support is needed, and the APS modules are needed for complex planning situations with an aim of doing scenario planning and optimisation of the production plan. However, their study only looks at two case settings (the same case, but at two different points in time). To build on their study, and further investigate the positive feedback received from the operationalisation of the MILP model developed for Paper 3, then Paper 4 investigates the relationships between the

context of the factory and the contribution of the APS module. The MILP model developed for Paper 3 was adjusted to fit an additional three embedded factories, which had differences in planning maturity and planning complexity. What was investigated was how these contingencies lead to differences in the frequency of use, as well as differences in the experienced contribution of the APS modules. As a result of the study, three propositions were proposed, which are further illustrated in Figure 4.7 (Paper 4):

"*P1: The contribution from APS, measured as the degree to which current performance is improved by applying the module, follows a u-curve as a function of factory planning maturity.*

P2: The frequency of use for APS modules will follow an s-curve as a function of factory maturity.

P3: The contribution from and the frequency of use of APS modules are moderated by planning complexity."

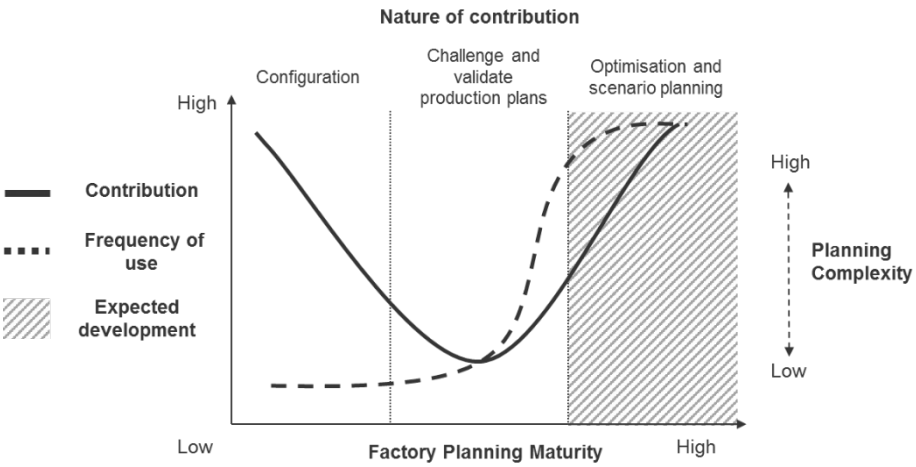

Figure 4.7. Proposed relationship between the contribution, the frequency of use, the factory planning maturity and the planning complexity (Source: Paper 4)

The first proposition is that for both factories with low planning maturity and high planning maturity, the contribution of APS is high, while for medium planning maturity, there is less contribution. This is contrary to the findings of Ivert and Jonsson (2014) who only operated with a high and low aim (planning maturity), by finding benefits for companies with a low planning maturity. For low planning maturity, the benefits of APS are not found in the optimised planning, instead, the APS provides inputs to the production set-up, in this case, which products that should be produced on which line to give the best production flow, thus optimising the product allocation and improving the tactical planning. For high planning maturity, the findings of Ivert

and Jonsson (2014) is confirmed, that it assisted in optimising the production plans and enabled scenario planning, by being able to calculate the effect of several scenarios. For the medium planning maturity, a granularity not investigated in Ivert and Jonsson (2014), the production set-up is already optimised, while the planning process is not yet mature enough to use scenario planning.

For the second and third proposition, it expands on the findings of Ivert and Jonsson (2014), as it is proposed that the use of APS follows an s-curve. APS is less used for low planning maturity while it needs to be used more frequently before the factory will see a high contribution. This supports the findings of Ivert and Jonsson (2014) on the individual skill level, as the employees need to trust the system before they can start using it for optimisation and scenario planning. The third proposition finds that the factories facing a higher planning complexity in terms of detailed and dynamic complexity saw a higher benefit from using the APS system than their less complex counterparts.

As this chapter illustrates, S&OP needs to be designed according to the contingencies of the company. The next chapter investigates how S&OP is implemented, which is used for proposing how to include a design-fit approach to implementing S&OP, to ensure that companies can reach the highest possible performance.

CHAPTER 5. S&OP IMPLEMENTATION

This chapter serves to investigate the current knowledge on how to implement S&OP (Paper 5), which will be used to inform the next chapter on how to include the design fit findings into the knowledge on implementing S&OP.

5.1. BEST PRACTICE S&OP IMPLEMENTATION

The best practice S&OP implementation is concerning how to implement S&OP, and how to achieve high S&OP maturity. So far, the research on S&OP implementation has mostly disregarded the S&OP design fit approach. Paper 5 is dedicated to reviewing the current knowledge of implementing S&OP. Here, the implementation approaches can roughly be divided into three phases; initial project planning, project operationalization and maturation (Paper 5; Pinto and Prescott, 1990). The next subsection reviews the two first phases, initial project planning and project operationalization, while the second investigates the maturation phase.

5.1.1. INITIAL PROJECT PLANNING AND PROJECT OPERATIONALISATION

The initial project planning is about ensuring the acceptance of S&OP, thus reducing barriers while enforcing enablers. The barriers and enablers are summarized in the force-field analysis framework proposed by Lewin (1951), in Figure 5.1, which maps the forces that are positive towards the desired state, and the forces which are negative towards the desired state. As with barriers and enablers, literature review found a number of similar areas that was either expressed as a driving force (positive) or as a restraining force (negative), such as “supportive metrics and monitoring” (Pedroso et al., 2016) as drivers, and “flawed performance metrics” (Iyengar and Gupta, 2013) as restrainers. Looking at the findings of the initial project planning from Paper 1, then the design related forces, which needs to be addressed prior to implementation are related to:

- Performance metric set-up
- Process ownership
- Standardized reports (Agendas, plans, etc.)
- Information systems and data
- Cross-functional integration

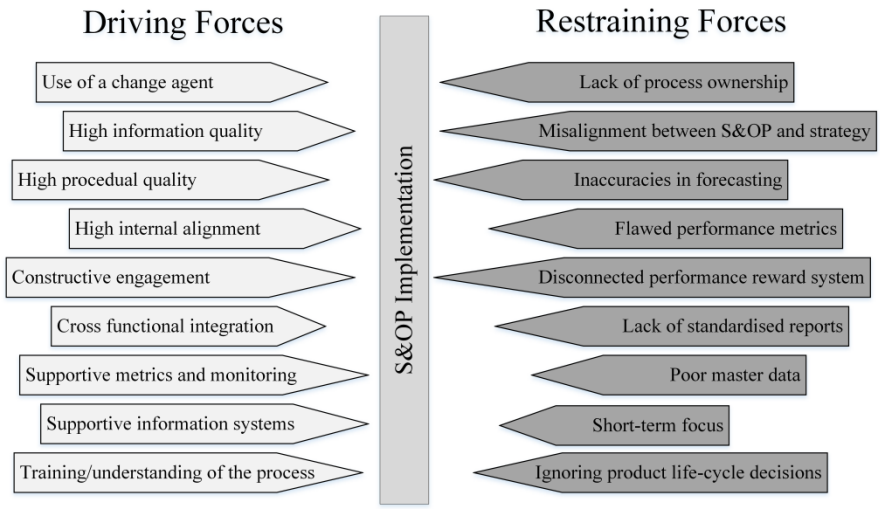

Figure 5.1. Force-field analysis of initial project planning (Paper 5).

Looking into project operationalization, this part is focusing on how to make the actual implementation a success, mostly focused on critical success factors (Pinto and Prescott, 1990). To shortly summarise the critical success factors from Paper 5:

- Training and support of employees
- Governance of the process (e.g. independent S&OP department)
- Ensure proper starting point (Pilot case, product group)
- Design the proper S&OP flow (linkages between S&OP and other processes)
- Standardizing calendar, agenda and processes

These two summaries show that the two areas of initial project planning and project operationalization are involved in designing S&OP. Meaning that for companies which are not already engaging in S&OP, this is the area of emphasis. This will be elaborated in the greenfield approach in Chapter 6.

5.1.2. MATURATION

The maturation phase of S&OP is the most researched of the three phases. Here, studies have commented on the positive effect of using *maturity models* for assisting companies in the maturation phase (Goh and Eldrigde, 2016; Tinker, 2010). A large number of maturity models have been proposed (Bauman, 2010; Cacere, 2012; Danese et al., 2017; Feng et al., 2008; Grimson and Pyke, 2007; Lapide, 2005; Wagner et al., 2014), and in Figure 5.2 (Source: Paper 1) is a summary of the findings of the maturity models which have been aggregated into a unifying model.

		Maturity Levels:			
		Level 1:	Level 2:	Level 3:	Level 4
Organisation & Processes	Meetings & Governance	• No formal process • Missing support • Silo culture	• Formal process • No governance • Low attendance • Missing support	• Executive buy-in • Strong governance • Strategy is driven through meetings	• Event driven • Real-time monitoring of performance
	Involvement	• Only the S&OP department or team	• Sales • Marketing • Operations (Manufacturing)	• CEO • Finance	• Product Development • Sourcing • IT
	Goal of the Process	• Create an operational plan (Overview of expected sales)	• Matching demand against supply	• Calculate profitability of the operational plan	• Demand sensing • Trade-offs • Conscious decision making
System & Tools		• Individual datasets (Often spreadsheets) • Datasets not linked	• System supported input • Manual consolidation (if any…)	• One shared plan • System supported consolidation	• Supported what-if scenarios • Financial optimization
Performance Management		• Functional performance measurements • No linkages	• S&OP performance measurements besides the functional	• S&OP driven performance measurements throughout the organisation	• Strategic measurements is reviewed in the S&OP-process
External Integration		• No external collarboraton	• Limited data from suppliers and/or customers	• Suppliers and customers deliver delivers input directly to S&OP	• Real-time access to external data

Figure 5.2. S&OP maturity model (Paper 1).

The use of maturity models have been found to positively influence the implementation efforts (Goh and Eldrigde, 2016; Tinker, 2010), and used as a self-assessment tool for assessing disperse business units (Basu, 2001). Some case studies have described the process of maturing the S&OP process (Prokopets, 2012), and even how the design is affected by the maturation (Danese et al., 2017). The next chapter investigates how these two elements can be seen in unison, and how this can guide companies towards the highest performance.

CHAPTER 6. DESIGN APPROACH FOR SALES AND OPERATIONS PLANNING

This chapter answers the second part of the third secondary research question, on how to incorporate design-fit into the implementation of S&OP, to ensure the achievement of high S&OP performance. The thesis proposes two approaches, one for new adopters of S&OP and one for a reassessment of the current S&OP design. The first is needed to ensure that the companies implement S&OP in the right design for their end goal. The second is needed, as 80 percent of Danish companies already have implemented S&OP in a formal or informal way, but 50 percent are "less satisfied" with their S&OP process (Lund and Raun, 2017), which may be explained by a design misfit or lack of proper implementation.

In line with systems theory (Galbraith, 1977), the article by Danese et al. (2017) found that companies make changes to all areas (i.e. 'people and organization', 'process and methodologies', 'information technology' and 'performance measurements') when transitioning from S&OP maturity steps. In addition, they found that the seriality of changes is evident for transitions in low maturity S&OP processes, meaning that changes in 'people and organisation' precede changes in 'process and methodologies', which then precedes the two latter categories (Danese et al., 2018, p. 13). This scenario is found to resemble a new implementation and follows established guidelines for implementing S&OP (Paper 5). This scenario calls for an approach build on conventional implementation practices, with the incorporation of design-fit elements at the outset of S&OP implementation; this is investigated in subsection 6.1, greenfield approach.

In addition, Danese et al. (2018, p. 14) find that for mature processes, transitioning towards higher maturity everything is interlinked and change in the different areas happen in parallel. This scenario more closely resembles a redesign-project, to change the organisation from one maturity stage to another. This is similar to what is proposed in Paper 1, that radical transitions require changes to be addressed at a system level (Galbraith, 1977), which considers the linkages between processes. Often, S&OP entail reciprocal interdependencies between the different areas (Thompson, 1967), which means that the output of one process is the input to another, and vice versa in a cyclical process, so that the interlinkages require a high amount of coordination between processes. In essence, an existing S&OP process is less flexible, due to design lock-in and system dependencies, thus it calls for a new method assessing the current design against the context and creating initiatives for achieving a better S&OP design fit. This is investigated in subsection 6.2, brownfield approach. This is further relevant, as the context of an S&OP process can change over time, which Ivert and Jonsson (2014) illustrate when they assess the same case over a period of six years,

which show both a more mature process and also that the organisational characteristics have changed.

6.1. GREENFIELD APPROACH

This section introduces the greenfield approach, which is based on the literature review reported in paper 5, combined with the findings from the other papers and the empirical observations from the interaction with the case companies. The green field approach is a conceptual guide, on how to apply the findings of the thesis for implementing S&OP. However, it has not been empirically tested, thus this is an area for further research. It develops a sequential step-guide that is in accordance with current guidelines (e.g. Wallace and Stahl, 2008; Milliken, 2008), with the addition of developing an 'S&OP design roadmap', which is added to address the design fit agenda. The step guide is as follows:

1. Decide on the project team and organizational placement, ideally with top-management support and participation
2. Identify S&OP goals
3. Develop S&OP design roadmap
    a. Assess current context
    b. Define desired S&OP design
4. Define an implementation plan, e.g. decide whether each element is implemented step-wise or simultaneous and whether the starting is a pilot or a company-wide process.
5. Identify, notify and train key stakeholders.
6. Continuously mature S&OP (Maturity assessment)
7. Yearly S&OP design reassessments (See section 6.2. brownfield approach)

The first step in implementing S&OP is deciding on a project team (Milliken, 2008), and here, as with all projects, it is important to get buy-in from the top management (Young and Jordan, 2008). A lot of critical success factors (CSFs) have been found in regards to S&OP (Paper 5), but the top management support is argued to be a meta-level CSF, as it drives commitment from the remainder of the organization (Young and Jordan, 2008). In addition, then S&OP is not a one-off project, rather it is a continuous process which needs continuous attention from top management.

The second step in implementing S&OP is the identification of the S&OP goals. Most companies have the ultimate goal of improving operational performance, through the mechanisms of S&OP. However, S&OP can achieve this through many ways – better forecasting alone is proven to increase operational performance (Danese and Kalchschmidt, 2011), so has the improved coordination of product introductions (Kaipia et al., 2017) and the coordination of promotion planning (Darmawan et al., 2018). In other words, different companies might engage in S&OP for different reasons, with different mechanisms, and ultimately receive the similar operational

benefits. The end goal of S&OP, at the highest maturity, will likely entail using all the mechanisms to achieve the highest benefits, but the road leading there can be significantly different depending on the company's goals. The following two examples illustrate this:

Case B

The company started their S&OP process in 2014 and at this point, sales were significantly improving in new and current markets, and while the production was running full speed, it could not fulfil all future demand. Several processes already existed to ensure that what was sold, could also be delivered, but the company needed tactical planning to ensure that what was sold was also what the supply chain was able to deliver. In addition, a longer outlook was needed for deciding on which factory should deliver to which demand, to ensure the total cost for the company was at a minimum. For these reasons and many more, the company decided to invest in an S&OP process.

Case B

The company started their S&OP process in 2009 and one of the many reasons for embarking on this journey was that during the financial crisis (2007-2008) the demand for the company's products fell. It was evident for the sales organization that demand would eventually drop, as contracts were being cancelled or changed, and since new orders did not arrive as previously. But, the signal did not reach the supply chain in time, instead, production continued on pre-crisis levels. As a result, a huge build-up in inventory was accumulated, severely hampering the cash-flow of the company. To be able to better coordinate between functions, and be able to react faster to changes in the market (again, one of many reasons), the company introduced a formal S&OP process.

While both of these S&OP processes from the outset appears similar (process-, IT- and organizational-wise), their outset was entirely different. These examples rely on ex-post stories from the employees at the companies, and the design of the early S&OP processes cannot be reviewed. However, arguably Case A and Case B would have entirely different aims of their S&OP process. Case A has a surplus of demand and is interested in getting the most profitable allocation of supply to demand, while Case B has a surplus of supply, and is interested in reassessing inventory and capacity for the most cost-effective approach to address the lowered demand while breaking departmental silos.

While these questions give input to the question of how to conduct and design S&OP, the following step would be to develop an S&OP design roadmap, starting by analysing the organizational context. Based on the papers from the thesis, the questions from Table 6.1 give a starting point for assessing the contextual impact on the S&OP design.

Table 6.1. Questions for making the S&OP design roadmap and for reassessing the S&OP design.

	Question	Effect	Source(s)
Industry	Are you a service or production company (Or a mix)?	If service company, then S&OP should focus on balancing available capacity, if not, see manufacturing strategy.	Paper 2
	What are your industry's special characteristics?	For instance, perishable goods drive a higher emphasis on inventory management, while project demand drives a need for Customer Relationship Management systems (CRM) and project portfolio management.	Paper 1, Paper 2
Dynamic complexity	Can you reasonably predict the future demand?	If not, a stronger focus is put on scenario planning, scalability of production and buffer management (e.g. inventory).	Paper 2
	Can you reasonably predict the future supply?	If not (e.g. food dependent on weather), there is a need for forecasting of supply.	Paper 2
	What is the length of your product lifecycle?	If the product lifecycle is short, then product phase-in and phase-out become essential to the balancing efforts.	Paper 2
Detail complexity	What is the degree of product- and process complexity?	The more complex product and process, the larger the benefits of balancing throughout the organisation.	Paper 2
	What is the degree of organisational complexity?	High degrees of organisational complexity can lead to the need of parsing the S&OP process.	Paper 2
	What is the degree of detail complexity?	If there is high detail complexity, S&OP need to be IT-supported.	Paper 2

Firm size	What is the size of the company?	Larger companies are in need of a formalised S&OP process to be integrated.	Paper 2
Manufacturing strategy	What is your manufacturing strategy (make-to-order, assemble-to-order, make-to-stock etc.)?	The manufacturing strategy decides whether to pursue a level production plan with a focus on inventory (make-to-stock) or a chase production plan with a focus on capacity (make-to-order) or a mix thereof (assemble-to-order)	Paper 2
Hierarchical production planning	What is the asset/inventory ratio?	Lower ratios suggest that strategic decisions, such as capacity extension are relevant for tactical planning (monolithic planning).	Paper 3
	How is the production planning hierarchy set-up?	S&OP needs to be aligned with the adjacent planning processes – For example; Master Production Scheduling, Rough-Capacity Planning and Demand Management.	Paper 2
Organizational characteristics	How is the top-management and organisational culture supporting S&OP?	All of these areas are barriers and enablers for S&OP implementation and affects the achievable aim of S&OP.	Paper 2
	How is the human skill level regarding the use of advanced planning methods?	This affects whether a successful implementation of an APS system can be achieved.	Paper 2
	What is the planning maturity, in terms of process control and aim of the planning?	If the process control is low, then APS can be useful in balancing production lines and increase capacity. If the aim is high, then APS systems can assist in optimising production plans and developing scenario planning.	Paper 4

Once the goals of the company and its context are assessed, it gives insights towards how to design the S&OP process, Table 6.1 can be used to ensure a better fit between the S&OP design and the context. The goals of the company can help prioritise which elements to emphasise when deciding the implementation plan.

The next part will be to decide on an implementation plan, here, at least some differences were seen in how Case A was implementing S&OP and how Case B had implemented S&OP. Case A had defined how they envisioned all the parts of their S&OP process, and started developing and running all of these parts simultaneous, and even for the entire organisation. Case B had a contrary approach, that started with one element – forecasting, and first when the forecasting process was running adequately did they progress to the next steps, however, they also opted for a process covering the entire business. The experience from Case A was that the full implementation for the entire company and all process steps revealed many areas where problems appeared in the way it was decided, and working with full implementation made resources for changing and improving elements scarce. So far, no studies have investigated what the optimal approach is, but it has been suggested to start with a pilot or smaller part of the organisation and expand from there (Alvekrans et al., 2016; Grimson and Pyke, 2007; Milliken, 2008). The reasons, amongst others, are to avoid some of the issues that were experienced in Case A, i.e. too many implementation issues and too few resources to make changes.

The following steps of implementing S&OP follows the conventional guidelines (Wallace and Stahl, 2008; Milliken, 2008) of identifying, notifying and training the key stakeholders. According to practitioners, a pitfall is often that too much emphasis is placed on the system side, while too little is placed on training the humans (Williams, 2016). Hereafter, the process is started, and continuously maturing the S&OP process, which can be supported by the use of maturity models (Danese et al., 2017), such as the one found in Paper 1. The last part is the “design reassessment”, which is what will be presented in the following section.

6.2. BROWNFIELD APPROACH

As 80% of Danish companies are already engaging in S&OP activities, thus the greenfield approach is not adequate to solve the issues of these companies, and neither the ones of Case A or B, as it does not thoroughly examine the interdependences in the systems. In fact, how to change the S&OP process, and especially, assessing the S&OP design is absent in academia and practice alike, except for descriptive maturity models which offer little prescriptive insights for changing S&OP on a system level (Paper 5). In addition, and as stated in Paper 1, to achieve the highest S&OP performance, the S&OP maturity needs to be high, which is happening through incremental improvements. However, S&OP design also needs to fit the context of the company to provide the best possible performance, and as proposed in Paper 1,

there is a need for discrete changes to alter the design of the process. This relationship is illustrated in Figure 6.1.

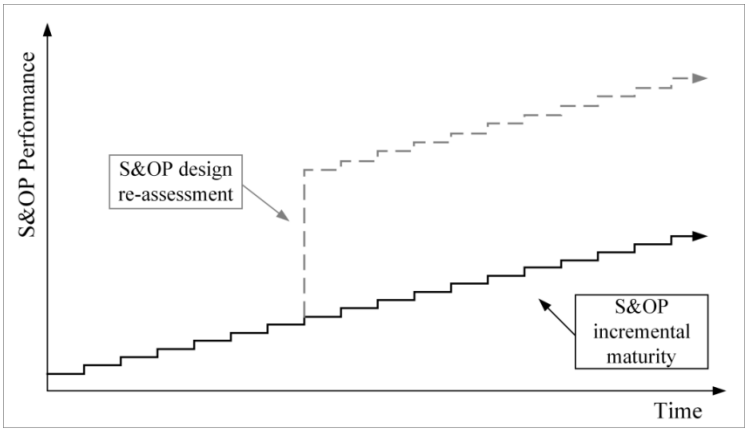

Figure 6.1. The development of S&OP performance through incremental maturity in design reassessment.

The brownfield approach developed is research in progress that has not been presented in the articles appended to the thesis, but is due for an adoption into an academic article. The brownfield approach uses a grounded theory approach (Glaser and Strauss, 2017) to provide recommendations on how to reassess the design of the S&OP process after it is already implemented and is running. The grounded theory approach first explains how the reassessment was conducted in Case A, present the result thereof, and finally, related these to theoretical findings. The goal of relating it to theory is to find theoretical replication, challenge current academic findings or refine the process based on theory, with the end goal of proposing a guideline for the reassessment of the S&OP design. As with the greenfield approach, the final suggestion has not been empirically validated and is a subject for future studies. The following outlines the process that leads to the reassessment, hereafter; the result is presented and related to theory, followed by a recommendation for future reassessments. In practice at Case A, the process involved two steps, identification of problems (i.e. the extended value stream mapping), and identification of solutions (i.e. the redesign projects).

6.2.1. EXTENDED VALUE STREAM MAPPING (EVSM)

The reassessment of the current S&OP process in Case A did not focus on S&OP solely, rather it was a process that assessed the information and decision processes in the entire supply chain, here amongst S&OP and its adjacent processes. The process was labelled “Extended Value Stream Mapping (EVSM)” internally, not to be confused with Value Stream Mapping, as it focuses on the transactional flow (information and decision processes) rather than the physical flow.

The EVSM idea originated in the Supply Chain Development department, which is a sub-department in the Supply Chain Planning department and focuses on driving strategic projects in the supply chain. The background for the idea was that the different areas of the company carried out their own projects disregarding the supply chain impact, despite the projects, in fact, had an impact on the supply chain as a whole. Thus, it was experienced that several departments spent resources on solving the same issues, or made changes that eased their own processes but created challenges in other departments.

To solve this, the department took the initiative to create a series of workshops, with the purpose of aligning the strategic initiatives across the supply chain. In addition, the workshops should investigate the challenges and areas of improvements, found throughout the supply chain.

The entire EVSM assessment was internally developed and conducted for all of the departments that influenced the supply chain in a period of five months, while an additional three months was spent on analyzing and disseminating these results. The process was divided into four phases, first the development of the EVSM method, followed by a preparation phase that at one point was parallel with the workshop phase. In total, five workshops were held, divided into different areas of the supply chain. After these workshops, the final phase consisted of analyzing the results and disseminating the results to the rest of the organization and top management. The timeline for developing and conducting the EVSM assessment can be seen in Figure 6.2.

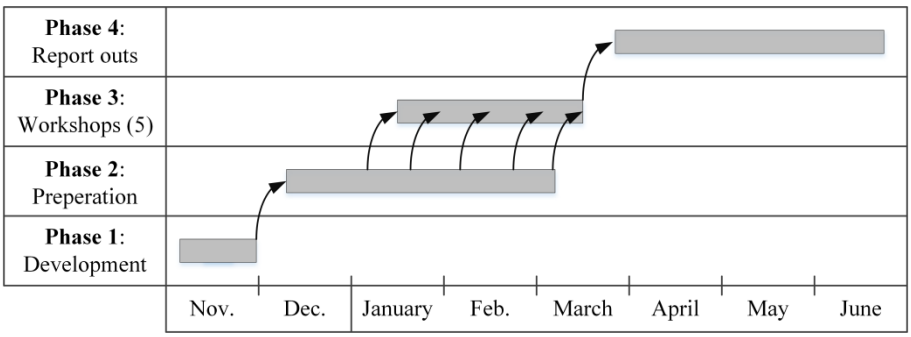

Figure 6.2. EVSM timeline.

The first phase of developing the EVSM method was done by the Supply Chain Development department. Throughout the process, one project manager from the department was in charge of the process, while the rest gave input and ideas during two workshops. For the preparation phase, a range of interviews was conducted with the different areas and stakeholders in the supply chain. This was done to make a pre-analysis to better facilitate the workshops, and in total, 30 interviews were conducted with 138 participants in total. For the third phase, it was decided to split the workshops

into different areas of the supply chain. This was done to focus the workshops and avoid having participants who only had an interest in a smaller part of the supply chain being occupied for multiple days. Therefore, five workshops were held, with the themes:

1. Transport (Also served as a trial run)
2. Supply and inflow to manufacturing
3. Operational Planning and Execution (part 1)
4. Operational Planning and Execution (part 2)
5. Tactical planning

For the workshops, there were a total of 121 participants for the five workshops; however, some participants attended more than one workshop, as they were important for understanding the total system, but it was not counted how many unique participants attended. For the last phase, the dissemination, a joint conference call was held to present the findings for all the participants at the workshops, of which 49 participated. This was followed by 11 meetings with the management in the different areas, where the overall result and specific results for their areas were presented and discussed, in total, 108 participants were involved. The summary of the data collection can be seen in Table 6.2, however, it only shows the participants for meetings and workshops and not the amount of data collected by e-mail or other means.

Table 6.2. EVSM data collection.

	Functions:	**Type and duration of meeting:**	**Number of meetings**	**Total partici-pants**
Phase 1:	Supply Chain Development	Workshops (8 hours per workshop)	2	16
Phase 2:	Sales, Transport, Supply Chain Planning, Purchasing, Quality, Finance, Manufacturing, R&D	Interviews (1 hour per interview on average)	30	138
Phase 3:	Sales, Transport, Supply Chain Planning, Purchasing, Quality, Finance, Manufacturing, R&D	Workshops (8 hours per workshop)	5	121
Phase 4:	Sales, Transport, Supply Chain Planning, Purchasing, Quality, Finance, Manufacturing, R&D	Dissemination (2-4 hours per dissemination activity)	12	108

In the first phase, the development phase, the objective and method were discussed and reviewed. Here, it was decided to use the SIPOC-template, a procedure that maps: Suppliers, Inputs, Process, Output and Customers. In addition to the standard template, it was decided that we also needed to map the resources that were used (in terms of IT systems), the government regulations affecting the possible decisions to make, the metrics used for assessing the performance of the process, and finally, the challenges and suggestions for improvement. The template that was developed is seen in Figure 6.3, and the goal of using it was to map out each process before the workshops, to have a baseline for discussion.

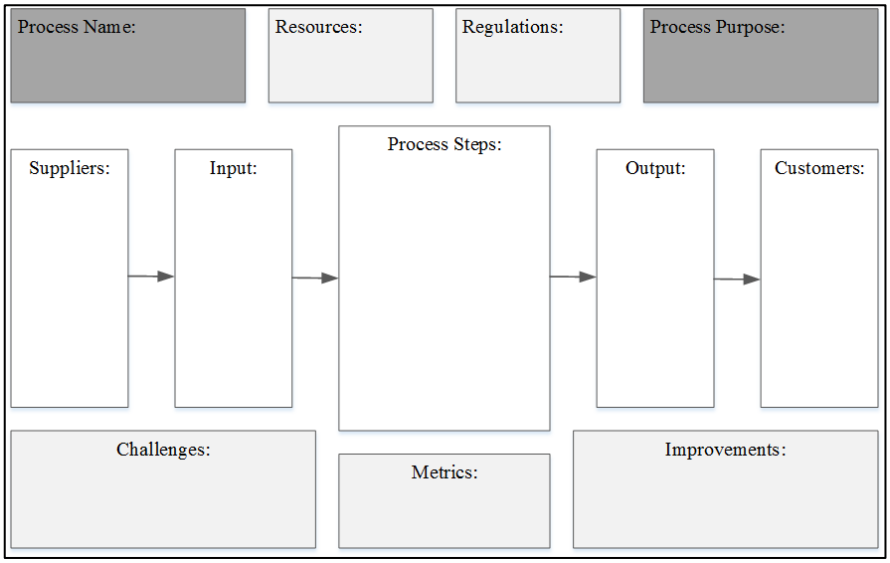

Figure 6.3. SIPOC template used for process assessment.

Aside from the template, a mapping of all processes was made (The Extended Value Stream (EVSM) Map), and at this point, it was decided to separate the workshops into the five areas and map out stakeholders relevant for the different areas. These stakeholders should either be interviewed in the preparation-phase, invited to the workshops or both.

For the second phase, the preparation phase, each process owner was asked to fill-out the SIPOC template together with their team. This was then followed up with an interview conducted by the Supply Chain Development team, where each challenge and potential improvement was discussed and supplementing data was collected. The researcher participated in all of these for the tactical planning area, and after the meetings, a summary of the meetings, the data and findings were sent to the participants for validation.

Using the example of the S&OP balancing process, Figure 6.4 represents the result of the SIPOC from the S&OP team, after it had been discussed with the Supply Chain Development team and validated by the participants.

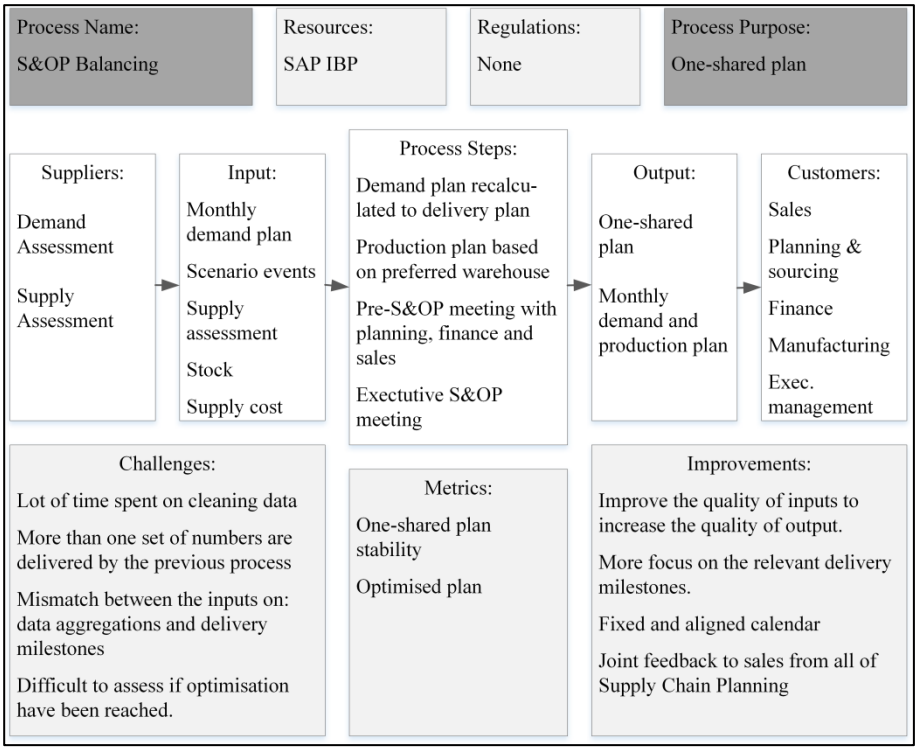

Figure 6.4. Example of an outcome of the preparation phase.

The findings of the second phase revealed a series of challenges; that the S&OP team had to spend a large amount of time on cleaning data inputs so that it could be used in the SAP IBP system. The S&OP team received multiple demand numbers (good and bad scenarios), but they could not get any firm commitment from the Sales teams to any of these scenarios.

During the review process, it was discovered that there was a mismatch between the data aggregation level they received, from the sales side they received the number of units that could be sold, but the units were not specified on which product type, as the products to a large degree is substitutional. In addition, the sales date they received, was when the entire project was sold and installed, and not when it left the factories. For the supply side, the units reported were on component and specific product type level. In addition, the production plan used for capacity planning was according to the date that it left the factory. For this reason, the first mismatch was to predict the amount of each unit on product level that needs to be supplied, here it is important to

understand, that while product A and B might fulfill the same need, a project sold with product A cannot be supplied with product B. The second mismatch is that it is difficult to predict when the products need to be finished from the factories, as the project installation date is highly dependent on the project plan and where in the world the project is installed. Therefore, it is difficult to assess when the products need to leave the factory, and this is challenging the balancing efforts.

For the third phase, the workshops, the purpose was to look at the processes in relation to each other. This was done to investigate the actions of each process and its implications for the total system and its processes. For the tactical planning area, the processes that were investigated are seen in Figure 6.5.

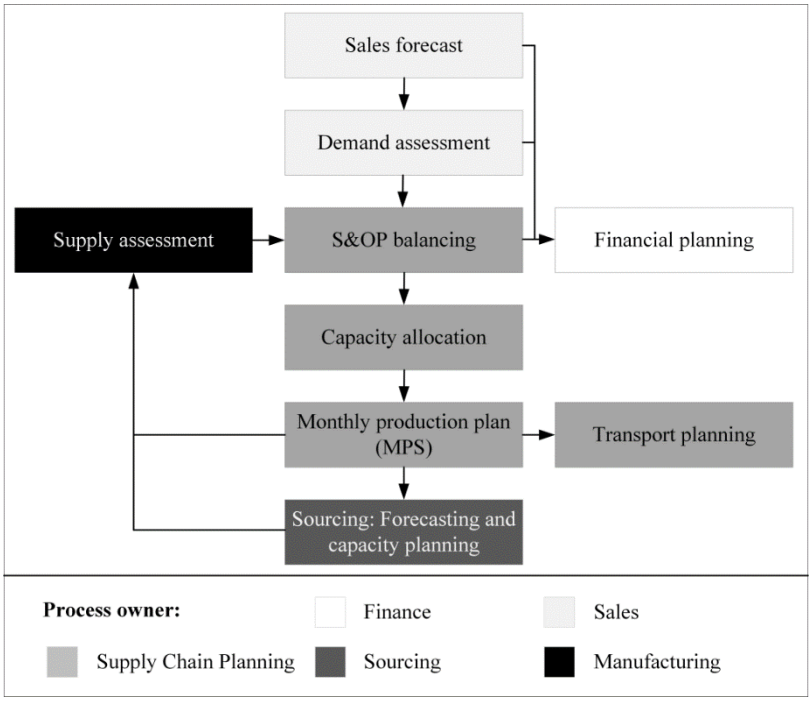

Figure 6.5. Linkages between tactical planning processes.

The ‘Supply assessment’, ‘Sales forecast’ and ‘Demand assessment’ are part of the S&OP process, while the S&OP balancing is referring to the pre-S&OP and executive-S&OP meetings. The processes after the S&OP balancing are the ‘Financial planning’ which is used to calculate expected cash flow and give inputs to the budgeting process. The ‘Capacity allocation’ is a sales gate, where each project has to go through, to get assigned the capacity to be able to confirm the sale. Hereafter, it is entered into the system as a fixed order, which the ‘Monthly Production Plan’ (Master Production Schedule (MPS)) is used to calculate a production plan. This is then used by ‘Transport planning’, to plan the needed transport capacity, as well as by the

sourcing department to send forecasts to strategic suppliers to ensure capacity. Finally, it is used as feedback into the 'Supply assessment' as a plan for the future capacity. The following will go through the different areas and explain how the processes are causing problems for the balancing of supply and demand.

Sales forecast and Demand assessment

During the workshop, much of the discussion revolved around the issues regarding the sales inputs to the S&OP process. In essence, the issue can be exemplified by the following: A sales business unit might work on ten projects, with different product compositions and different delivery dates, however, they are asked to submit a forecast that matches the budget. For this reason, they are required to assign, for instance, four projects as "sales projects" while the remaining will be labelled "backup projects". When this is forecast is sent to the 'Demand assessment' the management of sales are deciding on what is a realistic sale for each business unit, and they might agree that it is only realistic that this business unit is selling two of the sales projects. These two projects are then what is submitted to the S&OP process as the demand plan, together with a worst-case scenario and a best-case scenario.

This does, in essence, give a lot of issues, the Supply Chain Planning department would like the sales business units to commit to one set of numbers, to ensure that they are actively chasing the sales projects that the supply chain have been geared towards. The fact that the management of Sales have decided only to submit two sales projects out of the four that the sales business unit submitted, is not communicated to the sales business units because it is feared that they would lose motivation and be less aggressive in chasing sales projects. Therefore, the sales business units are chasing sales projects that there potentially is no capacity for, and they are submitting the same forecasts over and over again. At the workshops, one of the suggestions was that the sales business units should get more feedback, at least on available capacity. One example given was that the production in on sales area had been geared for a high production of product A, while the sales business units were trying to sell projects that composed of product B. As a result, a lot of unused capacity was experienced.

Capacity allocation

The capacity allocation is the process that allows a sales project to become a firm order, at this point the sales project has gone through all the preparatory sales gates, and it is ready to be confirmed with the customer. The capacity allocation process ensures that there is enough capacity to deliver according to the promises in the deal, and thereafter assign that capacity to the certain project. To do this, it looks into the one-shared plan that is the outcome of S&OP, however, several issues were found in this. The S&OP plan is made in monthly buckets of capacity, meaning that the capacity allocation process cannot see if the available capacity is at the start or the end of the month.

Second, they experienced a major gap in what was in the demand plan as sales projects, and what sales were actually selling. In essence, the sales business units often end up selling a backup project instead of a sales project, however, this backup project could be of an entirely different composition, selling another product type and with another delivery time. Therefore, it is challenging for the capacity allocation to fit the sold project into the one-shared plan, and here it becomes a challenge that the S&OP plan does not look at the entire sales pipeline. A few examples were highlighted, for example, that the sales business units were accused of purposely hiding expected sales projects as backup projects, to avoid it becoming a part of the expected budget, as the sales business units would rather under promise and over deliver, than the opposite.

Monthly production plan, Transport planning, Sourcing forecasting and capacity planning, and Supply assessment

The monthly production plan is, in essence, an MPS plan, that spans 2-24 months. The MPS plan is based on the fixed orders in the system, as well as the one-shared sales plan from S&OP. There are some clear overlaps in the plans (From 6-24 months), which results in added workloads and numbers that do not match. For transport planning and operational scheduling, the MPS plan is used, as this has project specific information for fixed orders, and the orders typically firm up around six months before they need to be shipped from the factories. However, for the sourced items with long lead times, and for the transportations that need to get approval from local governments, it is not enough to have project specific details on a six months horizon, so there appears to be a mismatch in the detail levels on the 7-12 months horizon. This overlap resulted in an additional process where the monthly buckets are made into weekly buckets for the entire 6-24 months period. Here, the workshop participants agreed that the planning horizons and the overlap between the two processes needed to be reconsidered, as it led to too much redundant work.

Here, it was evident that while the sales business units were not allowed to sell all the projects they wished, there was still unused capacity in the supply chain. The reason for this was that the sales business units were all selling a certain product A, which did not have enough capacity, while capacity was still available for product B and C. It was further discussed whether the supply assessment could become more proactive, currently, there was no overview of the available capacity in the supply chain, instead the demand was sent to the factories for verification of capacity, and this capacity was used as input for the next S&OP run. As a result, S&OP was always reactive, and there were no feedbacks to the sales department on how much capacity was available for different product types and different delivery dates. As a consequence, sales was not presented with the opportunity to align sales efforts with available capacity

For the suppliers, the forecast they received, from the S&OP plan, was of a very low quality, for instance, the S&OP plan mirrored the components needed for the two selected sales projects, but the two selected sales project could be two entirely different sales projects in the following month. This change seemed to be of little

importance to the sales department, as it had nearly two years' time horizons. However, for the suppliers with the longest lead time in the case companies supply chain, then they would need to produce according to an unstable forecast, with no certainties. Similarly, if an unforeseen project was sold, the entire supply chain would need to rush components through the supply chain, inferring a high transport cost due to, for instance, expensive air transport.

The fourth and final phase, the dissemination activities, consisted of a range of internal meetings in Supply Chain Development, to condense, summarize and prioritize the findings from the exercise. Based on the findings, a range of strategic projects was initiated to align the business processes across the entire supply chain. In addition to the strategic projects, a list of improvement projects that were not large enough to carry the strategic-label was made, which needed to be covered by the different departments themselves. Afterwards, this was reported to all participants, as well as through a series of meetings with the management of the different departments, to ensure resources and commitment to the projects that were to be initiated.

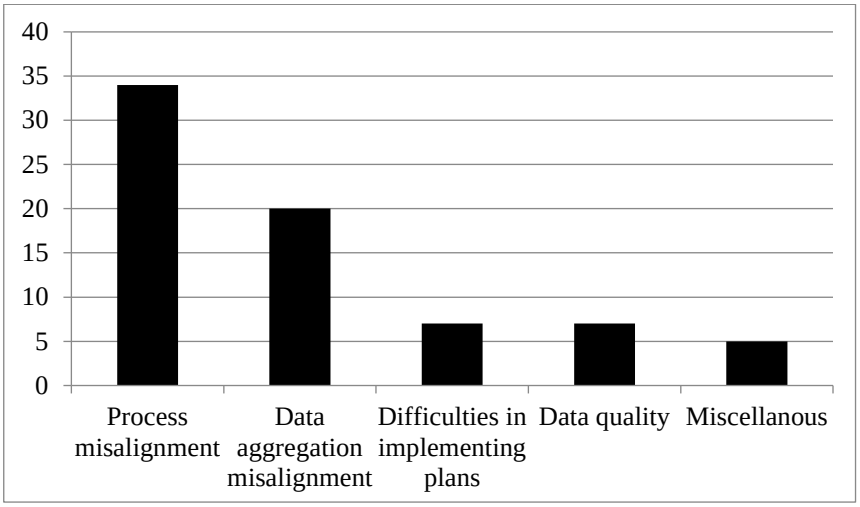

Figure 6.6. Aggregation of issues according to their type.

This exercise did help to investigate how S&OP fits into a planning hierarchy and enabled a better understanding of how the linkages in the processes affect the process of designing S&OP. It addresses one of the major gaps in the current S&OP literature, related to seeing S&OP as part of a system or hierarchical planning framework, as highlighted in Paper 2. Figure 6.6 aggregates the different issues from each process to the type of issue it refers, arguably, process misalignment, data aggregation misalignment and difficulties in implementing plans are all pointing towards the S&OP process not being designed according to the context of the planning hierarchy.

This subsection described the EVSM initiative, which looked at the processes for the entire supply chain. The next subsection is describing how the findings of the EVSM process lead to a redesign roadmap for S&OP.

6.2.2. REDESIGN PROJECTS

In practice, the redesign roadmap was decided after a series of informal meetings between a project manager working on improving the S&OP process from the Supply Chain Development department, a senior specialist in the S&OP department and the researcher. The end result was a roadmap detailing the current state and desired state for the areas depicted in Figure 6.7 (The bar illustrating how far from the desired state each process are). A range of these is seen as purely a matter of improving maturity, while others are a result of the issues highlighted through the EVSM process. The following is highlighting some of the planned changes to the S&OP design, which was a result of the EVSM process:

- **Splitting S&OP and MPS horizons**: As requested by the business, it was decided to split the S&OP and MPS horizons to avoid confusion, S&OP would look 12-24 months ahead, and potentially longer due to the long horizons of the industry and supply chain. As fixed orders were typically from 6 months, and some longer, the MPS would include project-specific details from a 1 to 12 months horizon, to ensure that for instance the suppliers and transport planning could get more specific details on the projects in the pipeline. This was considered an imperfect fix, as the 7-12 months period still would contain a mix of fixed and not fixed projects, but this could change after the changes in the supply assessment, as it was possible to work with available-to-promise capacity.
- **Supply assessment**: It was decided that the supply assessment should become more proactive, by investigating the available capacity at each factory, as well as the flexibility mechanisms in each factory. For instance tied to paper 3 and 5, which investigates APS modules for balancing supply and demand, as well as making capital investments on a tactical horizon to increase capacity. This capacity could then be used for the capacity allocation process to reduce the workload in matching S&OP plans and MPS plans, to find available capacity. Additionally, it could be used to inform sales, which is the next point.

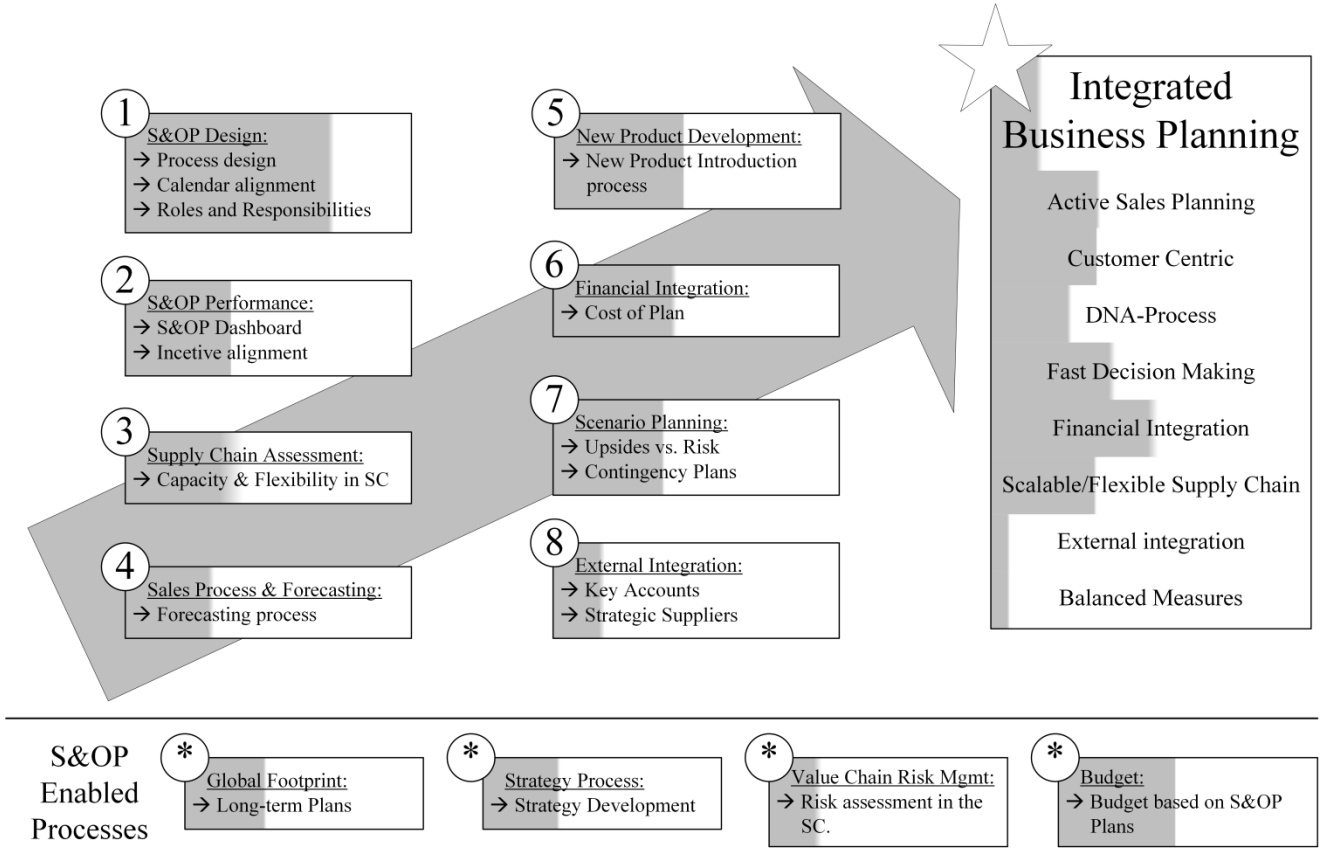

Figure 6.7. Roadmap for S&OP redesign in Case A.

- **Sales process and forecasting (Active sales planning)**: It was agreed that the Sales department and sales business units should be educated in how their decisions impacted the rest of the supply chain. In addition, it was agreed that the S&OP process should provide input to an ongoing process recently initiated by sales, labelled "Active sales planning". In essence, this process was created to inform Sales on the current state of the pipeline and if they were under or over the targets for the coming years. The S&OP process should together with the supply assessment inform the sales business units on which products had available capacity, to guide the priority of backup versus sales projects.
- **External integration**: It was found that some strategic suppliers had a significant long lead time due to the supply chain design. As a result of the process, they had to produce to inventory as they did not have any clear visibility of future demand. The goal was to eventually involve them into the S&OP process, to help prepare them for the future demand. In addition, it was found that some customers were considered more important than others, as their projects often involved higher profit. However, the way the processes were designed meant that it could not be guaranteed that there would be available capacity for their projects, despite the history of high margins. For this reason, it was envisioned to receive inputs on future projects from their strategic customers. While this was no guarantee that they would be the chosen supplier, it could give the company an edge to have more time to prepare an offer, as well as ensuring available capacity.

Aside from these highlights, a series of minor changes (low hanging fruits) was initiated to align processes and data aggregation. These were not a part of the meetings with the group but rather seen as a continuous improvement effort.

6.2.3. PROPOSED METHOD FOR REASSESSMENT

The method employed in Case A is extensive in terms of time and resources spent to prepare, conduct and evaluate the workshops, followed by designing projects for overcoming the gaps identified. It is acknowledged that the purpose of the process was more than to assess the S&OP design, thus a more focused approach would reduce time and resources. However, the CIMO logic has been used to evaluate the EVSM approach, in order to highlight the mechanisms and through that derive practical implications (Denyer et al., 2008; Pawson, 2006). The CIMO logic consists of the four elements (Denyer et al., 2008):

- Context (C): The external and internal elements.
- Interventions (I): The 'tools' that are available (e.g. leader style, forecasting technique or even S&OP as a whole (Jonsson and Holmström,2016)).
- Mechanisms (M): The mechanisms that triggered given a certain context.
- Outcome (O): The outcome of the intervention in its various forms.

The following statement is an attempt to convey the success of the EVSM approach by using the CIMO logic:

If you have an S&OP process that does not fit the contextual contingencies of your company (Context), use the EVSM approach (Intervention) to define redesign projects (Outcome) through an end-to-end assessment of the transactional flow of how the S&OP design fits into the contingencies for the processes (Mechanism).

In other words, the generative mechanism is the end-to-end assessment of the transactional flow. According to Jonsson and Holmström (2016), then the understanding of these mechanisms, and subsequent simplification and usage hereof can become a competitive driver, by being able to drive certain outcomes by using minimal resources. Similarly, Pawson (2006) suggest that practical and actionable implications are derived from the understanding of these mechanisms.

The proposed method consists of three steps:

1) Teach process owners how to use and maintain the SIPOC-template (One-time resource commitment)
2) Conduct yearly process assessment workshops
3) Define redesign projects, if any

The first step is to teach each process owner how to use and maintain the SIPOC template, as this template allows for the capture of all relevant information. Alternatively, a range of process mapping tools could be used to give the same result. The second step would be to conduct yearly process assessment workshops, the workshops are an important part of avoiding bounded rationality (Simon, 1972), as it proved to reveal issues with the S&OP design that was only apparent from another standpoint. The third and final step is to define the redesign projects in order to create a design fit.

CHAPTER 7. CONCLUSION

This chapter answers the research questions and provides and conclusion to the thesis. In addition, it assesses the limitations of the PhD study and suggests areas for future studies.

7.1. RESEARCH CONTRIBUTIONS

To sum up the research contributions, each of the secondary research questions will be answered, using insights from the thesis and appended papers, followed by a conclusion to the main research question.

Secondary research question 1: *How does S&OP design-fit influence S&OP performance?*

As found in Paper 1, S&OP is not a one-size-fits-all approach. It was found that while controlling for S&OP maturity there is a significant performance gap between cases with an S&OP design fit and the one case where the S&OP design was found to not give adequate support in regard to the context. As a conclusion, it is found that S&OP performance is not only a product of S&OP maturity, rather it is also about designing S&OP to fit one's context.

Secondary research question 2: *What is known about S&OP design-fit and how does it affect S&OP performance?*

The current academic literature was reviewed in Paper 2, in order to investigate what is known about how to design S&OP according to the context, as well as how this affects performance. Here, it was found that the following areas have an impact on the S&OP design: Industry, dynamic complexity, detail complexity, firm size, manufacturing strategy, hierarchical planning framework and organisational characteristics. In addition, Paper 3 contributed to the research question by investigating when to integrate strategic and tactical decision areas, as this was proven to reduce cost given the right contingencies. Paper 4 investigated when the use of APS modules provided benefits for the tactical planning, and found that it not only provides benefits for highly matured planning processes but also for immature processes, however, through different mechanisms. This paper further found that complexity increases the contribution of the APS modules for tactical planning, as the algorithms are able to handle more decision variables, and their interactions, than heuristic systems. Finally, Chapter 6 illustrates how the S&OP design is in need of being designed according to the processes and systems in the company, confirming the notion from Paper 2 on the importance of the hierarchical planning framework.

Secondary research question 3: *What is known about S&OP implementation and maturation, and how can design-fit be included to ensure higher performance?*

In paper 5, the current knowledge of S&OP implementation and maturation have been summarised and analysed. Overall, three implementation phases are in focus: initial project planning, project operationalization and maturation. In Chapter 6, the greenfield approach was conceptualised, for how to design and implement S&OP for new adopters of the S&OP process, where this thesis added an important element to this process, the S&OP design roadmap. Additionally, the brownfield approach was proposed based on the operationalisation of a redesign agenda in Case A, where an end-to-end process assessment was made to identify misfits in the S&OP design. The mechanisms leading to this have been proposed as a method for how to identify redesign projects for an existing S&OP process.

Main research question: *How can S&OP reach high performance, through the optimal design of the process, and implementation and maturation of S&OP?*

In conclusion, to reach high performance in S&OP, there is a need of both having a highly mature process, as well as achieving an S&OP design that fits the context of the company. To do so, this thesis proposes normative design suggestions on how context affects the S&OP design fit (e.g. see Table 6.2), as well as a proposed method for reassessing the S&OP design in existing S&OP processes.

7.2. RESEARCH APPLICABILITY AND LIMITATIONS

In the following, the limitations to the studies are examined, followed by a discussion on how it affects the research results and its applicability for industrial practice and theory alike.

- In relation to assessing the construct validity, then construct validity refers to the conceptualization and operationalization of the concepts being studied (Yin, 2014). In other words, construct validity is concerned with the extent to which a study investigates what it claims to investigate. For the purpose of this study, it was noted in Paper 2 that the "*S&OP purpose may differ…, for example, from a purpose to reduce inventories or lead times to ensure product availability during product launches*". Further examples of this appeared through the literature review, and are also evident in the motivation for implementing S&OP in Case A and B (see section 6.1). This introduces an element of concept ambiguity, where parts of the thesis have not accounted for the different purposes of S&OP. Rather, it could have focused on how to design S&OP (intervention/mechanism) for different purposes (intended outcomes), in different contexts (class of contexts), according to the CIMO logic presented by Denyer et al. (2018). However, it does not significantly alter the results of the thesis, as "reaching high S&OP

performance" would entail chasing a multitude of these intended outcomes. In addition, it was added as an important step in the greenfield approach, as a prioritization of intended outcomes are needed in practice.

- As one of the drivers for the PhD study was a close collaboration with practice, the focus of PhD was affected by their real-life problems. While the literature reviews were attempts at broadening the scope of the PhD study, then the use of single and multiple embedded case studies can have hindered the generalizability of the research contributions. However, with the critical realism perspective, the focus of these studies was to explore and explain the causal relations, i.e. theory building, which was supported using in-depth case information, in order to create theoretical generalizability. Theoretical sampling was used to identify cases that had the desired differences in context (Paper 1 and 4), however, large parts of the context remained the same amongst the embedded cases, as they originated from the same OEM, respectively. While the industry is similar between the two cases, then more nuanced industries might have given a broader perspective. But again, the research agenda and research results are positioned in a broader research agenda, that is reflected in other industries, such as; process industries (Noorozi and Wikner, 2017), food manufacturers (Ivert et al., 2015A; 2015B), retail industry (Dreyer et al., 2018), amongst others.
- The two cases in focus shared a multitude of similar characteristics; large multinational OEMs, with at least parts of the business focusing project sale. These characteristics provide a major coordination need between departments and entities, as a result, the research suggests an approach (brownfield approach) that fits into a large and complex organization. However, as stated in Paper 2, then it is found "*… that smaller companies are naturally more aligned than larger companies*." And that "*S&OP is more used, advanced and rewarding for larger companies. However, no studies have explicitly explored the underlying reasons behind this*." Therefore, the applicability of the research result has not been tested in smaller companies, and before investigating the generative mechanisms, it is impossible to say if all of the design proposals are needed and valid in a context of a smaller and less complex (and potentially less bureaucratic) organization.

7.3. FUTURE STUDIES

Multiple areas for research on S&OP design is proposed in Paper 2, while extensions and further studies are also argued in the remaining four appended papers. However, based on the conclusions of the thesis, as well as the limitations, then future studies should focus on:

- *Empirical tests of both the greenfield and the brownfield approach*: The two developed methods are either entirely conceptual (greenfield) or based on a single case (brownfield). The empirical test can be used to refine the method,

as well as provided knowledge on other S&OP design elements that need to be designed according to the different context contingencies.

- *Applying the CIMO logic for the normative design proposals*: As stated by Jonsson and Holmstöm (2016), then studying S&OP as an intervention and codifying the generative mechanisms can provide the foundation for innovating and simplifying the S&OP process. This can lead to achieving the same intended outcome with the use of fewer resources, hence, providing a competitive advantage. In addition, it would enable the identification of which S&OP design elements that lead to different intended outcomes, which can help in focusing and prioritising the S&OP design needed for different purposes.
- *Thoroughly combine or separate S&OP design and maturity research*: While the thesis focuses on S&OP design, implementation and reassessment, it neglects that a lot of maturity models included areas which would be considered S&OP design (A topic that is also discussed in Paper 1). However, in this thesis, the two areas a treated as separate entities, with the hypothesis that the two can be developed separately. On one hand, the S&OP maturity relies on a variety of supportive building blocks, which is matured through usage and cultural development in the organisation. If looking at other operations management maturity models, then this part resembles Hammer (2007)'s enterprise capabilities. However, it is naïve to believe that S&OP maturity models will entirely focus on enterprise capabilities, as it currently is also related to the advanced usage of the process (i.e. external integration or use of IT systems), hence providing normative guidelines on the design of S&OP, while disregarding the notion of design fit. As a consequence, maturity models might suggest a design that does not fit the context of the company, and future research should focus on either, including the design approach into current S&OP maturity models, or entirely separate these as two different aspects. For this, longitudinal studies of how S&OP design develops over time using the greenfield and brownfield approach should be conducted, which would give additional insights towards studies such as Danese et al. (2017), which investigates the transition between maturity steps.

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APPENDED PAPERS

Paper 1. Kristensen, J., Gubi, E. and Wæhrens, B.V. (2018), ”Assessing the design fit of Sales & Operations Planning (S&OP): An embedded case study”. An improved version of the conference article presented at: *23th EurOMA Conference 2016 in Trondheim, Norway.*

Paper 2. Kristensen, J. and Jonsson, P. (2018), ”Context-based sales and operations planning (S&OP) research: A literature review and future agenda”, *International Journal of Physical Distribution and Logistics Management,* Vol. 48, No. 1, pp. 19-46.

Paper 3. Asmussen, J.N., Kristensen, J., Steger-Jensen, K. and Wæhrens, B.V. (2018), ”When to integrate strategic and tactical decisions? Introduction of an asset/inventory ratio guiding fit for purpose production planning”, *International Journal of Physical Distribution and Logistics Management*, Vol. 48, No. 5, pp. 545-568.

Paper 4. Kristensen, J., Asmussen, J.N. and Wæhrens, B.V. (2018), ”A context-based study of Advanced Planning and Scheduling (APS) for tactical planning”. An improved version of the conference article presented at: *2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Singapore, Singapore.*

Paper 5. Kristensen, J. and Wæhrens, B.V. (2018), ”The approach for implementing and maturing Sales and Operations Planning (S&OP)”, An improved version of the conference article presented at: *24th EurOMA Conference 2017 in Edinburgh, United Kingdom.*

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