



# Integrating supply chain risk management activities into sales and operations planning

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## Abstract

Sales and operations planning (S&OP) became a relevant managerial topic for academics and practitioners with a growing literature body and implementation cases in the industry. However, S&OP has been analysed mostly in stable environments, with few implications for uncertain environments. With the current growing pressure to deal with unexpected changes in the business environment, the integration with supply chain risk management (SCRM) activities has been considered a promising direction for the next S&OP generation. Within this context, this paper aims to advance the theoretical understanding of the inter-relationship between S&OP and SCRM under different contexts and provide a practical guidance for adapting S&OP in uncertain environments. This goal is achieved by combining literature-based insights, obtained through a rigorous systematic literature review of 77 studies from academic and grey literature, with empirical insights from interviews with 15 industry experts. The research leads to a novel S&OP framework for dealing with uncertain environments. It integrates SCRM activities into S&OP, applying contingency theory as a theoretical foundation to address the context-specific nature of S&OP. Moreover, it embraces a holistic view for S&OP from an integrated people-process-IT perspective, encompassing the involved actors, the process itself and its steps, and the adopted information systems. Additionally, research findings reveal the possibility for an additional process to cope better with uncertain environments, which can run in parallel with the regular S&OP process. It is characterised by a higher planning frequency and a lower planning horizon, resulting in a closer linkage with operational planning and execution.

**Keywords** Tactical planning · Uncertainty · Contingency theory · S&OE

**JEL Codes** M1 (Business Administration: Production Management) · D20 (Production and Organization: General) · L2 (Firm Objectives, Organization, and Behavior: Organization of Production)

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## 1 Introduction

Sales and operations planning (S&OP) is a tactical supply chain planning practice with the aim of creating a balance between customer's demand and firm's supply capabilities (Thomé et al. 2012; Jonsson and Holmström 2016). It addresses an alignment within the firm, which can ultimately lead to improved coordination along the supply chain. As such, it plays an “essential role in realizing supply chain management” (Tuomikangas and Kaipia 2014, p. 244). S&OP has typically been considered a forecast-driven approach (e.g., Kaipia et al. 2017; Bhalla et al. 2022), often relying on historical data. As such, it can work well in stable environments (Christopher and Holweg 2017; Jonsson et al. 2021). Accordingly, S&OP can contribute to realising a wide range of operations-related, supply chain-related, and finance-related benefits (Kreuter et al. 2022). However, the realisation of these benefits is more difficult in uncertain environments, which challenges firms to adapt their S&OP (Jonsson et al. 2021).

Nowadays, the pressure for S&OP adaptations is rising due to a growing number of significant and unexpected changes in the business environment, for instance, reflected through the Covid-19 pandemic, the Russian war in Ukraine, or natural catastrophes like the series of fires across Europe in 2021. Adapting S&OP by building interfaces and linkages to other business practices is considered a promising approach for dealing with uncertain environments more effectively (Kristensen and Jonsson 2018). Such a linkage should extend S&OP's firm-internal view and enable looking “beyond the company borders to multiple tiers of the supply chain [...] if not the entirety of the supply chain itself, and beyond” (Jonsson et al. 2021, p. 557). In these regards, the integration of supply chain risk management (SCRM) activities, i.e., risk identification, assessment, treatment, and monitoring (Fan and Stevenson 2018), into S&OP has recently been suggested in the literature (e.g., Noroozi and Wikner 2017; Kristensen and Jonsson 2018; Dittfeld et al. 2021; Kreuter et al. 2022). While there is consensus in the literature on this need, concrete suggestions on how to realise this integration are lacking. In fact, research explicitly dealing with it as its primary goal is scarce (Dittfeld et al. 2021). Many studies, however, provide valuable implications that are instead associated with side findings. Therefore, there is a need to synthesise these knowledge fragments to identify how to adapt S&OP in uncertain environments through an integration of SCRM activities.

An S&OP adaptation in this regard comes along with two main challenges. First, it does not follow a ‘one-rule-fits-all’ approach (Thomé et al. 2014; Kristensen and Jonsson 2018). Accordingly, viewed through the lens of contingency theory, realising the integration of SCRM activities into S&OP can be contingent upon contexts (Kristensen and Jonsson 2018). Second, investigating the adaptation of the S&OP process alone is not sufficient. Instead, Kreuter et al. (2021) show that when developing and implementing a contextualised S&OP, people, e.g., the involved actors, and information technology (IT), e.g., the used information systems, must also be considered due to their strong interdependencies with the process. Therefore, by using contingency theory as a theoretical foundation and looking from a holistic and integrated people-process-IT perspective, this

paper poses the following research question: How can SCRM activities be integrated into S&OP?

In addressing this research question, the paper aims to advance the theoretical understanding of the interrelationship between S&OP and SCRM under different contexts and provide practical guidance for adapting S&OP in uncertain environments. To achieve this goal, the research follows a sequential two-step approach. First, a systematic literature review (SLR) is conducted to synthesise the fragmented findings available on the topic, as Thomé et al. (2016a) suggested. The synthesised findings are then used as the basis for the empirical research step. This second step consists of interviews with S&OP experts from different sectors, industries, and geographical areas to complement and extend the literature, resulting in practical guidance for adapting S&OP in uncertain environments. The research addresses the call for more exploratory studies by combining literature-based insights with empirical ones (Kreuter et al. 2022), generating a novel S&OP framework for dealing with uncertain environments. The topic of integrating S&OP with SCRM activities is investigated, whose need is emphasised by Kristensen and Jonsson (2018), Dittfeld et al. (2021), Kreuter et al. (2022), and Seeling et al. (2022). For this, S&OP is intended to be adapted from a context-specific view to advance the understanding of S&OP and contingencies (Kristensen and Jonsson 2018; Kreuter et al. 2021; Laari et al. 2023). Furthermore, the adaptation is analysed from a people-process-IT perspective, as suggested by Jonsson et al. (2021) and Kreuter et al. (2021).

The remainder of this paper is structured as follows: Section two provides background on S&OP and its context-specific nature, as well as on SCRM. The methodological approaches conducted in the research are described in the third section. The literature-based and empirical findings and their analysis are then presented in section four, leading to a novel S&OP framework, introduced and further discussed in section five. The paper ends with a conclusion and offers limitations and promising streams for future research.

## 2 Theoretical background

This section introduces S&OP and its context-specific nature, as well as SCRM as a potential solution for dealing with uncertain environments in S&OP.

### 2.1 Sales and operations planning

Since its first mention more than three decades ago by Ling and Goddard (1988), S&OP has evolved into an emerging practice, reflected in both a growing managerial interest and an increasing number of scientific publications (Kreuter et al. 2022). S&OP fulfils the role of an “integrative device” (Lawrence and Lorsch 1967) by addressing both a horizontal alignment across functional units and a vertical alignment across hierarchical levels through bridging between strategy and operational activities (Thomé et al. 2012; Kristensen and Jonsson 2018). It covers a tactical planning horizon, usually ranging from four to 24 months

(Ivert et al. 2015; Kreuter et al. 2022), and is conducted monthly with the overall objective of consolidating single business plans into one integrated set (Cox and Blackstone 2002).

The regular S&OP process is usually applied in discrete and process manufacturing firms (e.g., Noroozi and Wikner 2017) and embraces five steps. According to Wallace and Stahl (2008), these are (1) data gathering, in which all required historical data is collected; (2) demand planning, in which demand-sided departments create forecasts and aggregate them into a demand plan; (3) supply planning, in which operations departments develop a supply plan; (4) pre-meeting, in which representatives of all relevant departments meet to reconcile the demand and supply plans and to create a preliminary S&OP plan; and (5) executive meeting, in which top management reviews the preliminary S&OP plan and either approves or modifies it. The S&OP process follows a formal and hierarchical structure (Jonsson et al. 2021). Formal refers to the set of five steps, which are conducted sequentially and in line with a pre-defined schedule. Hierarchical means that “higher level plans constitute stable frames for the respective lower-level plans” (Jonsson et al. 2021, p. 558).

Although the process and its steps build the core of S&OP, the additional consideration of the involved actors (people) and the used information systems and their functionalities (IT) is essential for developing and implementing S&OP (Kristensen and Jonsson 2018; Jonsson et al. 2021). A holistic and integrated people-process-IT perspective enables an effective design and execution of S&OP (Kreuter et al. 2021). For instance, several studies show that using sophisticated information systems can enable more accurate planning, support decision-making, and save time for more important S&OP-related tasks (Ivert and Jonsson 2014; Taşkın et al. 2015; Danese et al. 2018; Kreuter et al. 2021). Different types of such systems can be used, such as simple spreadsheets, Enterprise Resource Planning (ERP) systems, Advanced Planning Scheduling (APS) systems, or traditional dashboards (e.g., Ivert and Jonsson 2014; Hulthén et al. 2016; Gray and Dougherty 2017). However, as Jonsson et al. (2021) emphasise, the role of information systems and their functionalities in S&OP will become even more important in the future. In this regard, big data and advanced analytics, artificial intelligence, or machine learning can contribute positively through providing more information (Jonsson et al. 2021; Schlegel et al. 2021; Xu et al. 2021).

Additionally, the cross-functional setting of S&OP also needs to be considered. S&OP brings together people from different “thought worlds” (Ambrose and Rutherford 2016, p. 24), whose plans and goals are often contradictory (e.g., Stentoft et al. 2021). Regular S&OP actors often mentioned in the literature are representatives from the demand side (sales, marketing), the supply side (operations), finance, and top management (e.g., Ambrose et al. 2018; Seeling et al. 2022). With less frequency, representatives from other departments, such as quality management, or external members from the supply chain, such as key customers or suppliers can also play an important role (Kreuter et al. 2021). Based on these aforementioned studies, an adaptation through an integration of SCRM activities into S&OP requires the consideration of all three dimensions (people,

process, and IT). Figure 1 offers a view on the regular S&OP from this integrated people-process-IT perspective.

An adaptation on all three dimensions could be operationalised differently due to the context-specific nature of S&OP (Kristensen and Jonsson 2018). This aligns with contingency theory stating that achieving organisational effectiveness requires fitting organisation-specific characteristics to so-called contingencies (Donaldson 2001). Transferring this idea to the topic of this research means that different S&OP adaptations towards integrating SCRM activities may be possible, depending on the contingencies. S&OP literature reveals several contingencies, which affect the design and the performance of S&OP (Kristensen and Jonsson 2018), such as the industry (e.g., Ivert et al. 2015), the firm size (e.g., Kreuter et al. 2021), or the manufacturing strategy (e.g., Bhalla et al. 2022). Dittfeld et al. (2021) have already shown that the integration of S&OP with SCRM activities on the process dimension can differ according to the contingency of the firm's aim of its S&OP, which is why further investigations on other contingencies are highly promising.

## 2.2 Supply chain risk management

Uncertain environments refer to situations in which firms face unpredictable changes in the business environment (Wong and Boon-itt 2008). When facing uncertainty, the outcome of such a change cannot be anticipated. It can result in positive (e.g., increased sales) or negative (e.g., stock-outs) outcomes without knowing whether the outcome will eventually be positive or negative (Simangunsong et al. 2012; Thomé et al. 2016b; Park and Shapira 2017). Uncertainty is a driver and an antecedent of a risk and is simultaneously a broader concept (Thomé et al. 2016b; Park and Shapira 2017). Accordingly, a risk emerges from uncertainty and is associated with negative consequences only (Simangunsong et al. 2012; Sreedevi and Saranga 2017; Baryannis et al. 2019). In the context of supply chains, i.e., the focus of this paper, a supply chain risk entails “any risk for the information, material and product flows from original supplier to the delivery of the final product for the end user” (Jüttner et al. 2003, p. 200) and can “adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities” (Ho et al. 2015, p. 5035).

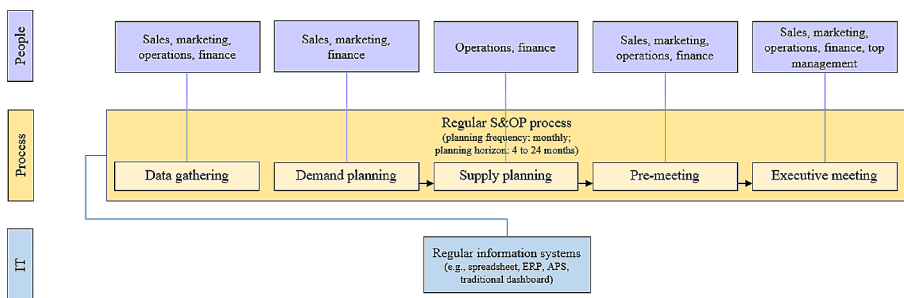


Fig. 1 Regular S&OP from a people-process-IT perspective

A traditional risk management, which focuses on general risks on the company level, is not individualised for dealing with risks associated with the supply chain, such as demand, production, distribution, or supply risks (Jüttner 2005; Ferreira et al. 2018). Instead, an approach needs to be in place, which focuses on supply chain risks specifically. Due to many unexpected and highly impactful changes in supply chains in recent years, SCRM has become a topic of growing popularity and importance in this regard (e.g., Wicaksana et al. 2022). While SCRM has been defined in different ways, the literature shares several commonalities (Ferreira et al. 2018), which can be combined in the definition from Fan and Stevenson (2018, p. 210): “The identification, assessment, treatment, and monitoring of supply chain risks, with the aid of the internal implementation of tools, techniques, and strategies and of external coordination and collaboration with supply chain members so as to reduce vulnerability and ensure continuity coupled with profitability, leading to competitive advantage.”

Accordingly, the activities of risk identification, assessment, treatment, and monitoring build the core for managing supply chain risks. Risk identification is considered a fundamental step in SCRM (Ferreira et al. 2018), as a proper identification is the basis for an effective and efficient management of supply chain risks (Fan and Stevenson 2018). This activity addresses the discovery of all potential supply chain risks and can be aided by tools and techniques, such as analytical hierarchy process or value stream mapping (Gaudenzi and Borghesi 2006; Fan and Stevenson 2018). It is followed by a classification into risk type schemes (Ho et al. 2015; Fan and Stevenson 2018), such as the one defined in Manuj and Mentzer (2008) (demand, supply, operational, and other risks). Risk assessment covers an evaluation of all identified supply chain risks according to their probability and impact, enabling a prioritisation and ranking of the most important supply chain risks (Tummala and Schoenherr 2011; Ferreira et al. 2018). It can be conducted either qualitatively (e.g., through expert judgement) or quantitatively (e.g., through scenarios) (Zsidisin et al. 2004; Tummala and Schoenherr 2011; Fan and Stevenson 2018). Risk treatment relates to making decisions if and how to deal with those supply chain risks identified and assessed. According to Fan and Stevenson (2018), five different strategies can be followed for treating supply chain risks: acceptance, avoidance, transfer, sharing, and mitigation. Finally, risk monitoring refers to the continuous tracking and reviewing of how supply chain risks are developing and if previous risk treatment decisions need to be modified (Fan and Stevenson 2018). It is considered the basis for implementing corrective actions (Ferreira et al. 2018), but therefore typically requires the use of data management and IT enabling, for instance, a review and analysis of key performance indicators (Tummala and Schoenherr 2011). Figure 2 displays the four SCRM activities, their purposes, and exemplary tools, techniques, and strategies for conducting them.

### 2.3 Integrating SCRM activities into S&OP

The need to integrate S&OP with SCRM and its activities has been emphasised by researchers in academic literature (e.g., Noroozi and Wikner 2017; Kristensen

SCRM activity	Explanation	Exemplary tools, techniques, and strategies
Risk identification	<ul style="list-style-type: none"> <li>• Discovery of potential supply chain risks</li> <li>• Classification into supply chain risk types</li> </ul>	analytical hierarchy process; value stream mapping
Risk assessment	<ul style="list-style-type: none"> <li>• Evaluation of each supply chain risk according to probability and impact</li> <li>• Ranking and prioritization of supply chain risks</li> </ul>	expert judgement; scenarios
Risk treatment	<ul style="list-style-type: none"> <li>• Decision-making on an appropriate treatment strategy</li> </ul>	avoidance; acceptance; transfer; sharing; mitigation
Risk monitoring	<ul style="list-style-type: none"> <li>• Continuous tracking and reviewing of the development of supply chain risks and of previous risk treatment decisions</li> </ul>	data management; early warning

**Fig. 2** Explanation and exemplary tools, techniques, and strategies for each SCRM activity

and Jonsson 2018; Dittfeld et al. 2021; Kreuter et al. 2022) and by practitioners in grey literature (e.g., Schlegel 2015; Bower 2018; Dunn 2019). However, research is still scarce on this topic (Kalla et al. 2023). Dittfeld et al. (2021) address it through a multiple case study. Their results indicate that the risk identification and risk treatment activities are suitable for integrating into S&OP. However, the study focuses on the process industry and distinguishes between different aims of S&OP, whereas other contingencies are also worth investigating. Additionally, the integration is explored from a process perspective. Going beyond this perspective towards a holistic view of S&OP embracing the involved actors (people) and the used information systems (IT) is still a research gap in the literature, opening avenues for future research. This integrated people-process-IT perspective for S&OP has been recently called by Kreuter et al. (2021). Consequently, this paper builds up and extends the valuable work of Dittfeld et al. (2021), embracing Kreuter et al.'s (2021) call. Therefore, the existing fragments on the topic available in the S&OP literature are identified, synthesised, and integrated. These findings are then complemented by interviews with industrial S&OP experts to develop a novel framework for dealing with uncertain environments in S&OP. The methodological approaches for these two steps are presented next.

### 3 Research methodology

This research encompasses a sequential two-step approach, as shown in Fig. 3. The first step embraces an SLR (Tranfield et al. 2003) to synthesise knowledge fragments available in the literature with implications about adapting S&OP through an integration of SCRM activities. Preliminary knowledge gained from the literature findings are then complemented, refined, and validated in a second step with practical insights from industry experts through interviews, revealing new knowledge about dealing with uncertain environments in S&OP. This section describes the approaches for conducting the SLR and the interviews.

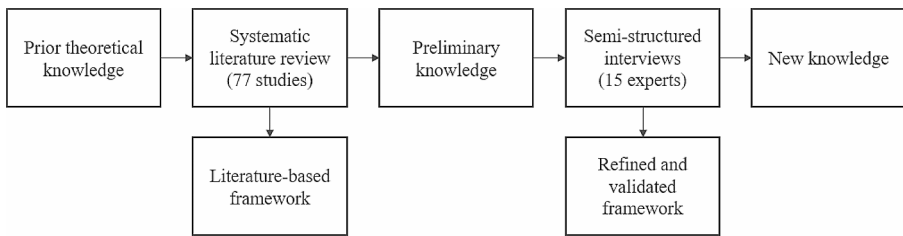


Fig. 3 Two-step research approach, adapted from Wieland and Wallenburg (2012)

### 3.1 Systematic literature review

The step-by-step approach of Thomé et al. (2016a) is followed for conducting the SLR. In the first step, the research problem is planned and formulated. The problem is motivated in the first section of this paper. Several SLRs have been published in the S&OP domain, investigating S&OP from different lenses, e.g., structuring S&OP descriptors (Thomé et al. 2012), coordination mechanisms (Tuomikangas and Kaipia 2014), supply chain integration (Noroozi and Wikner 2017), contextualisation (Kristensen and Jonsson 2018), decision-making (Pereira et al. 2020), and S&OP application in engineer-to-order settings (Bhalla et al. 2022). However, none of these SLRs have focused on dealing with uncertain environments in S&OP and, particularly, integrating SCRM activities into S&OP. Nevertheless, the literature offers many fragments on this topic that need to be synthesised, which is why an SLR is a suitable approach for this research. The research team comprises three members experienced in operations and supply chain management and S&OP. The scope of the research is determined by applying the taxonomy of Cooper (1988), which supports the research protocol adopted.

In the second step, literature is searched. For this, the Scopus and Web of Science databases are selected as they complement each other and are considered relevant in operations and supply chain management (Mongeon and Paul-Hus 2016). The two databases are queried with a search string consisting of two parts. The first part focuses on identifying S&OP studies. Therefore, the search string embraces (“sales and operations planning” OR “sales & operations planning” OR “s&op”) within the title, abstract, and keywords, based on Thomé et al. (2012) and Kreuter et al. (2022). The second part is based on the terms identified by Fan and Stevenson (2018) and is further subdivided into three areas to retrieve SCRM-related fragments in the S&OP literature. Therefore, keywords are searched in full text. The first area focuses on the four SCRM activities by using the terms risk\* OR uncertain\*. This enables the finding of literature which names the activities. The keyword uncertain\* is included in the search string as it is often used synonymously for risk (Jüttner et al. 2003; Simangunsong et al. 2012). The second area includes the names of common SCRM-related tools, techniques, and strategies. The third area focuses on the outcomes of SCRM and therefore incorporates the keywords (“profitability” OR saving\* OR vulnerab\* OR “continuity”). The keywords within the second part of the search string are



connected through OR connectors, the second part, in general, is associated with the first one through an AND connector. The whole search string and its purposes are presented in Table 1. Some other keywords have been tested as well, e.g., “dynamic complexity” (used in Kristensen and Jonsson 2018) or “resilience” (used in Jonsson et al. 2021). However, incorporating these keywords has not increased the overall sample and has therefore been left out.

The literature was screened in October 2022 and updated in February 2023. The application of this search string in the two databases retrieved 284 studies initially and 231 studies after removing duplicates. These studies were then analysed by two authors of this paper, who applied the following exclusion criteria for the abstract and full-text review, inspired by Kreuter et al. (2022): (i) studies not providing insights or fragments on managing risks in S&OP; (ii) studies published in books, conference proceedings or presenting preliminary findings later reported in final, complete papers; (iii) sales/advertising material; (iv) studies not written in the English language; (v) studies that could not be obtained or accessed. After reviewing abstracts, 107 studies remained due to many articles from other fields, such as natural sciences (as also found by Thomé et al. 2012). Furthermore, a high number of non-S&OP-specific studies was removed, which, for example, focus on demand forecasting only. After the full-text review, the total sample embraced 37 studies. A backward and forward search was applied afterwards with the same before-mentioned exclusion criteria, similar to Sageder and Feldbauer-Durstmüller (2019), increasing the sample by one additional study. Decisions to include or exclude studies were documented, and disagreements between the reviewers were debated until resolved.

In addition to the academic literature, the grey literature has been included as well, as also done in other S&OP SLRs (e.g., Tuomikangas and Kaipia 2014; Kristensen and Jonsson 2018; Kreuter et al. 2022). The grey literature was included as it enables the investigation of current topics, which are not yet subject in academia to a large extent (Adams et al. 2017). This is particularly true for the S&OP research domain, which in the past has often been guided by practically relevant problems addressed in grey literature first (Laari et al. 2023). For the inclusion of grey literature, the Journal of Business Forecasting (JBF) has been searched manually, following Tuomikangas and Kaipia (2014) and Kreuter et al. (2022), as it is a well-recognised source for grey S&OP literature. JBF articles were collected and searched according to the keywords (see Table 1). Incorporating academic and grey literature led to a final total sample of 77 studies.

The third and fourth steps of the SLR aim to gather data and evaluate quality. A concept matrix with coding schemes was developed by using a spreadsheet. Three contingency-related parameters are analysed, adapted from Kreuter et al. (2022): (1) Section/industry, following the Global Industry Classification Standard (S&P Global and MSCI 2018). (2) Firm size regarding employees and revenue, following Gartner (2023). Accordingly, small-sized firms have less than 100 employees and an annual revenue of less than 50 million \$, medium-sized firms have 100 to 999 employees and a revenue of more than 50 million but less than 1 billion \$, and large-sized firms have at least 1,000 employees and an annual revenue of at least 1 billion \$. (3) Strategy in terms of the manufacturing strategy (make-to-stock,

**Table 1** Search string

Part	Goal	Keywords	Filter
I	To retrieve S&OP literature	("sales and operations planning" OR "sales & operations planning" OR "s&op")	Title, abstract, keywords
II	To retrieve explicit SCRM fragments To retrieve implicit SCRM fragments through SCRM tools, techniques, and strategies	AND (risk* OR uncertain*) OR ("analytical hierarchy process" OR "value-focused process engineering" OR "Ishikawa" OR "value stream mapping" OR "cause-effect diagram" OR "expert judgement" OR scenario* OR "Bayesian" OR "probability-impact" OR accept* OR transfer* OR shar* OR avoid* OR mitigat* OR "data management system" OR "early-warning" OR "external coordination" OR "external collaboration") OR ("profitability" OR saving* OR vulnerab* OR "continuity")	Full text
	To retrieve SCRM fragments associated with SCRM outcomes		

make-to-order, engineer-to-order). Additionally, study-related parameters cover the S&OP dimensions according to Kreuter et al. (2021), i.e., involved actors (people), the S&OP process and its steps of data gathering, demand planning, supply planning, pre-meeting, executive meeting (process), and used information systems (IT) as well as the SCRM activities according to Fan and Stevenson (2018), i.e., risk identification, assessment, treatment, monitoring. This coding scheme was tested through a first pilot conducted in November and December 2022 with an analysis of ten studies selected randomly from the sample.

Data was analysed, synthesised, and interpreted in the fifth and sixth steps. The evaluation of an S&OP adaptation towards the integration with SCRM activities was conducted through content analysis (Seuring and Gold 2012) and the lenses of contingency theory (Donaldson 2001), operationalised through the adapted contingency-related parameters of Kreuter et al. (2022). By this, the SLR provides contextualised explanations of S&OP in uncertain environments, as Durach et al. (2021) recommended. As the relation between S&OP and an SCRM activity was not always highlighted explicitly, inferences were required. This happened through an interactive coding process among the reviewers. The seventh step of the SLR refers to presenting the results, which happens in the next section of this paper. An update of the SLR, which is recommended as the eighth and final step, is suggested for future research.

### 3.2 Expert interviews

Additional empirical data was gathered to complement, refine, and validate the findings from the SLR. For this, the key informant technique (Marshall 1996) was used, which originated initially in cultural anthropology but is now also being used in more fields, such as supply chain management (Roscoe et al. 2020). Key informants were S&OP experts, identified by selecting managers and consultants with at least three years of experience in S&OP. This included practitioner contacts from previous research projects conducted by this paper's authors, the recruiting of additional contacts through the professional social networking platform LinkedIn, and by indications from the respondents.

In total, 15 experts were interviewed semi-structurally, following the guidelines of Myers and Newman (2007). The list of all experts, their practical S&OP experiences in terms of their working positions (S&OP manager or consultant), years, sectors and industries (according to S&P Global and MSCI 2018), and regions and countries, the way how the interviews were conducted (in-person or remote), and the length of the interviews can be found in the [appendix](#) (Background on the experts). The names of the experts are replaced by codes (Expert 1, 2, ..., 15) to protect their anonymity and confidentiality. The sample of experts is diverse regarding years of experience, sectors/industries, and regions/countries. Accordingly, most experts have practical S&OP experience as S&OP managers, whereas three have experience as S&OP consultants only, and two with experience as both S&OP managers and consultants. The average practical experience among all 15 experts is 11.5 years. Eight experts have practical S&OP experience in more than one sector or industry. Furthermore, nine experts have experience in

S&OP for a specific country or region, whereas eight experts are experienced in S&OP with a global scope.

A semi-structured questionnaire was developed and designed, which guided the interviews (see [appendix](#): Interview Questionnaire). To ensure a common understanding, the five regular S&OP process steps and four SCRM activities have been introduced, defined, and explained to all interviewees before asking specific questions. The questionnaire was developed and influenced by the results of the SLR as well as by the three contingency-related parameters. Additional questions were asked when necessary. The interviews took between 46 min and 2:07 h. For coding reasons, all interviews except one were recorded and transcribed. One expert could not accept a recording due to organisational regulations. In this case, notes were conducted during the interview. Based on the guidelines of Rockmann and Vough (2023), direct quotes of the experts are used when they contribute to clarity and understanding purposes while presenting the research findings and analysis.

## 4 Research findings and analysis

This section is organised according to the four SCRM activities of risk identification, assessment, treatment, and monitoring (Fan and Stevenson 2018). For each activity, the results from the SLR and the expert interviews are presented. By doing so, this section offers the research findings and analysis on how S&OP can be adapted through an integration of SCRM activities.

### 4.1 Risk identification

There is an agreement in the literature (Nearneberg 2011; Alexander 2013, 2016; Hobby and Jaeger 2013; Grillo 2014; Gallego-Garcia and Garcia-Garcia 2021) and among all experts that a list of identified risks is essential for realising an effective S&OP. However, there is no consensus that identifying risks should be conducted within the S&OP process or outside so that identified risks are considered an input for S&OP. Some studies reveal the need for identifying risks explicitly within S&OP (Macon 2020; Baker 2021). Accordingly, demand-related risks can be identified in the scope of demand planning by sales and marketing departments (Ávila et al. 2019; Fitzpatrick 2020; Dittfeld et al. 2021), whereas manufacturing-related or supply-related risks are suitable to be identified in supply planning by operations departments (Fitzpatrick 2020; Dittfeld et al. 2021). However, also the pre-meeting (Islam 2013; Krishnan 2020; Dittfeld et al. 2021) and the executive meeting (Ivert and Jonsson 2010, 2014; Hobby and Jaeger 2013; Dittfeld et al. 2021) could be appropriate platforms for identifying risks within S&OP. Some experts also highlight the need for conducting risk identification in S&OP. Experts 2 and 8 emphasise that S&OP is the proper forum for identifying risks as it involves people with the right knowledge about demand and supply to identify related risks. Expert 7 would also embed the activity into S&OP “because it creates a certain kind of accountability.” Others emphasise that

it should not be an explicit agenda point in S&OP but that risk identification often happens naturally (e.g., Expert 1).

In contrast, several studies remain vague about the relationship between S&OP and risk identification, indicating that S&OP should not be adapted towards such an integration. Several experts consider risk identification instead as an activity that should take place outside S&OP. Expert 5 highlights that “S&OP is not so big that you should think of it as a basin where you throw everything in.” This is in line with Expert 12, who states that one needs to remember the purpose and scope of S&OP and that it does not have the duty “to solve all problems.” Integrating risk identification into S&OP is furthermore expected to be very time-consuming (Experts 6, 11, 15): “It is not possible to inflate the process even further in terms of time. The process is already relatively big” (Expert 11). Expert 6 adds that with such an adaptation, S&OP “would shift away from a decision-making tool towards a brainstorming-session tool.” One exception could be to integrate this activity when a firm faces an extreme situation characterised by a high degree of uncertainty in the environment: “It may be that in particularly uncertain times, such as during Covid-19, we need to adjust our agenda flexibly. [...] If there is a need to identify and discuss risks within S&OP, then we should do it” (Expert 5). This corroborates Experts 1, 3, and 10.

Although some studies indicate that risk identification can be conducted within S&OP in both medium-sized (Grillo 2014; Seeling et al. 2021a) or large-sized firms (e.g., Dittfeld et al. 2021; Seeling et al. 2021b), several experts distinguish between these two sizes. Expert 9 says that “larger organisations could and should have a dedicated unit with the preliminary task of identifying risks.” This is in line with Expert 15, who states that employees typically have clear roles and responsibilities in a large organisation. It would be difficult or even impossible to extend the job profiles of S&OP actors with an additional activity that does not belong to their primary job. Medium-sized firms, in contrast, often do not have the organisational, human, and financial resources to have a dedicated unit for identifying risks, which corroborates Experts 11, 12, and 13. Expert 12 stresses: “I am inclined to say that it [risk identification] can be a part of S&OP because S&OP is much leaner in small companies. Large companies are much more hierarchical, so I would not recommend it. In large companies, it makes more sense to centralise it [risk identification] in a department.”

In synthesis, an adaptation towards integrating risk identification into S&OP is not necessarily needed. However, it is an SCRМ activity that can be conducted in S&OP. It can be particularly valuable for medium-sized firms or firms that temporarily face a high degree of uncertainty in the business environment. If so, neither literature nor experts indicate the need to involve other actors or utilise different or specific information systems to identify risks within S&OP.

## 4.2 Risk assessment

Risk assessment is the most frequently mentioned SCRМ activity in the S&OP literature. The findings reveal a high need for integrating this activity into S&OP (e.g., Baumann 2010; Feng et al. 2013; Pedroso et al. 2016; Bower 2018; Macon

2020; Almeida and Conceicao 2021; Gallego-Garcia and Garcia-Garcia 2021; Schlegel et al. 2021; Almeida et al. 2022; Sorensen 2022). This is in line with the results from the interviews with the experts. Expert 1 emphasises that risk assessment “has to happen in S&OP, it needs to be an essential part of S&OP.” This corroborates Experts 5 and 15. Although risk assessment can always be wrong, as “no one has a crystal ball, it is crucial to think about this topic in advance”, which is why risk assessment “should definitely be part of S&OP” (Expert 5).

The findings reveal that conducting the assessment, i.e., evaluating the probability and impact of each risk, should mainly be done in the S&OP steps of demand planning and supply planning. Accordingly, demand planning is considered suitable for an assessment of demand-related risks made by sales and marketing departments (Sodhi and Tang 2011; Ivert et al. 2015; Gorbos 2017; Wood et al. 2017; Ben Ali et al. 2019; Fitzpatrick 2020; Bhalla et al. 2022). Similarly, operations departments can use supply planning for assessing manufacturing-related (Ivert and Jonsson 2010, 2014; Islam 2013; Calfa et al. 2015; Ivert et al. 2015; Gorbos 2017; Wery et al. 2018; Bhalla et al. 2022) and supply-related risks (Ivert and Jonsson 2010, 2014; Islam 2013; Ivert et al. 2015; Gorbos 2017; Wery et al. 2018; Fitzpatrick 2020; Bhalla et al. 2022; Hainey 2022). A review of these risk assessments should then be done in the scope of the pre-meeting and executive meeting (Harrison 2009; Bower 2012; Kelleher 2012; Warren 2012; Hobby and Jaeger 2013; Islam 2013; Singh and Lee 2013; Alexander 2016; Dunn 2019; Fitzpatrick 2020; Seeling et al. 2022). This structure, i.e., assessing risks in demand planning and supply planning and reviewing the risk assessments in the pre-meeting and executive meeting, is also suggested by almost all experts (Experts 2, 3, 5, 6, 7, 8, 10, 11, 12, 14, 15). The main reason for this is exemplified by Expert 2: “Many people are sitting in the executive meeting who do not have this detailed knowledge [of the risks and their probability and impact]. This is why risks have to be assessed beforehand.” A trustworthy risk assessment “creates confidence on the executive side” (Expert 5) and “puts the executives in a better position to make decisions” (Expert 6).

Sales and marketing as well as operations departments are considered the right actors for assessing risks volume-wise. However, a finance-wise assessment must not be ignored, which is why both literature (Bower 2018; Dunn 2019; Dittfeld et al. 2021; Seeling et al. 2021a, 2022; Clark 2022) and experts (Experts 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15) highlight the need for involving the finance department into an adapted S&OP. Only then a “full picture” can be provided, as stated by Expert 14, also in line with Expert 2. However, it is also possible to include other actors besides finance in the risk assessment activity within S&OP. For instance, Kreuter et al. (2021) name the possibility of collaborating with key customers, corroborating Expert 11. Another option would be to involve a legal department (Expert 12).

Information systems and their functionalities can play a significant role in assessing risks. While some experts state that regular information systems, such as ERP and APS systems, are sufficient for assessing risks properly, others highlight the need for more sophisticated information systems (Experts 1 and 11). A fast and powerful definition, simulation, and analysis of different scenarios are

considered vital for assessing risks in S&OP by both the literature (e.g., Feng et al. 2013; Ávila et al. 2019; Gallego-Garcia and Garcia-Garcia 2021; Kreuter et al. 2021; Seeling et al. 2021a) and experts (e.g., Experts 2, 14, 15). Furthermore, some experts indicate the high potential of modern technologies, such as artificial intelligence (AI) and machine learning (Experts 1, 7, 8). However, successfully implementing these technologies for assessing risks in S&OP could become very challenging, particularly for medium-sized firms, due to fewer human, technical, and financial resources. This corroborates Expert 9; he suggests first focusing on integrating the activity of assessing risks into the S&OP process steps of demand and supply planning. When this integration is understood and applied successfully, a firm should concentrate on how to solve the remaining issues through IT.

In synthesis, S&OP should be adapted towards the integration of risk assessment. More precisely, risks should be assessed by sales, marketing, and finance in demand planning and by operations and finance in supply planning. These risk assessments should then be forwarded to and reviewed in the pre-meeting and executive meeting as a basis for effective decision-making. A fast and powerful scenario analysis functionality is considered highly important for a practical risk assessment within S&OP.

### 4.3 Risk treatment

Both literature and experts emphasise that the SCRM activity of treating risks should also be integrated, leading to another S&OP adaptation. A vast majority of the studies reveal that the final decision-making on how to treat a risk should be conducted within the pre-meeting (Schlegel and Murray 2010; Bower 2012; Kelleher 2012; Singh and Lee 2013; Alexander 2016; Dreyer et al. 2018; Dunn 2019; Dittfeld et al. 2021; Seeling et al. 2021a, b, 2022) and the executive meeting (Bower 2012; Warren 2012; Hobby and Jaeger 2013; Singh and Lee 2013; Covas 2016; Dunn 2019; Baker 2021; Desmet 2021; Dittfeld et al. 2021).

However, proposals for treating risks should be developed before in the scope of demand planning and supply planning (Bower 2012, 2018; Kelleher 2012; Hobby and Jaeger 2013; Singh and Lee 2013; Baker 2021; Seeling et al. 2021b, 2022). All experts validate this structure. Accordingly, sales and marketing and operations departments should develop risk treatment proposals, which are then reviewed and decided upon during the pre-meeting or executive meeting. This is necessary, as decision-makers, particularly in the executive meeting, typically do not have the detailed knowledge to develop proposals (Experts 10 and 12). Expert 2 reveals: “Proposals must be developed in demand planning and supply planning. I have had cases where this did not happen in advance, and then it was said during the executive meeting: ‘We cannot decide now. We need more information.’”

One exception would be the treatment of risks that do not have a cross-functional or strategic impact. Accordingly, risks with effects on one functional unit only can already be decided in corresponding S&OP process steps, e.g., demand-related risks in demand planning and manufacturing-related and supply-related risks in supply planning (Experts 3, 5, 12, 14). Expert 5: “I have to decide what I can decide at my level. And everything that exceeds my competence or that can have a too big business

impact, I have to ‘transport’ to the next step.” However, this can only work if it fits with organisational characteristics regarding autonomy and hierarchy issues.

Finance should have an important role here as the execution of risk treatment strategies need to be in line with the overall budget and, thus, can have an impact on a firm’s profit, highlighted in the literature (Bower 2018; Dunn 2019; Baker 2021; Seeling et al. 2021b, 2022) as well as in the interviews (Experts 2, 5, 6, 7, 8, 9, 10, 11, 15). For this, finance must attend the pre-meeting and executive meeting, where final decisions on risk treatment are made. They can also be invited by sales and marketing departments in demand planning and by operations departments in supply planning to discuss and propose appropriate risk treatment strategies. Additionally, key customers and suppliers could be invited to collaborate on treating risks (Dreyer et al. 2018). Other information systems besides the regular ones are not necessarily required. However, as an effective risk treatment is highly dependent on correct risk assessments, scenario planning and analyses have a strong indirect role in risk treatment.

In synthesis, S&OP should be adapted towards the integration of risk treatment. Risk treatment proposals should be developed in demand planning and supply planning for risks with a cross-functional or strategic impact. In contrast, final decisions are made in the pre-meeting and the executive meeting. Finance representatives should attend these meetings. For risks with only functional-specific effects, decisions on how to treat risks can be made immediately in the demand planning and supply planning steps by sales and marketing or operations, respectively. The utilisation of additional information systems besides the regular ones and the ones capable of running scenario analyses is not required.

#### 4.4 Risk monitoring

The two tasks of risk monitoring (continuously tracking and reviewing supply chain risks and the success of risk treatment decisions) should be integrated into S&OP. Nevertheless, the literature is quite unclear regarding how to operationalise this integration. For instance, several authors emphasise its general need but do not provide further details (Lapide 2005; Baumann 2010; Schlegel and Murray 2010; Bower 2012; Covas 2016; Pedroso et al. 2016; Ávila et al. 2019; Macon 2020; Almeida and Conceicao 2021; Gallego-Garcia and Garcia-Garcia 2021; Seeling et al. 2021a; Hainey 2022; Lapide 2022; Tchokogué et al. 2022). In general, two approaches, which can be conducted both alternatively or complementary, can be observed from the literature findings and the expert responses.

First, an adaptation of the regular S&OP is possible, particularly suitable for those risks for which monthly monitoring is sufficient. In this regard, risk monitoring can be integrated into each step of the S&OP process, but with different foci. Accordingly, monitoring of risks and treatment strategies associated with demand can be conducted in demand planning (Oliva and Watson 2011; Kelleher 2012; Hulthén et al. 2016; Dittfeld et al. 2021; Temkin 2022) and with manufacturing and supply in supply planning (Burrows III 2007; Milliken 2011; Bower 2012; Hulthén et al. 2016; Bower 2018; Temkin 2022). Cross-functional risks or highly impactful risks can and should also be monitored in the pre-meeting



(Alexander 2013, 2016; Sinha 2015; Hulthén et al. 2016; Krishnan 2020) and in the executive meeting (Sinha 2015; Covas 2016; Hulthén et al. 2016; Stentoft et al. 2021). The regular S&OP actors are considered sufficient for this SCRM activity. All experts validate these findings.

For monitoring risks within an adaptation of the regular S&OP, a dashboard can provide valuable support: “Dashboards are often retrospective or show the status of today and the last 24 months, for example. But I need a view in the dashboard that is more predictive”, as stated by Expert 9 and also proposed by Expert 15. This highlights the need to enrich the regularly used traditional dashboard with metrics directly associated with risks and the effect of risk treatment decisions. These metrics can be linked to general risks, which a firm in an uncertain environment regularly faces (Experts 2, 9, 11, 12, 14). Here, external risks are particularly suitable, such as those associated with macroeconomic developments (Expert 2), price changes of key resources (Expert 3), or air and sea traffic data (Expert 12). Additionally, the dashboard could be designed flexibly so that specific risks are displayed and reviewed only in extreme situations (Experts 1, 5, 8, 9, 10, 12). For example, Covid-19 incidence rates could have been monitored during the pandemic, but are not necessary to further monitor afterwards. Continuous risk monitoring through a dashboard can provide current status updates and transparency among all actors (Experts 5 and 8).

Second, an adaptation can also be made by implementing an additional process parallel to the regular S&OP to ensure a close linkage between S&OP and operational planning and execution (Experts 2, 3, 5, 8, 15). This applies to those risks which need to be monitored more often than monthly. This additional process can be essential when firms are facing extreme situations or a very high degree of uncertainty in the business environment in general (Expert 14), e.g., when operating in highly competitive and innovative markets (Experts 1, 2, 5, 12). This additional process distinguishes from the regular S&OP in two ways: First, its planning horizon is lower, with a maximum of three months. Second, its planning frequency is higher with bi-weekly, weekly, or even daily meetings (e.g., Kaipia et al. 2017; Bagni et al. 2022). This is necessary when “things happen during the month, but you must act immediately” (Expert 4). The additional process, sometimes only conducted through one meeting and attended by actors from the regular S&OP and from people more associated with operational planning and execution, is then used for monitoring risks, but can also be used for treating risks if decisions are made (Expert 1). Information is exchanged frequently between this additional process and the regular S&OP. This additional process is mainly considered valuable for firms producing and offering fast-moving consumer goods (FMCG) with high volumes and low lead times, as revealed by Kaipia et al. (2017) and Bagni et al. (2022) in the literature and by Experts 5, 6, 7, 8, 12, 14, and 15. In contrast, it is unlikely to provide the same value in industries such as mechanical engineering (Expert 5), pharmaceuticals (Experts 6 and 11), or steel (Experts 3 and 12), where typically, a monthly or quarterly risk monitoring is sufficient.

For both options (an adaptation of the regular S&OP and an adaptation through the implementation of an additional process), early warning signalling is high-

lighted as a promising and vital IT functionality, although still not in place in many firms (Kelleher 2012; Bower 2018; Dittfeld et al. 2021; Hainey 2022; Lapidé 2022 and Experts 1, 2, 4, 5, 7, 8, 9, 12, 14, 15). Accordingly, many firms still follow a reactive approach in S&OP (Expert 11), where early warning signalling can contribute to switching to a purely proactive S&OP, which should be its objective (Experts 9, 14, 15). Expert 9 explains this through an example of likely supply problems in the future: “If I can already anticipate today that I might have to put employees on short-time work in eight weeks because I can no longer produce, then I can already think about how I can cushion this very early. [...] If I know all this eight weeks in advance, I have a much wider radius of decision-making possibilities.” Such early warning signalling can only work if the firm can gather the right data and information, ideally in real-time (Experts 1, 7, 8, 15).

In synthesis, S&OP should be adapted towards the integration of risk monitoring. Risk monitoring and the additional functionality of early warning signalling allow a proactive SCRM within S&OP. One option for the integration is to adapt the regular S&OP by conducting risk monitoring in any of the steps by the regular actors and by enriched and flexibly designed dashboard. Another option is to implement an additional process to achieve a closer linkage with operational planning and execution. This additional process is considered particularly relevant for firms operating in an FMCG context and requires the involvement of other actors and sophisticated information processing capabilities.

## 5 S&OP framework for uncertain environments

After synthesising the knowledge fragments identified in the literature and validating and refining them through interviews with experts, findings have been analysed, leading to an S&OP framework depicted in Fig. 4. It shows how S&OP needs to be adapted for dealing with uncertain environments by integrating SCRM activities. It embraces an additional process conducted in parallel, characterised by a higher planning frequency and a lower planning horizon, and suggested for high degrees of uncertainty in the business environment. The framework is developed through the lens of contingency theory (Donaldson 2001) due to the context-specific nature of S&OP (Kristensen and Jonsson 2018; Kreuter et al. 2022) and from an integrated people-process-IT perspective (Kreuter et al. 2021). The most prominent context analysed in literature and interviews regarded medium- to large-sized manufacturing firms facing uncertain business environments. Therefore, the framework is particularly relevant for firms operating in this context.

This research’s findings provide theoretical and practical contributions, presented next.

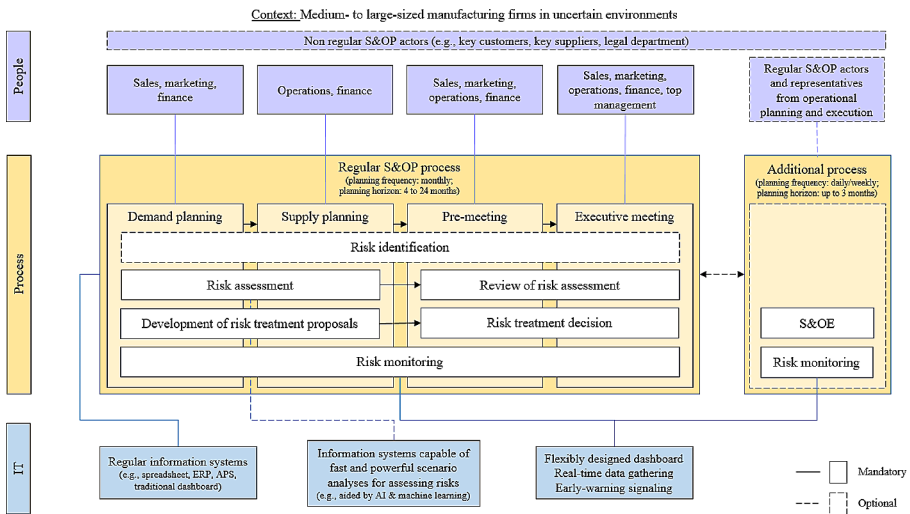


Fig. 4 S&OP framework for uncertain environments

### 5.1 Theoretical contributions

This research builds upon and extends the work of Dittfeld et al. (2021), which applied contingency theory as a theoretical foundation. It broadens the topic by investigating it through the contingencies of industry, firm size, and manufacturing strategy. Moreover, the research goes beyond the process perspective by also embracing people and IT.

According to the context, the findings highlight that the industry can affect S&OP, corroborating the studies of Ivert et al. (2015), Kaipia et al. (2017), Dreyer et al. (2018), Kristensen and Jonsson (2018), and Kreuter et al. (2021). In this research, it is reflected through the SCRM activity of risk monitoring and the implementation of an additional process, which triggers the need for adapting S&OP in specific industries. Furthermore, firm size can be considered another contingency affecting S&OP. Accordingly, medium-sized firms often have a leaner structure but fewer human, financial, and technical resources, which is why risk identification can be suitable to be integrated into the S&OP of these firms. Larger firms, in contrast, should have a dedicated unit for identifying risks that may be placed outside S&OP. As such, this research contributes to the literature as studies on the effect of the firm size on S&OP are still scarce, and their impact on S&OP is still not proven (Kristensen and Jonsson 2018; Kreuter et al. 2022). Lastly, the findings of this research do not indicate any effect of the manufacturing strategy on if and how S&OP should be adapted for dealing with uncertain environments. Literature-wise, this could be explained by the lack of S&OP studies in engineer-to-order contexts (Romão et al. 2021; Bhalla et al. 2022; Kreuter et al. 2022). However, also the experts have not revealed that the integration of SCRM activities into S&OP should be approached differently regarding the manufacturing strategy. Expert 15, for instance, highlights that cer-

tain activities could be conducted differently or could be more time-consuming in an engineer-to-order than in a make-to-stock context. However, more generally, the results would not differ, e.g., risk assessment and risk treatment should be essential steps within S&OP independent of the exact manufacturing strategy.

Furthermore, the research confirms the importance of having a holistic and integrated view when developing an adapted and contextualised S&OP. The results show that literature fragments mainly focus on adaptations from a process perspective. However, also considering the involved actors and the used information systems is essential for operationalising the adaptation. Accordingly, a few studies and almost all experts highlight the need to involve finance when assessing and treating risks. Moreover, risk assessment without sophisticated scenario analysis functionalities and risk monitoring without the possibility of gathering (real-time) data, displaying metrics in dashboards, or sending early warning signals is considered less valuable or even impossible. A pure process perspective would have ignored the implications about involved actors and required information systems, potentially leading into a less effective integration of SCRM activities into S&OP. This corroborates Kristensen and Jonsson (2018), Jonsson et al. (2021), and Kreuter et al. (2021), who emphasise the need to consider all three dimensions when adapting S&OP. Although specific people- and IT-related suggestions exist, the research reveals that regular actors and information systems should still be involved and used in S&OP dealing with uncertain environments.

## 5.2 Practical contributions

Based on contingency theory and the integrated people-process-IT-perspective, the novel S&OP framework aims to support managers with concrete management interventions by simultaneously considering specific contexts, addressing a research call of Jonsson and Holmström (2016). The framework provides practical guidance on how to adapt S&OP regarding which actors should be involved, how to conduct the S&OP process steps, and what information systems and functionalities are required. First, it can be implied that data gathering is no longer considered an appropriate process step, which aligns with several recent studies, e.g. Kreuter et al. (2021) and Seeling et al. (2021b). Second, the results show that an S&OP adaptation is required to integrate the risk assessment and risk treatment activities. Accordingly, risks should be assessed in demand planning and supply planning and further reviewed in the pre-meeting and executive meetings. The risk assessment should be made by sales, marketing, operations, and finance through technological aid in the form of fast and powerful scenario analyses. Furthermore, risks can be treated in demand planning, supply planning, pre-meeting, and executive meeting, dependent on the scope and impact of risks. For cross-functional and critical risks, treatment proposals should be developed in demand planning and supply planning, and final decisions should be made in the pre-meeting and executive meetings. Finance should be involved when treating risks. Risk identification is an SCRM activity that can, but does not have to be integrated into S&OP, as stated by Expert 5: “I don’t think there is a right or wrong.” Larger organisations should have a dedicated unit that focuses on iden-

tifying risks and providing them as input to S&OP. Medium-sized organisations with fewer resources and capacities and a leaner process can integrate risk identification as an explicit activity into each of the four regular S&OP steps. Similarly, risk monitoring is an activity that can be integrated into the regular S&OP and through an additional process. The additional process is particularly valuable for firms offering FMCG goods in high volumes and low lead times.

Proposing an additional process, which can and should be conducted parallel to the regular process, is a novel contribution to S&OP research. Up to now, academic and grey literature is still scarce on this topic. In the study of Bagni et al. (2022), a so-called parallel S&OP process with a higher planning frequency and a lower planning horizon is suggested for new product introductions. This research confirms this possibility but extends it by proposing to apply such a process also for established products when firms are dealing with high degrees of uncertainty in the business environment and facing extreme crises. As such, this additional process can be used for monitoring risks more frequently (e.g., on a weekly or even daily basis). A higher risk monitoring frequency can eventually lead to earlier anticipations of changes in the environment and consequently lead to faster and more effective risk treatment-related decision-making. As such, this additional process, sometimes associated with “sales and operations execution” (S&OE; e.g., Hailey 2022), can contribute to a “resilience-building S&OP” (Jonsson et al. 2021).

## 6 Conclusion

This paper introduces a novel S&OP framework for dealing with uncertain environments. It integrates SCRM activities into S&OP, applying contingency theory as a theoretical foundation to embrace the context-specific nature of S&OP and its adaptations. Moreover, the framework embraces a holistic view of S&OP encompassing the involved actors (people), the process and its steps (process), and the used information systems and functionalities (IT). To develop this framework, a two-step research approach was conducted. An SLR was required due to a highly fragmented literature base on the topic. The synthesis led to an advanced understanding of the current research state-of-the-art and was complemented through interviews with 15 experts for validation and refinement. The interviews extended the findings by providing valuable insights on contingencies and their effects on an S&OP adaptation and the role of different actors and information systems.

The research findings reveal that risk assessment and treatment should be integrated into the S&OP process. The involvement of finance as a relevant actor in the process and the utilisation of information systems capable of performing scenario analysis are required to do this effectively. Risk identification can, but does not necessarily need to be integrated into the S&OP process. Similarly, risk monitoring can be integrated into the regular S&OP process. Still, it can also be conducted through an additional process step parallel with the regular S&OP process but with a higher planning frequency and a lower planning horizon. This

results in a closer linkage with operational planning and execution that may cope better in today's uncertain business environments than the regular S&OP process and is a new and promising finding for S&OP research and practice. IT plays an essential role in monitoring risks properly due to its possibilities of gathering a high amount of internal and external data on a real-time basis, calculating and visualising risk-related metrics on a dashboard, and sending early warning signals to relevant actors. The industry and the firm size can affect how this integration is operationalised.

This research comes with limitations, simultaneously opening interesting research streams for future investigations. First, the contingencies of industry, firm size, and manufacturing strategy have been investigated, whereas others may also be considered. For instance, some experts reveal a potential effect of hierarchy and autonomy within an organisation. Consequently, investigating this topic by considering specific organisational characteristics (e.g., the role and involvement of top management) as another contingency could lead to interesting results. Additionally, the S&OP literature has mostly been focused on medium- to large-sized firms, which shaped the proposed framework of this study. Research on small-sized firms should also be an important front for future research, as their reality is different. This can bring further insights for academics and practitioners in adapting S&OP to uncertain environments. Second, the framework can further be applied empirically. Future research should deal with real-life settings and investigate if and how firms have already adapted their S&OP towards an SCRM integration. An in-depth single case study or a multiple case study with firms of different sizes and from various industries could provide interesting findings. In this regard, it could also be valuable to involve SCRM representatives. Third, this research presents the possibility of implementing an additional process associated with S&OP but does not provide further guidance. Future research should focus on such an additional process with a higher planning frequency and a lower planning horizon and its linkage with S&OP. This is a promising research avenue for a resilience-building S&OP and can be associated with risk monitoring to send early warnings and with risk treatment to enable early actions through S&OE. Finally, the people-process-IT perspective can support the investigations within each proposed research stream and could be further developed through an enterprise architecture approach.

Building upon the research findings and suggested streams for future research provided in this paper, Table 2 offers possibilities for propositions and exemplary research questions that could aid academics to build the next S&OP generation. The intention herein is not to be exhaustive, but to provide an outlook with promising avenues that can be followed by academics towards advancing scientific knowledge in applying S&OP in uncertain environments. One may notice that propositions and research questions are not exclusive to one single research stream.

**Table 2** Propositions and exemplary research questions for future research

Research stream	Research proposition	Exemplary research question(s)
Explore the effect of contingencies	Medium- to large-sized manufacturing firms should adapt their S&OP towards implementing SCRM activities from a people-process-IT perspective to deal with the current challenges associated with the growing number of significant and unexpected changes in the business environment.	<ul style="list-style-type: none"> <li>• Can small-sized manufacturing firms equally benefit from integrating SCRM activities into S&amp;OP as medium- to large-sized manufacturing firms?</li> <li>• Could this integration be applied to firms from the service industry?</li> </ul>
Apply the S&OP framework for uncertain environments	To deal with uncertain environments, S&OP should involve additional actors beyond the regular ones and should be enriched through a parallel process characterised by a higher planning frequency and a lower planning horizon to enable a resilience-building S&OP.	<ul style="list-style-type: none"> <li>• Can the proposed S&amp;OP framework for uncertain environments be generalised to consider specificities of the service industry?</li> <li>• Which challenges firms need to overcome to adapt their S&amp;OP towards an integration of SCRM activities?</li> </ul>
Implement an additional process to support risk monitoring	Risk monitoring should be conducted frequently enabling a weekly or even daily review to develop early warnings in uncertain environments.	<ul style="list-style-type: none"> <li>• How can risk monitoring be integrated into S&amp;OP from a people-process-IT perspective?</li> </ul>
Implement an additional process to support risk treatment	The integration of S&OP towards operational planning and execution through practices such as S&OE is essential to deal with uncertain environments to go beyond early warnings by embracing early actions.	<ul style="list-style-type: none"> <li>• How should firms implement S&amp;OE from a people-process-IT perspective?</li> <li>• Does S&amp;OE have a context-specific nature and, if so, how do contingencies affect S&amp;OE?</li> </ul>

## Appendix

**Table 3** Background on the experts

Expert	S&OP working position	Years of S&OP experience	S&OP experience		Interview	
			Sector (industry)	Geographical scope	Approach	Length
1	S&OP manager	34	<ul style="list-style-type: none"> <li>• Consumer discretionary (auto components; household appliances)</li> <li>• Consumer staples (beverages; food products; tobacco; household products)</li> <li>• Industrials (trading companies &amp; distributors)</li> </ul>	Argentina; Brazil; Canada; Columbia; Mexico; Puerto Rico; US; Global	Remote (Zoom)	2:07 h
2	S&OP manager	6	<ul style="list-style-type: none"> <li>• Utilities (electric utilities; independent power &amp; renewable electricity producers)</li> </ul>	Germany	Remote (phone)	1:04 h
3	S&OP manager	4	<ul style="list-style-type: none"> <li>• Consumer discretionary (distributors)</li> </ul>	Canada; Germany; US	In-person	1:21 h
4	S&OP manager	5	<ul style="list-style-type: none"> <li>• Industrials (machinery)</li> </ul>	China; Europe; US	Remote (Zoom)	0:46 h
5	S&OP manager	13	<ul style="list-style-type: none"> <li>• Consumer discretionary (auto components)</li> <li>• Industrials (machinery)</li> </ul>	Global	Remote (MS Teams)	1:10 h
6	S&OP manager	3	<ul style="list-style-type: none"> <li>• Health care (pharmaceuticals)</li> </ul>	Denmark	Remote (Zoom)	0:52 h
7	S&OP manager; S&OP consultant	25	<ul style="list-style-type: none"> <li>• Communication services (telecommunication services)</li> <li>• Consumer discretionary (auto components; household durables)</li> <li>• Consumer staples (beverages; food products; household products)</li> <li>• Health care (pharmaceuticals)</li> <li>• Industrials (trading companies &amp; distributors)</li> </ul>	Argentina; Brazil; Mexico, US	Remote (Zoom)	1:14 h
8	S&OP consultant	3	<ul style="list-style-type: none"> <li>• Consumer staples (food products)</li> </ul>	Finland; Germany	Remote (Zoom)	1:06 h
9	S&OP manager	13	<ul style="list-style-type: none"> <li>• Consumer discretionary (household durables)</li> <li>• Consumer staples (food products)</li> <li>• Health care (health care equipment &amp; supplies)</li> <li>• Materials (chemicals)</li> </ul>	Europe; Global	Remote (Zoom)	1:16 h
10	S&OP manager	10	<ul style="list-style-type: none"> <li>• Consumer staples (food products)</li> </ul>	Global	Remote (MS Teams)	0:55 h
11	S&OP manager	8	<ul style="list-style-type: none"> <li>• Health care (biotechnology; pharmaceuticals)</li> </ul>	Global	In-person	0:49 h



**Table 3** Background on the experts

Expert	S&OP working position	Years of S&OP experience	S&OP experience		Interview	
			Sector (industry)	Geographical scope	Approach	Length
12	S&OP manager	8	• Health care (biotechnology)	Global	In-person	1:19 h
13	S&OP manager	4	• Consumer discretionary (auto components)	Asia; Europe; North America; South America	Remote (Zoom)	1:09 h
14	S&OP consultant	19	• Consumer staples (beverages; food products)	Global	Remote (Zoom)	0:48 h
15	S&OP manager	18	• Consumer discretionary (distributors) • Industrial (machinery)	Global	Remote (MS Teams)	1:03 h

**Table 4** Interview Questionnaire

Openings	Introduction of the interviewer and the interviewee; overview of the research scope; introduction of the regular S&OP process steps and four SCRM activities; assurance of confidentiality
Demographic data	Years of experience in S&OP; industry sectors and regions/countries of experience as S&OP manager or S&OP consultant
General question	Which are the main uncertainty and risk sources that affect each S&OP step? Please, comment on your answer.
Specific questions for each SCRM activity	<ul style="list-style-type: none"> <li>• Please, let me know if [SCRM activity] should take place in the S&amp;OP process or another process of the organisation. Justify your answer.</li> <li>• If yes:</li> <li>• Where in the S&amp;OP process should it occur?</li> <li>• By whom?</li> <li>• Aided by which specific IT systems?</li> </ul>
Additional question	How does the industry, firm size, or manufacturing strategy affect how the conduction of SCRM activities within S&OP?
Closing questions	<p>Is there anything relevant that should be considered in the research that was left out or not completely covered?</p> <p>Could you recommend anyone experienced in the topic that could be reached in this panel?</p>
Additional unplanned / floating points	Could you tell me more about that? / explain in more detail? / provide more examples?

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## Declarations

**Conflict of interest** The authors have no competing interests to declare that are relevant to the content of this article.

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