Guest editorial: The future of S&OP: dynamic complexity, ecosystems and resilience

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1. Sales and operations planning: an introduction

The role of sales and operations planning (S&OP) is widely acknowledged to be a key business process for balancing supply capabilities with demand (Tuomikangas and Kaipia, 2014) and a common practice in manufacturing companies across most, if not all industry sectors (Kreuter *et al.*, 2021a; Lapide, 2002, 2005, 2007; Olhager *et al.*, 2001). Its focus and purpose are "the matching of supply and demand in the medium term by providing a process for the vertical alignment of business strategy and operational planning and execution, and for the horizontal alignment of demand and supply plans" (Grimson and Pyke, 2007; Feng *et al.*, 2010; Wagner *et al.*, 2014; Wallace and Stahl, 2008). Maintaining this position is however challenged by the need to connect planning to daily supply chain execution and to respond to the sudden and vast changes in the planning environment, combined with huge advancement leaps in technology, enabling the capture of multiple and disparate sources of data and rapid processing of knowledge from these changes.

The current, albeit somewhat scarce, literature on S&OP has emphasized the process design and conduct (Baker, 2019; Boyer, 2009), formalities of the process (Baker, 2019; Swaim *et al.*, 2016) and the coordination strength of the process (Goh and Eldridge, 2019; Tuomikangas and Kaipia, 2014). In general, the academic literature around the topic is well-focused but at the same time limited in volume, especially empirically (Kristensen and Jonsson, 2018). Literature reviews of the topic exist, taking for example the viewpoint of contextualization (Kristensen and Jonsson, 2018), coordination (Tuomikangas and Kaipia, 2014), integration (Noroozi and Wikner, 2017), maturity frameworks (Danese *et al.*, 2017), performance outcome (Thomé *et al.*, 2012) and theory-foundation of S&OP (Kreuter *et al.*, 2021a). These reviews are univocal in their findings about the overall scarcity of academic research on S&OP, thus indicating a need for high-quality research to advance the field.

Here, we consider the current state of S&OP and new emerging challenges and requirements for the process. We then summarize the contributions of five papers included in the special issue that all focus on specific contextual issues related to the implementation of S&OP. We then, based on the current and changing conditions and environments for S&OP, elaborate on an extended S&OP response that considers the focus of coordination for S&OP and the dynamic complexity of environmental contingencies that will likely drive the design and performance of a resilience-building S&OP process.

2. Current state of S&OP

Despite of the apparent simplicity of the S&OP process, companies are struggling in realizing the promised benefits out of the process in practice (Kreuter *et al.*, 2021a; Kristensen and Jonsson, 2018). One reason is the need to adapt and design the S&OP process to fit a company's unique context (Kaipia *et al.*, 2017; Kreuter *et al.*, 2021b). The context can affect the design and performance of S&OP (Kristensen and Jonsson, 2018), and moreover, incorporate a supply chain view, including customers, suppliers and other service providers to the process. Many companies report limited success in proceeding to advanced S&OP levels, which may raise concerns about the suitability of the process to its context (Kaipia *et al.*, 2017; Kreuter *et al.*, 2021b) or claiming the capabilities of the process not fully employed

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(Wilson and Raman, 2017). Before, however, anyone can write off S&OP, it is justified to ask if there are other previously unconsidered drivers for extending the S&OP response, to guide companies to realize the benefits from being able to orchestrate/balance supply and demand?

The S&OP evolution has been described through maturity models (e.g. Gartner, 2010; Grimson and Pyke, 2007; Lapide, 2005), with inflection points representing stable S&OP configurations on different levels of maturities. Various forms of organizational and technology barriers and requirements constrain the transition from these points to higher maturities (e.g. Danese *et al.*, 2017). One such inflection point is where the demand and supply sides of the organization become committed to the process, and where the process contributes to integrating demand and supply goals and volume plans, resulting in a coordinated supply chain that is planned and executed in a synchronized way. The development from this point can take different routes, including extending the financial perspective toward providing demand-driven profitable responses and driving the financial planning, and strengthening the corporate strategy and supply chain perspective by developing into facilitating proactive scenario-driven business planning. After its existence for over 30 years, S&OP appears to have reached yet another inflection point, due to rapidly shifting demographics, advances in technology, proliferation of data, constant and instant connection of people and things, and the interdependencies between them and the sheer brute force of computational power. This inflection point has been further driven by the need for more efficient risk management, creating more resilient supply chains because of the ever-growing complexity of global supply chains (Joglekar and Phadnis, 2021; Kahiluoto *et al.*, 2020), and new environmental factors such as frequent global crises, described as black swans (Taleb, 2007), all of which have severely disrupted the flow of products across many industry sectors on a global basis (Kahiluoto *et al.*, 2020). In view of this, there are growing calls of the need to rethink forecasting and supply chain planning in this dramatically different new context (Kahiluoto *et al.*, 2020; Turner, 2018). These advances present a conundrum because they promise the means to draw on all available data, thus providing an unprecedented predictive capability, while at the same time amplifying the nonlinearity in the conditions the predictions are trying to tame.

2.1 The conditions and changing environment for S&OP

There are a multitude of environmental factors that companies need addressing to drive the success of their S&OP processes, which can be broadly categorized as internal and externally derived. Given the nature of the internal conditions, there is still much uncertainty about understanding the role and purpose of S&OP.

2.1.1 Internal drivers. Various internally related drivers, in the form of barriers and enablers discussed in the literature, have contributed to the current rather than disappointing performance derived from implementations of S&OP. They include having clear vision and objectives, i.e. pursuing cost reduction at the expense of risk reduction (Wilson and Raman, 2017), suggesting low commitment to the output of the S&OP process, or a belief that the process provides successful outcomes (Wilson and Raman, 2017). Another is a lack of alignment across the firm, not involving, e.g. customer service in the process (Jain, 2019), gaps at the strategic level not in favor in building internal trust or collaboration and failing to recognize that the firm's suppliers are not actual competitors (Lapide, 2007, 2019). This misalignment may be accelerated by the metrics that are used to drive the process and measure the results (Cecere, 2015; Wilson and Raman, 2017), resulting in a lack of organizational alignment. A further factor is the misplaced translation, from not using one number and instead translating the agreed number for functional purposes (Wilson and Raman, 2017), to how the planning is translated for operational execution as opposed to go-to market execution (Cecere, 2015; Wilson and Raman, 2017). One factor is the lack of

commitment to understanding and investigating deviations in previous plans, leading to increased uncertainty, and likely repeating previous mistakes (Wilson and Raman, 2017).

In S&OP designs, the process and organization focus of S&OP has been dominant, while technology aspects have been presented as enablers in more mature S&OP phases (e.g. Danese *et al.*, 2017; Schlegel *et al.*, 2021; Ivert and Jonsson, 2014). Limited technology support is a barrier in several companies, but it is especially difficult to fit the level of technology support to the level of process and organization maturity of the S&OP process. Moreover, setting up and running the S&OP implementation projects may be difficult and a potential barrier for S&OP success (Pedroso *et al.*, 2016). The implementation process easily becomes work intensive, stretching over long time periods, with multiple revisions and delays.

Further, S&OP is not designed to be an adaptive business process, thus failing to reflect that the operating environment is under continuous change (Turner, 2018; Wilson and Raman, 2017), and suggesting that the firms' capabilities were designed for situations when there was greater industrial and societal stability (Turner, 2018). Lastly, translating S&OP into supply chain execution to meet demand remains a significant factor (Danese *et al.*, 2017).

2.1.2 External drivers. The planning environment for S&OP has been impacted by a growing number of externally derived factors, including globalization, environmental complexity and supply and demand volatility, and global or local crises with a global impact, as well as the advancements in information processing technologies. Supply chains remain global in their scope and predominantly cost-focused, meaning that efficiencies and cost reduction are aggressively pursued, creating lean but relatively fragile supply chain processes (Clark, 2020; Pilling *et al.*, 2021). There is also growing recognition that supply chains are actually complex systems (Azadegan and Dooley, 2021; Cecere, 2015; Sharma *et al.*, 2020; Wilson and Raman, 2017). Related to this, there are unprecedented levels of volatility created by supply chain connectiveness enabled by new technologies and new competition on a global basis (Cecere, 2015; Wilson and Raman, 2017). Such volatility also manifests itself in the market, caused by, for example, the "Amazon Effect", where consumers were switching their buying habits from in-store to online (Charm *et al.*, 2020; Wilson and Raman, 2017).

Examples of large externally derived drivers in the early 2020s have come from the simultaneous shocks caused by the combination of tariffs and trade wars, Brexit, the COVID-19 pandemic and local disruptions with global impact such as the Suez Canal blockage in March 2021 (Leonard, 2021a, b, c). The trade war between the US and China created tariffs that impacted the availability of supply capacity, which was further impacted by the prolonged Brexit negotiations (Handfield *et al.*, 2020; Moradlou, *et al.*, 2021). The COVID-19 pandemic was not just a health crisis but also generally a supply chain crisis, with huge global impacts (Dolgui and Ivanov, 2021; Harland, 2021; Joglekar and Phadnis, 2021; Singh *et al.*, 2021; Sodhi and Tang, 2021), including sudden changes in consumer buying habits, production delays and backlogs in industry, and causing simultaneously capacity shortages and slack capacity in global supply chains. Shipping of goods was prohibited or disturbed by closed country borders, limited availability of transport capacity and backlogs along the supply chain. During these rapid and huge changes, companies had to totally rearrange their planning processes, switch to agile and adaptive way of responding to changes and adopt more manual and hands-on planning, and quickly adopt new ways of capturing accurate information and using it in their responses to supply and demand changes.

The last external factor is the major technological advancement, often called revolution, in data processing and management, enabled by leaps in computing power (Kitchin, 2014). This development offers improved connectivity, the availability of data and the ability to extract, combine, process and communicate it (e.g. Xu *et al.*, 2021). Analytics can provide

a real time view to occurrences along the supply chain or an accurate prediction of the future by combining data from various databases (Sanders, 2016; Schlegel *et al.*, 2021). Adoption of new technologies, for example in forms of the use of digital technologies, such as the cloud computing, big data, artificial intelligence or blockchain technology, offers opportunities for building up more intelligent planning processes, for example, in terms of risk management and resilience (Ivanov *et al.*, 2019), decentralized planning and execution (Holmström *et al.*, 2019), and integrated advanced planning and scheduling (Stadtler *et al.*, 2015).

3. Emerging S&OP practices to deal with the changed planning environment

The purpose of this special issue is to provide a current perspective on the challenges that organizations face when implementing S&OP and to highlight some emerging S&OP practices. The more volatile planning environment with more frequently occurring crises brings forward the need to adapt planning processes accordingly. In this special issue, Kreuter *et al.* (2021b) examine the development and implementation of contextualized S&OP designs through enterprise architecture management (EAM). The value of the study is in demonstrating the context-specific S&OP challenges and S&OP design's contextual fit from a static contingency theory view. The EAM framework guides the development and implementation of a contextually adjusted design toward increased S&OP effectiveness. In addition to being complex, the planning environment has become dynamic and volatile.

In the world of increasing risks, knowing the serious consequences of those, the paper of Dittfeld *et al.* (2021) titled "Proactively and reactively managing risks through sales and operations planning" takes the viewpoint of risk management. The multiple case study drills in the S&OP processes of seven organizations in the process industry, drawing on in-depth interviews. The findings highlight the proactive nature of risk-focused S&OP design as a risk management tool. This aspect is highly relevant as risks can easily disrupt the demand-supply match, as we have recently seen.

In response to the high potential and advancement of data analytics, Schlegel *et al.* (2021) in their paper titled "Enabling integrated business planning through big data analytics: a case study on sales and operations planning" highlight how analytics capability increases an organization's information processing capacity and consequently enable efficient and effective S&OP. The paper applies organizational information processing theory to the implementation of S&OP in the organization and studies how an advanced analytics tool, incorporated in S&OP, improved the information processing capacity required to fit with information processing requirements driven by S&OP implementation-related uncertainty and equivocality, cross-functionality-related uncertainty and equivocality, and supply and demand uncertainty.

The data analytics theme is also addressed in another paper of this special issue, titled "On relating big data analytics to supply chain planning: towards a research agenda" by Xu *et al.* (2021), who review the literature on big data analytics in supply chain planning and define roles of analytics for the future of supply chain planning. They discuss how analytics could improve the planning performance through three roles. Big data analytics as supportive facilitator assists and facilitates improvement in supply chain planning process. Big data analytics as source of empowerment enables new processes and capabilities in supply chain planning process. They also discuss how it could play the role of game changer by enabling new ways of planning, for example, with environmental sustainability as objective functions or to balance supply and demand in case of disruptions.

Behavioral aspects have gained limited attention in S&OP research. An attempt to this direction is taken by Stentoft *et al.* (2021) paper of this special issue. Based on their single longitudinal case, the study stresses the need for a better understanding of personalities and

behavioral aspects in S&OP processes. By understanding personalities such as introvert versus extrovert, data collection based on intuition versus sensing, decision-making based on thinking versus feeling, key behavioral indictors (KBIs) are established to align salespersons and operational staff in the S&OP process.

4. A modified S&OP framework to accommodate the dynamic complexity

Over the last twenty years, it becomes clear that S&OP evolves from inside the firm, to spreading across the supply chain (Jonsson and Holmström, 2016). It also becomes apparent that not including external entities into the S&OP process exposes the firm/supply chain to supply disruptions with the subsequent potentially catastrophic consequences.

Ecosystems with access to not only diverse resources and response diversity positively increase the supply chain's resilience. Whereas we may try to limit the number of entities in the supply base, taking the ecosystem perspective may positively increase resilience by including a few additional entities that help to increase response diversity. The requirements on the S&OP from the increasing dynamic complexity manifest themselves in a need of integrating the S&OP process with related planning processes and for S&OP to manage to rebalance demand and supply in a more dynamic way than traditionally. It also changes the way the organization and people need to be involved and interact in the planning. Finally, technology needs to get a more central role in how the process is designed and carried out. Figure 1 summarizes the changed focus of S&OP in response to the changing dynamic complexity requirements.

4.1 Focus of coordination: from organizations to ecosystems

Traditional S&OP design is built around cross-functional collaboration aiming to balance supply and demand within the key functions of the organization, i.e. *thinking inside the box* (Turner, 2018). To effectively orchestrate supply and demand, we must look beyond the company borders to multiple tiers of the supply chain, i.e. *thinking outside the box* (Turner, 2018), if not the entirety of the supply chain itself, and beyond, i.e. *the ecosystem*. Involving suppliers in a feasible way would help with eliminating potential interruption in the supply of raw material or components. Without actively involving suppliers, the execution of the plan is dependent on timely receipt of raw materials and components from our suppliers. Informing suppliers about the planned future purchasing volumes is a step in the right direction and perhaps sufficient in a stable environment. Such an approach limits the S&OP from taking a more of a resilient approach that necessitates including both customers and suppliers.

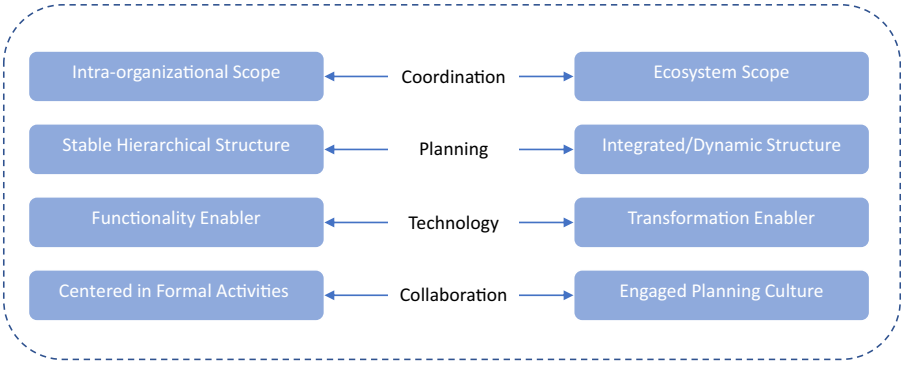

Figure 1.
Changing S&OP focus in dynamic complexity environments

In more dynamic environments, a more collaborative and iterative approach with customers and suppliers is required in the S&OP. The question then becomes how far into the supply chain and downstream do we go? And how do we collaborate?

Certainly, there have been calls for organizations to collaborate with the suppliers and the downstream actors all the way to the end consumer. If we include the entire supply chain, it may be more prudent to view the focus of coordination for S&OP at the entire supply chain level that encompasses not just suppliers and customers but also service providers (3PLs) and beyond. Such extended scope of the process may be most applicable in exceptional situations, such as peaking demand or capturing supply opportunities. Planning with such structural flexibility (Christopher and Holweg, 2017) also puts requirements on an open process design and information technology that enables flexible and decentralized data exchange.

Eventually, we may be able to expand the focus of coordination of the S&OP process to consider the ecosystem (Jacobides *et al.*, 2018) that the supply chain is part of, or embedded within, i.e. thinking in the presence of no box (Turner, 2018). An ecosystem perspective captures new entities (raw material and component suppliers, manufacturers, 3PLs, distributors, retailers and any other service providers) within and across the supply chain. Capturing all the entities should, however, improve performance, for example in improved risk management and mitigation, as well as capturing and utilizing opportunities, thus increasing the overall resilience and profitability of the supply chains.

4.2 Focus of planning: from stable hierarchical to integrated/dynamic planning structure

The formal nature of an S&OP planning process – a set of activities conducted sequentially and in accordance with a strict time plan – originates from its tactical role between the strategic business planning and operational master production scheduling, sales and operations execution and functional plans. The planning process configures a hierarchical structure where higher level plans constitute stable frames for the respective lower-level plans. S&OP is a tactical level process – typically with monthly planning practice. Most short-term supply chain changes, and corresponding needs to rebalance demand and supply plans, are handled in weekly processes such as described in terms of demand control (Bower, 2018), sales and operations execution (S&OE), demand-driven S&OP (Ptak and Smith, 2019) – outside the scope of the S&OP. With the increasing dynamic complexity in the supply chain, we can expect higher frequency of short-term disruptions (e.g. demand peaks or drops, and material shortages) with strategic and long-term impact. S&OP integration with the operational planning and execution (Lapide, 2016) becomes more critical. In global crises situations, like the COVID-19 pandemic, the supply chain uncertainty may require scenario-planning and re-balancing decisions to be taken weekly, daily or even multiple times a day. To be resilient, this will require a much more dynamic way of planning S&OP, where a formal process following a stable hierarchical structure is still followed but where this formal planning is combined with a more iterative, informal and dynamic way of planning – as, e.g. proposed by Schlegel *et al.* (2021) and Dittfeld *et al.* (2021). A dynamic planning structure contributes to resilience but may also have disruptive impact on the formal planning as informal adjustments need to be incorporated. Frequent continuous planning, in the guise of trying to be responsive to market changes, also creates potential supply chain instability with frequent changes (Kaipia *et al.*, 2006). The planning system needs to master the market dynamics while still maintaining planning stability.

4.3 Focus of technology: from functionality enabler to transformation enabler

The adoption of information technologies for the S&OP practice has been limited and been relying on the features of ERP systems, or Excel spreadsheets, specifically at lower S&OP maturity levels (Danese *et al.*, 2017). Existing advanced planning and scheduling (APS) system,

dedicated S&OP software and exchange platforms (Ivert and Jonsson, 2014; Stadtler *et al.*, 2015) contain much of the necessary planning, integration and visualization functionalities to enable the highest levels of S&OP maturities. Jonsson and Holmström (2016) discuss how technology may be an important mechanism to extend the capability and scope of S&OP, and Xu *et al.* (2021) propose advanced analytics as a potential game changer for supply chain planning to widen the planning scope and enable more responsive planning for mid- and long-term planning like S&OP.

More advanced forms of S&OP require the use of advanced information processing technologies, in particular in dynamic complexity situations. Here, the common planning practice should be able to, for example, sense and visualize demand and supply market volatilities, conduct what-if/scenario-based planning based on the use of digital supply chain twins, assess and propose appropriate demand and supply plan responses to disruptions and allow for efficient and dynamic information exchange and integration across functions and processes in the organization and with external entities. The integration needs, both between planning processes on different hierarchical levels, and between entities and processes in terms of efficient handovers, increase when the planning structure becomes more dynamic.

We can also expect that several emerging forms of technology, e.g. artificial intelligence and machine learning for better predictions to drive from unknown uncertainties to known variability, integrated S&OP software in a cloud-based platform and a digital supply chain twin to model and simulate the physical supply chain, will be needed for aligned decision-making in the supply chain. Analytics should provide the process with much richer information and combine data from various sources to intelligent inputs for the process. They may, as Xu *et al.* (2021) propose, transform the way S&OP is carried out for the future of S&OP. Temporary collaboration in the ecosystem may be enabled through open platforms and, e.g. decentralized blockchain-based smart contracts. With advanced forms of technology, it becomes possible to extend S&OP to an ecosystem scope with permanent and temporary actors and to combine formal and informal planning in a dynamic planning structure.

4.4 Focus of collaboration: from a formal activity to engaged planning culture

Many organizations still have not been able to create a mindset of organizational orientation that supports reaching the higher levels of S&OP process maturity (Qi and Ellinger, 2017) or is favorable for successful S&OP implementation. In their paper, Tuomikangas and Kaipia (2014) suggest organization culture being one of the important coordination mechanisms to enhance S&OP performance. The culture creates the positive attitude toward planning. The cultural factors in favor of S&OP success include having clear objectives, commitment throughout the organization to the process itself and to the planning result. Clear governance, management participation, good leadership and training enhance the planning-oriented culture of an organization and are expected to result in commitment and trust, and organizational engagement (Swaim *et al.*, 2016). As such, S&OP offers a forum for discussions between functions to overcome the siloed, departmental operations. When the planning process covers an extended number of interfaces and reaches suppliers and customers, efficient coordination becomes critical.

A planning organization is typically described by roles and teams, and specifically by the meeting practice. The planning organization however builds up from individuals, with various capabilities, skills, behaviors and attitudes. The planning-oriented culture in the company sets directions for the S&OP work that reinforce such behaviors that enhance reaching targets. Here, empowerment and decision-making authority, rewards for good performance and engagement to actively affect and improve the process are drivers or

precursors for a collaborative way of working, which encourage an S&OP team to achieve goals beyond their functional targets (Ambrose *et al.*, 2018). This is becoming even more important when moving toward a more dynamic way of planning. One feature of a dynamic planning culture is including structural flexibility to planning organization, in terms of actors and resources, or organizational plans to set up a task force, to work intensively with the planning, tasks, aimed to be exploited in hard times, as one form of company resiliency.

5. Future practice and research on dynamic complexity and resilience-building S&OP

We conclude that S&OP is at an opportune moment to shine and deliver all its promises. It has the potential to incorporate the planning needs originating from the dynamic complexity of the global supply chain, the need for building resilient supply chains and companies involved in them, and the adoption of digital-related technologies and the ecosystems that a supply chain exists within and is impacted by. Current S&OP designs, however, need to be developed from static and formal planning processes toward resilience-building S&OP. The proactive nature and tactical planning level are however still the core of S&OP. Also, in resilience-building S&OP, the purpose of S&OP is to generate *a plan,* i.e. give contingent directions and guide actions for various parts of the organizations. Therefore, the process needs to be equipped with capabilities to adapt to changing conditions. First, capability is connected to adjusting the S&OP design parameters, e.g. planning object, planning horizon and planning frequency (e.g. Wallace and Stahl, 2008) to respond the planning needs. Second, capability is to move to a short-term or event-driven parallel planning process, i.e. where critical planning objects are separated to a more accurate process for the most challenging time, for example in a supply disruption. Last, S&OP needs to be designed for reaching the set targets by developing a gap identification capability, to enable initiating gap closing activities.

This special issue contains five papers on topics related to resilience-building S&OP and gives interesting yet not comprehensive, insights related to the topic. Figure 2 summarizes characteristics of resilience-building S&OP where new technology and an adapted planning organization enable dynamic S&OP planning with an ecosystem scope. The segments illustrate mechanism areas contributing to generate resilience-building S&OP. The segment terms are not conclusive but give a direction of the respective segment content. Consequently, all segments and their interactions represent potential areas for future research on the transition to resilience-building S&OP.

The organizing for S&OP becomes essential in advanced forms of S&OP, in high maturity stages, and the development into the higher maturity levels becomes more difficult as it requires managing multiple S&OP dimensions simultaneously (Danese *et al.*, 2017). Resilience-building S&OP extends the most advanced stages of S&OP maturity. In accordance with Danese *et al.* (2017), we, consequently, expect that developing into resilience-building S&OP requires working with all dimensions of Figure 2. This concerns the content and design of dimensions, as well as how they contribute to generate resilience-building S&OP. For example, how could an adaptive planning organization, with a collaborative culture and an ecosystem perspective provide generative mechanisms for resilience-building S&OP?

The transition toward resilience-building S&OP is also a relevant area for future research. One question deserving further attention is "what does it mean to take different development paths in S&OP design?" This means, e.g. following a supply chain integration path from intra- to inter-organizational integration (Flynn *et al.*, 2010), suggesting that S&OP not only affects the resilience of a single firm but also the supply chain and even the ecosystem. Resilience-building S&OP is a response to manage the demand and supply orchestration in a dynamically complex context. The S&OP literature is clear about that there is not one generic S&OP configuration that fits all companies and contexts (Kristensen and Jonsson, 2018;

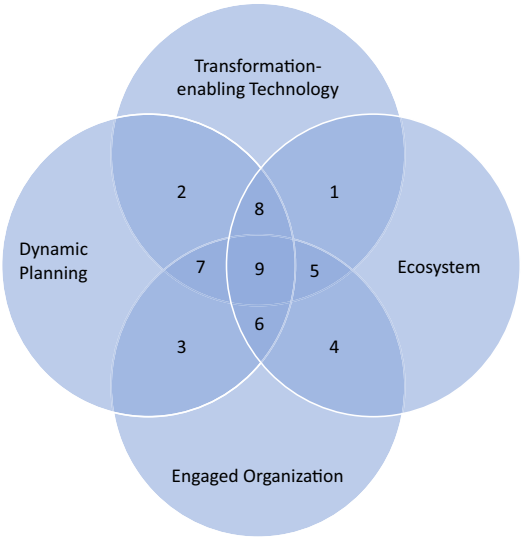

Figure 2.
The characteristics of resilience-building S&OP

Kreuter *et al.*, 2021b), but that each S&OP process needs to be adapted and designed uniquely. Consequently, various forms of resilience-building S&OP responses are expected in different contexts to achieve the intended outcome. Being resilience-building suggests that S&OP is one of the mechanisms that contribute to an organization's or supply chain's resilience. The question for future research would be: To what extent could S&OP contribute as a resilience-building mechanism in companies and supply chains?

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