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Making Decisions in Highly Uncertain and Opportunistic Environments: Towards a Decision Support System for Sales and Operations Planning

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Abstract: Sales and Operations Planning (S&OP) is a methodology used by most companies to make planning decisions on a medium-term horizon. This methodology and associated tools have been designed for a relatively stable environment. However, this assumption is not relevant anymore, and practitioners face difficulties to perform S&OP in highly uncertain and opportunistic environments. Therefore, this paper proposes to pave the way towards a solution to these difficulties, by introducing a conceptual framework for designing a decision support system for performing S&OP in highly uncertain and opportunistic environments. The paper concludes with a set of research avenues to make it real.

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Keywords: Sales and operations planning, S&OP, decision support systems, risk management, uncertainty, decision-making process, information system, MRP II, supply chain management.

1. INTRODUCTION

When an act of purchase of a product takes place, it is conditioned by the capacity of the associated supply chain to make this product available to the consumer. This capacity to make the product available includes production, transport and storage activities carried out by the actors in the supply chain. In order for products to reach consumers in the best possible conditions (costs, deadlines, quality, etc.), both from the point of view of industrial players and consumers, the supply chains of these products must be perfectly mastered by the players who make them up. This control of supply chains is associated with the "Supply Chain Management" (SCM) domain (APICS, 2016).

One component of SCM is to anticipate future needs in order to have time to adapt these supply chains to ensure their ability to meet the needs expressed by the associated markets. This is called "supply chain planning" (APICS, 2016; Fleischmann et al., 2015; Rohde et al., 2000; Stadtler et al., 2015). The level of anticipation required depends on the implementation time of the associated adaptation decisions. This is why several planning horizons are necessary to make these decisions at the right time. The following three planning horizons are generally considered: short-term, medium-term, and long-term (Fleischmann et al., 2015). These horizons are also called operational, tactical, and strategic. This paper focuses on the medium-term (i.e., tactical), and more especially on “Sales and Operations Planning” (S&OP), a component of the well-known MRP II methodology (Arnold et al., 2008).

Until a few years ago, the environment of these supply chains was relatively stable (market context, political context, environmental context, etc.) (Pinon et al., 2018). This was especially the case for the aeronautical sector, as this sector was used to having a visibility of its order book over several years with very little uncertainty. As a result, companies have focused on minimizing the operating costs of these logistics chains in order to meet their needs, assuming that the future is known and controlled (Olhager, 2013; Pinon et al., 2018). The designers of planning methodologies for supply chains, such as ASCM, initially based their design on this assumption (Christopher and Holweg, 2011; Pinon et al., 2018). The same is true for the designers of software for digitizing these planning activities, who therefore based their software design on this hypothesis (Santa-Eulalia et al., 2011; Stadtler et al., 2015).

However, this assumption has been strongly challenged since the beginning of the 2000s and particularly by recent events (economic crisis of 2008, COVID-19 crisis, etc.) which have shown how sensitive the economy and logistics chains are to disruptions and uncertainties, even in the aeronautical sector (Christopher and Holweg, 2017; Clifford Defee and Fugate, 2010; Narasimhan and Talluri, 2009; Simangunsong et al., 2012; van der Vorst and Beulens, 2002). The quality of the decisions that supply chain managers have to take is more than ever dependent on the uncertainties and decision options that they are able to consider (Boonyathan and Power, 2007; Hult et al., 2010; Sáenz and Revilla, 2014). In order to avoid the risks associated with uncertainties and to seize the opportunities associated with decision options within a supply network, it is necessary to have the means to identify and characterize these risks and opportunities.

This first section of the paper introduced the research area, from SCM to S&OP, and highlighted the importance of considering the multitude of decision options and uncertainties. The second section is a literature review describing the fact that practitioners do not have appropriate methodology and tools for making S&OP decisions by considering the multitude of decision options and uncertainties. It concludes by formalizing the research question to be addressed: “how a solution could be designed to enable practitioners making S&OP decisions by considering the multitude of decision options and uncertainties?”. Then,

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the third section describes the contribution which is a first answer to the research question: a conceptual framework proposal aiming at guiding the design of a S&OP decision support system compatible with highly uncertain and opportunistic environments. This contribution is inspired from Oger et al. (2021) and Oger (2019). While the mentioned research work focused on long-term planning, this current paper intends to translate its approach from long-term to medium-term planning. Finally, the fourth section concludes the paper by a synthesis and by suggesting avenues for future research for extending this work and making the S&OP decision support system real.

2. LITTERATURE REVIEW

2.1 Sales and operations planning

S&OP was first introduced by Ling and Goddard (1988) in the book "Orchestrating success: Improve control of the business with sales & operations planning". There are several definitions in the literature, but authors mostly define it as business process that unifies plans from several departments (e.g., sales, marketing, development, manufacturing, sourcing, and financial) into one integrated plan (Grimson and Pyke, 2007; Olhager et al., 2001; Thomé et al., 2012). The term Integrated Business Planning (IBP) also appeared during the last decade. Some authors mention it as an updated version of S&OP. But there is a lack of literature to really assess it independently from S&OP (Oger, 2019; Pinon et al., 2018). It is similar for the concept of Adaptive Sales and Operations planning developed by the Demand Driven Institute (2018) that still lacks detailed information to be assessed.

2.2 Lack of guidelines to consider the multitude of uncertainties and decision options

When having a look at the S&OP process described in the literature, we mainly find high-level description of the process such as the one described in Figure 1. When diving into the process explanations, authors such as Ling and Goddard (1988) and Arnold et al. (2008) mention the importance of considering uncertainties and decision options by making alternative planning scenarios. However, Oger (2019) formalized S&OP processes proposed by different authors, using the BPMN standard, and it shows that the consideration of the multitude of uncertainties and decision options is not explicitly described as a component of the S&OP process. This means that practitioners implementing S&OP do not have clear guidelines for considering uncertainties and decision options. This might lead to implementation difficulties; a situation that has been observed among several companies performing S&OP.

2.2 Lack of tools to consider the multitude of uncertainties and decision options

Several authors concluded that the S&OP process cannot be efficiently performed without an appropriate computerized information system (Ivert and Jonsson, 2010; Kristensen and Jonsson, 2018; Tuomikangas and Kaipia, 2014). In addition, Oger (2019) identified 3 types of information system mentioned in the literature to support the S&OP process (ERP, APS, and spreadsheets). But the conclusion was that none of them are appropriate for considering a multitude of uncertainties and decision options. In a recent paper, Ivanov et al. (2021) undertook a survey among researchers to understand the current state of knowledge and to propose future research opportunities for operations management scholars. The results indicate that a link between S&OP and data science has been pointed out by researchers and it also indicates that no literature combining both has been found yet.

From the software editor perspective, a lot of commercial software claiming being able to support the S&OP process emerged during the past few years. However, even if it seems some of them would enable companies to consider several what-if scenarios, the available information found about them seems to show that they would not make possible the consideration of a multitude of uncertainties and decision options.

To conclude about existing tools with the practitioners' perspective, a study undertaken by the company West Monroe (2021) has shown that spreadsheet is still the most frequently used technology to perform S&OP today. But as mentioned by Fleischmann and Koberstein (2015) the complexity and frequency of planning updates can overload human planners if they use only spreadsheets. A situation that can explain the difficulties encountered by practitioners.

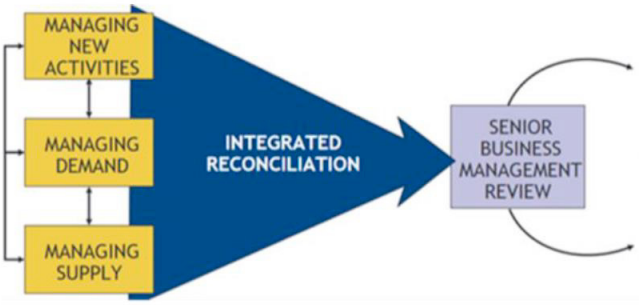


Figure 1: S&OP process by Coldrick et al. (2003))

2.3 Conclusion and problem statement

It has been explained that considering the multitude of uncertainties and decision options is crucial for performing S&OP nowadays. Unfortunately, existing solutions (both methods and software) to support S&OP decision-making have not been designed for such unstable and opportunistic contexts and now have critical limitations, especially in terms of robustness (Christopher and Holweg, 2011; Oger, 2019; Pinon et al., 2018; Santa-Eulalia et al., 2011; Stadtler et al., 2015). In practice, they are often purely deterministic and limited to a pre-established configuration that is fixed in time. This characteristic of the existing systems makes them obsolete with respect to today's industrial reality. This causes difficulties in ensuring the relevance of decisions taken and thus difficulties in maintaining the performance of supply chains when the future is not exactly what the companies expected. In concrete terms, this leads to additional costs for companies, a sharp drop in the level of service provided to consumers, and even layoffs and bankruptcies.

The lack of detailed description of how to consider the multitude of uncertainties and decision options in the S&OP

process might be due to the lack of appropriate tools to make it possible. Therefore, the main research question this research focuses on is the following: "how a solution could be designed to enable practitioners making S&OP decisions by considering the multitude of decision options and uncertainties?". The following section proposes a first answer to this question.

3. CONTRIBUTION

To start answering the research question described in the previous section, this section proposes the conceptual framework of a comprehensive decision support system (DSS) that would enable practitioners to consider the multitude of uncertainties and decision options while performing their S&OP process. This contribution is inspired from Oger et al. (2021) and Oger (2019) which had similar objectives but focused on long-term planning. Therefore, the S&OP DSS conceptual framework proposal intends to translate the approach from long-term to medium-term planning.

Considering the vision of DSS inspired from Oger (2019), the S&OP DSS is defined by the 4 following components illustrated in Figure 2: its purpose, decision-making process, information system, and people. The purpose is directly related to the research question, it is to provide practitioner with a comprehensive solution to help them in making S&OP decisions while considering the multitude of uncertainties and decision options. The main principles of the 3 other components are described in the following subsections.

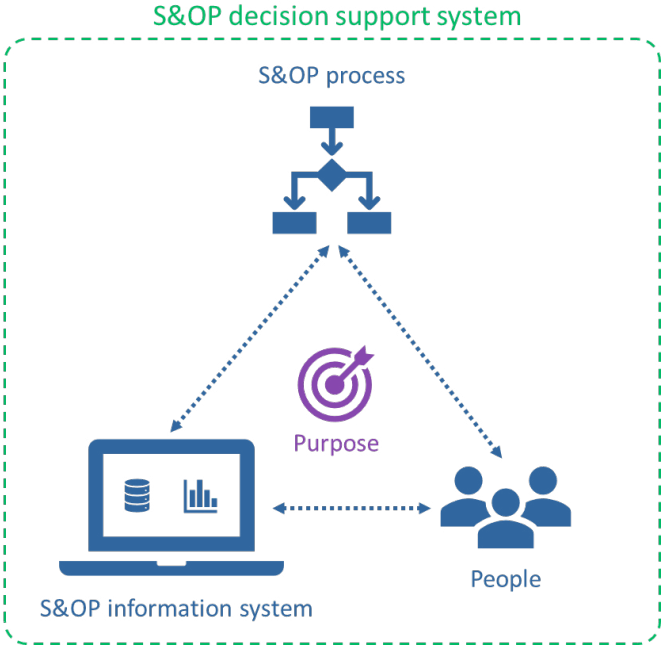


Figure 2: the 4 components of the proposed decision support system for sales and operations planning (inspired from Oger (2019))

3.1 S&OP people

Regarding people, they are 3 categories that would be involved in the S&OP DSS. The first one could be "information providers" who would be in charge of providing the right information that is required to perform the S&OP process. Most departments of a company have a direct or indirect relationship with the business performance considered during the S&OP process (e.g., supply, procurement, manufacturing, sales, marketing, product development, continuous improvement, finance). Therefore, each department should have its own information providers to feed the S&OP process with the appropriate information. As mentioned by Oger et al. (2019), it is crucial to gather companies' departments around a common vision because they all have a direct or indirect impact on the business performance and are all correlated when considering the company as a whole.

The second category could be "process managers" who would be in charge of overseeing the S&OP process as well as performing the analysis tasks leading to recommendations of the decisions to make. This category could be divided into two types of roles, a first one dedicated to the management of the S&OP team, and a second one dedicated to the analysis part.

Finally, the third category could be "decision makers" who would be responsible for making the final decisions based on the recommendation from the S&OP managers.

3.2 S&OP process

The main principle of the S&OP process is to effectively guide companies towards making their S&OP decisions in highly uncertain and opportunistic environments. It implies guiding companies in implementing an S&OP routine and in performing this S&OP routine. Considering the limitations regarding existing S&OP processes, two important elements to design an appropriate S&OP process will be the following: first, include all the necessary steps that described the specificities of a process enabling to consider the multitude of uncertainties and decision options. Second, formalize the process in detail so that there are no ambiguities regarding how to implement and perform it.

Figure 4 describes the S&OP DSS conceptual framework proposal seen from the process viewpoint, including the information system and people dimensions. This conceptual framework is inspired from the approach that has been proposed by Oger (2019) for making long-term supply chain capacity planning decisions. Even if the proposal made by Oger (2019) was focused on long-term decisions, most components should be applicable for medium-term decisions. Therefore, the proposed S&OP process high-level view is composed of two phases, implementation and routine, and each part is composed of some subparts providing its main elements. The implementation part illustrates the people dimension while the routine part illustrates the information system dimension, however, in practice all those dimensions should be interrelated at several stages to make the S&OP DSS possible.

Regarding the implementation phase, its main objective is to guide companies in configuring the S&OP process that corresponds to their context, decisional vision, and objectives. The first step is to define the decision-making perimeter. It consists in deciding the type of uncertainties and types of decisions to consider, as well as the key performance indicators that will be required to support making decisions of the chosen types. The second step is to define the data that will be necessary to perform the S&OP routine. It consists in

deciding the data sources, the data scope (especially in terms of manufacturing perimeter and product portfolio), and the data granularity (e.g., product families or product references). The third step is to define stakeholders involved in the S&OP process. It consists in defining information providers, process managers, and decision makers, for which roles have been described in the previous subsection.

Regarding the routine phase, its main objective is to guide companies in making the chosen types of decisions. The first step is to prepare the decision-making meeting. It consists in gathering data and preparing recommendations for decision makers using the S&OP information system. The second step is the final decision-making meeting to make decisions based on the output of the previous step.

3.3 S&OP information system

Regarding information system, its main principle is to be a computerized solution that enables to identify and assess the multitude of scenarios of potential futures resulting from the combination of the multitude of uncertainty sources and decision options. The major mindset of this information system is to automate as much analysis as possible to minimize the time people have to spend on generating results, maximize the number of considered uncertainties and decision options, and increase the time people spend on analyzing the results for preparing recommendations rather than producing the results.

Figure 3 describes the S&OP DSS conceptual framework proposal seen from the information system viewpoint and including parts of the process and people dimensions. This illustration has directly been taken from Oger et al. (2021) because we believe that a very similar information system approach would be appropriate for supporting the S&OP process. It is composed of two parts, on the left are given some specific decision-making process stakeholder's activities, and on the right are described the main components of the information system. The proposed information system would be composed of 4 main building blocks described thereafter.

The first building block is the "supply web modeler", a module that structures the information collected from information providers to make it available for further analysis.

The second building block is the "assessment model generator", a module that generates a generic model to assess the performance of the company that will be compatible with all what-if scenarios that can exist according to the considered uncertainties and decision options. An assessment model should be understood as an element to which we provide input parameters, and which provided key performance indicators as a result. It is a key element towards the automation of the information system, and what will make possible not to have to create a specific assessment model for each scenario. A counterexample would be the use of spreadsheets as an assessment model. When companies that use spreadsheet to perform their S&OP process want to analyze a new scenario implying a structural modification such as a new product, equipment, or supplier, they usually have to create a completely new spreadsheet for this specific scenario, which is very time-consuming.

The third building block is the "what-if scenario generator and assessor", a module that defines scenarios to assess and uses the assessment model generator to assess scenarios.

Finally, the fourth building block is the "dashboard generator", a module that aims at displaying scenario assessment results to the users, to analyze the outputs and prepare recommendations for decision makers.

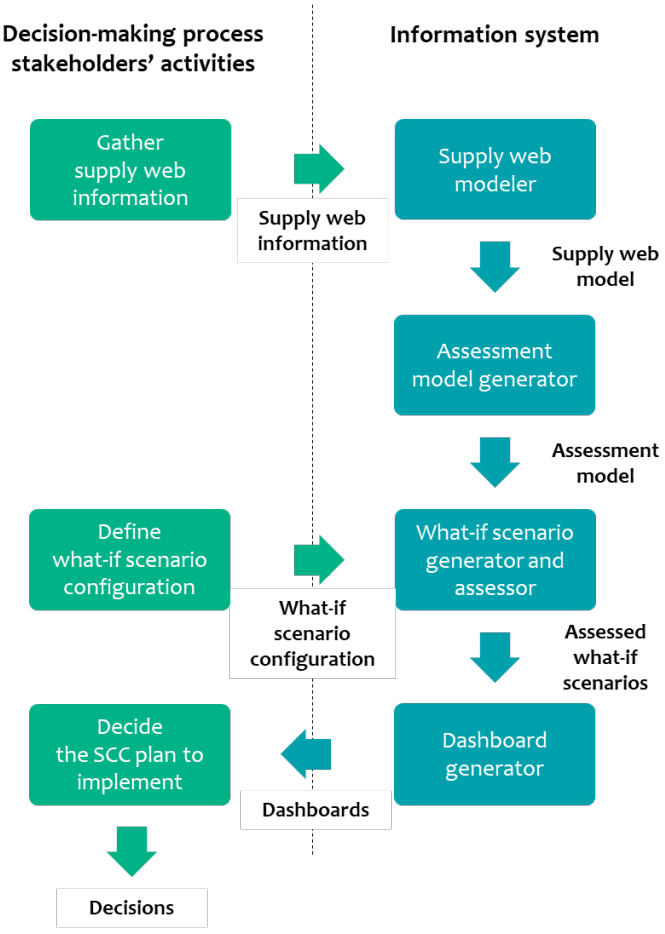


Figure 3: S&OP DSS conceptual framework proposal seen from the information system viewpoint and including parts of the process and people dimensions (Oger et al., 2021)

3.4 S&OP DSS conclusion

To conclude regarding this contribution section, the proposed S&OP DSS conceptual framework is a very high-level view describing the main component of what could become a S&OP, that provides practitioners with all material they need to implement and perform it, and compatible with making decisions in a highly uncertain and opportunistic environment.

Considering (i) that this approach is highly inspired by the research work undertaken by Oger et al. (2021) and Oger (2019) in the context of strategic supply chain capacity planning, (ii) the theoretical and industrial results of the research work undertaken by Oger et al. (2021) and Oger (2019), and the similarities of this planning context with S&OP, we believe that this approach and conceptual framework will enable to achieve the associated objectives.

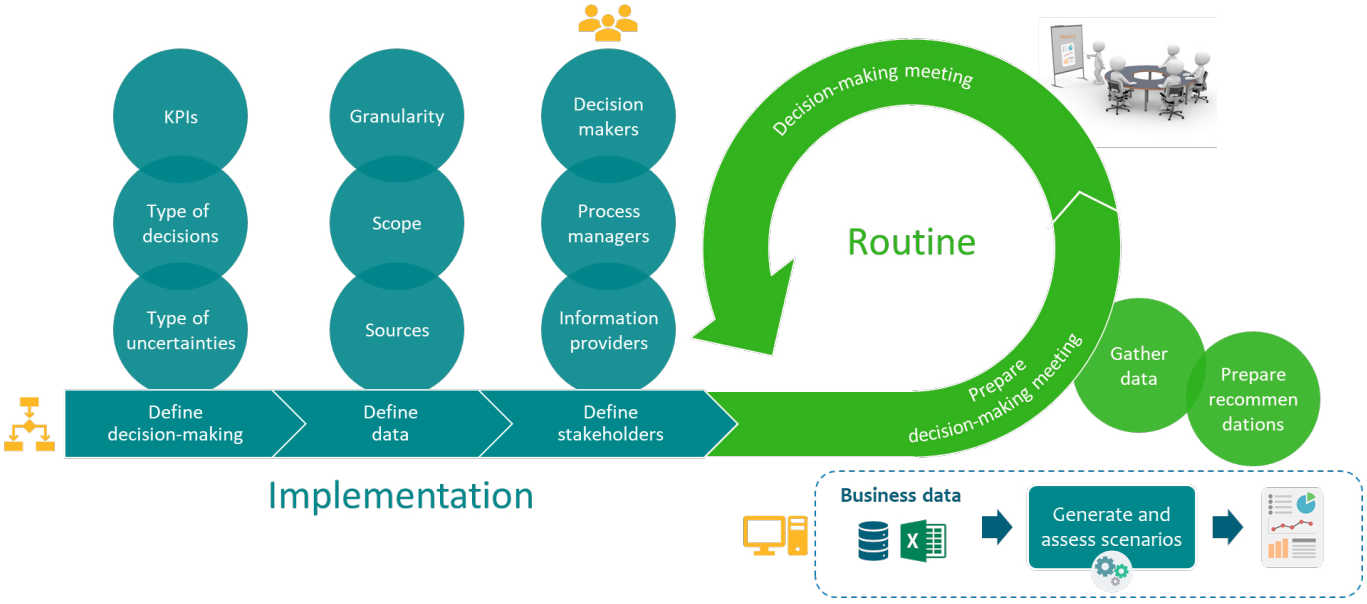


Figure 4: S&OP DSS conceptual framework proposal seen from the process viewpoint and including the information system and people dimensions (inspired from Oger (2019))

4. CONCLUSIONS AND RESEARCH AVENUES

This paper started by introducing the importance of planning and the difficulty for practitioners to perform sales and operations planning (S&OP) in highly uncertain and opportunistic environments. It has been identified that these difficulties are mainly due to the fact that existing methodologies and associated tools have been designed for stable environments and are not appropriate to support decisions in highly uncertain and opportunistic environments.

Therefore, this paper aims at paving the way towards a solution to these difficulties faced by practitioners. It does it by making a proposal of a conceptual framework for designing a S&OP decision support system suitable for making decisions in highly uncertain and opportunistic environments.

This contribution is a first building block, but there are still a number of steps to undertake to make the proposed S&OP decision support system real. Some avenues for future research are described thereafter. A first avenue would be to propose a detailed S&OP process involving the appropriate people and information system. A S&OP process that would provide practitioners with clear implementation and execution guidelines. A second avenue would be to design and develop the aforementioned S&OP information system that would be the keystone of the S&OP DSS by making possible the consideration of the multitude of uncertainties and decision options. A third avenue would be to design and perform additional industrial experiments to verify the effectiveness of this DSS validated by Oger (2019), but for medium-term horizons. Finally, the last avenue not to forget is to organize the industrial transfer of the results to make it available to practitioners.

5. ACKNOWLEDGMENTS

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