THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Perspectives on sales and operations planning

Integrating functions, creating resilience, and using artificial intelligence

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Cover:
A planetary gearbox symbolizing coordination between functions in an S&OP process.

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ABSTRACT

Many organizations use Sales and Operations Planning (S&OP) to create a balanced demand and supply plan in the tactical horizon. Over the years, research has established how S&OP should be implemented, the benefits it provides, how to coordinate it, and how it could be improved and matured. Although the benefits are clear, organizations have struggled with the process. One reason is the lack of integration across the functions, which can affect the output from the process. The second reason is that recent disruptions have questioned the established supply chain processes. The COVID-19 pandemic and global semiconductor shortages have highlighted the issue of supply chain resilience as many organizations struggled. Another reason is the recent rise of artificial intelligence tools, which are expected to automate supply chains and bring changes to the process. Considering the effects of these internal and external factors on the S&OP process, the purpose of this thesis is to understand how the S&OP process responds to the challenges of integration, resilience, and AI. This thesis draws from three studies to answer this purpose and employ a multiple case study approach.

The first study explores the integration requirements within each subprocess. It conceptualizes S&OP integration by examining subprocesses within S&OP. It contributes to research on integration by developing a framework for understanding how integration is created in the S&OP process. This highlights the importance of analyzing subprocesses and showing that integration requirements vary across different planning situations, thereby extending the view that a one-size-fits-all approach to S&OP is insufficient.

The second study explores how routine and temporary SCP processes interact to build organizational resilience during supply chain disruptions. The second study also explores how organizations transform from a routine state to a disruptive state. It contributes to resilience research by linking supply chain planning to resilience and clarifying the roles of both S&OP and temporary planning processes in enabling organizations to respond to disruptions. This study also contributes to the responsiveness view of the supply chain from the perspective of supply chain planning.

The third study examines the role of AI in S&OP. It highlights opportunities and barriers in the implementation of AI in S&OP. This study also analyzes existing AI implementation cases. It contributes to the emerging literature on AI in S&OP by conceptualizing AI-enabled S&OP and explaining, through a CIMO-based perspective, the mechanisms and contextual conditions that shape successful AI implementation. This study also provides conceptual guidance on how AI can support various activities in the S&OP process.

Overall this study contributes to the development of the S&OP process and how it responds to these challenges. S&OP is a dynamic process that accommodates these challenges and evolves in response to remain relevant and useful to the organization. A summary of the different contexts, interventions, mechanisms, and outcomes is provided, which synthesizes the findings across all studies in this thesis. This provides practical guidance for organizations seeking to design, adapt, and improve their S&OP processes in ways that are responsive to contextual challenges and supportive of sustained organizational performance.

Keywords: sales and operations planning, integration, resilience, artificial intelligence

LIST OF APPENDED PAPERS

Paper I: *Ahmed, S., Jonsson, P., and Lind, F. (2026). Exploring sub-process integration in sales and operations planning (S&OP): a multiple case study*

Sahil Ahmed was responsible for conceptualizing the study, collecting data, analyzing data, and writing the first draft. This paper is under review at a journal. An earlier version of the paper was presented at the NOFOMA conference 2023.

Paper II: *Ahmed, S., and Jonsson, P. (2026). Supply chain planning process configuration and coordination for responsiveness*

Sahil Ahmed was responsible for conceptualizing the study, collecting data, analyzing data, and writing the first draft. This paper is under review at a journal. An earlier version of the paper was presented at the EUROMA conference 2022.

Paper III: *Ahmed, S., and Jonsson, P. (2026). Supply chain planning transition capabilities during uncertainty*

Sahil Ahmed was responsible for conceptualizing the study, collecting data, analyzing data, and writing the first draft. This paper is under review at a journal. An earlier version of the paper was presented at the EUROMA conference 2024.

Paper IV: *Ahmed, S., Agrawal, T., and Jonsson, P. (2026). AI-enabled Sales and Operations Planning automation: An empirical study and research agenda*

Sahil Ahmed was responsible for conceptualizing the study, collecting data, analyzing data, and writing the first draft. This manuscript is currently in development for submission to a journal. An earlier version of the paper was presented at the EUROMA conference 2025.

Paper V: *Ahmed, S., Agrawal, T., and Jonsson, P. (2026). Towards effective artificial intelligence implementation in supply chain planning processes – A CIMO based approach*

Sahil Ahmed was responsible for conceptualizing the study, collecting data, analyzing data, and writing the first draft. This manuscript is under review. An earlier version of this paper was presented at EDSI conference 2025.

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After I completed my master's in 2020, I felt something was incomplete and had a desire to explore more. Here I am now, more than five years later, the journey still continues. This journey has been incredible and has really pushed my boundaries. Looking back, I was never alone. I had the support, encouragement, and trust of so many people, and this journey would not be complete without thanking everyone who has been a part of it.

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Sahil Ahmed
Gothenburg, August 2026

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List of Abbreviations

AGI	Artificial General Intelligence
AI	Artificial Intelligence
ANI	Artificial Narrow Intelligence
ANN	Artificial Neural Networks
APS	Advanced Planning and Scheduling Systems
CIMO	Context Intervention Mechanism Outcome
GAI	Generative Artificial Intelligence
HOT	Human, Organization and Technology
IBP	Integrated Business Planning
IT	Information Technology
LLM	Large Language Model
ML	Machine Learning
S&OE	Sales and Operations Execution
S&OP	Sales and Operations Planning
SCM	Supply chain management
SCP	Supply chain planning
SCRES	Supply chain resilience

Chapter 1

Introduction

This chapter provides the background to the study by outlining the importance of the S&OP process and how it is affected by cross-functional integration, resilience, and artificial intelligence. It then identifies the gaps in the existing literature, which motivates the overall purpose of the study and helped in formulating the research questions which guide this thesis.

1.1 Background

The goal of a supply chain is to deliver the right products at the right time and in the right quantities (Jonsson and Mattsson, 2009). In order for this goal to be achieved, all members of the supply chain must work together, as every organization within the supply chain has a role in ensuring the smooth flow of goods and services to the end customer. Just as a supply chain comprises a network of organizations and relationships (Lambert and Cooper, 2000), an organization is comprised of individuals who are assigned to perform different portions of a task (Lawrence and Lorsch, 1967). Some of the different assignments, or functions, in an organization are sales, marketing, finance, production, research and development, purchasing, and logistics (Lambert and Cooper, 2000). Supply chain planning (SCP) is an approach used to guide individual functions and to integrate the different tasks into one set of actions. Specifically, SCP involves balancing demand and supply with the goal of delivering the right products at the right time; when demand and supply are not balanced, unmet demand turns into lost sales, backorders, and lower service levels, while overestimated demand creates excess inventory, tied-up working capital, obsolescence risk, and waste (Jonsson and Mattsson, 2009). Achieving this balance is difficult because demand and supply are shaped by different functions with different objectives and decision criteria. Namely, sales and marketing seek to respond to customer needs and market opportunities, while operations and production focus on capacity and efficiency; meanwhile, purchasing and logistics manage material and flow constraints, while finance emphasizes cost control and profitability. Consequently, balancing demand and supply across functions becomes challenging.

Sales and operations planning (S&OP) is a cross-functional, tactical SCP process (with a planning horizon of approximately 3–24 months) intended to bring together different sets of plans into one unified plan (Thomé et al., 2012b). S&OP emerged as a response to inefficiencies stemming from functional silos; accordingly, it aims to prevent functions from maximizing their individual goals and instead work together towards the goals of the organization. The S&OP plan serves as the target for the operational plans (i.e., the 1—3-month horizon) while also incorporating the organization's strategic plans (2–5-year horizon) through the involvement of top management. In this way, S&OP serves as the link between the strategic goals of the organization and the operations decisions (Grimson and Pyke, 2007). Through S&OP, an organization works in concert to match customer demand with supply. However, the S&OP process is not without its own issues. In this study, three challenges are considered: cross-functional integration, resilience, and artificial intelligence (AI) technology.

First, S&OP creates integration in an organization which is segmented based on specialized functions. While the aim of S&OP is to achieve integration, that aim is not easily achieved (Shurrab and Jonsson, 2026a); merely establishing a process cannot guarantee integration, as integration requires the investment of resources (Barratt, 2004). A lack of integration can hinder the success of the S&OP process in the organization. To this end, the different organizational functions—with their own goals and competitive priorities—can reduce integration (Ambrose et al., 2018); additionally, cultural elements, such as a lack of open communication and teamwork, also hinder integration (Pagell, 2004). Integration cannot be solved through technology alone, as the latter is not a substitute for the fundamental structural, cultural, and relational changes required for integration (Barratt, 2004).

Second, while organizations work towards achieving internal integration, the external environment in the supply chain also undergoes changes, putting pressure on organizations. Changes are not new to supply chains, as they have always faced changes and disruptions; however, supply chains have recently faced increasing quantities of disruption involving higher intensities, as during 2020–2023, uncertainty was higher than in any previous decade (OECD, 2025). On 30 January 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a public health emergency of international concern (World Health Organization, 2021). with this pandemic leading to lockdowns and border closings which disrupted supply chains all over the world. While COVID-19 continued to endure, organizations faced another disruption—semiconductor shortages, which affected most manufacturers in the fourth quarter of 2020 (Frieske and Stieler, 2022). Consequently, automotive companies suffered a severe impact due to a lack of components, resulting in substantial losses (Brinley, 2023). Then, in March 2021, the Suez Canal was blocked, creating estimated inventory carrying costs of $88 million(Tran et al., 2025). This was then followed by the geopolitical issues caused by the Russian full-scale invasion of Ukraine in February 2022 (United Nations, 2022), which led organizations to reconfigure their supply chains due to the sanctions and boycott of Russia after the war started (Srai et al., 2023). Geopolitical issues such as trade wars and tariffs have continued to hinder global trade since March 2025 (Lawder et al., 2025). This list of examples is not exhaustive, but it is illustrative of the external threats which can disrupt the balance between demand and supply. The disruptions from 2020 onward have emphasized the need for organizations to develop resilience. This has prompted researchers and organizations to examine ways to keep operations ongoing despite the disruptions. This phenomenon of maintaining operations despite disruptions is called resilience (Christopher and Peck, 2004).

The third challenge concerns in particular the emerging use of AI in S&OP. Developments in digitalization, advanced analytics, and AI are reshaping how organizations forecast (Andersson et al., 2026), simulate scenarios (Shurrab and Jonsson, 2026c), and make complex decisions (Walter et al., 2025). AI can be applied at different parts of the supply chain and may improve performance and competitiveness (Sharma et al., 2022); specifically, the ability to analyze large amounts of data, learn from it, and generate predictions or recommendations is what enables AI to improve performance (Helo and Hao, 2022; Richey et al., 2023). The use of AI in supply chain management (SCM) is not a new phenomenon—one of the first articles on AI in SCM was published in 1994—but research on AI and SCM gained momentum from 2002 onwards (Sharma et al., 2022). The launch of ChatGPT on 30 November 2022 (OpenAI, 2022) significantly increased public awareness and the adoption of generative AI (GAI), which has the potential to radically change SCM and may lead to productivity increases (Richey et al., 2023). These recent AI developments have created high expectations in the supply chain, potentially affecting what planning processes can and should accomplish; for example, research suggests that such tools could support a broad set of planning and coordination tasks (Sharma et al., 2022). Realizing this potential may require organizations to adapt how they conduct planning and S&OP. Figure 1.1 presents selected major disruptions and challenges that have severely affected supply chains. As these challenges grip the organizations, there is a need to rethink how demand and supply planning is carried out in organizations.

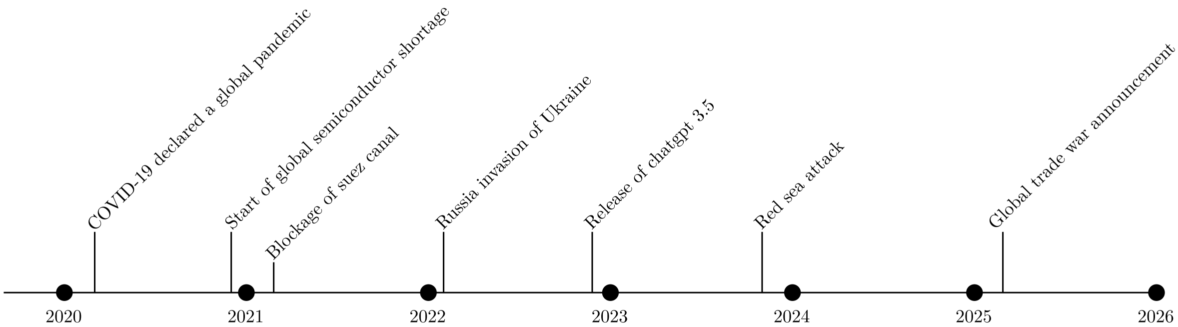

Figure 1.1: Timeline of major disruptions in the supply chain

These three challenges—integration, resilience, and AI technology—are interconnected rather than isolated, as they affect different parts of the S&OP process. Many S&OP maturity models (e.g. Pacheco et al., 2025; Danese et al., 2018) involve integration and technology aspects, comparatively, resilience has received scant attention in S&OP maturity models, although recent literature has emphasised the importance of incorporating resilience in the S&OP (e.g., Kalla et al., 2025). Integration enhances resilience through an ability to anticipate disruptions by sharing information and jointly developing solutions to mitigate them (Alem Fonseca et al., 2026). Integration is a necessary antecedent to resilience (Iftikhar et al., 2021; Nikookar et al., 2025). Integration is also required to enable data exchange across functions, which influences the implementation of AI technology (Andersson et al., 2026). Conversely, resilience underscores the necessity of cross-functional integration for problem-solving (Ivanovic et al., 2025), as well as influences the AI capabilities which are required to improve resilience. Technology can improve integration through real-time data-sharing and transparency across functions (Tchokogué et al., 2022); AI also improves resilience through quicker information-sharing, identifying risk situations, and developing scenarios (Modgil et al., 2021b). Collectively, these three areas can improve organizational performance: AI can support faster and higher-quality decision-making (Helo and Hao, 2022), integration can improve decision-making and organizational performance (Pagell, 2004), and resilience can help organizations sustain performance during disruptions (Swink et al., 2025). These relationships are illustrated in Figure 1.2.

1.2 Research Problem

As outlined in the previous section, the existing literature recognizes integration (Pellathy et al., 2019), supply chain resilience (Hohenstein et al., 2015), and the adoption of AI (Richey et al., 2023) as sources of competitive advantage and positive contributors to organizational and supply chain performance. However, there is comparatively less evidence on how organizations achieve integration, build resilience, and adopt AI within S&OP. Since S&OP is a central process in many organizations and aims to integrate different functions and create a single plan (Kreuter et al., 2022), understanding how integration is created and maintained within S&OP is important. Achieving integration is still challenging for organizations (Ambrose et al., 2018), and we still know relatively little about the specific mechanisms and organizational conditions through which integration is achieved in real organizational settings (Oliva and Watson, 2011; Tuomikangas and

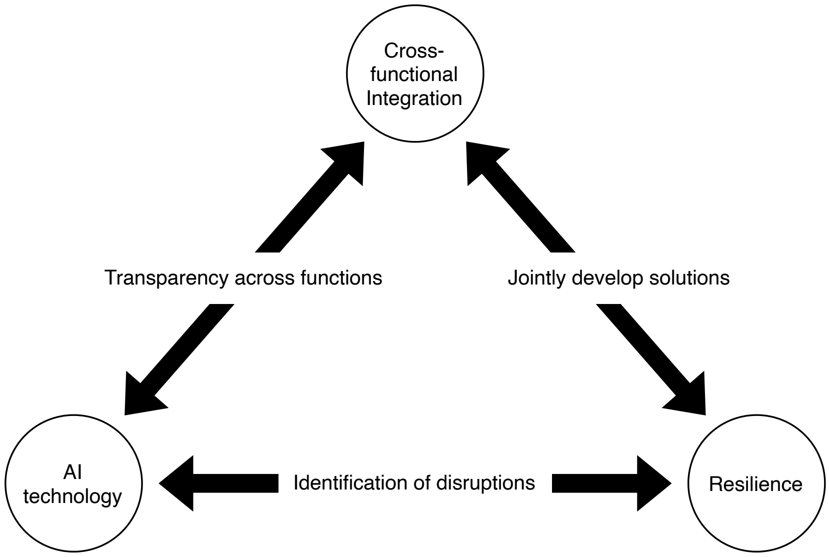

Figure 1.2: Interplay of cross-functional integration, resilience, and AI technology in the S&OP process

Kaipia, 2014). On the other hand, during disruptions, the S&OP process must be prepared to operate in uncertain environments and contribute to organizational resilience. At the same time, during disruptions, the S&OP process must be prepared to operate in uncertain environments and contribute to organizational resilience; however, there is little evidence on how S&OP can manage risks and contribute to resilience in practice (Fakhry et al., 2025; Kalla et al., 2026). Similarly, in terms of AI adoption, there is still relatively little evidence on how AI can be embedded into S&OP in practice and on the organizational requirements for its successful implementation (Jazairy et al., 2024). As a result, although integration, resilience, and AI adoption are all viewed as desirable, the capabilities through which they are achieved within S&OP remain insufficiently explored.

Against this background, the purpose of this research is to understand how the S&OP process responds to the challenges of integration, resilience, and AI. This purpose is then further divided into three research questions, which are explained below.

1.3 Research Questions

Based on the purpose, the study formulates three research questions (RQs).

RQ1. How is integration created in the sub-processes within the S&OP process?

The integration framework by Tuomikangas and Kaipia (2014) outlines the mechanisms used to create integration in the S&OP process. A drawback of this model is that it treats S&OP as a process with uniform integration requirements, when in reality, S&OP is a complex process with different functions working towards different purposes. The S&OP process commonly consists of four sub-processes: demand planning, supply planning, pre-S&OP, and executive S&OP. For example, the demand planning sub-process requires integration between sales and demand, while the supply planning sub-process requires integration between operations, procurement, and logistics (Noroozi and Wikner, 2017). Due to differences in the involvement of various functions and hierarchical levels, as well as differences in the objectives, a deeper analysis of the integration requirements for the various sub-processes of the S&OP process is needed, as the integration mechanisms from Tuomikangas and Kaipia (2014) may not work across the different sub-processes.

The S&OP process is also heavily influenced by the context in which it is implemented (Jonsson and Holmström, 2016), and hence it is necessary to understand the integration requirements in different contexts. There is no "best" integration structure, as the level and nature of the integration required in a supply chain depends on its complexity (Patrucco et al., 2025). For example, the S&OP integration requirements in a small organization with a single manufacturing unit are different from those in a multinational organization with multiple factories around the world.

Moreover, integration is not a unique S&OP problem but exists in other processes in SCM, within which there is also relatively little clarity on how integration is achieved (Frankel and Mollenkopf, 2015). One reason for this is that the integration construct is poorly specified in the supply chain, lacking a consistent definition and theory (Pellathy et al., 2019). Accordingly, there have been calls to refine the integration model and to improve understanding of how integration works across different functions (Pellathy et al., 2019).

RQ2. How does the S&OP process adapt and contribute to resilience during a disruption?

Existing studies show that organizations can manage certain risks through S&OP by designing the process around dominant risk exposures (Dittfeld et al., 2021). Some of the techniques include scenario planning, event-driven meetings, and involvement of customers and suppliers in the S&OP process(Danese et al., 2018), and they can be used proactively or reactively to manage risks. However, risks are different from disruptions: the former are associated with known events and consequences (Jüttner, 2005), whereas the latter involve unknown and difficult-to-predict situations (Sengupta et al., 2025). Disruptions change the context under which the process operates, and so managing disruptions requires a different set of adaptions to the S&OP process. Systematic literature reviews have concluded that disruption management in S&OP remains under-specified in the literature and that practitioners lack well-defined procedures for integrating uncertainties, scenarios, and decision-making into the process (Fakhry et al., 2025; Kalla et al., 2025). While, Kalla et al. (2025) have developed a framework for adapting S&OP to dynamic environments, they have not studied the S&OP process under a large-scale disruption (like the COVID-19 pandemic).

The COVID-19 pandemic is a clear example of a long-lasting disruption which had a severe impact on supply chains around the world. While existing techniques are good, a disruption on that scale goes beyond just S&OP, requiring additional processes to overcome the disruption. While exiting literature has identified planning configurations, there is limited understanding of how these configurations are implemented and how they interact with each other. For their part, Swink et al. (2025) provide evidence that SCP systems improved recovery and reduced losses during the COVID-19 disruption; this points to the need for a holistic understanding of S&OP and its connected SCP processes, as resilience is created not through isolated activities but through the interaction of multiple planning structures.

RQ3. How can AI be applied in the S&OP process, and what capabilities are required for its successful implementation and adoption?

S&OP treats information technology (IT) not as "supporting infrastructure" but as part of the process design itself. Case-based research on S&OP adaptation demonstrates that advanced planning and scheduling systems (APS) can both enable and constrain expansions of S&OP scope, creating new dependencies among technology, process parameters, and organizational maturity (Wu et al., 2025); this suggests that the use of AI would also lead to such changes in the S&OP process. Jazairy et al. (2024) highlights organizational paradoxes in preserving existing ways of working vs. incorporating AI in S&OP, which can be resolved through establishing different ways of using AI in S&OP. While other fields of supply chain— like procurement (Van Hoek, 2024), transportation (Nowacki and Wierzbic, 2024), and resilience (Baryannis et al., 2019)—have shown attention to AI application, such studies relating to S&OP are lacking. Similar AI-focused studies are needed to understand the role of AI in S&OP, not just with respect to potential AI applications but also to developing a deeper understanding of ongoing applications. Moreover, the technology is placing greater demands on the S&OP process through the expectation to analyze more data and create complex scenarios (Shurrab and Jonsson, 2026c). Supply chains need to develop the ability to process the latest information and respond rapidly, and advanced analytics and decision support technologies are important to managing uncertainties in the supply chain (Fakhry et al., 2025).

Furthermore, successful AI implementation cannot be considered only as a technological issue: in the S&OP process, people, processes, and IT are strongly interdependent. Research on S&OP implementation shows that technological changes can require corresponding changes in organizational structures, planning activities, skills, and responsibilities (Kreuter et al., 2021). Advanced planning-system implementation, for example, has been associated with requirements for human, organizational and technological (HOT) maturity, while leadership and human judgement remaining important even as planning technologies become more advanced (Ivert and Jonsson, 2014). Therefore, understanding AI adoption in S&OP requires investigation both of the potential AI applications and of the HOT requirements which enable these applications to be successfully implemented and adopted.

In the examination of these challenges, it is necessary to study and understand the S&OP process in its context. Because S&OP does not operate independently of its setting, this thesis adopts a contingency perspective and applies the logic of the Context-Intervention-Mechanism-Outcome (CIMO) framework to structure the analysis. Prior research shows that S&OP design and implementation are shaped by the unique organizational context and that changes in contingencies may require corresponding adjustments to the process, rather than reliance on universal or one-size-fits-all models (Kreuter et al., 2021). Researchers have called for more empirical research related to this and to develop a deeper understanding of the S&OP process (Kreuter et al., 2022). This research uses contingency theory and the CIMO model to link context, intervention, mechanism, and outcome to develop an understanding of how S&OP works under varying conditions.

1.4 Outline of thesis

The remainder of the thesis is structured as follows.

Chapter 2 reviews the literature on S&OP, cross-functional integration, resilience, and AI in supply chains. The chapter ends with contingency theory and an explanation of the CIMO model.

Chapter 3, the methodology chapter, describes the research design and analytical approach. This chapter provides details about the case research, case selection, data collection, and data analysis. The chapter ends with a summary of the research quality.

Chapter 4 contains a summary of the papers included in this thesis. The research questions, the methodology, and the main findings are outlined for each paper.

Chapter 5 contains the findings of the thesis, organized according to the three research questions. The chapter first explains how integration is created within S&OP, then examines how S&OP and SCP contributes to organizational resilience in disruptive environments. Finally, it presents findings on the role of AI in S&OP and the capabilities required for successful AI adoption.

Chapter 6 discusses the findings in relation to the existing literature and lays out the theoretical and practical contributions of the thesis. It also presents a model which clarifies how contextual conditions influence the mechanisms through which integration, resilience, and AI adoption generate organizational outcomes.

Chapter 7 concludes the thesis. It summarizes the main findings and contributions, points out the limitations of the research, and identifies avenues for future research.

Chapter 2

Literature Background

This chapter compiles the review of literature related to S&OP, integration, resilience, and AI. The chapter also introduces the contingency theory and the CIMO framework. This chapter forms the bases for the discussions in Chapter 5 and Chapter 6.

2.1 Supply chain planning (SCP)

SCP consists of different activities in which the organization engages so as to meet customer demands and utilize their supply chain resources effectively (Petropoulos et al., 2025). SCP can be divided into three planning horizons: strategic/long-term, tactical/mid-term, and operational/short-term (Fleischmann et al., 2015). Strategic or long-term planning focuses on a multi-year horizon (typically 5–10 years into the future) and concerns planning decisions related to infrastructure, technology, distribution network, etc. (Fleischmann et al., 2015). Tactical or mid-term planning typically looks at the 1–2-year horizon and is concerned with resource requirements, inventory level, and production quantities (Fleischmann et al., 2015). Operational or short-term planning works at the 3-month horizon and contains the highest details concerning lot sizing, scheduling, and distribution (Fleischmann et al., 2015). The specific horizon depends on the various organizational and contextual factors and will vary across organizations.

S&OP, one of the methods of tactical planning, serves as a bridge between strategic planning and operational planning. Resource-allocation and capacity-constraint decisions are made through the S&OP process (Shurrab and Jonsson, 2026b), making it an important planning process in an organization. Sales and operations execution (S&OE) is a similar process which is used to manage the execution of the S&OP plan on the operational horizon. This thesis mainly focuses the tactical level—i.e., S&OP—and, to a lesser extent, the operational level—i.e., S&OE.

2.2 Sales and operations planning (S&OP)

S&OP is a cyclical planning process used in organizations to balance demand and supply in the medium term (Grimson and Pyke, 2007). This planning process connects different functions to create a single plan for the organization (Kalla et al., 2026). It integrates horizontally, by bringing different functions together, and vertically, by connecting the strategic plan to the operational plan (Thomé et al., 2012b). By bringing different functions together, the S&OP process attempts to break down organizational silos.

The S&OP process is divided into multiple steps. Traditionally, it was divided into five steps (Wallace and Stahl, 2009), but recent literature have adopted a four step process (Kalla et al., 2026), removing the step of “data gathering”. Data gathering was its own step at the start of the process and entailed ensuring that all the data up to the current S&OP cycle was up-to-date and that the new information required for the S&OP cycle was collected and distributed to everyone (Wallace and Stahl, 2009). Due to recent advances in digitalization and data-sharing, this step does not require the same level of priority and amount of time as before; moreover, the activities in this step can be combined with the other steps. Hence, data gathering is no longer considered as necessarily a separate step. In line with this development, this thesis considers four steps, which are also referred to as "sub-processes" to indicate that they are not simple steps but instead bigger cross-functional stages. The four sub-processes, described below, are demand planning, supply planning, pre-S&OP, and executive S&OP (Kalla et al., 2026).

The S&OP process starts with the demand planning sub-process. In this sub-process, a demand plan is created based on both forecasts and qualitative information (Wallace and Stahl, 2009). The data gathered for this step include historical sales, orders, new product launches, and marketing initiatives (Seeling et al., 2022). The sales function is primarily responsible for providing the latest sales figures and upcoming customer information. The marketing function and the product development function can also be part of the process by providing information about promotions and new product development, respectively (Seeling et al., 2022). The historical information is used to generate a baseline forecast, which is then adjusted based on the other qualitative inputs (Grimson and Pyke, 2007); at this point, the various inputs are collected, and consensus is reached among the different functions. The main output from this sub-process is the unconstrained demand plan. Once the demand plan is created, it is then passed to the supply planning sub-process.

The supply planning sub-process creates a supply plan based on the available capacity. This supply plan is created by checking production, inventory, material supply, logistics, and warehouse resources (Wallace and Stahl, 2009). The data-gathering component of supply planning involves obtaining the latest information related to these resources (Seeling et al., 2022), which it utilizes to determine the best way to fulfill the demand plan. The unconstrained demand plan is then converted to a constrained plan, wherein the resource constraints and the gaps with the demand plan are identified and the possible actions and alternatives are developed (Wallace and Stahl, 2009). The output of this step is the supply plan, which is then used in the next S&OP sub-process.

The third sub-process is pre-S&OP. In this sub-process, the demand and supply plans are brought together and reconciled to finalize a plan (Wallace and Stahl, 2009); the participants are representatives from the demand-planning and supply-planning sides. The plans are evaluated, and a preliminary demand-and-supply plan is created. At this point, gaps are identified and alternative solutions are evaluated. The pre-S&OP is an important step in reviewing the plans before they are presented for executive approval. Certain decisions are made when possible, but there may be decisions which the different functions did not agree on or decisions which require a mandate from the executive team. The identified decisions are carefully evaluated and prepared for the top management's consideration.

The demand and supply plans and the unresolved issues from pre-S&OP are then taken to the executive S&OP sub-process, the final phase of the S&OP cycle. Here, top management reviews and makes decisions regarding the plans, and the plans are approved or returned for additional action. Top management's participation is an essential part of this sub-process, to ensure that the plans are in line with the long-term objectives of the organization (Swaim et al., 2016). Approval is important, as it brings legitimacy to the plan and enforces the organization's commitment to a single plan. When the plans are approved, they are then distributed to the rest of the organization to be followed. The operations planning following the approved S&OP plan. This S&OP cycle then begins again with demand planning.

In these four sub-processes, primarily the demand and supply planning teams are involved, but there are other organizational functions which could improve the output of the S&OP process. Two such widely-considered functions are finance and product development, which are not considered part of conventional S&OP but as part of the Integrated Business Planning (IBP) process. IBP can be considered an extension of the S&OP process to include finance and business strategy as well as product portfolio review (Nyman et al., 2025). The inclusion of finance can influence profitability (Seeling et al., 2022) and improve strategic alignment (Shanahan et al., 2025). With the direct participation of finance, the decision-making in the sub-processes can be sped up, while their absence can delay decisions since mitigation actions such as overtime, alternative sourcing, or expedited freight have financial consequences which require approval (Seeling et al., 2022). By considering financial evaluation throughout the process, better decisions can be made in comparing alternatives (Nyman et al., 2025). In addition to finance, product development can offer valuable input to the S&OP process. New product introductions (NPI) are very challenging for demand and supply planning, due to lack of historical data, and they have implications for such plans (Fakhry et al., 2025); accordingly, S&OP processes which include NPI have been shown to improve NPI performance (Goh and Eldridge, 2015). Due to high uncertainties due to NPI, Bagni et al. (2022) suggest a separate parallel S&OP for NPI in order to manage it better. This thesis does not emphasize the differences between IBP and S&OP, as the concepts are highly similar and IBP is often viewed as a rebranding of S&OP (Kristensen and Jonsson, 2018).

As stated earlier, the demand and supply plans are created on a mid-term horizon, which is usually 3—24 months, and the process is usually executed every month (Thomé et al., 2012b); however, the horizon and the cycle length depend on the organizational context. Some organizations have a short horizon and cycle, due to market dynamics (Ivert et al., 2015). The functional involvement and the process design are also context-dependent (Noroozi and Wikner, 2017). Due to these differences, there is no single best way to conduct an S&OP process, and the process looks different for different organizations (Kristensen and Jonsson, 2018), depending on the aim of the process and what the organization is looking to gain from it. Some of the contextual factors which affect S&OP design are product characteristics, demand characteristics, supply, and environment (Ivert et al., 2015). Another factor that affects the process design is the maturity of the process.

An S&OP maturity model is a framework to describe how an S&OP process develops from a basic state to an advanced state (Danese et al., 2018). Different maturity models are available in the literature, classified based on different criteria (e.g., Grimson and Pyke, 2007; Danese et al., 2018; Pacheco et al., 2025; Wagner et al., 2014). One example of a maturity model is that of Danese et al. (2018), who use the following criteria: (i) people and organization, (ii) process and methodologies, (iii) information technology, and (iv) performance measurement. These criteria are then ranked as Stage 0–No S&OP process, Stage 1–Reactive, Stage 2–Standard, Stage 3–Standard, Stage 4–Advanced or Stage 5–Proactive. Stage 5 is the ultimate stage, and it is what organizations should strive for, but there is lack of real-world examples of Stage 5 S&OP processes (Danese et al., 2018).

2.3 Integration in S&OP

Integration is not just an S&OP challenge, but also a challenge in the supply chain (Ho et al., 2019). While higher integration leads to higher benefits (Pagell, 2004), integrating different functions and different organizations is challenging; this is also true for integration in the S&OP process. Before we identify the different ways to achieve integration, it is necessary to define integration itself.

There are many associated terms like “coordination,” “collaboration,” “cooperation,” and "alignment" found in various S&OP literature (see Tuomikangas and Kaipia, 2014; Ambrose et al., 2018; Oliva and Watson, 2011). In this study it was possible to identify three terms which could be differentiated from one another: coordination, collaboration, and alignment. The specific definition of these terms and how they are related are explained in detail in Paper I. Coordination is managing the flow of information between the different functions. This is created through formal procedures. For example, when the demand planner provides the demand plan to the supply planner on the third Monday of every month. Here, there is a defined day and format for the data to be transferred from one function to another. This is agreed upon and followed between the different functions.

Collaboration means that two or more functions work together to create a solution. This is differentiated from coordination in the sense that in coordination, when one function exchanges the information to another, coordination is completed, but when the two functions work together, then collaboration is achieved. For example, collaboration occurs when a supply planner and purchaser work together to create the supply plan. Without collaboration, the supply planner only provides the supply plan plan to the purchaser, and then the supply plan is followed.

Alignment occurs when everyone is working toward the same goal. So, usually this goal from an S&OP perspective is the strategic goal of the organization. Goal alignment is one of the reasons achieving integration is so difficult as different functions have contradicting goals which makes it difficult to align (Ambrose et al., 2018).

The integration framework from Tuomikangas and Kaipia (2014) is used to understand how integration is achieved in the S&OP process. This framework consists of the mechanisms of organization, process, tools and data, performance management, strategic alignment, and culture and leadership. In this model, except for culture and leadership (considered as a soft mechanism), all other mechanisms are considered hard mechanisms, or ways to coordinate the process (Tuomikangas and Kaipia, 2014). The testing of this model has revealed that culture leads to better performance through alignment and information processing (Goh and Eldridge, 2022). Other research has addressed the soft aspects concerning how to improve collaboration in the process, including development of superordinate identity (Ambrose et al., 2018), social cohesion and autonomy (Ambrose et al., 2018), and development of collaborative behaviours (Stentoft et al., 2020). Despite these findings, as Section 1.3 pointed out, this model and the related studies do not explain the integration requirements of each sub-process in S&OP, as it treats the entire process as requiring the same integration.

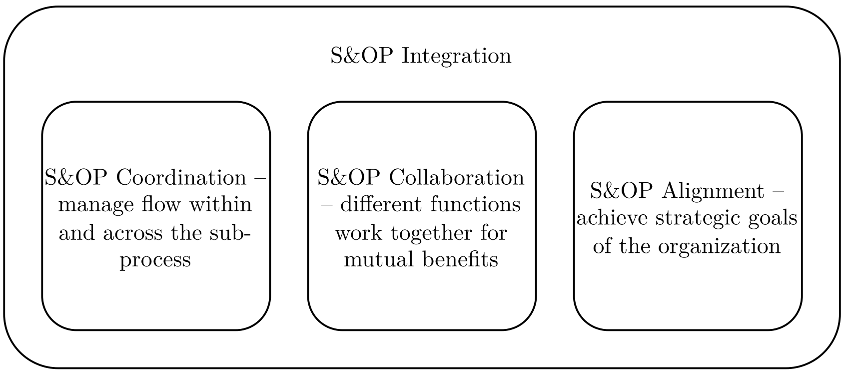

Figure 2.1: Integration model consisting of coordination, collaboration, and alignment. Source. Paper I

2.4 Sales and operations execution (S&OE)

As mentioned in Section 2.1, S&OE is a similar process to S&OP but focuses on the short-term horizon. This process is a recent phenomenon in many organizations, driven by the need to handle operational challenges. Most of the information on S&OE comes from grey literature, including consultant reports (Hippold, 2019), student master's theses (Carvalho, 2018), practitioner publication (Hainey, 2022) and conference proceedings (Rodrigues et al., 2023); hence, the concept lacks a peer-reviewed academic base. Only a few organizations have implemented S&OE, and they have had it for a short period of time (Rodrigues et al., 2023).

The aim of S&OE is to meet the plans set by S&OP by identifying deviations from the plans and mitigating them (Hainey, 2022). One advantage of S&OE is that, if it is present, operational issues can be discussed in that process, and then the tactical plans can be discussed in S&OP. Many authors suggest that S&OE should operate with a planning horizon of 0–3 months and a weekly cadence (Hainey, 2022; Rodrigues et al., 2023); similar to S&OP, S&OE should also be designed according to the contextual needs of the organization. Notably, S&OE has been shown to improve the service level in the organization (Rodrigues et al., 2023).

2.5 Uncertainty in supply chains

Uncertainties are inevitable in a supply chain; they can lead to a drop in the performance of the supply chain, but they might also reveal opportunities (Sengupta et al., 2025). They can arise from different sources: internal, supply chain, or environmental sources (Jüttner et al., 2003). The effect of uncertainty can also be different. The effects of uncertainty can also vary. If the knowledge about the sources and probability of uncertainty is combined with the knowledge about the effect of uncertainty, then uncertainties can be classified into different categories (Sengupta et al., 2025; Vilko et al., 2014). The uncertainty categories from Sengupta et al. (2025) are given in Figure 2.2. The four categories are known–known, known–unknown, unknown–known, and unknown–unknown. The responses to be undertaken are based on the type of uncertainty. An uncertainty category is not fixed, as the uncertainty can change over time. An uncertainty can also depend on the organization and their existing capabilities (Scholten et al., 2025). The category of interest here is the unknown–unknown category, as it is for this category that resilience should be developed.

		Knowledge about the outcome of the event	
		Known	**Unknown**
Knowledge about the event	**Unknown**	Unknown - Known E.g., fire at a supplier Reactive strategy	Unknown - Unknown E.g., global pandemic Adaptive strategy
	Known	Known - Known E.g., seasonal demand peaks Predictive strategy	Known - Unknown E.g., production yield Proactive strategy

Figure 2.2: Typology of uncertainties. Adapted from Sengupta et al. (2025)

2.6 Resilience in supply chains

The earliest definition of resilience in supply chains comes from Christopher and Peck (2004), who defined it as "the ability of a system to return to its original state or a new desirable state after being disturbed." The definition has been further developed as the adaptive capability to prepare, respond, and recover (Ponomarov and Holcomb, 2009). Depending on different definitions, resilience can be divided into the different phases of readiness, response, recovery, and growth (Hohenstein et al., 2015). Readiness occurs before the disruption, while response, recovery, and growth occur after a disruption. The latter three phases can overlap and do not have to follow one after the other. The capabilities required to create resilience are given in Table 2.1; many capabilities do not strictly fall under one category and can span multiple categories.

Although the definitions focus on supply chain level, most studies take a firm-level perspective rather than analyzing supply chain-level resilience. There have been some studies that particularly refer to firm-level resilience (e.g., Ambulkar et al., 2015; Conz and Magnani, 2020). However, the capabilities required for resilience are similar. Organizational resilience focuses on the survival of the organization, while supply chain resilience is about the survival of the supply chain. Supply chain resilience involves flexibility, visibility, and joint decision-making with different partners in the network to build resilience (Yaroson et al., 2021); organizational resilience addresses on internal capabilities, like organization culture, infrastructure, supply chain capability, manufacturing capability (Iftikhar et al., 2021). However, there is no clear separation between the two streams of literature, and many studies examine organizational resilience instead of resilience at the network level (this is done by, for example, Münch and Hartmann, 2022; Iftikhar et al., 2023; Shen and Sun, 2021). In this thesis, organizational resilience is addressed, as the object of study is the planning processes within organizations, but the term "supply chain resilience" is used to keep the work consistent with the rest of the literature. Nevertheless, the internal SCP process does contribute to resilience outside the organizational boundaries, as these processes are integrated with customers and suppliers.

Table 2.1: Capabilities to create resilience. (Source Han et al., 2020; Hohenstein et al., 2015)

Resilience Phase	Required Capabilities
Readiness	• Collaboration: Information sharing, risk sharing, and joint decision-making. • Visibility & Situation Awareness: Real-time monitoring, sensing potential threats, and early warning communication. • Redundancy: Safety stocks, strategic inventory, multiple sourcing, and excess capacity. • Security: Cyber-security, personnel, and physical security measures. • Planning: Predefined decision plans, contingency plans, and building a risk management culture. • Human Resources: Employee training, education, and forming cross-functional crisis teams
Response	• Agility: Speed of responsiveness, velocity, and rapid supply chain redesign. • Flexibility: Ability to adapt and adjust rapidly, including flexible production and distribution channels. • Leadership: Top management support and high-quality, sound decision-making during the crisis.

Resilience Phase	Required Capabilities
Recovery	• Contingency Planning: Supply chain reconfiguration, restoration plans, and resource realignment. • Market Position: Leveraging financial strength and market share to absorb losses and fund recovery.
Growth	• Competitive Advantage: Exploiting the disturbance to achieve a more desirable state than before the event. • Performance Boosting: Strategies to increase market share, financial performance, and customer service level beyond pre-disruption levels. • Transformation: Adapting to new configurations and surviving/thriving in turbulent change. • Knowledge Management: Learning from feedback, innovation, and developing solutions for future events.

The current definition has been considered an engineering view of resilience (Wieland et al., 2023), as the focus is on recovery and getting back to previous levels of performance. Since supply chains are complex systems which are not perfectly engineered, the definition of resilience should also go beyond to incorporate an ecological view of resilience. To this end, resilience comprises three levels: persistence, adaptation, and transformation (Wieland et al., 2023). During a disruption, persistence involves maintaining the same system, adaptation refers to adjusting the system, and transformation entails radically transforming the system (Wieland et al., 2023). A similar theory was put forth by Richey et al. (2023) called "supply chain responsiveness", which argues that supply chains are always responding to different signals in the environment and continuously evolving. Supply chain responsiveness is a higher-level capability which includes resilience in addition to improvisation, process changes, policy changes, and structural changes. These response capabilities also occur at different levels; improvisation has a smaller impact and is used in the short term, while structural change is a long-term process. In summary, resilience involves different phases, different capabilities, and different levels.

2.7 Risk and resilience in S&OP

Within the S&OP literature, risk management is therefore treated as an integral element of the planning process rather than as a separate activity. Dittfeld et al. (2021) argue that S&OP processes should be designed around the risks most relevant to the organization, particularly demand, material, and capacity risks. They further suggest that multi-level S&OP structures can improve risk identification and enable risk pooling across organizational levels.

Several other approaches have been proposed to strengthen these risk-management capabilities as well. For example, demand-related risks can be addressed through APS systems and scenario planning (Ivert et al., 2015). Collaboration and information sharing among supply chain actors are also associated with improved performance, indicating their importance for managing uncertainty (Kaipia et al., 2017). Similarly, S&OP maturity models position scenario planning and close collaboration with suppliers and customers as characteristics of more mature planning processes (Danese et al., 2018).

The literature also considers how S&OP can support the management of disruptions once they occur. Dittfeld et al. (2021) propose using existing S&OP structures, such as executive S&OP meetings, to coordinate the response. They also identify temporary adjustments to the planning horizon and cycle length as potential means of improving responsiveness during disruptions.

In cases involving NPI, a separate S&OP process dedicated to the new product may further support coordination and risk management (Bagni et al., 2022).

While literature explain how S&OP should be designed for particular risk, they do not address uncertainty management (Fakhry et al., 2025). As per the maturity model, risk management is a trait of a highly mature S&OP, and even then, it is the IT system which is responsible for risk management and scenario analysis (Danese et al., 2018). This conceptualization is not viable, as organizations with lower IT maturities also need to manage disruptions. In other words, risk management cannot be treated as an IT issue alone; the S&OP process needs to incorporate guidelines about how risks should be managed. A further limitation of the existing S&OP literature concerns the limited adaptability of the process (Wu et al., 2025) as S&OP follows a formalized process in organizations. This leaves little room for adapting the process to the dynamic situation or disruptive situations. This indicates a gap in the literature regarding how S&OP processes can be adapted to manage uncertainty and disruptions effectively.

2.8 AI in supply chain management

AI is the ability of machines to think and act like humans (Sharma et al., 2022). AI can be categorized broadly as artificial general intelligence (AGI), which can match human intelligence, and artificial narrow intelligence (ANI), which is using AI for very specific tasks (Sharma et al., 2022). There are also many other classifications of AI: depending on its function, they can be classified as predictive, generative, agentic, and embodied (Chalmers et al., 2026); depending on its analytical level, it can also be classified as descriptive, predictive, prescriptive, or cognitive (Walter et al., 2025); and depending on its interaction with humans, it can be classified as assisting, arresting, augmenting and automating (Brau et al., 2024). While there are many classifications, the main area of interest in this thesis are predictive and generative AI and how these helps in automating and augmenting S&OP tasks.

AI is not a single tool but rather a variety of different tools; which tools are considered AI and which are not is not clear. For examples, some of the tools mentioned in literature include genetic algorithms, fuzzy set theory, technique for order of preference by similarity to ideal solution (TOPSIS), and analytic hierarchy process (AHP) (Sharma et al., 2022), but these are not considered predictive AI. Specifically, predictive AI learns from past data to make predictions for the future; some examples of predictive AI used in SCM are Random Forest, Artificial Neural Network (ANN), Linear Regression, Support Vector Machine (SVM), Extreme Gradient Boosting (XGBoost), K-Nearest Neighbors (KNN), and Support Vector Regression (Culot et al., 2024). Apart from predicting, it can also classify data and detect anomalies, as well as learn over time from new data or through interactions with humans (Jackson et al., 2024). Generative AI (GAI), the latest form of AI, can create new texts, images, and videos (Chalmers et al., 2026; Jackson et al., 2024; Richey et al., 2023); once GAI became widely popular, this was considered "actual" AI. This does not mean that older approaches are not AI: GAI is still a subset of predictive AI and is built on top of neural networks and deep learning (Jackson et al., 2024). The main advantage of AI is to improve decision-making capability and improve operational efficiency (Sharma et al., 2022). Where AI excels is its ability to process large amounts of data and use it to learn, predict, and make decisions (Helo and Hao, 2022; Jackson et al., 2024).

AI has many applications in the supply chain, including supply chain network design, supplier selection, inventory planning, demand planning, and green supply chain management (Jackson et al., 2024). Demand planning is one area where AI can be used to detect patterns from past data and improve forecast accuracy (Walter et al., 2025).

Using and adapting AI to the various processes in SCM would be an advantage to organizations (Jackson et al., 2024). The main benefit is the use of AI for better decision-making (Sharma et al., 2022), which then results in improved performance through cost reductions and enhanced service levels (Culot et al., 2024). AI can reduce logistics costs through better utilization of resources (Nowacki and Wierzbic, 2024), and it can improve forecasting accuracy, which in turn can reduce inventory requirements (Hasija and Esper, 2022). AI can also lead to improved productivity: as it can learn from and analyse information more quickly than humans, it can screen various sources of information and speed up decision-making (Helo and Hao, 2022) and it can also uncover patterns which are not so obvious to humans (Walter et al., 2025). It can automate many of the repetitive tasks which would free the person to do other tasks (Brau et al., 2024; Culot et al., 2024). It can also reduce human errors and improve reliability (Culot et al., 2024)—although this can be a double-edged sword with GAI, as hallucinations (i.e., AI creating incorrect information) are a known problem (Richey et al., 2023). Another area of advantage is better risk management through continuous monitoring and responding (Baryannis et al., 2019) as it absorbs information from various sources and use that to make decisions by sensing risks and predicting disruptions (Richey et al., 2023). Although, many advantages of AI are found in literature, it is not clear what or when it will happen and what its impact on the supply chain is. The applications and benefits of using AI are summarized in Table 2.2

Table 2.2: Various uses of AI in supply chains

Supply Chain Area	How its used	Type of AI	Benefits
Demand planning	• Improving forecast	• Agent based, genetic algorithm, combine ARIMA and neural network (Sharma et al., 2022), • Long short term memory (Jackson et al., 2024)	• Higher accuracy (Jackson et al., 2024)
Scheduling	• Staffing at hospital (Sharma et al., 2022)	• Stochastic dynamic programming (Sharma et al., 2022)	• Reduced costs
Production planning	• Forecast production capacity (Jackson et al., 2024)	• Decision tree and neural networks (Jackson et al., 2024)	
Purchasing	• Tracking spending (Sharma et al., 2022), • Track supplier performance (Sharma et al., 2022), • Supplier negotiations (Van Hoek et al., 2022)	• Multi-criteria decision-making, fuzzy analytics hierarchy process, ANN (Sharma et al., 2022), • LLM (Van Hoek et al., 2022)	• Reduced costs

Supply Chain Area	How its used	Type of AI	Benefits
Supply chain network design	• Calculate the optimal location and size of facilities (Sharma et al., 2022)	• Genetic algorithm (Sharma et al., 2022)	• Optimum cost, quicker decision-making (Jackson et al., 2024)
Green SCM	• Green sourcing (Sharma et al., 2022)	• Fuzzy set theory (Sharma et al., 2022)	• Improved sustainability
Inventory planning	• Minimizing inventory required, simulating queuing and inventory (Jackson et al., 2024)	• Hybrid fuzzy set, fuzzy multi-objective linear programming, neural networks, SVM (Sharma et al., 2022), • Natural language processing (NLP) (Jackson et al., 2024)	• Reduce inventory, reduced costs
Distribution and transportation	• Shortest path (Jackson et al., 2024)	• Reinforcement learning (Jackson et al., 2024)	• Reduced costs, improved efficiency
Supply chain risk management	• Proactive identifying and mitigating risks (Baryannis et al., 2019)	• Multi-agent system, Bayesian system, neural networks(Baryannis et al., 2019)	• Quicker reaction, agility

Implementation of AI is not straight-forward. It requires a combination of HOT factors for success (Maghroor et al., 2025). When it comes to technology, the AI tools require large amounts of high-quality data (Walter et al., 2025). Even if data is available, it might be stored in different silos and in different formats, which makes access difficult (Hasija and Esper, 2022). Cybersecurity and privacy is another aspect which needs to be considered when thinking about data-sharing (Zamani et al., 2023).

When it comes to the AI tools, they are constantly evolving with constant development. In the organization, lack of knowledge about AI among the decision-makers is one barrier towards its implementation (Sharma et al., 2022); this prevents organizations from setting strategic targets for AI implementation or even identifying areas for implementation. Without a consistent strategy, there is a lack of alignment between business needs and AI utilization (Culot et al., 2024). Strategy is also necessary for top management's support and investment in resources (Mohiuddin Babu et al., 2024). AI is expensive, and investment in AI is a long-term process (Jazairy et al., 2024); without a strategy, its return on investment is harder to define (Cannas et al., 2024). Investment in AI is a long-term plan (Jazairy et al., 2024).

Moreover, at the individual level, the employees using AI have to develop new technical skills related to data science, model development and adjustment, and AI ethics (Jazairy et al., 2024), so investment requires training and skill upgradation. At this level, implementation can be hindered when employees fear for their job security, leading to resistance to adoption (Jazairy et al., 2024; Sharma et al., 2022). In addition, trust in AI is difficult, due to it being a black box, which run contrary to the experience held by the employee using it (Jazairy et al., 2024). Finally, AI could result in the loss of individual expertise (Jazairy et al., 2024) but at the same time it could also overwhelm planners, as it provides many scenario analyses (Shurrab and Jonsson, 2026c).

2.9 AI in the S&OP process

Much emphasis in S&OP is placed on planning software and tools (see Tuomikangas and Kaipia, 2014). Especially in maturity models like that of Danese et al. (2018), the availability of advanced tools is an indicator of a highly mature process. These maturity models do not address AI or automated S&OP processes, but they do specify how technologies should support decision-making. In this perspective, AI is an enabler for highly mature S&OP process and supports decision-making.

S&OP has received some attention regarding the application of AI. Jackson et al. (2024) highlight that AI could improve S&OP performance by improving forecasting and supporting decision-making. At the same time, Jazairy et al. (2024) highlight the various tensions between traditional and AI-enabled S&OP processes and how these two opposing forces needs to be managed for the S&OP process to incorporate AI. Many of the benefits and barriers mentioned above are also applicable to the S&OP process. Implementing AI-enabled S&OP is not straightforward, and the current S&OP should be mature enough to implement it (Jazairy et al., 2024); without a stable existing process, integration faces hindrances across functions, as decision-making, data sources, and procedures are unclear. Above all, there is an absence of literature establishing an AI-enabled S&OP process framework.

2.10 Contingency Theory

Contingency theory proposes that the structure of the organization should match the contingency, or context, of the organization (Donaldson, 2006). A high match—–i.e., fit—–between the structure and the contingency results in higher performance, while a misfit leads to lower performance. It should be noted that there are multiple ways to create fit. Sousa and Voss (2008) extend this theory to operations management, contending that different practices in operations management should fit the organization's contingency. Some studies related to lean, just-in-time, quality management and to total productive maintenance have used the lens of contingency theory (Sousa and Voss, 2008). Supply chain planning has also utilized contingency theory. One study Jonsson and Mattsson (2003) concerns matching the fit between environment and planning method. This study notes that even when a good match is obtained, if it is not implemented correctly, dissatisfaction could still occur. Three variables are associated with fit: the contextual or contingency variable, which is external to the organization and over which the organization has little control in the short term; the response variable, which is the action taken to mitigate the situation; and the performance variable, which relates to assessing the consequence of the fit (Sousa and Voss, 2008).

When organizations enjoy higher performance due to fit, it leads to their expansion, which changes the contingency. At that point, organizations need to move towards a new structure to regain fit, which is labelled as "structural adjustment to regain fit" (SARFIT) (Donaldson, 2006). This concept reinforces that the fit between contingency and structure is not static. Moreover, it is possible that the organization is not in a state of perfect fit but in a state of quasi-fit, where they are close to the perfect fit or moving towards it (Donaldson, 2006). SARFIT is also a useful concept here, where the organization faces challenges from the external contingency and thus attempts to change their structure as mitigation. A Context Intervention Mechanism Outcome (CIMO) framework is useful to explain how organizations change.

2.11 Context-Intervention-Mechanism-Outcome (CIMO) Framework

While SARFIT explains that organizations need to change, it does not explain how changes are achieved; CIMO is a useful framework to explain the latter. There are concerns about the lack of practical relevance of organization and management studies and this CIMO framework links context to intervention and specifies the mechanism (generated by the intervention) which creates the desired outcome (Denyer et al., 2008). Context is defined differently here than in contingency theory: here, it refers to both the internal and external environments of the organization. Intervention is the available tool to influence behaviour, and it is the change that is brought to the organization. An intervention could be a number of things, such as the implementation of S&OP or a change in the forecasting software. Mechanisms—e.g., employee empowerment—are triggered by the intervention. Finally, outcome is related to the performance or benefits gained from the intervention.

The CIMO model is useful, as it develops propositions which link these factors together. This is highlighted in Jonsson and Holmström (2016), who point out that planning interventions are not widely adopted in organizations but this could be solved by studying such interventions through the CIMO model. Their research was based on real-world variables which would help practitioners successfully implement them. Jonsson and Holmström (2016) also suggest that in addition to expected outcomes, unexpected outcomes should also be highlighted in research.

2.12 Contingency and CIMO studies in S&OP

S&OP, like other processes in an organization, is also considered to require implementation based on the organization's context. Of the many contingency factors, complexity is one factor which appears in the literature. Detail complexity and dynamic complexity are two types of complexity which are considered (Thomé et al., 2014): detail complexity refers to the structure, which could be the number of products, components, customers or markets, or production sites (Thomé et al., 2014); dynamic complexity is related to uncertainty in demand and supply (Thomé et al., 2014). High detail complexity creates a need for higher IT capabilities, to manage the large amount of data. In such an environment, the use of APS is appropriate (Ivert and Jonsson, 2014). Another way to manage detail complexity is to parse the S&OP process when multiple S&OPs are conducted in the organization (Kristensen and Jonsson, 2018); S&OP can be parsed in different ways, for example by product types, regions, or manufacturing sites. Dynamic complexity can be managed through the adoption of S&OP parameters such as planning frequency, adaptable horizon, and changing scope (Ivert et al., 2015). Scenario planning is another way to manage dynamic complexity (Kristensen and Jonsson, 2018). While APS is helpful here in creating different scenarios, setting up the scenarios and knowing about them are essential to see the benefits (Ivert et al., 2015). Finally, dynamic complexity can also lead to increasing the planning horizon, as a longer horizon can help in dealing with seasonal variations (Ivert et al., 2015).

Firm size is another notable contingency factor: larger firms are found to reap bigger performance gains from the S&OP process than smaller firms (Thomé et al., 2014). Larger firms have dedicated S&OP teams (Dreyer et al., 2018), although the size of the firm has not been shown to have much of a link to the design of the S&OP process (Kristensen and Jonsson, 2018). Larger firms also have more mature S&OP processes (Kristensen and Jonsson, 2018). Also, when it comes to integration, smaller firms benefit less from S&OP, as smaller firms tend to already have integration compared to larger firms which require integration generated from the S&OP process (Kristensen and Jonsson, 2018). All of this stems from the fact that larger firms tend to have higher detail complexity, which could lead to the need for an S&OP process and subsequently the maturity, performance, and integration gained from it.

The type of industry affects the S&OP design. S&OP has also been studied in different types of industries, including grocery retail (Dreyer et al., 2018), food manufacturing (Ivert et al., 2015), healthcare (Alvekrans et al., 2016), and the process industry (Noroozi and Wikner, 2016). For groceries and food, the complexity leads to changes in the S&OP process; since grocery retail depends on information from the suppliers, input like supplier material forecasts can be included in the S&OP process (Dreyer et al., 2018). For their part, the process industry requires specific information like maintenance information, yield, and raw material availability in the S&OP process (Noroozi and Wikner, 2016). In addition, studies have examined different countries, including Brazil (Pedroso et al., 2016), India (Sehgal et al., 2006), South Korea (Kim and Shin, 2024), and the Asia Pacific (Goh and Eldridge, 2015); there are no country-wise differences in the S&OP process. Finally, there are studies on Made-to-order (MTO), engineer-to-order (ETO) (Bhalla et al., 2023), and made-to-stock (MTS) (Amico et al., 2025). For ETO, a new S&OP process is developed for date-setting. The summary of studies on contingency is given in Table 2.3.

Table 2.3: Contingency related studies in S&OP

Contextual Category	Specific Factors and Their Influence
Industry and Environment	• Industry type influences S&OP design, adoption, maturity, and organizational characteristics (Alvekrans et al., 2016; Dreyer et al., 2018; Ivert et al., 2015; Noroozi and Wikner, 2017) • National culture can pose obstacles to implementation (Pedroso et al., 2016)
Complexity and Dynamism	• Dynamic Complexity increases the need for risk management, scenario planning, and cross-functional coordination (Dittfeld et al., 2021; Ivert et al., 2015; Wu et al., 2025) • Detail Complexity affects whether S&OP processes need to be “parsed” into multiple processes (Ivert et al., 2015; Lapide, 2011)
Organizational Characteristics	• Firm size where larger firms may obtain larger advantages from S&OP (Thomé et al., 2012a) • Organizational orientation/culture either facilitates or hinders the coordination efforts necessary for S&OP success (Ambrose et al., 2018; Stentoft et al., 2020)

The CIMO model can be used to derive the framework used for this study. The internal and external planning contexts create tension between the existing S&OP design and the requirements imposed by the environment; organizations respond through interventions, which reconfigure the people, process, and technological dimensions of S&OP. These interventions influence mechanisms of information-sharing, cross-functional collaboration, alignment, and coordination, as well as enables resilience capabilities such as agility, flexibility, and responsiveness; another necessary mechanism is the ability to understand the technological complexities and their applications in the S&OP process. The outcomes concern both the integration of the S&OP process and the ability of the organization and its supply chain to respond and adapt to disruption. This is summarized in Figure 2.3.

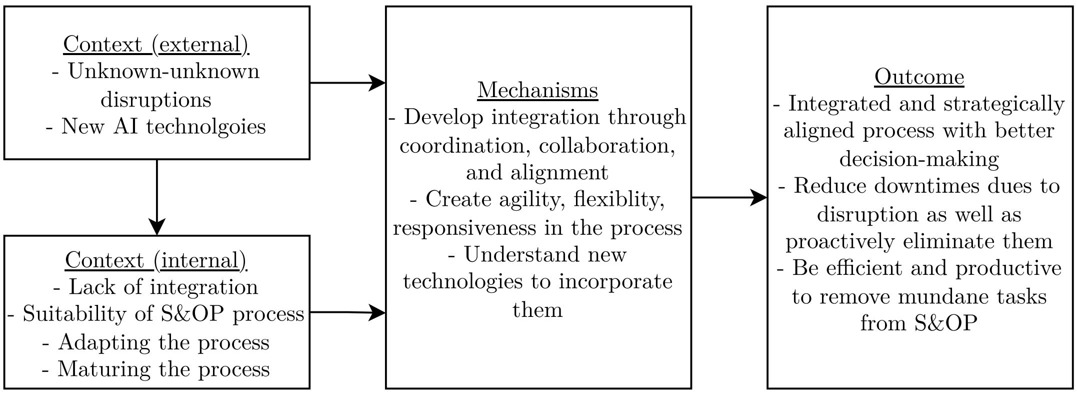

Figure 2.3: Literature framework derived from the CIMO model. Here, the intervention is the changes to the S&OP process.

Chapter 3

Methodology

This chapter defines the methodology used across the three studies. It starts with the research design, followed by the timeline of the studies. It then continues with case selection, data collection, and data analysis. The chapter ends with a reflection on the quality of the case studies.

3.1 Timeline of Studies

The doctoral studies started in February 2021, with the aim of reducing manual re-planning in organizations to manage risks. This was to be achieved through the use of the latest technology, which can automatically re-plan when risks are detected. As there are different sources of risks, integration was necessary in order to understand the risk effects. The first of the conducted studies aimed to understand the current usage of technology and how it enables integration in the S&OP process. A further review of the literature revealed that the term "integration" was poorly defined and required further elaboration. At the same time, a few organizations were contacted to understand the technology they used; however, none of them conducted organizations used advanced technology to conduct S&OP, and the contribution of technology to integration was minimal. As a result, Study 1 was changed to understand integration in S&OP processes, and the role of technology was dropped. A preliminary version with two cases was presented at NOFOMA 2021, and an updated version with five cases was presented at NOFOMA 2023. This then became Paper I.

At this time, the COVID-19 disruption was in full effect; this led to the emergence of resilience as an attractive topic of research whose development was ongoing. As resilience was closely related to risk management, and since the pandemic was a disruption unlike anything seen before, there was an opportunity to study how resilience was developed in organizations. Moreover, the literature neglected the role of SCP in creating resilience. This led to the development of the second study, the aim of which was to understand the role of SCP in resilience. Thereafter, the research project Building resilience: Aligning supply chain reconfiguration and dynamic planning (REAL) was approved as part of the Produktion 2030 initiative from the Swedish government innovation agency, Vinnova. The REAL project ran from Nov 2021 to Nov 2025. Study 2 officially began in January 2022 and continued through 2024. The preliminary findings of Paper II were presented at EUROMA 2022. The paper was developed further, and as the scope expanded, another paper was spun off, creating Paper III; Paper II focused on the configuration of SCP during disruptions and how it created resilience, while Paper III focused on the capabilities for transformation. Paper III was presented at EUROMA 2024. In 2024, the licentiate seminar was presented.

At this point, the focus returned to the initial topic of technology and to the concerning realization that technology usage in the S&OP process was limited. To this end, in 2024, Study 3 was initiated with the aim of understanding how technology can be better utilized in the S&OP process. This study was connected to Study 2, as the literature offered many suggestions about harnessing technology to improve resilience in organizations. Additionally, by 2024 the technological landscape had changed since 2021, when the PhD began; more attention was paid to the use of AI, and organizations were interested in understanding how to incorporate AI. This development was the motivation behind this study. Study 3 was split into two papers: Paper IV was conceptual and dealt with AI usage, and Paper V was about the capabilities for successful AI usage. Preliminary versions of Paper IV and Paper V were presented at EUROMA and EDSI, respectively, in 2025; these papers were further developed after the conference in preparation for submission.

The timeline of the studies is outlined in Figure 3.1.

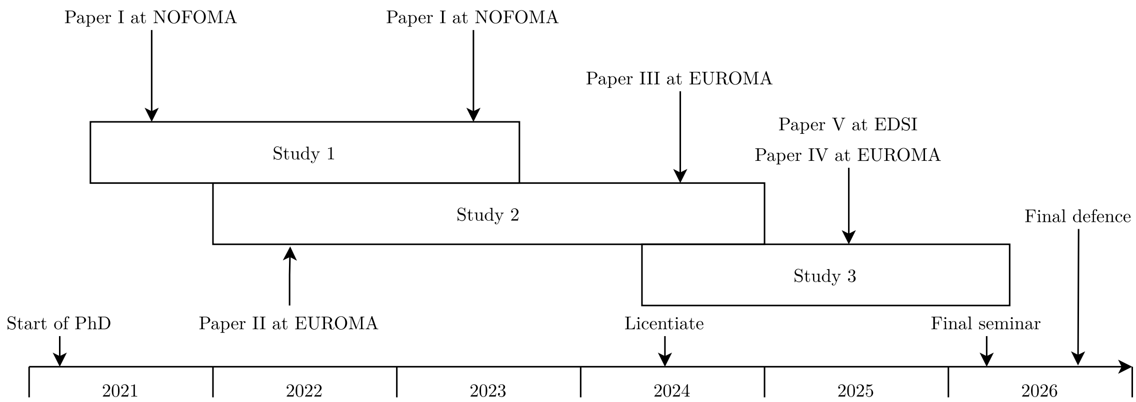

Figure 3.1: Timeline of studies

3.2 Research Design

A qualitative research design was adopted to serve the purpose of the studies, for multiple reasons. First, qualitative research is suitable for topics which are under-explored and where existing theory requires further development (Eisenhardt et al., 2016). S&OP is a complex, context-dependent process, and researchers have called for more empirical research in different contexts (Kreuter et al., 2021). As regards resilience, the last few years have seen an explosion of publications (Castillo, 2023), but few have focused on the topic of SCP, and even fewer have addressed the topic of transitioning and adapting SCP processes. Similarly, AI has received a lot of attention recently, but empirical studies on SCM are lacking (Cannas et al., 2024). The lack of exploration and the complexity means that there are factors and capabilities which are not captured, and in order to capture these phenomena, an in-depth research design is needed. In summary, the lack of exploration, the complexity, and the lack of existing theory points to qualitative research as an appropriate method (Eisenhardt et al., 2016).

The overall purpose of this research is to understand how the S&OP process responds to the challenges of integration, resilience, and AI. The research design was interactive. The purpose was divided into three research questions. RQ1 was identified from the literature and driven by the lack of understanding on integration in the S&OP process. RQ2 was driven by both literature and practical need: from a practical standpoint, organizations were interested in understanding how to navigate COVID-19 and create resilience, and research simultaneously needed to identify capabilities to improve resilience. COVID-19 was a special event in terms of influence, and we are unlikely to see a disruption of this scale again in the near future. As for

RQ3, much attention was paid to the phenomenon of AI with the release of ChatGPT at the end of 2022 (OpenAI, 2022)—specifically, there was much speculation about the possibilities of using this tool and how it would affect the supply chain—but there was a lack of literature concerning its application in S&OP. Additionally, from a practical point, the application of AI in S&OP was not clear.

In order to answer these RQs, a multiple-case design was adopted. Case studies enable an in-depth study of a phenomenon (Yin, 2014); because it is not clear how integration, resilience, and AI adoption are developed in organizations, case studies are an appropriate method for studying these phenomena. Moreover, these are complex phenomena, wherein multiple capabilities interact to generate the output; case studies are suitable for exploring such complex phenomena (Yin, 2014). Data collection was mainly done through interviews. The interview data was then coded to form the analysis. The detailed description are provided in the following sections.

Other methods could have been considered, such as surveys and simulations. Survey studies have the advantage over case studies that it allows higher generalizability. Survey studies have been conducted on related topics, including integration and S&OP (e.g. Ambrose et al., 2018; Goh and Eldridge, 2015), antecedents of resilience (Nikookar et al., 2025), impact of AI on reverse logistics (Alkalha et al., 2025), to name a few examples. B. However the constructs and variables in the current studies—namely integration, resilience, and AI adoption—were not sufficiently developed, which makes them harder to define. Moreover, a survey would only test relations about which we know—i.e., it requires a deductive approach. Without clarity around the phenomena, an exploratory approach is better suited, as a survey may not uncover new phenomena. Simulation is another method option; for example, Dohmen et al. (2023) use simulation to study planning processes under disruption. There are mathematical models also that proposed models to improve resilience (Wang, 2024). In such studies, the change in planning conditions needs to be quantitatively represented; it does not capture the actual people who are involved in the planning, nor how they have made replanning possible.

3.3 Case Studies

Case studies are defined as an in-depth study of a bounded system (Bell et al., 2022). While all three studies in this project utilize case study methodology, they differ from each other; notably, they did not use the same case boundaries, as each study had a different research focus. The case study design allowed for the refinement of the research focus and the case boundaries; that occurred in all three studies, where the research questions were refined as the data collection and analysis progressed. As they were exploratory studies, new opportunities were revealed as the studies progressed. The case study methodology strengthened the three studies, grounding them in real-world organizations and enabling examination of S&OP and SCP as it happened in practice. The differences between the studies are explained below, and the connections between the three studies and the five papers are given in Figure 7.

In Study 1, the system boundary was the S&OP process. The initial study relied on the coordination framework from Tuomikangas and Kaipia (2014) to understand the degree of integration in each of the interface. As described above, the study changed focus to understand the phenomenon of integration in cross-functional planning processes. This illustrates one of the advantages of case studies, which enabled a change in direction as data were collected and new insights were reached. The preliminary analysis was presented at the online NOFOMA conference in September 2021; based on the feedback, new cases from the REAL project were added to the study, which resulted in more interfaces. In addition, a new integration framework was developed which consisted of coordination, collaboration, and alignment, and all five cases were analyzed using this framework. These results were presented at NOFOMA in June 2023.

The usage of the term “interfaces” was found to be confusing to the audience; hence, “interfaces” was changed to “sub-processes,” which simplified not only the presentation of the results but also the analysis. The latter occurred because the S&OP process differed across the cases, which resulted in many interfaces which were present only in individual cases. By using a sub-process perspective, the interfaces could be grouped and then compared across the cases.

The aim of Study 2 was to understand resilience in planning processes. The case study was based on the exploration of resilience characteristics in the S&OP process. Before the interviews, the case boundary was the S&OP process; however, the data collection revealed that it is not just S&OP but a group of different planning processes which leads to resilience. At that point, the case boundary expanded to include the entire planning processes, rather than only the S&OP process. This illustrates how the case boundary was modified. As the study progressed, it was necessary to understand the transformation of the planning process, as this capability is important during disruption; with that, the idea for Paper III was born. The same cases were used in both papers. Paper III also had the ambition to explore transformation after the disruption, but the empirical material had better insights into the pre-disruption stage; accordingly, the post-disruption stage received less emphasis in the paper.

Study 3, investigating the adoption of AI technology in the S&OP process, started with the intention of understanding what could be done in the S&OP process. At this point, an in-depth analysis of existing S&OP processes at two organizations was performed; insights from the previous two studies were used here, as there had been many discussions on the S&OP process design at these organizations. However, the analysis of the S&OP sub-process revealed that some machine learning (ML) and AI solutions were already being used in the organization, and this presented an opportunity for learning about the factors for successful AI implementation. The two papers of this study (Paper IV and Paper V) complement each other, as one is about possibilities and the other is about the mechanisms to achieve them. Nevertheless, the case boundaries were different in the two papers: Paper IV was confined to the S&OP process, while the boundary in Paper V was a specific planning activity. Additionally, in Paper IV, the cases were utilized in a different way than in the other papers; while all papers took a theory-building approach, in Paper IV the case was used an example to demonstrate the S&OP process and to ground the possibilities of AI in real-world examples.

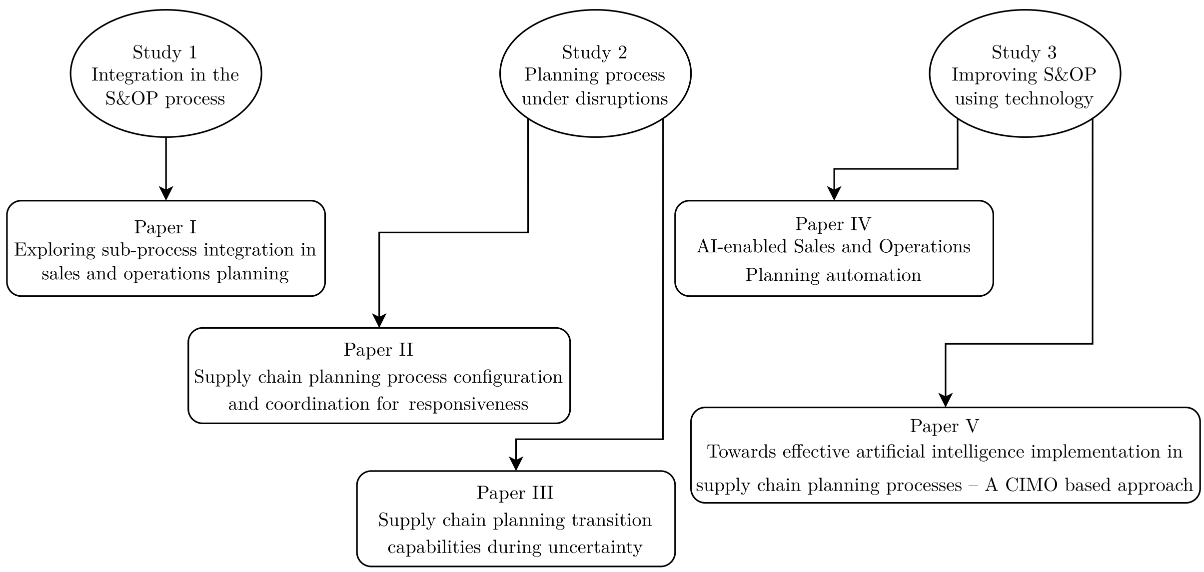

Figure 3.2: Connection between the three studies and the five papers

3.4 Case selection

Case selection is an important part of qualitative research, and there are different case selection criteria. For example, in a single-case study, either a representative case or an extreme case could be selected, and for a multiple-case study, contrasting cases could be chosen (Yin, 2014). On this point, according to contingency theory, there is no single best way to implement the S&OP process, as the best process depends on the unique context (Kristensen and Jonsson, 2018); accordingly, different contexts provide necessary information about the differences between the S&OP processes in different contexts. Moreover, a single case would be too restrictive in terms of results, while multiple cases allow for different aspects to be incorporated so as to provide a generalized result (Yin, 2014). These points indicate the benefits of selecting multiple cases from different contexts. A summary of the cases used across the studies is provided in Table 3.1.

In the selection of the different cases, a theoretical sampling procedure was followed. The objective of theoretical sampling is to choose cases which can extend theory (Eisenhardt, 1989), and since the purpose was to explore a previously-unexplored area, theoretical sampling was appropriate here. At the same time, random sampling is not at all beneficial in theory-building (Eisenhardt, 1989). All the studies had one important criterion in their case selection: having an established S&OP process which was stable and running for a few years—specifically, S&OP could not have a low maturity, and at least a Stage 3 maturity level from the Danese et al. (2018) model was required. The specific case selection criteria for the different studies are explained below.

In Study 1, the purpose was to explore S&OP integration, having different S&OP process designs enabled studying integration in different contexts. Various organizations were contacted and given information about the purpose of the study and the data required of them. Initially, two organizations agreed, and data collection started with them, although the search for more S&OP cases remained ongoing. After the project's approval, the researchers had access to more cases. Three more cases, all with established S&OP processes and operating in different contexts, were added to the study, bringing the total to five. The multiple cases clearly demonstrate how different organizations conduct the S&OP process differently and with different levels of integration, as well as the differences in carrying out global S&OP processes at organizations.

When Study 2 began, four cases were available from the research project case pool. All cases for Study 2 were experiencing disruption and hence were good candidates for understanding how the planning process was executed during the disruption. One criterion for the case selection was that they were largely affected by the COVID-19 disruption and also managed to overcome it. The study started with three cases, and the fourth case was added later. The selected cases represented different contextual conditions and were affected by the disruption in different ways; this variation supported cross-case analysis and improved the generalization of the findings. The long-term nature of the project also provided commitment from the organizations and the possibility of following how the processes changed during the disruption.

For Study 3, two cases came from the research project case pool; these organizations were interested in the use of AI in the S&OP process. While this was workable for Paper IV, which was about conceptualizing the use of AI in S&OP, the cases were not sufficient for Paper V, as these two organizations did not have enough ongoing implementations, and the aim was to have close to eight different AI implementations. Consequently, additional companies were contacted, and one additional organization was included as a case. Software companies were also contacted for their perspective, but limitations in the depth of data collected led to them being dropped.

Case selection was an important part of the process. Case studies require in-depth collection of data and hence commitment from the participating organizations. Organizations are hesitant to participate in research projects, mainly due to time commitments. Moreover, it is difficult to determine whether a case is critical or not before data has been collected, so it is necessary to collect in-depth data from available sources. Due to the exploratory of the topic and to contingency theory, it follows that no single critical case exists: there cannot be a single organization which has the best integrated process, or is the most resilient, or is the most technology-oriented; every organization has its strengths and weaknesses. Balancing companies' strengths and weaknesses could be achieved through a multiple-case study—the approach followed in the three studies here.

Table 3.1: Summary of case companies and corresponding studies

Case Company	Study Used	Industry	Size
Alpha	Study 1, Study 2, Study 3	Telecom equipment	263b SEK
Beta	Study 1, Study 2, Study 3	Automobile	552b SEK
Gamma	Study 1, Study 2	Healtcare equipment	29b SEK
Kappa	Study 1	Confectionary	8b SEK
Psi	Study 3	Mining equipment	120b SEK
Sigma	Study 2	Industrial equipment	81b SEK
Zeta	Study 1	Pharmaceutical	550b SEK

3.5 Data collection

Data collection relied primarily on semi-structured interviews and process documentation. Direct observations were not used as a data collection method; while this could have been a good addition and improved reliability, companies always regard S&OP as very sensitive information. Additionally, there was a lack of access to the executive teams in the organizations, which is clear in all the papers, which fall short when it comes to the executive S&OP sub-process (i.e., the sub-process where the top management team is involved). The decisions made in this sub-process and how they are made could be valuable inputs which improve the understanding on integration, resilience, and AI.

Semi-structured interviews were the primary source of data collection in the cases. A semi-structured nature was utilized to allow exploration of the phenomenon, offering flexibility during the interview to collect all the information but also preventing a drift into irrelevant topics (Stuart et al., 2002). With semi-structured interviews, it was possible to follow up on different topics as well as seek clarification from respondents. Before the interviews, the interview guide was shared with the respondents, both so that they could prepare and so that they could gauge whether they were the right person for the interview, as a few people declined the interview request; the preparation from both parties also kept the interview focused. The interview guide improved over the years. The interview guides are provided in the respective papers as appendices to improve reliability (Yin, 2014).

The S&OP managers at the organizations were the main starting points of all the studies, as they were the project's primary contacts at the organizations. Other respondents were identified through the S&OP managers based on their involvement in the studies; these respondents were shaped by the S&OP managers' perspective and knowledge about the organization. The data depended on access to key informants. This was a shortcoming in Study 1, as only the S&OP managers were interviewed there. The best access to respondents occurred in Study 2, due to the combination of project contracts and the commitment from the S&OP managers in arranging interviews; even then, not all organizations provided equal help in setting up interviews. It is possible that some perspectives were missed because the right informants were not identified as they were not part of the formal planning process. The different interviewees and information about the conducted interviews are given in Table 3.2.

At least two rounds of interviews were conducted in all the studies: the first round for gathering information, and the second round for filling in missing information. Wherever possible, a third round of interviews was conducted for verification. At this point, the collected data was presented to the S&OP manager; if this interview was not possible, the data was sent via email to the S&OP manager for review. Emails were also sent to the respondents if points which needed clarification but did not require a longer interview. The interviews were conducted during or close to the disruptions and AI implementation process, which meant the data collected was timely and context-rich. The data collection was iterative, and new questions were raised as new details emerged from other interviews. Almost all the interviews were conducted online. This made it easier to record and transcribe, as such functions are built into online tools; however, online interviews limited the development of deeper relationships with the respondents and possibly affected their reflection on the processes. The automatic transcriptions were checked for errors and corrected, and the transcripts were used for the analysis. The recordings were preserved safely so that it was possible to go back to the original source in case of ambiguity during the analysis.

Table 3.2: Summary of interviews conducted in each paper

Paper	Title of interviewees	No. of interviews	Avg length of each interview
Paper 1	S&OP director/manager, Head of SC planning, ERP Specialist, Demand planner, Supply planner	10	1 h 15 minutes
Paper 2	S&OP director/manager, Demand planner, Supply planner, Sales manager	18	1 h
Paper 3	S&OP director/manager, Demand planner, Supply planner, Sales manager	29	1 h
Paper 4	S&OP director, demand analyst, demand planner	4	56 mins
Paper 5	S&OP director, demand analyst, data scientist, forecasting product owner, digital strategy director	9	56 mins

In addition, S&OP and planning process documents were also obtained from the organizations. This source acted as a source for triangulation and improvement of construct validity (Yin, 2014). However, this evidence was not available in all the organizations; this was understandable, as the phenomena studied were either still emerging and did not have prepared documentation (resilience and artificial intelligence) or could not be captured in documents (integration). When information was missing in a case, it was clarified either in the second round of interviews or through emails. Multiple respondents were also used within each organization, to further triangulate the data. Group interviews were another effective method of data collection, as the groups were able to complement each other in the information they provided. A drawback is that, group interviews could be dominated by a single person (Voss et al., 2002), but that was not observed during interviews.

In addition to the interviews, workshops were conducted as part of Study 2 and Study 3; three workshops were connected to the resilience study and two to the AI study. These workshops were arranged under the REAL project and involved participants from multiple case companies, as part of broader project meetings which also included topics beyond this thesis. They were used to present preliminary findings, develop research directions, and improve buy-in from participating companies. The participants were mainly S&OP managers along with planners, executives, and AI specialists, with participation depending on the topic of the workshop. These participants were a good source of validation for the analysis. The workshops also improved trust and relationships with the S&OP managers and case companies. The workshops were not recorded, and the input was mainly documented through notes. The author tool an active role in the workshops by presenting findings, preparing discussion questions, and taking notes from participant responses. Nevertheless, the main data sources were still the interviews and the process documents. The different sources of data collected in each paper are summarized in Table 3.3.

Table 3.3: Summary of data collected in each paper

Paper	Sources of data used
Paper I	Interviews, S&OP process documents
Paper II	Interviews, Group interviews, planning process documents, Workshops
Paper III	Interviews, Group interviews, planning process documents, Workshops
Paper IV	Interviews, S&OP process documents
Paper V	Interviews

3.6 Data analysis

The unit of analysis can be anything from organizations to processes to individuals to interventions (Yin, 2014). In Paper I, the unit of analysis was the S&OP process—not the organization, as the same organization could have different S&OPs in different parts. In Paper II, the unit was the planning processes which were used to manage the disruption. Here, data collection started with a focus on S&OP, but the data soon revealed that it was more than this process; hence, the focus was expanded to include other SCP processes, as it was clear that resilience was created from the combination of planning processes. In Paper III, the unit was the change in the planning process. This was complicated, as a change could be big or small; nonetheless, the focus was on the capabilities required to make the change, regardless of whether the change was big or small. In Study 3, the focus returned to S&OP: in Paper IV, while the case boundary was the S&OP process as a whole, the individual steps in the S&OP process were used for the analysis; for Paper V, there was a detailed inquiry into what the specific implementation was, so here, the unit of analysis was the actual implementation connected to the S&OP process.

It should be noted that the analysis outlined in this paragraph applies to Papers I–III and Paper V, as these papers follow the same structure (the analysis used in Paper IV is described in the final paragraph of this section). The first step in the analysis was data coding, but the papers differed. In Paper I, the integration model was developed from the literature, and coding was performed based on the integration model, making it more deductive; however, recoding and re-analysis were undertaken when the literature framework was modified as the paper went through different stages. Papers II and III followed a more open approach, where some concepts (e.g., the integration model or responsiveness) were defined but the coding was also open to new codes emerging from the data, for a balance between theory and empirical material. Paper V followed a structured inductive Gioia methodology (see Gioia et al., 2013), ensuring that the first set of coding was kept as close to the informants' terms as possible and then moving on to second-order and aggregate dimensions. This approach made the analysis more transparent and easier to trace from empirical statement to theory. Paper V also benefited from the experiences with the previous papers, which sped up the data analysis. Thus, over time, from Paper I to Paper V, the analytical process became increasingly systematic. This progression also highlighted the importance of enhancing transparency by clearly documenting and presenting the steps of the qualitative analysis.

As all papers were multiple-case studies, after coding they followed the process suggested by Eisenhardt (1989) of structured within-case analysis followed by cross-case analysis. In the within-case analysis, specific constructs from the case were extracted, and explanations were created. A detailed description of each case was also compiled to increase familiarity with the case. At this stage, the cases were presented back to the organizations for verification, from whom additional details were also sought to fill in gaps. Thereafter, a cross-case analysis was performed to check for similarities and differences between the cases. A comparison matrix was used for this analysis (Miles et al., 2014), which helped to structure the analysis and simplify the description into categories. With cases arranged by column and constructs arranged by row, the patterns across cases could be compared and analyzed in a structured manner. These tables can be seen in the respective papers. The coding and the preliminary analysis were conducted by the author, and the interpretations were then discussed with co-authors to help to reduce the risk that the findings reflected only the main author's point of view. Microsoft Excel and Word were used in the data analysis to organize codes, descriptions, and the comparison matrix in Papers I–III. Although NVivo was considered during the early stages of this thesis, Excel and Word were used because they provided a familiar and flexible way to work with the empirical material at that stage. In Paper V, NVivo 15 was used in the coding and analysis, as by this stage, the analysis followed a more structured logic inspired by the Gioia methodology, making NVivo more suitable.

Paper IV is different from the other papers, as it is a conceptual paper rather than an empirical study. Here, the analysis followed a pattern-matching approach. The first step involved identifying the various AI application possibilities from the literature. Then, the S&OP processes at the organizations were divided into various steps. AI applications identified in the SCM literature were matched to the various predefined steps of the S&OP process. This made it possible to assess where AI could support various planning activities and to develop a conceptual proposal for an AI-supported S&OP process. The summary of the analysis method is given in Table 3.4.

Table 3.4: Summary of data analysis in each paper

Paper	Unit of Analysis	Analysis Method	Software Used
Paper I	S&OP sub process	A priori coding	Excel, Word
Paper II	Planning process	Open coding	Excel, Word
Paper III	Changes in planning process	Open coding	Excel, Word
Paper IV	Steps in S&OP process	Pattern matching	Excel
Paper V	Implementations of AI	Gioia method	Nvivo 15

3.7 Research quality

One way of evaluating quality in research is to look at its construct validity, internal validity, external validity, and reliability (Yin, 2014). Since these measures come from positivist research traditions, they are criticized for not being applicable to qualitative research (Andersen et al., 2018). Other quality measures are suggested, like internal coherence, simple theory, grounded in data, and rich and unexpected insight (Eisenhardt et al., 2016). These sets of quality criteria have some overlap, but they are used together to highlight the quality of this research, which is summarized in Table 3.5.

The first criterion from Yin (2014) is construct validity, which specifies the extent to which the empirical material captures the concepts which the study intends to examine. In this thesis, the construct validity was supported by the use of multiple sources of information, namely interviews, process descriptions, and internal documents in Papers I, II, and III. Papers II and III also had multiple types of respondents, enabling corroboration of the same phenomenon; however, Paper I relied on S&OP managers as the main informants, which restricted the possibility of corroborating integration practices across several functions. In Paper V, construct validity was limited, as there was a lack of access to process documentation; this was addressed through clarification with the respondents as well as through the Gioia data structure. For all papers, the information was presented to the organizations in a verification round. This review was mostly conducted in online meetings except for one case, where it was communicated through email. This verification improves the accuracy of the information. To further improve the construct validity, a chain of evidence was produced in the papers (mostly in the appendices), with detailed case descriptions and how the constructs were derived from the data. This supports construct validity through increased transparency.

Internal validity refers to logical coherence (Yin, 2014). Yin (2014) mentions that this criterion is applicable to explanatory research, not exploratory or descriptive research. The studies in this thesis include both explanatory and exploratory elements, as this research aims to develop an explanation for the explored phenomenon. Here, internal validity was supported through presentations of the proposed models to the case companies to assess whether the interpretations were reasonable. Additionally, discussions with co-authors also helped to refine the logical coherence of the explanations; furthermore, early versions of all the papers were presented at major conferences. The feedback and critique from reviewers and audiences resulted in improvements. In addition, the studies relied on systematic iteration between theory and data (Dubois and Gadde, 2002), which strengthened the fit between the observations and the explanations. The papers have also undergone many iterations and reviews, which supports the internal validity.

External validity is the extent to which the findings can be generalized beyond the case studies (Yin, 2014); in case study research, it concerns analytical generalization rather than statistical generalization. To improve external validity, multiple case studies were used in all the papers, meaning the findings were not dependent on a single case. Additionally, through cross-case analysis, the similarities and differences across the cases were identified. Contextual information was also included in the analysis, in order to help with generalization. This helps readers to understand the boundaries of the system and assess its validity in other situations. Still, the generalization is limited to the S&OP domain; the findings should not be understood as statistically generalizable to all organizations or all planning processes. Rather, their relevance is strong to organizational settings which share similar planning characteristics.

The fourth criterion is reliability, which requires that other could repeat the study and arrive at similar conclusions (Yin, 2014). To support reliability, a detailed outline of the interview guide, data collection, and analysis steps are provided in all the papers, to support transparency in the research. Additional descriptions and analysis material are also provided as supplements in all the papers, creating an 'audit trail' for the research. Nevertheless, a qualitative study cannot provide complete reproducibility. The studies were conducted in real organizational settings, where contextual conditions change over time. The analysis is also dependent on the author's interpretation. Transparency was provided to readers to assess the outcomes of the studies.

Regarding the theoretical quality criteria suggested by Eisenhardt et al. (2016), the first aspect is strong theory. To this end, the concepts are well-defined in the papers (for examples, see the descriptions of integration in Paper I and the responsiveness model in Paper III). In each paper, the relationships between concepts are discussed in detail before the propositions, to ensure that arguments are well motivated and grounded in empirical material. The second aspect is consideration of alternate definitions and boundary conditions. To this end, systematic combining and detailed descriptions of the constructs and relationships were used to satisfy this aspect. The third aspect is having a simple and parsimonious theory; on this point, the propositions as models are kept as simple as possible, without too many boundary conditions or complexity. The fourth aspect is grounding in compelling data; to this end, the detailed empirical material and analyses are provided in the papers and in the appendices. The fifth aspect is rich and unexpected insight. On this point, this thesis has attempted to capture its contribution to theory and highlight how this contribution is different from existing literature. One example of an unexpected insight comes from Paper III and concerns how advanced IT tools are not so critical during reactions to a disruption.

Table 3.5: Summary of quality criteria in research

Quality criteria and definitions	Study / Paper
Strong theory — emergence of coherent theory (Eisenhardt et al., 2016)	Concepts are defined in the respective papers; relationships and arguments are provided in the discussion sections before propositions.
Address alternate definitions and boundary conditions (Eisenhardt et al., 2016)	Boundary conditions are provided in terms of context of the studied phenomenon. Systematic combining performed to check theory and data.
Simple theory (Eisenhardt et al., 2016)	Attempts were made to simplify theory while capturing the essential parts. The propositions are kept to a minimum and without too much complexity.
Grounded in compelling data (Eisenhardt et al., 2016)	Detailed data and analysis are available in the appendix or supplementary material of every paper; detailed analysis steps are also provided.
Rich and unexpected insight (Eisenhardt et al., 2016)	The contribution in each of the papers and how it differs from existing research is clarified.
Construct validity — do the things measure what they should measure? (Yin, 2014)	Multiple sources (interviews and documents) and review of case data by informants are included; a clear definition of concepts and a chain of evidence are provided.
Internal validity — explanation, logical model (Yin, 2014)	The model was presented to case companies through workshops; papers were presented at conferences.
External validity — applicable in other scenarios (Yin, 2014)	The findings are not specific to a case. Multiple cases were used in all papers, which carried out cross-case analysis. The contextual factors were included.
Reliability — demonstrate the study (Yin, 2014)	Interview guides were used; clear documentation of data collection was kept; within-case and cross-case analysis were performed.

Chapter 4

Summary of Papers

This chapter summarizes the papers included in the thesis. It presents the purpose, research focus, methods, main findings, and contributions of each paper.

4.1 Paper I

S&OP is a structured, cross-functional process which is essential to balancing demand and supply in manufacturing organizations. It integrates various functions into a cohesive set of plans to enhance organizational alignment and coordination. However, the literature is fragmented with regard to integration, and it lacks a unified framework which clarifies aspects like alignment, collaboration, and coordination. This paper aimed to explore integration requirements across the different S&OP sub-processes—namely demand planning, supply planning, pre-S&OP, and executive S&OP. This paper is framed around three research questions:

1. What characterizes different types of sub-processes in the S&OP process?
2. What are the implications of integration for various S&OP sub-processes?
3. What is the maturity of integration within the S&OP process?

Through a multiple-case study of five companies with mature S&OP processes, this paper investigated how integration within individual sub-processes contributes to overall process integration, thereby enriching the S&OP literature and offering a conceptual framework for process integration.

An integrated S&OP process is crucial to aligning demand and supply plans with an organization's strategic goals. This paper highlights that while all five examined cases have established mature S&OP processes, the degree of integration varies. The S&OP process consists of several sub-processes, including demand planning, supply planning, pre-S&OP and executive S&OP, with distinct function involvements and organizational setups.

Coordination is a fundamental component throughout the S&OP process, as the formalization of data and activities facilitates interaction between fragmented functions, thereby enabling a comprehensive global S&OP plan. A interplay between coordination and collaboration is observed; if coordination is absent—especially in less formal settings—collaboration is present. Factors such as organizational culture and trust contribute to successful collaboration, particularly in less complex sub-processes with fewer involved functions. Additionally, a greater level of collaboration is observed in local-global hierarchies in the same sub-process.

Alignment of S&OP sub-processes with strategic objectives can be either active or passive. Active alignment involves direct participation from key functions (such as finance and product development), leading to improved coordination and responsiveness to changes. By contrast, passive alignment occurs through inherent intra-functional understanding, and it often relies on feedback from executive processes taken later in the cycle.

The analysis categorizes S&OP process integration into four maturity stages:

1. No coordination or S&OP implementation, with possible collaboration existing in smaller setups.
2. Implementation of S&OP with formal coordination but only passive alignment.
3. Introduction of collaboration in sub-processes, leading to informed (albeit limited) demand and supply planning.
4. Comprehensive alignment towards strategic goals, representing the highest integration maturity level and enabling rapid response to opportunities.

This maturity model emphasizes that the evolution of integration progresses from coordination to collaboration and culminates in alignment. This maturity model differs from traditional models, which address the various dimensions of S&OP such as people, process, IT, and performance (e.g. Danese et al., 2018).

4.2 Paper II

Supply chain disruptions, such as the COVID-19 pandemic and the global semiconductor shortages, highlight the need for effective SCP to maintain responsiveness. Established processes like S&OP and S&OE are seen as key to managing risks and enhancing supply chain resilience. However, the existing literature primarily focuses on S&OP, and it offers limited guidance on designing SCP processes during disruptions. Despite recognition of the importance of responsiveness and resilience, there is insufficient understanding of how SCP processes operate in complex, high-impact disruptions, and of the necessary interplay between routine and temporary processes. This paper examined the configuration and coordination of SCP processes during major disruptions, through a multiple-case study of four global manufacturers affected by recent crises. It aimed to: (1) explore interactions between routine and temporary SCP configurations; (2) identify coordination methods; and (3) analyze how SCP responsiveness is achieved. The paper contributes to SCP theory by framing planning during disruptions as a dynamic configuration of coordinated processes, and it elucidates the relationship between responsiveness and resilience in SCP.

The results highlight that while S&OP aims to balance demand and supply, its inherent formalization often constrains flexibility, which reduces responsiveness during uncertainty. The findings also suggest that existing S&OP processes alone are insufficient to manage the complexities of significant disruptions which require more agile responses.

Instead, the findings reveal the creation of temporary, disruption-specific SCP processes which complement traditional routines. These additional processes include executive-led decision meetings for quick responses, operational-level monitoring teams for real-time issue identification, and tactical continuity planning for long-term scenario development. The paper emphasizes that coordination during disruptions occurs more through intra-process formalization rather than inter-process ties, relying heavily on top management's active participation and on standardized data-sharing to facilitate informal communication.

Furthermore, the paper differentiates levels of responsiveness in SCP, from improvisation in early disruption phases to adaptability as situations stabilize. Resilience in SCP and organizational structures is highlighted as crucial, indicating that robust supply chain capabilities can reduce the immediacy of extreme responsiveness. The paper's propositions focus on integrating routine and temporary processes and enhancing S&OP and S&OE with proactive and reactive strategies so as to improve adaptability and resilience during significant uncertainties.

4.3 Paper III

Organizations face challenges in SCP due to evolving uncertainties. S&OP and S&OE are key practices for balancing demand and supply, with methods such as scenario planning aiding in uncertainty management. However, S&OP and S&OE may not be able to address very high uncertainties; consequently, adapting SCP to respond effectively to disruptions, such as those caused by COVID-19 and semiconductor shortages, is crucial. To this end, this paper investigates the capabilities necessary for transitioning SCP processes to adapt to uncertainties. These capabilities are analyzed through the interplay of people/organization, processes, and IT. In its analysis of four case studies of global manufacturers, this paper extends the research on SCP by emphasizing the importance of adapting SCP under uncertainty, thereby contributing to the S&OP literature.

As regards process capabilities, S&OP is viewed as a critical process for demand–supply management, but findings reveal its limitations in handling supply chain uncertainties, particularly in agile decision-making during disruptions. This paper highlights that SCP processes require modification and refocusing in uncertain environments, as illustrated in various studies. Disruption characteristics necessitate adaptive measures; known–unknown uncertainties demand reactive strategies. The inability of case companies to manage uncertainties leads to necessary transformations in their SCP processes, with a combination of proactive and reactive approaches. Key observations underscore that SCP processes must be contextually designed and adaptable to evolving uncertainties.

People/organization-related capabilities are crucial for transforming SCP during uncertainties, which highlights the need for open communication and cross-functional collaboration. The role of top management expands significantly during disruptions, as their involvement in decision-making processes is vital for quick responses. Knowledge acquisition, particularly through previous experiences, plays a crucial role in swiftly adapting SCP processes.

Finally, technological capabilities during disruptions often prioritize maintenance over advancements, with organizations leveraging existing IT systems creatively. In-house IT teams prove essential for modifying processes in response to emerging needs. The paper reveals a diminished role for advanced technologies during disruptions, indicating instead a reliance on basic communication channels over complex IT solutions. The implications of these findings suggest further exploration into SCP adaptability in future research.

4.4 Paper IV

The recent developments in AI present SCM organizations with opportunities for developing a competitive advantage. While GAI has recently gained prominence, there had previously been various ML algorithms which had been suggested to improve SCM processes. Despite numerous studies examining the potential of AI in areas like procurement, transportation, and demand planning, a gap remained in research on S&OP. S&OP is crucial for aligning strategy and operations and thus is an ideal candidate for improvement using AI. Hence, the purpose of this paper was to explore how AI could be used in the S&OP process and what the requirements are to use it. It started by identifying the possibilities of automating S&OP through AI, utilizing two cases to demonstrate application.

The analysis highlights how AI can be utilized into the different sub-processes of the S&OP process (demand planning, supply planning, pre-S&OP, and executive S&OP). In demand planning, where forecasting is central, AI excels in utilizing extensive datasets containing structured and unstructured external data (such as economic conditions and social media trends) to enhance forecasting accuracy. However, forecasts depend on various factors, and it is difficult to provide a specific forecasting approach which is applicable for every situation. Apart from forecasting, challenges exist in preparing data for AI use, especially for necessary pre-forecast activities such as error correction; these activities could be semi-automated with AI. In supply planning, GAI's role is less pronounced, with the focus instead on optimization algorithms which complement ML techniques. AI could assist in risk management across the supply chain by utilizing historical data to anticipate potential issues, which would facilitate proactive adjustments in plans. The review processes in supply planning where AI could help include identifying data errors and optimizing business rules concerning inventory and production. Finally, the pre-S&OP and executive S&OP phases involve scenario analysis and decision-making, where AI can support but not replace human judgement; the executive team always has the final say, emphasizing collaboration across organizational functions. In summary, this paper outlines the many different research opportunities related to AI implementation in S&OP.

4.5 Paper V

AI refers to a machine's ability to mimic human cognitive functions and utilise historical data to make predictions and recommendations. Recent advancements (particularly in transformer architectures) have made AI more accessible, facilitating the deployment of AI-driven solutions in SCM. The application of AI in SCM covers areas including forecasting, network design, risk management, and inventory management, where it significantly enhances efficiency and adaptability (Sharma et al., 2022). However, the adoption of AI in SCM is hampered by challenges such as a dearth of skilled talent, trust issues regarding AI outputs, and fears of job displacement (Hasija and Esper, 2022). Successful AI integration necessitates organizational readiness, clear strategies to align AI capabilities with specific business goals, and overcoming technical barriers like data quality issues and the opaqueness of AI models. This paper evaluated eight AI interventions in three organizations focusing on S&OP, a less explored area of AI in SCM. Using a CIMO framework, it analyzed practical AI implementation and factors important for successful adoption. A multiple-case study with 8 cases of AI implementation was used in the analysis.

Like previous studies highlighting that humans are an important part of AI implementation (Mohiuddin Babu et al., 2024), specific human factors are identified in this study. Human motivation and skill are important to developing and driving AI implementation projects, while human capacity and flexibility are required to adapt AI-supported processes. Organizations also require flexibility, in order to adjust processes, structures, and employee roles in line with the AI transformation. Organizations must also invest the necessary resources to develop talent, skills, and infrastructure for the AI implementation. Investment decisions and top management's support derive from the AI strategy at the organization; without a long-term strategy, a mismatch could arise between organization priority and implementation effort.

As regards technological factors, readiness in terms of infrastructure and data availability is required, as is awareness of the limits of AI. The effectiveness of AI depends on the quality of the data (Cannas et al., 2024). While a wonderful technology, AI is still limited in what it can do; thus, awareness of these limitations is essential, otherwise the technology may not provide the expected output. Here, it is necessary that humans complement the AI outputs, as human validation is vital for the effectiveness of AI in planning. Continuous human oversight ensures the quality and trustworthiness of AI outputs: human experts provide contextual understanding and ethical judgements which AI alone cannot replicate. This paper also emphasizes that employee involvement during AI development enhances the perceived reliability and utility of solutions. This will avoid "black-box syndrome" (see below) and develop trust in the AI systems.

However, an over-reliance on automated decision-making can lead to risks such as bias, misinformation, and skill erosion; thus, a balanced collaboration between human expertise and AI capabilities is essential for successful implementation. Organizations must guard against "black-box syndrome," ensuring transparency in AI processes in order to build trust and understanding among users. Concerns are also raised about the transfer of biases from humans to machines, wherein AI inherits and amplifies existing biases due to poor data and algorithms. This necessitates not only validation of AI results but also critical evaluation of its outputs and limitations. Furthermore, the paper highlights the potential for deskilling among employees due to over-automation and emphasizes the need for strategies to preserve critical thinking and problem-solving skills when integrating AI. Additionally, organizational strategies for AI adoption should involve complementing existing systems rather than replacing them outright, to allow for gradual integration and trust-building. Clear governance structures and strategic alignment are crucial to ensure that AI initiatives move beyond isolated pilot projects to scalable solutions. At the same time, it is difficult for organizations to judge the value of AI implementation; to this end, they should undertake further investigation and pilot studies to verify the suitability of AI.

Chapter 5

Results

This chapter presents the findings of the thesis, organized according to the research questions, and synthesizes insights across the included papers. It also highlights how integration is created in S&OP, how S&OP relates to resilience, and how AI can support SCP.

5.1 Integration of functions in S&OP

The aim of S&OP is to create an integrated set of demand and supply plans (Thomé et al., 2012a). S&OP integration is a topic studied by many scholars (e.g., Oliva and Watson, 2011; Ambrose et al., 2018; Stentoft et al., 2020; Tuomikangas and Kaipia, 2014). Apart from S&OP, integration within the organization and across the supply chain has also been widely studied, primarily because integration leads to benefits and improves the organization's performance (Pagell, 2004). The more integrated a process or an organization, the better the decisions that can be made, which can reduce costs and improve performance. Integration can also lead to better visibility and agility and is associated with overall improvement for the organization internally as well as externally (Scholten and Schilder, 2015). The research gap highlighted in this thesis is the lack of conceptualization of integration and that the existing integration model (Tuomikangas and Kaipia, 2014) takes a high-level perspective, not a detailed one. This section begins with integration in each S&OP sub-process before. describing the coordination, collaboration, and alignment in the S&OP process. Thereafter, the discussion turns to integration during disruptions and finally ends with an S&OP integration maturity model.

5.1.1 Integration in S&OP sub-processes

The results from Paper I demonstrate that the demand planning sub-process in all cases has coordination present. This is because all organizations sell their products globally and coordination is required to collect forecast data from various sales offices. To create a global demand plan, the perspectives of different sales regions need to be taken into account. Forecasting accuracy is improved by forecasters who are as close to the customers as possible, for they possess better insight into customers' requirements (Kaipia et al., 2017). Thus, the perspectives of different sales regions that are relatively close to customers are considered.

Paper I further demonstrates that collaboration is present in demand planning in all cases. If there is collaboration in the sub-process, then the global demand planner and the regional or local demand planner work together to finalize the plan. However, even within the same organization, there may be differences, because some regions may have collaboration whereas others do not. That dynamic is captured in the following quotation:

> "In some cases it's a super (collaboration). You could see something completely different coming out from the (region) than on the on the on the (Customer level) because they have challenged each other and come to a plan, ... And then for some other market... Yes, you could see that in 9 or 10 cases, the (region) S&OP aggregates the different (customer) numbers where they basically gone straight on the customer view".

With collaboration, the demand planners exchange relatively detailed insights and challenge each other before they finalize the plan. The challenge could, for example, involve reviewing past sales data, performance, upcoming possibilities, and other factors that could influence the forecast. Such collaboration, though challenging each planner, could improve the quality of the demand plan (Oliva and Watson, 2011). Another way to improve the demand plan is by coordinating and collaborating with more functions that influence the demand for the product—for example, product development and marketing (Pereira et al., 2020; Vereecke et al., 2018). Involving product development would improve the alignment because product development is a key strategic part of business planning (Neto et al., 2025) and has been shown to improve performance (Bagni et al., 2022; Goh and Eldridge, 2015). As shown in the results in Paper I, product development is involved in the S&OP process in two cases, because both have higher rates of product introduction and modification than the other three cases. Alignment could also be improved by involving the finance or even executive team in the sub-process of demand planning, as observed in three cases.

When it comes to supply planning, there is coordination with the demand planner to obtain the demand plan. Then there are two possibilities depending on the manufacturing context as seen in Paper I–If the supply could be fulfilled only by specific factories or if there is some flexibility regarding supply. If it is fulfilled by specific factories, then the local supply planners create a plan based on the demand allocated to those factories. Next, a global supply plan is developed that highlights concerns and makes adjustments to the supply plan. If there is flexibility between the factories, then the supply plan is created at the global level. After that, the plan is reviewed by the factories in question, and any concerns are raised. The functions that are usually involved in the supply planning sub-process are procurement, production, distribution (Neto et al., 2025). That trend is demonstrated in all cases except for the one involving only the production function. When it comes to collaboration, the functions work together to create the supply plan. Another function involved in supply planning is finance, which improves alignment within the sub-process. Finance can evaluate the cost of plans and the implications of constraints and mitigation to improve alignment (Seeling et al., 2022). However, only one case in Paper I has involved finance.

Next is the third sub-process: pre-S&OP. As demonstrated in the cases in Paper I, pre-S&OP is a global process primarily involving coordination because the plans are shared across functions. A few issues and bottlenecks with the plans are highlighted and solved together, and collaboration may be required to a greater extent if the cases incorporate scenario and what-if analyses, because those activities necessitate it (Nyman et al., 2025). Finance could be involved in the pre-S&OP sub-process in order to improve alignment, as exemplified in two cases.

The last step is executive S&OP, which is usually a global process, though some cases also have a regional executive S&OP. In executive S&OP, the plans and decisions are most often approved as they are presented, as shown in Paper I. That tendency is exemplified in the following quotation from one of the cases:

> "And when they (top management) have a review, the (wanted) decisions, which they support in 99% of the cases."

Although meetings could involve coordination with data sharing only, decisions are also made if required, which indicates collaboration. The executive team does provide feedback, if necessary, to be incorporated in the next S&OP cycle. Doing so improves alignment in the S&OP, as proposed by Shanahan et al. (2025), by ensuring that S&OP plans support strategic goals.

5.1.2 Coordination in S&OP

Studying the S&OP process across different organizations, as reported in Paper I, reveals different types of S&OP designs, which consequently reveal different types of integration. That finding confirms the general argument that S&OP design has to fit the context (Kristensen and Jonsson, 2018) and, likewise, different types of S&OP designs are evident across the cases.

Coordination is the most common mechanism of integration across the S&OP processes in the cases in Paper I. That observation aligns with Tuomikangas and Kaipia (2014) finding that the S&OP organization (i.e., defined people and role) and S&OP process (i.e., defined process) are central mechanisms of integration. The same has also been shown by Kreuter et al. (2021) that the process's design has to match the organization and the IT system. One respondent highlighted how prevalent coordination is in the S&OP process:

> "they're full-time professionals who work in the S&OP process. It's their job description. ... of course there's an issue and there's concerns, but people adhere and sort of participate in the process. There are fixed agendas ... and fixed timings for the meetings. We know that Workday 11 in the month, we get the forecast into the system. There's a heuristic has run and workday 14, we have a meeting with, or 13, we have a meeting at the site and workday 15, we have a meeting with the product S&OP and workday 20, we have a global supply chain council. And we have inputs and outputs for all of those meetings."

TThe respondent's description is not surprising because S&OP is considered to be a formal process. Formalization and standardization are prominent in the literature (e.g., Wallace and Stahl, 2009) and the S&OP process itself has been defined as a formal, standardized process for collaborative planning and decision-making (Tuomikangas and Kaipia, 2014). However, it is surprising that one of the cases did not involve coordination in the sub-process of supply planning.

Integrating the S&OP process begins with coordination by connecting the different functions together across the globe. Coordination is also necessary across the sub-processes as a means to exchange information. However, having only coordination and weak collaboration could limit the potential of S&OP (Ambrose and Rutherford, 2016).

5.1.3 Collaboration in S&OP

Mature forms of S&OP cannot be achieved with coordination alone as it requires collaboration (Pacheco et al., 2025). Collaboration is primarily developed within the sub-processes because the functions have a shared understanding. For example, in demand planning, the demand planners collaborate around forecast assumptions and customer inputs to create a demand plan. This could be due to the development of group identity, as proposed by Ambrose et al. (2018). Across the sub-process, collaboration is relatively challenging because of conflicting priorities.d

In one of the cases, coordination was less necessary in smaller teams, and collaboration can develop without coordination. The finding that S&OP can function without coordination when limited to smaller teams is surprising. Collaboration is easier on smaller teams because developing relationships is easier. Shanahan et al. (2025) have also observed that smaller organizations have fewer challenges with integration. However, as teams develop and increase in size, coordination is required because planners are dispersed across different functions and hierarchies across the globe.

Collaboration is not equally necessary across all S&OP activities, because coordination may be sufficient for some activities. Collaboration is necessary, however, when there is conflict and joint problem-solving is required. S&OP designs may benefit from small collaborative activities within sub-processes, which enable deeper collaboration and utilize coordination across the activities. That observation extends Oliva and Watson (2011) conceptualization of constructive engagement by showing that constructive engagement can be embedded selectively in smaller activities within S&OP sub-processes where it adds the most value.

5.1.4 Alignment in S&OP

Achieving alignment in the S&OP is difficult (Shanahan et al., 2025). Bridging S&OP plans and the executive team is finance, which analyzes the plan in terms of revenue, budgets, and profitability (Seeling et al., 2022). By involving finance in the different sub-processes, the organization can improve its active alignment. An important finding in Paper I is the distinction between active and passive alignment in the S&OP process. Active alignment is present throughout all the stages of an S&OP process, whereas passive alignment occurs primarily at the end of the S&OP cycle, when outputs are compared and reconciled by the executive team. Active alignment likely supports faster reactions because inconsistencies are identified earlier. As shown in Paper I, active alignment is evident in three cases but only within the sub-process of demand planning. Passive alignment inevitably leads to rework and escalation later in the next S&OP cycle. Although active alignment may appear to be superior, it is not required in every stable situation and can be a waste of resources. That possibility would be more influential in dynamic environments, which require a strong linkage between strategic, tactical, and operational planning (Kalla et al., 2025).

5.1.5 Integration during disruptions

Integration can also be activated and even improved as a result of disruptions as see in Paper II and III. The following quotation from one of the cases in Paper II captures that possibility:

> "We understood we need to set up communication channels and getting the latest information, join forces with the inbound, production sites, supply chain planning. That we did automatically."

As shown in Papers II and III, new functions can become part of the S&OP process. This demonstrates the need for the S&OP process to adapt S&OP integration based on the contextual requirements. For example, if only coordination existed before, then there would need to be a shift to collaboration during dynamic complexities, followed by a reversion to coordination when the complexity decreases. Other links for integration revealed in Papers II and III have included integration with the IT team. Because IT systems are an integral part of the S&OP process (Kreuter et al., 2021), such integration supports rapid prototyping and the deployment of solutions to meet the needs of the changing S&OP process. That result is surprising, because integration across the SCM functions is obvious and considered to be necessary, even as integration with the IT team is not given its due importance. The following quotation from one of the cases emphasizes the lack of integration with IT as a hindrance during disruptions:

> "we tried to put the tickets. It took so long time to respond to and to come with a solution and they really didn't understand we were requesting. So all the communication to IT department wasn't that good. I wish it was better that they understood more what we are doing in terms of the technical part of how we're using the system. We're still struggling with that."

By contrast, the following quotation demonstrates how integration with IT can be essential for quick adaptation:

> "If you have an issue in the morning, you can call (IT) and say, 'can we do this?' 'No, it's not possible (now).' And then you get the message in the afternoon, 'Now you can do it.' "

Integration with IT is also essential as new technology such as AI is introduced that requires the adaptation of the S&OP process. Both knowledge about AI expertise and S&OP expertise is required to implement AI (Jazairy et al., 2024). As results in Paper V show, successful implementation requires the integration of planners and data scientists to develop solutions.

5.1.6 Integration maturity model

To synthesize the above findings, an S&OP integration maturity model has been defined using the integration framework. The model consists of four stages. In the lowest stage, there is no coordination across the different functions, which is akin to the "no S&OP" stage in many maturity models (Danese et al., 2018). At the lowest form of S&OP, coordination is implemented across the functions, after which collaboration may be implemented, with the functions working together; however, such collaboration is applicable only when collaboration is possible but not applicable at every interface. Afterward, alignment can be implemented such that all functions are aligned to the organization's strategic goals. A detailed description of the maturity model is provided in Paper I.

Studies have shown that there is no best sequence for developing mature S&OP (Danese et al., 2018), and there are no universal S&OP designs as it depend on the context of implementation (Kreuter et al., 2021). The proposed model thus serves as a reference framework more than a fixed path. Beyond that, coordination, collaboration, and alignment could be developed to different degrees in different sub-processes. For example, demand planning could have a high degree of collaboration, whereas supply planning involves coordination only. Organizations may map their capabilities for integration within each separate sub-process in order to analyze opportunities for improvement based on their needs.

5.2 Resilience in S&OP

The COVID-19 pandemic and semiconductor shortages affected the organizations in different ways. There were lockdowns worldwide, which affected the movement of goods. Acquiring materials from suppliers and transporting finished products to customers was not possible. However, those disruptions had different effects across the different cases. As seen in Papers II and III, the disruptions led to a dramatic increase in demand in one case, whereas in other cases, anxiety about the economic slowdown dominated, at least initially. Those effects were difficult to predict during the COVID-19 disruption, because uncertainties continued to shift. Per Sengupta et al.'s (2025) classification, it was unknown-unknown in the beginning of the disruption and as it progressed, the disruptions took a known-unknown form.

The following sections analyze planning processes and disruptions, beginning with the role of the S&OP and S&OE processes in creating resilience. They next continue with the different types of temporary SCP before summarizing practices for SCP transition.

5.2.1 Role of S&OP

Although many authors (e.g., Dittfeld et al., 2021; Fakhry et al., 2025; Kalla et al., 2025) have emphasized the role of S&OP in risk management, the results in Papers II and III demonstrate that S&OP's potential for risk management was not enough to create resilience in organizations during disruptions. Those results are not entirely surprising, because S&OP is considered to be a tactical process that balances demand and supply over a medium-term horizon (Grimson and Pyke, 2007), and the priority during disruptions at the case companies was maintaining operations. However, what is surprising is that, despite such long-term disruptions, S&OP was not utilized or adapted to analyze long-term impact and mitigation strategies. That finding challenges S&OP's presumed capability to manage risks and disruptions and contrasts with its capability to manage risk highlighted by Danese et al. (2018), Dittfeld et al. (2021) and Kalla et al. (2025). On that count, the thesis's results align with Jonsson et al. (2021) and Wu et al. (2025), who argue that resilience-building S&OP requires dynamic adaptation.

One reason for the lack of adaptation is the formalization of S&OP. Because S&OP is a cross-functional process involving interfaces with different functions, a formalized structure is necessary. However, formalization also makes it difficult to change and adapt (Goh and Eldridge, 2019). Such a formalized design also limits S&OP's ability to respond quickly to disruptions.

Although S&OP was found to be an important process in organizations that has driven operational planning during normal situations, such was not the case during disruptions as seen in Paper II and III. The difference does not mean, however, that S&OP had no role during disruptions in the studied cases. Paper II shows two ways in which it was done: by integrating temporary SCP and by setting direction for temporary SCP. As the results show, the integration that S&OP created across the functions in the organizations also helped with easily creating integration for temporary SCP. The established cross-functional links were necessary for mitigating disruptions. The S&OP also created plans that could guide temporary SCP. However, there was no need for the S&OP cycle every month, because there were few changes as seen in Paper II. As the following quotation from one of the case companies demonstrates, organizations sometimes cannot halt the S&OP process nor conduct it in a different way:

> "We probably should have (stopped S&OP), we didn't [laughs]. We were asking for the demand every month and the demand was 50% higher than what we could get. And we asked for it every month. And it was the same."

Considering that S&OP did not play an active role creating resilience, there are different ways in which S&OP can contribute to resilience are proposed — primarily though scenario planning, adding new participants/functions, modifying the planning horizon, and planning cadence. Scenario planning could serve as an important capability in the S&OP process during disruptions in order to account for uncertainties. Scenario planning has been emphasized in the literature as an important capability in highly mature processes (Fakhry et al., 2025); however many organizations are not in the high maturity bracket (Schlegel et al., 2021) and lack the scenario planning capability. One of the organization even had scenario planning in its S&OP but that was not utilized. However, during the disruption that organization managed to intensify its use, as shown in the following quote.

> "(We are) much more scenario driven after this (disruption) happened to us I would say. And also from a more resilience perspective that has continued of course, now looking at other perspectives, not only COVID, we have a geopolitical situation"

Another option is adding new functions to the S&OP process. Goh and Eldridge (2015) have reported that involving suppliers in the S&OP process improves performance during challenges arising from the introduction of new products. Because semiconductor components had very long lead times during semiconductor shortages, one case company included the purchasing function in the S&OP process.

Although S&OP can be modified in terms of the horizon and cadence (Bagni et al., 2022; Dittfeld et al., 2021), it can also be paused. If changes in demand are minimal, then S&OP could be paused temporarily as seen in one of the cases in Paper II and III. However, depending on the disruption, demand planning could be conducted differently. For example, if there is a need for higher forecast accuracy, then the demand planning process could be updated to capture better signals from customers or run at a higher frequency. Demand planning sub-process was modified by one the cases in Paper II and III.

5.2.2 S&OE during disruption

Another surprising finding in Papers II and III is that S&OE was not sufficient for handling the disruptions. S&OE has been positioned as a complement to the S&OP process in order to manage operational deviations (Kalla et al., 2025). Although three of the four cases had an existing S&OE process, such S&OE had a small scope, limited to a factory or region, and lacked the decision-making capability required during disruptions. Those realities became evident in one of the cases, as exemplified by the following quotation:

> "We could have used the S&OE meetings, but kind of the S&OE meetings for us, that's more... for the operational questions to handle. But we don't usually in the S&OE meetings take big decisions. It's more like, okay, yes, we look at KPIs"

Large-scale disruptions required an integrated effort from the entire organization across all functional boundaries. Temporary SCP processes took center stage in all the case companies and were the primary way in which the organizations managed the disruptions. Temporary SCP is a set of short-horizon, frequent processes used to respond when disruptions occurred. Although that arrangement is similar to S&OE (Hainey, 2022), the case companies demonstrated how separate temporary SCP was implemented. The temporary SCP was necessary considering the uncertainties that the organizations faced at the time. That finding supports Lapide's (2021; Lapide, 2024) argument that uncertainty and volatility require additional quick-response or special planning teams that operate on a shorter horizon and higher frequency than usual S&OP.

5.2.3 Temporary SCP

As shown in Paper II and III resilience is primarily achieved through a set of different activities involving three types of processes during disruptions. The first type is operational-level decision-making meetings, which are similar to S&OE but involve the executive team and occur at high frequency depending on the volatility of the disruption. Such adaptations allow agile decision-making (Kohl et al., 2022). The second type of process is operational-level process monitoring, which is used to identify volatility in supply and demand and to propose actions to mitigate the volatility. Doing so ensures that the organization monitors the situation at hand and tracks its performance. The third type is tactical-level continuity planning, which entails the analysis of long-term scenarios and preparing for recovery from the disruption. This tactical-level continuity planning was only implemented by on the cases in Paper II.

5.2.4 Practices to transition SCP

As discussed, SCP needs to continuously transition as disruptions evolve. In Paper III, the practices required to transform SCP are analyzed from a people/organization–process–IT perspective. The capabilities required during a disruption depends on the type of disruption (Scholten et al., 2025). An uncertain future, which may change from day to day, requires a process that has a high planning frequency in order to react to the latest information. Uncertainty also requires scenario planning in order to ensure that multiple future possibilities are considered. Scenario planning is useful in the kind of complex environments (Kristensen and Jonsson, 2018) created by disruptions. As shown in Paper III, disruptions had massive impacts across all organizational functions, and mitigating them required a focused, cross-functional effort from the organization. Resource shortages also created a need for prioritization and decision-making in the process. Thus, the SCP process requires those capabilities during unknown–unknown or known–unknown disruptions. The capability to reconfigure the SCP process to meet the requirements of the disruption's context is essential to generating resilience.

In order to reconfigure, Paper III identifies four capabilities related to people and organization. The first is the informal collaboration required to establish and implement the new processes. In the cases, those SCP processes were not formalized and required personnel to work informally toward the objective. By contrast, stable situations require a formal, standardized S&OP process (Stentoft et al., 2020). The second is top management's involvement in the process. During disruptions, decisions need to be made quickly, which is facilitated by top management. The third capability is the expansion of job roles, because personnel have worked more and taken on more responsibility during the disruption. The fourth and final but equally important capability is accumulated knowledge. In the cases, previous experiences with disruption enabled personnel to react quickly and adapt processes when the disruption occurred. Although many resilience models consider knowledge management to be a post-disruption capability (Ali et al., 2021), knowledge management is also used during sudden disruptions.

When it comes to IT capabilities, it is important to acknowledge that the IT systems in the studied cases in Paper III have lacked advanced features—for instance, scenario planning and data analytics—that could improve resilience (Swink et al., 2025). However, what the cases had in terms of data as well as tools such as business intelligence and Excel proved to be useful for creating dashboards, sharing information, and running smaller scenarios. Those tools were leveraged to create resilience. Added to that, collaboration with the IT team and its knowledge about business processes enabled efficient ways to implement changes.

5.3 AI's impact on S&OP

Despite studies on utilizing AI in different areas of the supply chain (e.g., Toorajipour et al., 2021; Sharma et al., 2022; Walter et al., 2025), there is a lack of knowledge regarding AI's utilizing in the S&OP process. When it comes to utilizing AI in S&OP, there are two aspects: understanding how AI can be used and what capabilities successfully using it requires. This section first examines the use of AI in different steps of the S&OP process before presenting human, technological, and organizational requirements for its implementation.

5.3.1 AI augmented S&OP

In Paper IV, a detailed analysis of the different steps in the S&OP process reveals certain activities that are common across the sub-processes in S&OP. There are four main types of activities: data gathering and review, calculation, plan evaluation, and decision-making meetings. However, the findings show that a substantial part of S&OP work takes place before any decision-making meetings. The different steps in different sub-processes, summarized in Table 5.1. Utilization of AI in the different activities are explained next.

First activity, data gathering and review, ensure that all data that are required for the S&OP process are available and ready. This data is fed into the following step (i.e., calculation). Examples of data required are sales data, KPIs, marketing plans for demand planning and inventory data, production data, lead times, and inventory and production strategies for supply planning. For data gathering, automation is possible and, if used, can ensure that the data are up to date. Creating data pipelines to collect data is one of the first steps toward deploying AI (Bokrantz et al., 2024). Some organizations use a mix of fragmented IT systems being (Wu et al., 2025) and hence data pipelines are needed to standardize, and make data available across these systems. After being collected, the data have to be reviewed. To that end, ML could be utilized to detect anomalies and conduct data corrections (Cannas et al., 2024). It is also possible to include contextual information in order to improve the accuracy of data collection such that anomalies are correctly identified. For that purpose, GAI can be applied, for the contextual information is usually unstructured.

Table 5.1: Summary of activities in S&OP process

Steps	S&OP Sub-Process			
	Demand planning	Supply planning	Pre-S&OP	Executive S&OP
Data gathering and review	Review actual sales data, historical trends, and past performance KPIs, and marketing plans. Prepare data for forecasting.	Review demand plan, gather inventory data, production data, lead time data, production and inventory strategies.	Prepare reports for review.	Prepare reports for executive review.
Calculation	Generate statistical forecast	Generate rough cut capacity plan, inventory plan.		
Plan evaluation	Review forecast, identify risks, create scenarios, add soft information	Review feasiblity, identify bottlenecks, supply risks, create scenarios	Review demand and supply plan, identify gaps	Prioritize issues
Decision making meetings	Conduct cross-functional demand reviews and finalize demand plan	Conduct cross-functional supply reviews and finalize plan	Cross functional meeting to finalize plan and identify decisions required by executive team	Finalize demand and supply plan, review trade-offs, approve decisions

The calculation activity is commonly automated in most organizations as exemplified by forecast generation in demand planning and rough-cut capacity planning in supply planning. There are documented cases about the use of APS in S&OP, which can generate near-optimal demand and supply plans (Ivert et al., 2015). Forecast generation is indeed one of the most-studied applications of AI (Culot et al., 2024), though no consensus exists about a specific AI algorithm that performs well across all situations (Walter et al., 2025). The reason for that deficit is that demand patterns differ for different products, and different algorithms perform differently. For supply planning, many optimization algorithms are available that utilize AI to improve solutions (Sharma et al., 2022).

The plan evaluation activity in which the data is reviewed for accuracy and adjusted as required. Evaluation is necessary because AI may not incorporate the latest information or soft information in the generated plans; for that reason, planners with knowledge and experience can adjust and review the plans that are created (Jazairy et al., 2024). That process aligns with what Brau et al. (2023), have argued: that human judgment remains important in demand planning, especially when special events and/or contextual information are not fully captured in the data. Nonetheless, in some contexts, certain products lacking dynamic complexity could be automated completely. However, for other situations, AI can be used to identify products that require attention by looking for signals such as sudden changes and data abnormalities.

In the evaluation step, AI may be useful for identifying risks, creating scenarios, and supporting what-if analysis (Modgil et al., 2021a) be it for the demand plan or the supply plan. In more uncertain environments, S&OP must also help firms anticipate disruptions and evaluate risks making the S&OP more proactive. This connects with studies that call for integrating supply chain risk management into S&OP (Fakhry et al., 2025).

The last type of activity is decision-making meetings, where information is exchanged between different functions, and decisions are made. Such meetings are an important part of the S&OP process as a means to improve integration (Tuomikangas and Kaipia, 2014). Because the final approval of the S&OP plan remains a managerial and cross-functional decision, automating it can be difficult due to two reasons: the dynamic complexity and the AI's current limitation. If the organization operates in a stable environment with low complexity, then decision-making could be automated. The current AI technology cannot account for the variety of factors that go into decision-making meetings or reason appropriately to make decisions. Although AI lacks common-sense reasoning and deep understanding of the complexities in SCM (Durach and Gutierrez, 2024), it could contribute to preparing reports and briefs for these decision-making meetings.

5.3.2 Human, Organization, and Technology requirements

The second part of the research question involves analyzing various real-world implementations of AI in the planning process in order to explore the factors required for its successful implementation. Indeed, its implementation needs to be understood according to the combination of all three human, organizational, and technological factors together. Those factors are designated into three phases of implementation: pre-implementation, implementation, and post-implementation.

The findings from Paper V show that human knowledge and motivation are important aspects of implementing AI, because they are needed to judge the applicability and usefulness of AI. Without knowledge, including knowledge about both SCP and AI technology, mismatches in application can occur. An inflated expectation of technology could also lead to a disappointment in performance (Sodhi et al., 2022). Motivation, meanwhile, is required to initiate and drive the project to completion. The cases from Paper V demonstrate that the pilot projects are driven by the motivation to experiment and improve existing processes even in the absence of a concrete organizational AI strategy, as demonstrated in the following quotation:

> "Most of the time these are like planners basically coming up with these ideas where they see things should be improved and there is enthusiasm."

In such situations, an organizational strategy is needed that aligns the use cases and the strategic priority of the organization. In Paper V, the successful cases had an organizational strategy. That trend confirms earlier research showing that many organizations struggle with AI because they lack a clear strategy and clear commitment to implementation (Cannas et al., 2024). Such strategies are necessary for selecting and investing in the right solutions (Prataviera et al., 2026). A concrete organization strategy can lead to leadership backing and investment in AI implementation projects (Maghroor et al., 2025). Along those lines, the following quotation from one of the cases demonstrates how the organization did not prioritize AI's implementation and did not generate the necessary support:

> "We've really not had the time to use any machine learning and this is then also coupled with the fact that, now with my colleague, leaving, we're somewhat understaffed, so we've had to be take a rather pragmatic approach to to the situation."

Organizations also need to evaluate the expected benefits of the solutions generated. Doing so is not straightforward due to the lack of past projects (Culot et al., 2024). Several cases in Paper V assessed the perceived benefits of implementation. This confirms previous studies that identified perceived benefits as a critical success factor for AI adoption, and a lack of clarity regarding economic benefit can become barriers (Cannas et al., 2024; Dora et al., 2022). The implication is that organizations should avoid presenting AI as an abstract strategic priority. Instead, AI should be connected to concrete operational outcomes such as better forecasting, improved inventory, lower costs, and improved efficiency and decision-making (Cannas et al., 2024).

When it comes to technology factors, the availability of data is important because AI, especially ML, relies heavily on existing past data (Walter et al., 2025). This importance of data availability and accessibility is also reflected in Paper V, where AI implementation was selected because relevant data were available and accessible. The S&OP process depends on inputs from different functions, and different functions use different systems and/or different assumptions, as well as speak different organizational languages (Ambrose et al., 2018). These inconsistencies needs to be fixed before AI could be utilized.

An important finding in Paper V concerns the role of supply chain planners during the implementation phase, a role that involves ensuring that the AI system developed complements the needs of the planners. Planners' involvement may also explain how trust in AI develops, because their involvement in development has been identified as a way to improve AI acceptance (Chalmers et al., 2026). Involvement of planners also helps them understand the benefits and limitations of AI which is necessary for interpreting the output from AI. Planners also need to be provided with necessary training in AI; otherwise, as the following quotation shows, planners may not use AI functionality simply because they were not aware of it:

> "the awareness was still a challenge because many users did not know this to exist. So this is a challenge that we have faced. Yeah, yeah, they they didn't now know because some maybe they skipped the training or missed the chance to participate in the session"

Lack of AI knowledge and technical skills has been highlighted in the literature as a barrier to AI implementation (Cannas et al., 2024; Maghroor et al., 2025). According to Jazairy et al. (2024), planners do not need to become AI experts but have to be able to set boundaries and guardrails for AI systems. For that reason, future supply chain planners need to combine operational knowledge, judgment, and a basic understanding of AI.

A key finding is that AI implementation requires flexibility from both planners and the organization. As AI takes over routine tasks, planners need to adapt their ways of working, and shift their attention towards exceptions, products requiring manual intervention, and decisions that depend on contextual judgment. This finding supports studies emphasizing the potential for AI to offload routine planning tasks (Shurrab and Jonsson, 2026c).

At the organizational level, AI must be integrated into existing processes in a way that creates value. This requires investments in employee upskilling, recruitment of relevant talent, computational resources, and the redesign of roles and processes to fit AI-enabled ways of working (Shurrab and Jonsson, 2026c). Cross-functional integration is important because AI applications often depend on data, knowledge, and decisions from several functions. Low integration across departments and the supply chain has been identified as a barrier to AI implementation (Cannas et al., 2024). Organizations should therefore strengthen cross-functional integration as part of their AI implementation efforts.

Another surprising finding is the flexibility required from both the human level and the organization level. The planners need to adjust their ways of working to accommodate AI. The tasks also change when new workflows and procedures are developed. The focus would be on products that require manual intervention that AI could not take over. This supports existing studies that highlight the need to offload routine tasks to AI (Shurrab and Jonsson, 2026c). The organizations also need to ensure that the organization can absorb the implementation without disrupting the existing ways of working and it provides value to the organization. AI processes would need to integrate different functions together in order to develop values for the organization. AI implementation involves significant costs in terms of upskilling employees, hiring talent as well as computational resources. It also involves efforts in terms of changing roles and processes in order to align with AI usage. Hiring should be also updated in terms of matching skills with the new processes (Shurrab and Jonsson, 2026c). Literature also identifies low integration across departments and supply chain as barriers to AI implementation (Cannas et al., 2024). Organization should work towards improving integration across departments to improve AI implementation.

While piloting and small-scale projects are necessary to demonstrate AI's value, they need to be scaled up to the entire organization. As seen in Paper V, many projects remain in the pilot stage. The benefits may be easier to define when AI is applied to specific steps. While smaller functions may make initial implementation easier, the benefits may be limited. Along those lines, the findings also imply that organizations may need to start small but cannot remain fragmented if they want to realize broader AI value.

Another important finding is that AI should complement existing systems and build trust over time. In similar published findings, Cannas et al. (2024) have reported preliminary mistrust among operators toward new AI technology. In response, Jazairy et al. (2024) have recommended incremental adoption (e.g., starting with simpler tasks), which can build trust and reduce risk over time. Along those lines, employees are more likely to accept AI when they can compare its recommendations with existing processes, observe its benefits, and understand its limitations

However, organizations should recognize that complete automation is unwise. For example, human input is required is during disruptions (Shen and Sun, 2021). Human intervention remains necessary when situations are ambiguous or exceptional. This confirms Helo and Hao's (2022) view of AI as support for planners rather than a full replacement of human decision-making. It also aligns with Jazairy et al. (2024), who emphasize the continued need for human judgment in situations involving missing data. Similarly, Durach and Gutierrez (2024) have argued that AI chatbots can support operations and supply-chain managers, but should be seen as co-pilots, not replacements, particularly in complex disruptions.

5.4 Mechanisms for integration, resilience and technology in S&OP

The CIMO model, shown in Table 5.2, is used to synthesize the findings in this thesis. In this model, the starting point is a series of organizational situations in which interventions become necessary. The model therefore suggests that S&OP evolves from a formal mechanism for connecting siloed functions into a broader planning capability that can support collaboration, strategic alignment, resilience, and technology-enabled decision-making. S&OP should be seen as a configurable planning intervention whose purpose changes with the context. The common outcome across all rows is improved planning performance, though the specific form of that performance differs according to the context: integrated plans, shared decisions, strategic fit, continuity under disruption, better forecasts, or more capable planning processes. When the context changes, the S&OP design should fit that changing context. An explanation of each row in Table 2 is provided here for different configurations of the S&OP process.

The starting point of S&OP is in organizations where functions operate in silos with fragmented planning and irregular information exchange. That step is shown in Table 5.2, row 1. In such a context, the intervention is the introduction of a formal S&OP structure, including recurring meetings, defined roles, shared data, and standardized procedures (Tuomikangas and Kaipia, 2014). The mechanism generated by the intervention is coordination, and the outcome is a supply plan that meets the demand, not disconnected plans.

Despite coordination, organizations may still face planning situations characterized by trade-offs between functions that cannot be solved through information exchange (Table 5.2, row 2). There needs to be risk management with respect to known–unknowns, and in such cases, the intervention required is joint problem-solving, creating shared ownership, and involving additional functions and top management. The mechanism thus generated is collaboration between functions. The outcome is balanced demand and supply plans that consider trade-offs, not supply plans that merely follow demand plans.

Even when functions collaborate, the demand and supply plans may remain weakly linked to broader strategic priorities and financial goals (Shanahan et al., 2025) as shown in Table 5.2, row 3. In that context, the intervention is including finance and top management and performing scenario planning. The mechanism created is alignment, wherein planning is connected both horizontally across functions and vertically to strategy and finance. S&OE can be also introduced to improve operational planning alignment. The outcome is that tactical and strategic plans are in sync instead of only reconciling supply and demand.

Row 4 in Table 5.2 addresses contexts of extreme uncertainty that lead to unknown–unknown risks and rapidly changing information—for example, from major disruptions such as the COVID-19 pandemic and semiconductor shortages. The intervention is a temporary planning layer that supplements S&OP with detailed reviews, increases the frequency of planning, and involves top management. The mechanism generated is responsiveness, and the outcome is not a balanced plan in the traditional sense but the restoration and continuation of operations by prioritizing supply and demand.

Row 5 in Table 5.2 addresses the context in which forecast accuracy is weak but suitable historical data and explainable features are available, as well as a thorough understanding of AI technology. In such situations, the intervention is ML-enabled demand forecasting and supply planning in S&OP, simulations, and anomaly detection, all through the use of high-quality, real-time data. The literature cautions that such approaches depend heavily on the availability and quality of training data (Cannas et al., 2024), which means the intervention only works under suitable data conditions. The mechanism generated is information processing capability with augmented planning, wherein the output from ML is used to support planners in making decisions. The outcome is better forecast quality and therefore improved demand inputs into S&OP.

Last, row 6 in Table 5.2 addresses the context of high planning complexity, limited human planning capacity, and heavy manual work. In such cases, the intervention is AI-enabled planning support, including planning agents for data preparation, exception handling, and plan evaluation. The mechanism generated is information processing capability, which allows the organization to process large volumes of information. The planning is also augmented with improves planning efficiency, and support better trade-off decisions. The outcome is therefore faster S&OP plans, along with better planner productivity and improved decision quality.

Table 5.2: Mechanisms for integration, resilience, and AI adoption in S&OP process

Context	Intervention	Mechanism generated	Outcome
Siloed functions with fragmented planning and irregular information flow	Formal S&OP structure with defined roles, schedules	Coordination between functions	Supply plans in line with demand plan
Coordination exists but dynamic complexity with low forecast accuracy, supply constraints, trade-offs between functions	Joint problem solving, shared ownership, expansion of functional involvement, executive involvement	Collaboration between functions	Balanced supply and demand plans
Collaboration present but plans are not linked to strategic long term objectives, no financial goals	Finance involvement, higher executive involvement with linking strategic plan, performance review, shared objectives, introduce S&OE	Alignment between functions	Tactical plans and strategic plans in sync
Extreme uncertainty, unknown-unknown risks, rapidly changing information, reduced service levels	Short-term reactive planning, top management involvement, detailed scenario analysis, supplement S&OP	Responsiveness through agility, flexibility, adaptability, redundancy	Restore operations and prioritize supply and demand
High complexity, good quality historical data and features but with good understanding of technology and its capabilities	Machine learning forecasting, supply planning, simulations, anomaly detection,	Information processing capability, augment planning	Higher plan quality
Limited resources, manual workload, multiple information system	AI assistant in the S&OP process	Information processing capability, augment planning	Faster S&OP process

Chapter 6

Contributions

This chapter begins by highlighting the thesis's contribution to theory. It then synthesizes the findings and develops a model to explain the various ways in which S&OP can be adapted. The chapter ends with a summary of managerial implications.

6.1 Contributions to literature

This thesis contributes to several streams of literature. The main focus has been the SCM literature on S&OP; therein, the contribution lies in the design of S&OP and the necessary success factors. Another contribution lies in the wider SCM literature related to cross-functional integration, resilience, and AI. In the supply chain resilience literature, this thesis contributes knowledge about organizational adaptation and how it is achieved. This thesis also contributes to the emerging field of AI in SCM with knowledge on the adoption of AI. Specific literature contributions from each paper are given below and are summarized in Table 6.1.

Paper I contributes to theory by advancing a more fine-grained and contextualized understanding of integration in S&OP. First, it develops an integration framework which brings together the fragmented literature on the concept of integration (Pellathy et al., 2019). This framework can be used to analyze integration in both S&OP and other supply chain processes. Differentiation of the integration concepts and clarification of meaning both enable improved construct validity in research and improve theory-building, as concept development is a precursor to theory development (Gioia et al., 2013). With respect to S&OP, this paper extends prior literature which primarily conceptualizes S&OP integration at an overall process level, rather than through its constituent sub-processes. In doing so, this paper shows that integration requirements are not uniform but rather vary across different S&OP sub-processes. This paper further demonstrates that these integration needs are shaped by manufacturing context, thereby challenging the one-size-fits-all assumptions often associated with generic S&OP maturity models. This paper also supports contingency-based views of S&OP design (Kreuter et al., 2021). By proposing an integration maturity model, the paper theorizes integration as a capability which can develop over time rather than as a binary condition of either presence or absence—a model which complements previous work on S&OP maturity dimensions (Danese et al., 2018). The integration model also simplifies the S&OP maturity model to focus on its main objective, which is to create integration in the organization.

Planning processes are an important resource for generating resilience in organizations and creating adaptability (Sengupta et al., 2025), the availability of empirical evidence is lacking—which is the main contribution area for Paper II and Paper III. Specifically, Paper II contributes to theory by strengthening the link between SCP and supply chain resilience and by showing how resilience and responsiveness are produced through various planning processes. Rather than treating resilience as the outcome of a single capability, this paper depicts resilience as emerging from an interplay of planning activities. Accordingly, it improves the understanding of the role of S&OP as a process which can support resilience. In addition, the paper contributes to the responsiveness view of the supply chain (Richey et al., 2022) by showing how responsiveness is enacted through planning processes. This aligns well with prior work showing that S&OP can be both proactively designed for risk management and reactively adapted when risks materialize (Dittfeld et al., 2021). This further extends the concepts from Dittfeld et al. (2021) to the use of S&OP and S&OE in unknown–unknown disruptions.

Paper III develops an understanding of S&OP and SCP as dynamic processes which need to be transformed under disruptive conditions; planning processes cannot merely be executed as stable routines. Much of the S&OP literature has examined process design and implementation under relatively stable conditions (Kalla et al., 2025). By contrast, this paper shows how disruptions trigger temporary reconfigurations of planning structures, roles, and decisions; a single configuration to handle all disruptions does not exist. In this way, the paper extends the people–process–IT perspective (Kreuter et al., 2021) by demonstrating that these three dimensions are important for adapting SCP during disruptions. In particular, the people dimension—through top management support, organization reconfiguration, experience, and business knowledge—could drive the modification in process and IT. Furthermore, by drawing on empirical insights from the contexts of the COVID-19 pandemic and semiconductor shortage disruptions, the paper adds knowledge on how organizations adapted their planning processes in response to unprecedented disruptions.

In contrast to much existing literature—which examines AI in relation to single planning tasks, such as demand forecasting, inventory planning, or scheduling—Paper IV contributes to theory by conceptualizing automation across the entire S&OP process. Notably, it contributes to the recent research on tensions around redesigning S&OP processes for AI (Jazairy et al., 2024), and in doing so, it develops the notion of an automated S&OP which is grounded in the realities of how S&OP is actually organized and enacted in practice. Additionally, by addressing the various steps within the S&OP process, this paper contributes by revealing the nuances among different types of AI technologies; this is relevant, as it improves clarity on how automation can be achieved and what its limitations are. This scope is in contrast with other S&OP AI studies, which treat AI as a single process (Jazairy et al., 2024) or which study only parts of the process, like scenario analysis (Sengupta and Dreyer, 2023). The paper further shows that while many activities can be automated, the steps involving decision-making meetings are still not ready for automation, and a complete automated S&OP is neither feasible nor desirable. This paper also contributes to the understanding on an organization's progression towards the attainment of a Stage 5 mature process (Danese et al., 2018). By incorporating real time data-gathering and scenario analysis, as well as by incorporating supplier and customer information, AI enables S&OP to be more proactive. Lastly, this paper contributes with an agenda for further research related to the challenges of task and contextual aspects in automating S&OP.

Finally, while existing literature has increasingly highlighted the potential of AI in planning (e.g. Sharma et al., 2022; Jackson et al., 2024), much of it (including Paper IV in this thesis) remains conceptual. Although empirical research on AI in supply chains is growing, there is still limited cross-case evidence explaining how AI is implemented in real organizational settings and in SCP activities. Such studies are needed to encourage the broader use and implementation of advanced planning processes in practice, instead of limiting them to theory (Jonsson and Holmström, 2016). Herein lies the contribution of Paper V. Paper V extends existing theory on requirements for effective AI adoption. By taking the HOT perspective, it reveals that AI implementation depends not only on the availability of advanced tools but also on a combination of requirements related to the individual and the organization, with many of the identified factors lying at the intersection of HTO. In contrast to Maghroor et al. (2025) who identify certain HOT+environmental-related barriers for GAI implementation through expert judgement, and to Hasija and Esper (2022), who identify AI trustworthiness factors through managerial interviews, this paper builds these factors by drawing on actual organizational settings. The cases present different implementation states, including fully deployed, partially deployed, failed, and pilot projects; this makes it possible to examine the conditions associated with contrasting outcomes across implementations. This paper also specifically focuses on S&OP-related activities like forecasting, inventory planning, production allocation, and S&OP-related activities covering both ML and GAI applications.

Table 6.1: Summary of theoretical contributions from the studies and corresponding paper

Paper	Theoretical Contribution
Paper I	• Development of integration framework by differentiating the concepts of integration • Importance of sub-process analysis in S&OP, which reveals differences in requirements • Variation in integration requirements extending the one-size-does-not-fit-all approach • Integration maturity model focused only on integration and shows combinations of integration in different parts of the S&OP process • Study of S&OP under different manufacturing contexts, adding to existing literature
Paper II	• Link between SCP and resilience, and importance of SCP in managing disruptions • Understand resilience as generated from combination of activities, not from a single process • Understand the role of S&OP and temporary processes in creating resilience, wherein temporary processes focus on short-term uncertainties • Understand link between temporary and reactive processes • Responsiveness role of SCP, extending responsiveness view of the supply chain and strengthening the conceptual definition
Paper III	• Transformation of processes during disruptions, and how this takes place • Understanding of the dynamic nature of planning processes and S&OP and the need to consider this in its design • Extend people–process–IT model to disruptive scenarios to reveal important people, process, and IT capabilities • Empirical knowledge of how organizations adapted to the COVID-19 pandemic
Paper IV	• Spans the entire S&OP, compared to current single-application AI studies (e.g., demand planning, inventory planning) • Conceptualization of automated S&OP, grounded in real S&OP processes • Future research agenda for automating S&OP
Paper V	• Bridge knowledge between theory and practice regarding application of AI • Development of 14-factor HTO framework explaining AI implementation • Real organizational cases across successful, partial, failed, and pilot AI implementation efforts

6.2 Practical Contribution

S&OP is a practical cross-functional planning process, and the findings from this project are highly relevant to practice in myriad ways. The practical contributions are summarized in Table 6.2.

Paper I provides practical guidance for managers by showing that integration needs differ across the various sub-processes of the S&OP process. The paper also shows that the benefits of S&OP depend on how well the level of integration matches the specific requirements of each part of the process. Managers can determine which areas require collaboration and which can be handled with coordination, which helps organizations to effectively target S&OP improvements.

Paper II contributes to the configuration of SCP during disruptions. For managers, this means realising that resilience does not depend solely on having a formal planning process in place, as the paper offers insight into how existing S&OP routines can be complemented by temporary reactive planning arrangements. This highlights what issues need to be handled by the reactive process and what can be handled by the routine process, as well as how S&OE is an important process for handling short-term disruption. Paper III's practical implications stem from its identification of the capabilities needed to transform planning processes during disruption. For managers, it is important to realize that these capabilities need to be developed. To wit, knowledge management and experience are important, and these should be preserved to improve the response to disruptions; moreover, other capabilities such as leadership, cross-functional collaboration, and the ability to adjust roles and routines are required for transformation.

Paper IV contributes to practice concerning how AI can be used in S&OP and where its limitations lie. For managers, this is valuable because the paper shows the areas where automation and decision support can improve planning activities. At the same time, the study makes clear that not all parts of S&OP can or should be automated to the same extent, which helps managers to make more informed choices about AI investments, as it clarifies the noise and hype related to AI possibilities. Paper V further contributes practically by identifying the success factors and barriers associated with implementing AI in SCP. For managers, this offers stronger support for implementation by showing that successful AI adoption depends not only on the technology itself but also on issues such as data quality, organisational support, and individual factors. By highlighting both enabling factors and obstacles, the paper supports managers in planning AI initiatives more realistically and in avoiding implementation problems.

Table 6.2: Summary of practical contribution from the studies and corresponding papers

Paper	Practical Contribution
Paper I	• Integration requirements for different parts of S&OP • Matching integration requirementt with the benefits of the process
Paper II	• Configuration of SCP during disruption • Importance of setting up S&OE
Paper III	• Capabilities to manage uncertainties using SCP • Capabilities to transform SCP
Paper IV	• Practical ways to use AI in S&OP, as well as its limitations • Cut through the hype and understand the AI possibilities
Paper V	• Practical ways to use AI in SCP as well as its limitations • Success factors and barriers to accommodate during implementation

Chapter 7

Conclusions

This chapter concludes the thesis by summarizing the main findings and contributions. It also discusses the limitations of the research, and it identifies opportunities for future studies.

7.1 Concluding Remarks

This thesis has examined how the S&OP process responds to the challenges of integration, resilience, and AI. This was carried out through three studies, which resulted in five papers. The results of this study are synthesised in the framework provided in Table 5.2.

The first RQ examined integration in S&OP. This led to the development of an integration framework which was used to analyse integration at five organisations. The findings show the importance of coordination to creating integration between various functions. Collaboration can be implemented in certain contexts, depending on the organisational structure and the S&OP maturity. Alignment can be achieved through the participation of the executive and finance functions in all the sub-processes, or at least in the executive S&OP sub-process. These findings demonstrate that the specific needs of each sub-process shape integration in S&OP.

The second RQ focused on how resilience is created through S&OP and SCP processes. Drawing on case studies of four organisations during the COVID-19 pandemic and the semiconductor shortage, the findings show that resilience is not created through a single planning process but through interactions between established and reactive SCP processes. The reactive S&OE process assumes a central role during disruptions, while important capabilities are drawn from the pre-existing structures in S&OP and related planning processes. The findings also show that the transformation of SCP processes during disruption depends primarily on people-based capabilities: top management involvement and leadership, business knowledge, and experience emerged as important capabilities for adapting planning processes to the disruption. By contrast, IT capabilities played a limited role in the cases studied. This shows that resilience in S&OP emerges from process reconfiguration and managerial action under disruption.

The third RQ investigated how AI can be applied in the S&OP process. The findings show that AI has the potential to automate S&OP by matching different tools to different steps of S&OP. At the same time, due to the complexity and cross-functional nature of S&OP, human oversight and managerial decision-making is necessary. The analysis of AI implementation reveals that the use of AI in S&OP is shaped by different contextual and motivational factors which can both enable and hinder adoption; it also identifies the mechanisms through which AI interventions lead to certain outcomes. These findings encourage AI implementation in the S&OP process through detailed analysis of the use of AI in S&OP.

Overall, this study contributes to the development of the S&OP process and how it responds to the above challenges. S&OP is a dynamic process which accommodates these challenges and evolves in response so as to remain relevant and useful to the organisation.

7.2 Limitations

This research was designed as an exploratory study; for this purpose, case study research was an appropriate method. However, case studies have limitations regarding the generalisability of the findings. This study is based on a limited number of cases, all of which are located in Sweden, and so the findings should be interpreted with caution when considering other geographical or organisational contexts. It should be noted that the cases were not selected as exemplary cases but rather as relevant empirical settings for exploring the phenomenon.

Another limitation is that the data was primarily collected through interviews. Retrospective sense-making is a limitation of interview data (Eisenhardt and Graebner, 2007). Direct observations could have complemented the interview data and provided additional insight into how planning activities are carried out in practice; however, the use of observations was constrained by limited access, as well as by the complexity of SCP processes, which span multiple functions.

A third limitation is that the performance was not measured in any of the studies. The studied organisations were large firms operating near the top of their respective industries, with established S&OP processes, relatively good performance during disruptions, and positive experiences of AI use—and the assessments were based on respondents' accounts, rather than on objective performance measures. Moreover, the respondents were closely connected to the SCP process; therefore, the findings may reflect a planning-centred perspective rather than a broader assessment of organisational performance.

7.3 Future Research

This research identifies several directions for future research. One area for future research is the S&OE process. This research identifies the growing need for an S&OE process in organisations and highlights how it contributes to resilience. The S&OP process has been criticised in areas where operational issues are the focus instead of tactical planning (Kalla et al., 2026); introducing S&OE is a way to address operational issues. S&OE can also improve the link between tactical and operational planning, as well as an area which has not been studied: the integration of S&OP with other processes. The COVID-19 pandemic and the semiconductor shortage illustrated the value of S&OE ; however, compared to S&OP, S&OE remains less extensively researched and less clearly defined in the literature. Despite substantial attention paid to S&OP, there is still limited knowledge regarding how organisations should structure and manage short-term execution through S&OE. Further studies on the S&OE process design, success factors, and its integration with the S&OP process need to be developed.

The COVID-19 pandemic and the semiconductor shortage affected the short-term planning horizon, but other types of disruptions may unfold over a longer time frame and can therefore be addressed in the S&OP process. Disruptions could occur over a longer multi-year period; in such contexts, S&OP can contribute to the supply chain responsiveness mechanism by identifying emerging changes and enabling the transformation of the supply chain. This thesis investigated cases with a persistence form of resilience, where the objective was to get back to the previous state (Wieland, 2021), but other disruptions require a long-term transformation of the supply chain. Therefore, future empirical studies could examine other disruption contexts which are handled by S&OP. At the same time, transformation in the S&OP process could also occur with the use of AI. The current project studied automation in light of how the S&OP process is carried out today; it might be possible to conduct the S&OP process in a different way using the technology (Jazairy et al., 2024). Future research could also examine how AI could reshape the S&OP process.

The cases included in this thesis are all based in Sweden, which has a stable environment and supportive public institutions. Generating resilience does not rely just on adapting the SCP but also on many other external factors—one of which is government support. During the COVID-19 disruption, organisations received support from the government, which helped to reduce firms' vulnerabilities (Hughes et al., 2025). The cases in Study 2 received specific government support. Although this support was identified in Study 2, its role was not examined in depth, but it nevertheless deserves further investigation. Extensive support from the government could lead to a situation where organisations may limit their internal resilience development, implying that a balance of government support and organisational responsibility is required for resilience. To this end, future studies could compare organisations from different countries to examine the role of government in generating resilience.

This thesis did not measure the performance implications of cross-functional integration, resilience, or AI use. Therefore, future research could adopt a longitudinal design to examine how integration, AI-enabled planning tools, and resilience-oriented planning practices influence planning performance over time.

Study 3 explores AI capabilities related to automation of the S&OP process. While it mentions some measures related to risk identification and treatment, this topic requires further attention. While Swink et al. (2025) specify how advanced planning technologies can facilitate faster recovery during disruptions, further empirical evidence is needed to explain how technology could be used to proactively create resilience. The possibilities for AI and resilience in SCM are available in the literature (Modgil et al., 2021b; Richey et al., 2023); in S&OP specifically, proactive risk management is associated with real-time data-gathering and scenario analysis. To this end, future research should examine the conditions and requirements to improve AI-supported scenario analysis in the S&OP process.

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