

1 Introduction

Chapter 1 introduces the foundational elements and overarching frame of this study. In the following, Section 1.1 introduces both the motivation and the problem statement of this research, establishing a contextual background and defining the specific problems that this research aims to address. Subsequently, Section 1.2 delineates the research objectives, highlighting the phenomenon under investigation and the intended outcomes of the study. Section 1.3 details the research design, outlining the methodological approach adopted to conduct this research. Lastly, Section 1.4 offers an overview of the thesis structure, elucidating the organizational framework of the dissertation.

1.1 Motivation and Problem Statement

Today's globalized business environment is characterized by growing market uncertainties and increasing supply chain complexity (Bode & Wagner, 2015). As such, supply chain management (SCM) has evolved from improving relatively simple processes to managing complex global networks (Vidrova, 2020). SCM encompasses the end-to-end management of goods as they move through the supply chain (Pittmann & Atwater, 2022). Within this extensive concept of SCM, supply chain planning (SCP) has emerged as a pivotal framework of diverse demand-facing and supply-facing activities (Oliva & Watson, 2011; Jonsson & Holmström, 2016). Yet, particularly in manufacturing and retailing, the intricate network of procurement, production, distribution, and sales processes presents challenges in managing supply chains. A recent survey on the top business challenges found that organizations struggle to forecast customer demand, encounter problems with promotional activity distorting the demand forecasts, and face increasing pressure from competitors to fulfill demand more rapidly (Kilcourse & Rosenblum, 2018). In response to these challenges, many organizations aim to integrate the functional departments within the firm and partners across the external supply chain to plan and control their operations more efficiently and effectively. In pursuing this integration, both academia and industry are concentrating on enhancing collaborative business processes, such as sales and operations planning (S&OP), to achieve a competitive advantage (Noroozi & Wikner, 2017b; Thomé et al., 2012a; Tuomikangas & Kaipia, 2014).

S&OP is an evolving operations management (OM) practice that focuses on orchestrating SCP tasks and activities in a cyclical process that aims to balance demand and supply plans while aligning performance across various business functions to support the strategic business plan (Feng et al., 2008; Thomé et al., 2012b; Jonsson & Holmström, 2016). S&OP has

its roots in the industry, primarily evolving through practical application (Thomé et al., 2012b). The growing interest of S&OP in practice has been mirrored in its academic interest as evidenced by numerous literature reviews aiming to synthesize the growing body of literature (e.g., Thomé et al., 2012b; Pereira et al., 2020; Kreuter et al., 2021a). Successful implementation of S&OP can yield key benefits, including increased sales revenue, improved resource allocation, and, consequently, higher profits (Cecere et al., 2009; Hulthén et al., 2016; Ivert et al., 2015). Thus, it is no surprise that the over three-decades-old concept of S&OP has evolved into an established process across industries (Hulthén et al., 2016; Kristensen & Jonsson, 2018; Ling & Goddard, 1988; Noroozi & Wikner, 2017b). Despite its importance, organizations implementing S&OP still face challenges, hindering organizations from realizing the full benefits of S&OP. Prominent keynote sessions at the Gartner Supply Chain Symposium 2023 highlight that practitioners seek practical solutions to solve these challenges of S&OP, emphasizing the need to use more widely data-driven decision-making (cf. definition in Section 2.3.1) and increase flexibility in order to adapt to the increasingly volatile environments and to generate executable plans (Gilchrist, 2023; Lund 2023a, 2023b; McCarthy, 2023).

Well-planned and neatly implemented decisions can directly impact supply chain costs (Souza, 2014). More data-oriented and informed decision-making practices that consider a more extensive information base can improve the quality of decisions (Dutta & Bose, 2015; Klein et al., 2018; Schoenherr & Speier-Pero, 2015; Singh Jain et al., 2017). In turn, the need to process the ever-growing amount of data faster and reliably has notably driven the rapid rise of information technology (IT) (Dutta & Bose, 2015), i.e., the technologies solving the business problems (Hevner et al., 2004) such as business analytics applications. Consequently, it is not a coincidence that (big) data has evolved to become an asset for organizations (Nguyen et al., 2018). The necessary analytical methods and techniques to gain meaningful insights from the collection of data sets generated by the organizations are subsumed under the term data analytics (Jeble et al., 2018; Kamble & Gunasekaran, 2020). Data analytics applied in a business context is called business analytics and includes "the people, processes, and technologies that turn data" (Wixom et al., 2013, p. 111) into business insights. Generated insights can be used across the organization, from purchasing and operations to marketing and sales to after-sales services (Hopkins & Brokaw, 2011; Sanders, 2014; W. Yu et al., 2018). Both scholars and commercial vendors have recognized the potential of data-driven decision-making, subsequently creating tools and systems designed to leverage the power of business analytics.

Software vendors are often at the forefront of addressing intricate business challenges and creating tailored solutions. In the case of SCP, organizations have invested heavily in

dedicated solutions (Olhager, 2013). The combined SCP and business intelligence software markets are expected to grow to over 53 billion USD by 2025 (Statista, 2020). The software and tools must be embedded into the business processes, such as S&OP, to unleash these IT investments' full potential. However, while the increased availability of greater amounts of data from the functions involved in S&OP has led organizations to increasingly turn towards technology to support the S&OP process (APQC, 2020), a recent survey by APQC (2020) found that roughly half of the surveyed S&OP professionals already use big data or analytics to support their S&OP process. However, 37% of the respondents are just beginning to move beyond spreadsheets to support their S&OP process, and only 15% of the organizations integrate cross-functional data into an advanced S&OP process. Thus, while commercially available offerings exist to facilitate data-driven decision-making, a prevailing gap seems to impede their widespread adoption.

Similarly, academic research on business analytics has grown exponentially in recent years (Yin & Fernandez, 2020). Within the field of SCM, business analytics has emerged as an imminent research theme and is assumed to prevail as a dominant research theme in the future (Wieland et al., 2016). Business analytics is at the intersection of multiple disciplines, such as operations research, artificial intelligence, and information systems (Hindle et al., 2020). Numerous business analytics applications have been developed in the context of SCM (Chehbi-Gamoura et al., 2019; Malik et al., 2018; Nguyen et al., 2018; Sharda et al., 2018), as well as specifically to support S&OP (Pereira et al., 2020). Previous research on the utilization of IT in S&OP has shown firstly that the successful integration of IT depends on the S&OP maturity and secondly that the appropriate level of IT integration is an enabler for the process (Thomé et al., 2012a). Yet, a gap remains between available decision support mechanisms for S&OP and observed S&OP cases (Danese et al., 2018).

Both practitioners and academia have recognized the need to embed business analytics into the S&OP process. However, the lack of success stories highlights that a significant gap remains. As applications of business analytics are prevalent, the argument is made that deficiencies lie in S&OP's organizational and procedural design of S&OP to facilitate their integration effectively. This is surprising as recent scholarly works advocate that interdisciplinary collaboration and processes optimize the value retained from business analytics (Kamble & Gunasekaran, 2020). It is thus argued that S&OP, as a prevalent interdisciplinary process, can become a central point for coordinating and aligning information and decisions (Pereira et al., 2020; Thomé et al., 2012b). Investigations on the usage of IT in S&OP are no novelty (e.g., Ivert & Jonsson, 2010, 2014; Chase, 2019; Pereira et al., 2020). However, fully integrated or advanced S&OP concepts primarily exist as visionary propositions yet to be realized in practice (Grimson & Pyke, 2007; Danese et al., 2018).

Current designs of the S&OP process predominantly focus on business process elements alone, largely omitting considerations of IT integration. By integrating business analytics into S&OP, companies stand to generate insights at a faster pace. This paves the way for more agile business processes that can rapidly adapt to ever-changing market conditions. Integrating business analytics into S&OP is emerging as a significant research area, necessitating an intricate and purposeful design of socio-technical systems. Socio-technical systems are central to the Information Systems (IS) domain, providing the framework for the practical application of IT to resolve organizational and human challenges (Hevner et al., 2004; Mikalef et al., 2016). Aligning business and IT design is crucial to realizing value from IT investments (Hevner et al., 2004; Henderson & Venkatraman, 1993). Investigating business analytics in the context of S&OP from a socio-technical viewpoint aligns with the research fields of IS and OM by enriching the understanding of the interplay between technological applications and organizational structures, enabling a more holistic and integrated approach to solving operational and strategic challenges within an organization.

In light of the previous paragraphs, this study addresses the multifaceted challenges associated with the evolution towards a more data-centric paradigm within S&OP, wherein business analytics are crucial integrative components. Such an S&OP process will hereafter be referred to as *data-driven S&OP*. Given the importance of effectively incorporating business analytics into the S&OP process and the evident lacuna in comprehending this integration, there is an imperative need for focused and meticulous investigation. Addressing this gap is not only critical for enhancing the understanding of the S&OP process but also crucial for optimizing the benefits derived from it.

1.2 Research Objective

Given the identified issue of missing or inadequate guidance for data-driven decision-making in S&OP, this research explores and addresses the gap in guiding the development of a data-driven S&OP approach. The identified research gap necessitates investigations in three key areas. First, an exploration into the conditions essential for the successful integration of business analytics into S&OP processes is needed. Second, an examination of the relationship between organizational process and business analytics applications in S&OP is crucial, focusing on how business analytics effectively integrates into the process design. Third, systematic guidance is needed to facilitate the integration of business analytics in S&OP processes, promoting coherent and effective data-driven planning and decision-making. This will extend and apply existing knowledge, making it more accessible to researchers and practitioners.

Consequently, the major research question is as follows:

Major Research Question: Where and how can the usage of business analytics enhance decision-making in S&OP?

Three integrally connected research questions (RQs) and their corresponding research goals (RGs) have been derived in the context of the major research question. The insights derived from RQ1 and RQ2 will act as the fundamental building blocks, which will be integrated and refined in the design approach developed under RQ3. Building blocks refer to the foundational components that contribute to developing a comprehensive data-driven S&OP design. Each research question yields distinct insights and knowledge, culminating in a comprehensive understanding of the overarching research objective. These research questions are thematically linked and contribute to answering the major research question.

Research Question 1: Which capabilities shape the design of S&OP?

As previously stated, S&OP is a business process. Business processes are actions, sets of procedures, routines, or activities that companies perform to achieve specific business goals or objectives (Ray et al., 2004). Business processes are based on and are thus a representation of how a firm realizes the competitive potential of its resources and capabilities (Ray et al., 2004, Wang & Ahmed, 2007). Resources and capabilities are constructs emerging out of the resource-based view (RBV) and dynamic capabilities view (DCV) (Wang & Ahmed, 2007). The RBV describes a firm's competitive advantage through the bundle of resources it possesses (Wójcik 2015), while the DCV describes how a firm transforms its resources based on its business environment (Teece et al., 1997). Section 3.2.1 presents an in-depth view of the RBV and DCV. Business capabilities are fundamental to the firm's performance (Aldea et al., 2015; Danesh & Yu, 2014; Stirna et al., 2012) and are supported by IT capabilities which aid organizations in collecting, processing, and assimilating information and formulating an efficient response (Cadez & Guilding, 2008; Dale Stoel & Muhanna, 2009; Trkman et al., 2010). Processes make use of both business and IT capabilities and link them together, e.g., S&OP capabilities and business analytics capabilities. A prevalent method to assess a firm's capabilities within a specific discipline is through the evolutionary path of maturity models (Becker et al., 2009, 2010). Numerous maturity models for S&OP have been developed in academia (e.g., Wing & Perry, 2001; Lapide, 2005; Grimson & Pyke, 2007) and practice (e.g., Cecere et al., 2009; Viswanathan, 2009), yet S&OP research remains predominantly a-theoretical (Kreuter et al., 2021b) and

a theoretically grounded perspective on S&OP capabilities must still be developed (Ivert et al., 2015; Kristensen & Jonsson, 2018).

Furthermore, addressing the evolving business challenges stemming from the usage of business analytics necessitates organizations to refine and enhance their business analytics resources and capabilities in alignment with their business operations. In alignment with IT capabilities, business analytics capabilities refer to the firm's ability to utilize business analytics to effectively generate insights supporting decision-making processes (Cotic et al., 2015). These capabilities are a prerequisite for a firm to implement a more data-driven S&OP process. As highlighted in the preceding section, extant research on S&OP seldom examines the function of business analytics within S&OP. Numerous studies have investigated business analytics through the lens of RBV and DCV theory (e.g., Mikalef et al. 2017, 2018, 2020; Conboy et al. 2020). However, the findings have not been linked to S&OP. It is argued that there is limited guidance on designing an S&OP process as the underlying foundation remains ambiguous. This necessitates a dedicated investigation into S&OP capabilities, subsequently shaping the S&OP design.

Research Goal 1: Provide a taxonomy of S&OP resources and capabilities.

RG1 aims to identify resources and capabilities for S&OP in the form of a taxonomy that leads to a successful S&OP process. Taxonomies are classifications of empirical entities, which consist of mutually exclusive and jointly exhaustive characteristics that describe a given phenomenon (Nickerson et al., 2013). The capabilities are derived from the predominant literature on S&OP and business analytics and classified based on the meta-characteristics derived from the RBV and the DCV, which are established theories in the field of management and information systems (Wade & Hulland, 2004). By incorporating established theories into the analysis of existing S&OP literature and extending them with theory and insights from business analytics literature, a theoretically grounded overview of S&OP resources and capabilities can be developed, which, in the following, is simply referred to as the *S&OP taxonomy*.

The derived S&OP taxonomy is a structured classification delineating the distinct attributes and proficiencies supporting S&OP processes. This taxonomy facilitates the identification of the resources and capabilities a firm possesses or develops, each leading to diverse design options for the S&OP process design. By leveraging the distinct design choices stemming from the S&OP taxonomy, organizations should be able to tailor their S&OP processes and enhance their ability to make data-driven decisions.

Research Question 2: What are the objectives and tasks that constitute an S&OP process, and where can business analytics provide support?

Within the guardrails of the S&OP design set by the firm's capabilities, it is essential to understand the specific objectives and tasks that make up an S&OP process and to identify where business analytics can support decision-making. Furthermore, it is needed to break down the S&OP process to see where analytics can make decision-making better and more informed. This is important because it helps to know how to use business analytics within these planning tasks to make better plans and respond quicker to any changes in the market. Given its context-specific nature, S&OP necessitates meticulous customization and adaptation to fit the unique conditions of each organization (Kristensen & Jonsson, 2018). In order to enable practitioners and academics to develop context-specific S&OP processes effectively, an exhaustive blueprint detailing potentially relevant *business objectives*, *tasks*, and *analytics* applications is essential.

Research Question 2a: What are the business objectives addressed by S&OP?

An S&OP process should be designed to ensure that an organization's business objectives, i.e., performance metrics, key performance indicators (KPI), or targets, are achieved. Fulfilling these business objectives is crucial for ensuring that the outcomes of the process align seamlessly with the organization's overarching goals. S&OP research has been focused on appraising the performance of S&OP (Kreuter et al., 2021b). These investigations have generally been characterized by identifying diverse performance metrics to evaluate the efficiency and efficacy of S&OP processes (e.g., Hulthén et al., 2016; Thomé et al., 2012b). Only recently have studies explored the decision points in the process, as highlighted by the studies of Pereira et al. (2020) and Bhalla et al. (2022). The integration and alignment of business analytics with specific business objectives are crucial, fostering quicker decision-making processes. However, the existing studies predominantly approach the subject matter from the operations research perspective, aiming to analyze the various decision points involved in optimization models. An OM perspective on the business objectives of S&OP is missing to date. This absence indicates a need for a more in-depth exploration and understanding of which business objectives are addressed by S&OP and their interrelations. These findings contribute to shaping the design and execution of S&OP processes to optimize alignment with the broader organizational goals. Such insights are pivotal for developing more refined and effective S&OP processes.

Research Goal 2a: Develop a performance framework of S&OP.

RG2a aims to identify business objectives from extant literature and derive their logical interrelations. A conceptual framework is a coherent collection of interrelated propositions that “provides understanding, or suggestable testable hypotheses” (Meredith, 1993, p. 7). The identified business objectives are to be mapped into a conceptual framework, hereafter referred to as *S&OP performance framework*, in order to provide a structured overview of the business objectives, their inherent relationships, and their connection to S&OP. By linking the individual business objectives, the S&OP performance framework will provide a comprehensive and systematic approach to determine the planning scope of the S&OP process, ensuring that the desired outcomes will be achieved. This will provide practitioners and academics guidance to design an S&OP process that is aligned with the organization's overarching goals and to ensure that the business objectives are effectively fulfilled. Additionally, possessing a clear and comprehensive understanding of the business objectives is instrumental in pinpointing the most suitable business analytics applications. This clarity ensures that the decisions made are well-informed and align precisely with the organization's overarching goals, reinforcing the strategic intent and promoting more effective and insightful decision-making processes.

Research Question 2b: Where can business analytics be applied to support decision-making in S&OP?

As previously stated, numerous business analytics applications exist in practice and academia. However, these applications are not sufficiently linked to S&OP (cf. Section 1.1). In order to bridge business analytics applications and S&OP effectively, a meticulous understanding and overview of the SCP tasks orchestrated by S&OP are imperative. Currently, the prevailing structures of the S&OP process typically structure S&OP into broad phases (e.g., Wallace & Stahl, 2008a), resulting in a generalized perspective that doesn't offer a detailed insight into which specific SCP tasks contribute to S&OP. RQ2 seeks to identify relevant SCP tasks and align them with corresponding business analytics applications. This investigation will yield an overview—the status quo—that delineates which SCP tasks and respective business analytics applications are viable for integration with S&OP. From these findings it can be derived how the integration of these business analytics applications can support the decision-making process within S&OP. The findings will provide organizations added guidance in understanding and defining suitable areas for business analytics applications within S&OP, thereby contributing to the development of more cohesive and informed S&OP processes.

Research Goal 2b: Build a classification of SCP tasks and business analytics applications for S&OP and a framework guiding the application of business analytics to S&OP.

The aim is to identify SCP tasks essential for S&OP and associated business analytics applications from S&OP and business analytics literature. The findings are to be gathered in respective classifications. Classifications refer to the general activity of grouping objects of interest (Nickerson et al., 2013). They can thus be understood as conceptual descriptions, i.e., structured descriptions of the studied phenomenon (Meredith, 1993), or constructs, i.e., high-level concepts or variables representing a phenomenon (Hevner et al., 2004). These classifications will help form a data-driven S&OP process, providing more insight into the application areas of business analytics in the context of S&OP. Insights invariably contribute varying levels of value to the business (Ackoff, 1989). Depending on the business analytics applications, different insights with deferring degrees of value are added to the S&OP process. Hypotheses will be logically induced to link business analytics and S&OP directly. These hypotheses will be integrated into a conceptual framework, referred to as the *BA-S&OP framework*, designed to ease the integration of business analytics into the S&OP process. The BA-S&OP framework will offer a structured method for the deployment of business analytics in S&OP.

Research Question 3: How can a data-driven S&OP process for improved decision-making be effectively designed?

RQ3 aims to bridge the gap between the current state of business analytics integration in S&OP and the potential of data-driven S&OP. Existing approaches to developing S&OP processes often fall short of fully realizing the potential of business analytics. Traditional S&OP designs, anchored in time-tested but inflexible methodologies, tend to overlook the dynamism and insights that a data-driven approach can offer. Kreuter et al. (2021a) made strides by developing an approach for contextualized S&OP processes, offering a more holistic understanding of organizational intricacies. However, these advancements still contend with the unpredictability of today's business landscape, particularly as business objectives consistently adapt to outside influences. Therefore, this research seeks to bridge this observed gap, aiming to provide structured guidance to design an S&OP process that acknowledges and leverages the power of business analytics, ensuring agility, responsiveness, and enhanced decision-making in the face of modern business challenges.

Research Goal 3: Develop a design method for data-driven S&OP.

The pursuit of developing data-driven S&OP processes calls for a dedicated design method. A method is a structured process that outlines recommended actions and offers clear guidance and instructions to address a specific problem (Becker et al., 2007). To construct a data-driven S&OP process, there's a pertinent need to incorporate both comprehensive business processes and business analytics applications. Herein, the implementation of a process that is not only systematic and analytical but also flexible and contextual is crucial to reconciling various business elements, including process and technology, ensuring strategic alignment and operational excellence. Thus, the goal is to provide organizations with structured guidance to integrate business analytics into S&OP, ensuring a strategic and operational fit. This design method must harmoniously intertwine the firm's inherent capabilities, business objectives, processes, and business analytics applications derived from the previous RQs. The outcome of this research is a coherent method for integrating business analytics into the S&OP process design, offering practitioners a structured and innovative alternative to traditional S&OP processes. By adhering to this structured methodology, practitioners can explore and operationalize an advanced and promising alternative to conventional S&OP, enhancing adaptability and precision in organizational decision-making processes.

1.3 Research Design

This study is firmly rooted in its meticulously crafted research design. This design serves as a rigorous pathway for investigating the research questions raised in Section 1.2. It outlines the research paradigms and research methods guiding this research. This section begins by introducing the research paradigm (Section 1.3.1), laying out the philosophical foundations. It then transitions to discuss the research methods (Section 1.3.2), detailing the specific methods employed to gather, analyze, and interpret the data.

1.3.1 Research Paradigm

The target of this thesis is to guide organizations in the development of a data-driven S&OP process, which leverages the application of business analytics for improved cross-functional decision-making. This calls for the creation of innovative artifacts focused on solving real-world problems. Thus, this study follows a pragmatist epistemological research approach (Hevner et al., 2004; Saunders et al., 2019) using design science research (DSR) as its research paradigm. DSR is defined as follows: