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Intrinsic investigation of sales and operations monitoring and planning in a challenging and complex project-based organization

A case study

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ABSTRACT:
S&OP has gained extensive admiration from companies recently due to its potential benefits, such as reduced inventory levels, improved forecast accuracy, better resource utilization, and increased customer satisfaction. A S&OP process is one of the fundamental components for companies to survive and sustain a competitive edge in today's challenging and complex business environment.

Considering the recent recognition of S&OP, this master's thesis explores how an S&OP process can be designed and executed in a challenging and complex business environment. The objectives of the thesis were to map and describe how the case company currently performs its S&OP process, identify gained benefits, current process challenges, and the roles and responsibilities of the process. Based on the key findings, suggested improvement proposals were developed, for the case company as remedies to take the process to the next level. A qualitative case study was conducted to answer the research questions and reach the goal and objectives of the thesis. Data was collected and analyzed through interviews, observations, and secondary company material. Based on the findings and observations, a comparison was made against existing literature, theories, and frameworks to find similarities and gaps.

The findings indicate that the case company follows a five-step S&OP process initially designed for high volumes businesses and not for companies characterized by high complexity, demand fluctuations, and weak forecasting precision. That can be one of the reasons why the case company struggles to acquire all expected benefits from S&OP. Related to this, another key finding was that there are no existing theories or frameworks available for S&OP in an engineer-to-order environment. Through S&OP, the case company has achieved many benefits like improved alignment, communication, teamwork, visibility, accountability, decision-making capacity utilization, risk reduction, enabled bundling opportunities in project purchasing and logistics, and reduced inventory levels. Many S&OP-related challenges were also identified, through the empirical study. The main challenges identified are limited supplier collaboration, systems connectivity, missing performance management, and data availability and accuracy. The study provides many managerial implications, and suggested improvement areas in the case company's S&OP process. All these recommendations are intended to support the case company and eventually, other companies to overcome typical challenges. The key enablers of S&OP in a complex and challenging project-based environment are highlighted. Even though the findings generated from this study are based on the case company, other companies operating in a similar environment can acquire beneficial insights and guidelines that might be relevant to them. Finally, future research could investigate how an advanced planning system can support organizations operating in a challenging and complex project-based environment and investigate how to measure the performance of the overall S&OP process.

KEYWORDS: Sales and operations planning, S&OP, demand and supply, forecasting, supply planning, process development, case study

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ABSTRAKT:
Försäljning och verksamhetsplanering har på senare tid fått ett ökat intresse från företag på grund av dess potentiella fördelar, såsom minskade lagernivåer, förbättrad prognosnoggrannhet, bättre resursanvändning och ökad kundnöjdhet. Processen är en av de grundläggande komponenterna för företag att överleva och upprätthålla sin konkurrenskraft i dagens utmanande och komplexa affärsmiljö.

Detta magisterarbete redogör för hur en sådan process kan utformas och tillämpas i en utmanande och komplex affärsmiljö. Uppsatsens mål var att kartlägga och beskriva hur det aktuella fallföretaget genomför sin S&OP-process, identifiera uppnådda fördelar, aktuella processutmaningar samt rollerna och ansvarsområden. Resultaten utvecklades på basen av förbättringsförslag för fallföretaget och åtgärder för att ta processen till nästa nivå. En kvalitativ fallstudie genomfördes för att besvara forskningsfrågorna och uppnå uppsatsens mål och syften. Data samlades in och analyserades genom intervjuer, observationer och sekundärt företagsmaterial. Baserat på resultaten gjordes en jämförelse mot befintlig litteratur, teorier och ramverk för att hitta likheter och möjliga luckor i existerande litteratur.

Resultaten visar att fallföretaget följer en femstegs S&OP-process som ursprungligen utformades för företag med höga volymer och inte för företag som kännetecknas av hög komplexitet, efterfrågefluktuationer och svag prognosprecision. Detta kan vara en av anledningarna till att fallföretaget kämpar med att uppnå alla förväntade fördelar. Ett annat nyckelfynd var att det inte finns några befintliga teorier eller ramverk tillgängliga för företag med skräddarsydda produkter och lösningar. Fallföretaget har uppnått många fördelar med processen såsom förbättrad samordning, kommunikation, synlighet, besparingar i logistik- och inköpskostnader samt minskade lagernivåer. Företaget har också flera utmaningar med processen, var de huvudsakliga utmaningarna är begränsat samarbete med leverantörer, systemanslutning, prestationsstyrning samt tillgänglighet och noggrannhet av data. Studien ger många ledningsmässiga implikationer och föreslagna förbättringsområden i fallföretagets S&OP-process. Alla dessa rekommendationer är avsedda att stödja fallföretaget och eventuellt även andra företag att övervinna dessa utmaningar. Även om resultaten från denna studie är baserade på fallföretaget kan andra företag som verkar i en liknande miljö erhålla gynnsamma insikter och riktlinjer som kan vara relevanta för dem. Slutligen kan framtida forskning undersöka hur ett avancerat planeringssystem kan stödja organisationer som verkar i en utmanande och komplex projektbaserad miljö samt undersöka hur man mäter prestandan för den övergripande S&OP-processen.

NYCKELORD: Försäljning och verksamhetsplanering, S&OP, tillgång och efterfrågan, prognostisering, försörjningsplanering, processutveckling, fallstudie

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Abbreviations

S&OP	**Sales and Operations Planning**
ETO	**Engineer-to-Order**
VUCA	**Volatility, Uncertainty, Complexity, and Ambiguity**

1 Introduction

1.1 Research background

Many companies today face challenges like stock-outs, unhappy customers, high inventory levels, delayed deliveries, and poor cash flow. These problems can be solved, partly or completely, by implementing a business procedure named S&OP. That is also one of the main reasons why S&OP has gained extensive admiration from companies around the world recently (Wallace & Stahl, 2006a).

According (Hart, 2023) there are some main motives behind its recent traction. First, the potential benefits the process can generate, like reduced inventory levels, improved forecasting accuracy, better utilization of resources, and increased customer satisfaction. Increased complexity is the second reason, where complexity has several dimensions. Companies today operate more on a global scale than earlier. That increases the complexity of managing the operations side of the business. Secondly, operating in Global business environments adds complexity due to longer supply chains. The final reason for the increased interest in S&OP is because of the continuously changing business circumstances, like more demanding customers, shorter product lifecycles, and increased competition. S&OP can strongly support companies in complex business environments to balance their demand and supply, both internally and externally (Hart, 2023).

A solid S&OP process is one of the fundamental components for companies to survive and sustain a competitive edge in today's challenging and complex business environment. Organizations with multiple supply chain networks can utilize S&OP to strengthen their business results. There is no doubt that commercial business environments are affected by VUCA (volatility, uncertainty, complexity, and ambiguity). Hence it is even more essential for organizations to oversee and run their operations and supply chain effectively. That is where S&OP serves as a support for companies to align and coordi-

nate business functions like sales, marketing, project management, supply management, and manufacturing to boost their productivity and profitability (Manish, 2024).

1.2 Case Company

This research investigates the case company's current S&OP process and its ups and downs. The company is a large international player operating in the energy and marine markets, offering sustainable solutions and world-class services for customers worldwide. They have three independent businesses consisting of several business units. This research is conducted for the business operating in the energy market, specifically for the business unit offering engine power plant solutions to its customers. The nature of the engine power plant business is characterized by, high complexity, demand fluctuations, and weak forecasting precision.

By examining the case company's current S&OP process and benchmarking it against existing literature, frameworks, and theories, the research targets to generate best practices, opportunities, and resolutions to the current process bottlenecks. Chapter 4 further describes the case company in depth, its characteristics, and the current S&OP process.

1.3 Research gap and purpose

Even if S&OP has gained extensive recognition both from companies and academic practitioners, the existing literature, theories, and frameworks are primarily designed for high-volume businesses like retail or companies operating in a make-to-stock environment. Additionally, it has also been highlighted by (Boyer, 2009a; Lapide, 2004a) that many companies fail to realize some of the expected benefits from S&OP. Hence a broader insight into S&OP in complex project-based environments is required. A deeper understanding of how the process can be implemented in this specific environment, identify complex project-based specific S&OP requirements, benefits, and challenges.

Because of that, this research intends to investigate the existing research gap of missing S&OP frameworks and guidelines for companies operating in a complex project-based environment. The research aims to bridge the gap between S&OP in make-to-stock environments and complex project-based environments. That is achieved by examining how the case company currently performs its S&OP process and identifying its challenges, benefits, and opportunities. Furthermore, benchmark these findings against the existing theories and frameworks designed for make-to-stock environments to find similarities and differences.

Furthermore, it was a strategic decision of the case company to implement S&OP at the beginning of 2023, and it is indispensable for them to have a functioning and well-performing S&OP and structure. Currently, the case company struggles to realize all expected benefits due to challenges with manual inputs, data availability, and accuracy, forecast accuracy, systems connectivity, dedicated S&OP team, and lack of performance management.

Hence, the purpose of this thesis is to evaluate the case company’s current S&OP practices and identify potential opportunities and improvement areas. That is completed by an extensive literature review and semi-structured interviews, observations, and reviewing existing secondary company sources. Additionally, an extended S&OP playbook focusing on the S&OP process, benefits, challenges, and roles and responsibilities is created. The playbook describes the process, summarizes benefits, and challenges, and highlights the identified roles and responsibilities. That will support the case company's overall S&OP journey and assist future planners in identifying potential business risks, such as bottlenecks or other risks related to sales, operations, or the supply chain. The objectives and research questions listed in the next chapter will work as support to fulfill the purpose.

1.4 Research objectives and questions

The objectives of this research are highlighted in bullet points below:

- Map and describe how the case company currently performs its S&OP process.
- Investigate who is involved, and what are the inputs and outputs for each process step?
- Explore from academic literature: what benefits S&OP can generate for companies?
- Benchmark these benefits against the case company's achieved advantages.
- Identify challenges the case company currently faces in its S&OP process.
- Map and identify the S&OP stakeholders in the case company.
- Create a high-level RACI model for the S&OP process and a detailed RACI model for supply planning (auxiliary equipment).
- Generate recommendations and improvement proposals for the case company.

To achieve the research objectives above the following research questions must be answered:

RQ1: How is the current S&OP process executed in the case company?

RQ2: What benefits have the case company gained from its S&OP process?

RQ3: What are the current barriers and challenges of S&OP in the case company to prevent them from reaching the next level?

RQ4: What are the roles and responsibilities in the case company's S&OP process?

Research question two is answered by analyzing existing academic S&OP literature and comparing the findings with the information obtained from the data collected through

interviews and observations. The importance of establishing a solid S&OP process and the benefits companies can generate in return will be identified. The remaining research questions are answered, through the empirical section of the thesis. The empirical part is carried out through interviews, observations, and by examining the case company's existing materials, data, and information. That will support the researcher in gaining a deep understanding of the current ways of working, practices, roles, responsibilities, and tools utilized to execute the monthly S&OP cycles and the challenges preventing the case company from reaching the next level.

1.5 Research structure

The first chapter introduces the reader to S&OP. After this chapter, a presentation of the research motivation and background, purpose, objectives, and a brief presentation of the case company. In the second chapter, an extensive literature review is carried out based on relevant academic literature related to the subject to guide the reader through the main characteristics of S&OP. The material for the literature review is collected from proper databases and varies from business journals, books, and articles. Findings in the literature review support the answer to the second research question. Simultaneously, it will provide guidelines and references required for the case company.

After the literature review, a detailed presentation of the research methodology is highlighted. The purpose is to describe the research process and demonstrate the methods required for the empirical study. Chapter four describes the case company in detail. Chapter five describes the main results obtained from the empirical research. Findings from the literature review, data collected from the interviews and observations, and existing data and materials from the case company are analyzed to reach the research objectives.

The sixth chapter critically evaluates and discusses the findings against existing theories and concepts, generating ideas, recommendations, and suggestions for further improvements to the case company. This chapter is followed by a section on managerial implications. Lastly, the final chapter wraps up the research by reflecting on and summarizing the findings and answering the research questions.

2 Literature Review

This chapter aims to give the reader a comprehensive overview and understanding of key concepts, literature, and material closely connected to the research topic. First and foremost, the literature review introduces the core elements of sales and operations planning and the definition of the concept. The section continues to identify possible benefits an organization can achieve by implementing a solid S&OP process. A deep dive into the monthly S&OP process and success factors are presented. The S&OP planning parameters are emphasized, together with S&OP enablers and the linkage between supply chain management and S&OP. Finally, roles and responsibilities are explained, general challenges associated with S&OP are presented, and how S&OP in an engineer-to-order environment differs from a more standard make-to-stock environment.

2.1 Introduction to S&OP

Businesses such as wholesale, industrial, and pharmaceutical often encounter challenges like customer dissatisfaction, inventory overflow, poor cash flow, and lack of harmony between demand and supply. It is a well-known phenomenon that if the demand exceeds the supply, the customer service level may drop, and companies might risk failing to deliver the required volumes to customers. In contrast, if the supply surpasses the demand, it can result in high inventory levels, which, on the other hand, can lead to production stops, plants cease operating, employee redundancies, and decreased competitiveness (Dr. G. Kumar, 2016).

Both scenarios presented above could have been bypassed if there had been an appropriate balance between demand and supply. An advanced system that detects imbalances between demand and supply can support organizations with this problem. Every company strives to synchronize their purchase order from customers with the supply. Here, the S&OP process can support companies to avoid imbalances between demand and supply. To maintain a desired customer service level and simultaneously

optimize inventory levels, companies must be on top of both demand and supply. If they want to stay competitive and have a greater possibility to keep in line with the performance goals (Dr. G. Kumar, 2016).

Authors Muzumdar & Fontanella (2006) insist that if you ask anyone in supply chain management whether S&OP is essential to their organization, disregarding company type or size. The answer will almost certainly be yes. Anyhow, many companies encounter serious challenges with implementing S&OP and fail with the core elements of keeping their demand and supply in balance.

Celik (2023) further highlight that the challenges vary across different businesses or companies focusing on selling consumer goods tend to either have inventory surplus or supply shortages. While companies selling consumer products have issues with seasonality and the build-ahead principle, where sales forecasts typically are based on historical patterns. Industrial organizations spend much time and resources planning their operations but face great unpredictability and volatility from customers and suppliers. Distributors on the other hand have issues with finding the balance between excess inventory and selling products to a reduced price because of too high inventory levels. Heavily discounted products can also result in an increased unpredicted demand, which eventually can lead to a shortage of products and many unsatisfied customers. So, how can companies build a solid strategy for mitigating and managing the daily exposure to risks and volatility? While simultaneously increasing the profitability of the business? The answer is S&OP (Celik, 2023)

2.2 S&OP basics and definition

According to Sheldon (2006), S&OP was introduced by the inventor of MRP (material requirements planning), Oliver Wight, during the 1980s. After that, the S&OP process started to gain maturity because companies started sharing S&OP experiences and best

practices via organizations like APICS. In 1988, S&OP was recognized and defined as an own business process to balance demand and supply (Sheldon, 2006). Thanks to the internet, ERP, and advanced planning systems, the S&OP process has developed remarkably and gained maturity since its birth. Today most of all companies have implemented an S&OP process to balance the demand and supply (Ambrose & Rutherford, 2016a).

S&OP can according to Thomé et al. (2012) as a process that merges various business plans into one consolidated plan. S&OP has two key objectives. First, balancing demand with supply and connecting the company's strategic business plans with the operation plans (Thomé et al., 2012). In academic literature, many different definitions of S&OP exist. These definitions put S&OP into various planning hierarchies. For example, Olhager et al. (2001) & Olhager & Rudberg (2002) place S&OP in the highest planning hierarchy and highlight that S&OP is aimed for long-term planning for sales, production, and resource planning. If an unbalance between demand and supply is detected, S&OP must flag the imbalance (Thomé et al., 2012). Another author Feng et al. (2008), disagrees with placing S&OP at the highest planning level and instead sees S&OP as a tactical mid-term planning process.

APICS (American Production and Inventory Control Society), which recently changed its name to ASCM (Associate for Supply Chain Management), describes S&OP as the process of generating plans on a tactical level and supporting the management to steer the business in the desired strategic direction. S&OP unites all the different business plans from various departments, such as (sales, financial, supply chain management, project management, product development, and service), into one consolidated business plan. S&OP should be executed monthly and accommodate all aspects of demand, new products, and supply plans on a detailed and aggregated level and always be connected to the overall business plan. When carried out correctly, it connects an organization's strategic plan with its operational activities, evaluates the business performance through different measurements, and continuously seeks improvement oppor-

tunities (Hoag, 2014). In Table 1 below a consolidated view of different S&OP definitions from various authors is presented.

Reference	S&OP Definition
Thomé et al. (2012)	A process that merges various business plans into one consolidated plan, with two objectives. First, balancing demand with supply and connecting the company's strategic business plans with the operation plans
Jonsson & Holmström, 2016	A tactical planning process that desires to balance the demand with internal supply capabilities.
Tuomikangas & Kaipia, (2014)	S&OP is an essential business process for matching demand with supply within the medium-term planning horizon.
Grimson & Pyke (2007)	S&OP links a company's strategic plans with its operations plans, which enables the possibility of balancing demand and supply for products.
Kelwig, (2023)	S&OP is a planning process that aligns financial plans with the supply and demand plans of a company's products.

Table 1 - Consolidated S&OP definitions from various authors

R. A. Stahl & Wallace (2008) & Wallace & Stahl (2006) emphasize that S&OP consists of several subprocesses to make decisions of three key elements. The first element is to balance demand and supply second is to connect all business plans (demand, operational, and financial) into one integrated business plan. Finally, to align on both mix and volume. Since the correlation between demand and supply and the importance of integrating business plans into a consolidated plan have already been described, the aspect of volume and mix will be presented.

Volume is the big picture, and the mix focuses more on details. The volume is a combination of different product categories and groups, while the mix is expressed as specific products. Mix answers to the question “which products”, and volume answers to “how many”, hence, the terms correlate to each other in a similar way as demand and supply, where demand is the clear driver of the supply, and volume is a clear driver of the mix (R. A. Stahl & Wallace, 2008a; Wallace & Stahl, 2006b).

2.3 Benefits

Successful S&OP can lead to several advantages for organizations. Hinkel et al. (2016) underline benefits like lower inventory levels, less production downtime, higher delivery reliability, and increased forecast accuracy. Besides that, S&OP can result in revenue growth and boost the success rate of new product releases (Hinkel et al., 2016a). S&OP can also help organizations become more flexible and increase their capabilities to mitigate unexpected events (Sheldon, 2006). Table 2 below summarizes the main S&OP benefits identified from various authors and references.

Benefit	References
Improved forecast accuracy	(Bower, 2005a, 2006a; Grimson & Pyke, 2007a; Hinkel et al., 2016b; Lapide, 2004; R. A. Stahl & Wallace, 2011)
Reduce inventory level	(Hinkel et al., 2016b; Jordan, 2021; Muzumdar & Fontanella, 2006; R. A. Stahl & Wallace, 2008)
Better Management of risks and uncertainty	(Lapide, 2004; Muzumdar & Fontanella, 2006; R. A. Stahl & Wallace, 2011)
Improve supply chain performance	(Bower, 2006; Elisa, 2022; Jonsson & Holmström, 2016; Oliva & Watson, 2011; Thieuleux, 2023)

Improved customer service	(R. Kumar & Srivastava, 2008a; Muzumdar & Fontanella, 2006a; Seeling et al., 2022a; R. A. Stahl & Wallace, 2011a)
Reduced supply chain cost	(Bora et al., 2004; Boyer, 2009b; Lapide, 2004b; Olhager et al., 2001b; Singh, 2010a)
Increase profits	(Grimson & Pyke, 2007a; Jonsson & Holmström, 2016b; Muzumdar & Fontanella, 2006a; Singh, 2010a; R. A. Stahl & Wallace, 2011a)
Organizational alignment	(Bower, 2005a; Jordan, 2021a; Kristensen & Jonsson, 2018a; Oliva & Watson, 2011)

Table 2 - Consolidated S&OP benefits from various references

Jordan (2021) points out that S&OP can generate non-numerical advantages or qualitative benefits mainly related to people and internal processes. In an S&OP cycle, all involved parties must know their roles and responsibilities both on a department level and on an individual level. That leads to clear accountability and that the decisions are taken from the right people. Furthermore, it can improve communication between stakeholders since there is a clear requirement to exchange data and information between participants to complete critical tasks in time. Since S&OP is a reoccurring process, persons involved in the cycles must redo certain activities monthly to close the loop. Repeating activities can bring out new, improved skills to the involved. Lastly, S&OP can reduce workload and allow organizations to put time and focus on issues and risks. That results in less rework, new ways of working, and improved well-being (Jordan, 2021b).

Wallace & Stahl (2006) categorize S&OP benefits into two groups hard and soft benefits. The hard benefits are those that can be measured and are directly connected to an organization's financial performance. Successful S&OP can support companies to bal-

ance their demand and supply, which increases the possibility of delivering on time. On-time deliveries again raise customer service levels and support managers to avoid stockpiles and manage inventory levels more effectively. Since S&OP is a forward-looking process, it allows companies to either frontload or backload the production if required. This results in steadier supply rates, which increases the productivity of the factories, vendors, and contractors (Wallace & Stahl, 2006b).

The forward-looking aspect also supports companies in predicting the future, identifying potential issues, and avoiding them before they occur. The fact that S&OP is forward-looking also helps organizations to release new products more rapidly and in a more disciplined manner. Potential risks with production capacities, vendor capacities, and the availability of products can be detected and mitigated before the consequences are too devastating. Companies in a make-to-order environment can also through S&OP, reduce the backlogs of customer orders, and hence shorten the overall lead times (Kalla et al., 2024).

According to (Niels, 2015), the soft benefits can also contribute to valuable advantages. Firstly, it results in improved synergy between teams, departments, and people working together towards a common goal and not in silos. Teams and individuals also take more accountability for their activities and actions. Furthermore, S&OP assists people and organizations in making better and faster decisions, boosting the overall company performance. Another great advantage is that S&OP enables organizations to manage and control their operations through one source of truth. That means that the whole organization is working with the same fixed numbers, for example, everyone is using the same demand plan instead of all departments second-guessing and modifying it. One source of truth also decreases the time and effort required for financial planning and increases its accuracy since it is synchronized with the operational plans (Niels, 2015).

In a case study conducted by Wagner et al. (2014) where a total of 88 supply chain professionals were questioned about the benefits generated from S&OP and had to assess them on a summative scale from 1-5. Where one equalled to completely disagree and, five completely agree. Improved accuracy in forecasting got the highest mean score, closely followed by improved supply chain visibility and lower inventory levels. These benefits also minimize the exposure of supply chain disruptions. Other expected benefits with scores on the higher end were better utilization of capacity and resources, lower numbers of obsolete products, better availability of goods for promotion and marketing, and enhanced customer satisfaction (Wagner et al., 2014).

Even if the concept and context of S&OP are relatively easy to follow, S&OP as a process is both hard and challenging to implement. Many of the participants in Wagner et al. (2014) study expressed how often organizations attempt to implement S&OP but fail at the finishing line to generate the predicted benefits (Wagner et al., 2014).

2.4 S&OP process

According to Lapide (2004), the S&OP process has been existing for a long period. Some companies started to implement the process in the early 1990s, while recently, its practitioners have increased drastically, and S&OP has received much recognition in the last few years. A clear signal of the increased enthusiasm for S&OP is that organizations have used large amounts of money on planning applications and software in recent years. Anyhow, many organizations are unable to generate all the anticipated advantages the planning software can give due to incomplete S&OP processes.

Hence, many organizations are revisiting their S&OP processes and modifying them to increase the possibility of achieving the benefits. Lapide (2004) also emphasizes that organizations that have a high maturity level in their S&OP processes are likely to surpass and outperform the competition with an inadequate S&OP process or no one at all. Organizations with an efficient S&OP process have a greater likelihood of fulfilling

the demand, maintaining low inventory levels, and simultaneously reducing costs associated with operations.

This section aims to describe in detail how the S&OP process is executed and to explain each process step thoroughly.

2.4.1 Overview

S&OP is a process supporting organizations in making mid- and long-term decisions. Based on current market conditions, sales history, future outlook, and common business sense, the decisions are taken by involved persons like executives and middle managers. During the S&OP cycle decisions, for example, the following matters can be taken and agreed upon: modify the demand plan, edit the supply plan, determine inventory levels, review, and potentially modify the approach and plan for volume and mix, or nothing if the plans are acceptable and approved (R. A. Stahl & Wallace, 2008a).

The approved decisions and final S&OP plan must be well-recorded and distributed within the company. Based on these, decisions on both local and global plans for demand, supply chain, financial, and development of products and services are made. These are then further developed into detailed plans for product levels, areas, production facilities, and customers. S&OP should not be considered as a meeting taking place once a month. Before the S&OP meetings, a lot of prework needs to be done. Once the cycle is over, the prework for the next cycle starts. These prework tasks can, for example, be to amend the demand forecast, review the supply plans and ensure enough capacity and products are available, elaborate on issues and how to resolve them, and draft proposals to executives for decision-making (Grimson & Pyke, 2007).

Various authors and researchers state that the S&OP process consists of five main steps that are performed in a cycle where several departments are participating. It starts from the data gathering, continues with demand planning then supply planning, and

ends with pre-sop meetings and executive S&OP meetings Ávila et al. (2019a) & Wagner et al. (2014). The five steps involved in an S&OP process cycle are presented in Figure 1 below. All these S&OP steps are further described in the upcoming chapters.

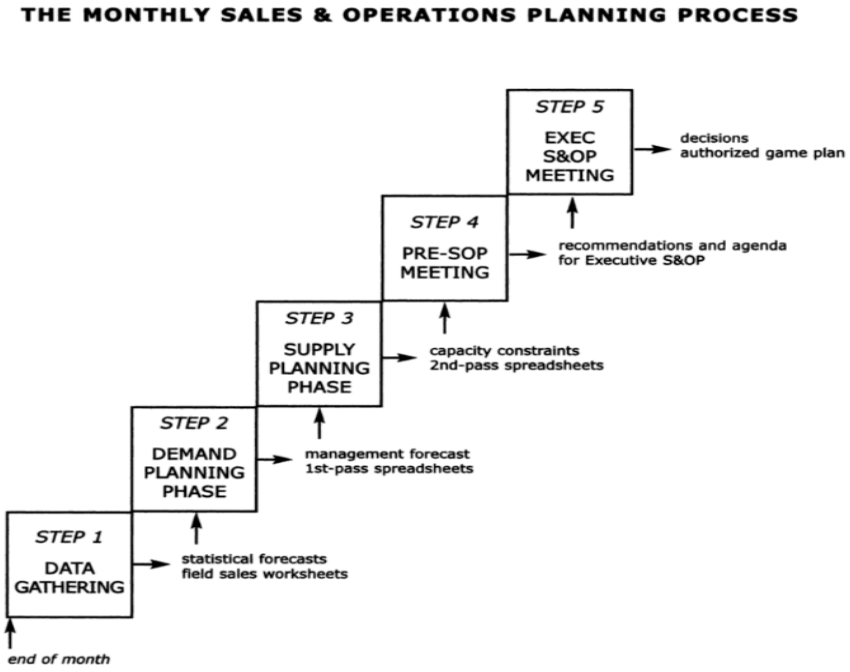


Figure 1 – S&OP process structure (R. A. Stahl & Wallace, 2008a)

2.4.2 Data gathering

According to Falck & Småros (2013), it is a difficult task to decide the level of detail required in the S&OP process. Hence, the decision-making must be done based on accurate and adequate data and information, to ensure that each process step is executed and evaluated based on relevant data to achieve the best possible result. To ensure that the data is sufficient and as accurate as possible organizations can do data audits, do validation checks, and regularly perform data cleaning activities. Clean and reliable data is the core for the S&OP process to work efficiently (Falck & Småros, 2013a).

In the 1990s organizations had to manually extract, clean, filter, and analyze the data required for the S&OP cycles. Today, companies can rely on real-time data and extract it from data archives, and databases or access it through data clouds. Many authors

and sources like Stahl & Wallace (2011) & Wagner et al. (2014) still admit that data gathering is the first step in an S&OP cycle. Other sources claim that data gathering is more of an everyday process for all departments rather than a specific S&OP process step. As a result of a study conducted by IBF (Institute of Business Forecasting), it was evident that under 5 percent of the respondents used a designated process step for data gathering. Anyhow, many stated that they use tools and practices for forecasting, reporting, creating baselines for plans, and other data-related activities. However, this does not lessen the relevance of using factual and accurate data when running the monthly S&OP process, because data is still the core of S&OP (Wilson, 2021).

Although organizations today have access to real-time data, the S&OP process needs to be executed on monthly snapshots to enable the possibility of comparing current plans with previous plans and actual performance. It would almost be impossible and time-consuming to update plans and trace changes if real-time data were used when running the S&OP process since there would be changes all the time (Wilson, 2021).

Typically, the required data for the S&OP process is gathered at the end of each month for the upcoming cycle and consists of data varying from sales trends, actual sales, manufacturing, backlogs, and inventory levels. This information is later in the process used to, for example, generate baseline demand forecasts, financial plans, and operation plans based on planning parameters, requirements, or other inputs from the planners (Wagner et al., 2014). The data is typically sourced from different parts of the organization, or possibly handled by the IT department (Russell, 2023).

2.4.3 Demand Planning

Once the required data is collected, the S&OP process continues with the demand planning step. Ambrose & Rutherford (2016) & Wagner et al. (2014) emphasize that during this phase the sales organization produces a sales forecast. The forecast should not be constrained by the company’s operational capabilities or supply abilities, but

rather focus on possible sales volumes if supply capacities are infinite. Another important aspect the sales organization must consider when creating the demand forecast is to integrate foreseen marketing strategies, like the introduction of new products and endorsement or advertising campaigns. Likewise, the demand forecast must be translated and aligned into financial plans to support the forecast of the future financial performance of the company. Hence, sales must be closely interacting with colleagues from the finance and marketing departments (Ambrose & Rutherford, 2016b; Wagner et al., 2014).

R. Stahl (2010) further highlights the essence of historical views and data when sales personnel generate the monthly forecast, on top of inputs from marketing and financial departments and customers. All the inputs are required to carry out unity on the demand plan, and this is usually done through a demand agreement meeting (R. Stahl, 2010b). During the demand planning step, it is important to build a forecasting process that is collaborative and includes both statistical and critical elements. This forecast is compared with the organization's yearly business plans and then handed over to the persons responsible for the supply planning step (Ross, 2005).

Furthermore, Grimson & Pyke (2007) underline the importance of selecting a correct and meaningful planning horizon, when executing the demand forecasts. Generally, they lie in intervals between half a year and up to three years. Usually, the most standard planning horizon is between six and eighteen months. Anyhow, there are discrepancies between industries when it comes to the planning horizon, depending on the frequency of the S&OP cycles, the timing of the S&OP cycle, and product seasonality. Companies with lengthy lead times for production and a lot of seasonality usually have long planning horizons. Industries with shorter lead times and little seasonality utilize shorter horizons (Grimson & Pyke, 2007a). A third option companies can use is a rolling planning horizon. This approach is used when organizations must incorporate quick short-term decisions into their long-term plans (Cuisinier et al., 2021).

Several authors like (Grimson & Pyke, 2007b; R. Kumar & Srivastava, 2008b; Schorr, 2007; R. A. Stahl & Wallace, 2008a) are aligned with the expected outcome of the demand planning phase. That is through collaboration, creating an unconstrained demand plan that must be based on consensus and inputs from various stakeholders. Another outcome that Boyer (2009) highlights is the aspect of reviewing and analyzing previous months performance, and if the gaps between plans and actuals are too large, a root-cause analysis can be conducted to detect the reason behind the gaps and find possible solutions to minimize the gap (Boyer, 2009). Organizations can gradually improve the quality of the demand plans by measuring different key performance indicators or other potential metrics. These can, for example, be forecast accuracy and hit rate for sales among many others (Schorr, 2007).

The moderator or person in charge of the demand planning face is usually a demand planner or demand manager. This person gathers all the relevant inputs, facilitates the demand planning meetings, consolidates the final version of the consensus demand plan, and hands it over to the person(s) in charge of the next step Schorr (2007), described in the upcoming section (2.4.4).

2.4.4 Supply Planning

Several authors (Ambrose & Rutherford, 2016a; Cecere et al., 2009a; Grimson & Pyke, 2007a) state that the outcome of the demand planning meeting serves as the core input for the supply planning phase. Grimson & Pyke, (2007) further emphasize the importance of collecting additional inputs during this phase, for example, inventory policies and different capacities related to production, logistics, supply chain, and resources. Once these are gathered, the demand plan is utilized as a base to generate an initial supply plan, also called a rough-cut capacity plan. An initial supply plan should consider all the demand stipulations. Many companies typically first generate an unconstrained supply plan where the supply resources are considered infinite (Grimson & Pyke, 2007a).

Once the unconstrained supply plan is created, Cecere et al., (2009) state that based on the outputs from the demand planning phase, a constrained supply plan must also be generated. The constrained supply plan evaluates the best way forward for the business based on profitability, return on total assets, working capital, and customer service level. Furthermore, all identified constraints, demand shortages, and capacity opportunities should be highlighted and serve as inputs to the pre-S&OP meeting. A good practice many companies have adopted to cover demand fluctuation and forecasting errors is to generate supply plans with both flexibility and agility (Cecere et al., 2009a).

Ávila et al., (2019) also emphasize the importance of collecting relevant information related to internal and external capacities. Internal capacities mainly concern inventory policies, production capacities, resource requirements, logistics, procurement, packing, storing, or any other supply chain-related capacity. External factors are likewise essential to gather, if possible, these can be capacity constraints at suppliers, ports, truck companies, or any other constraint like country regulations. Once all the inputs are collected the data is compared against the demand plan and the best options based on customer service, profitability, and revenue work as input to the pre-S&OP meeting (Ávila et al., 2019a).

In the supply planning phase, the participants should present production, logistics, purchasing, engineering, and finance. Bower, (2006); Cecere et al., (2009) have identified different job roles, working in the departments mentioned above. It is also essential that the S&OP process owner is present during the supply planning process. Another important aspect is that if a company has production at several plants or countries inputs, feedback, and suggestions are collected from all stakeholders.

According to R. A. Stahl & Wallace, (2008), the monthly supply planning process can be further divided into five sub-processes. These five sub-processes are presented in Figure 2 below.

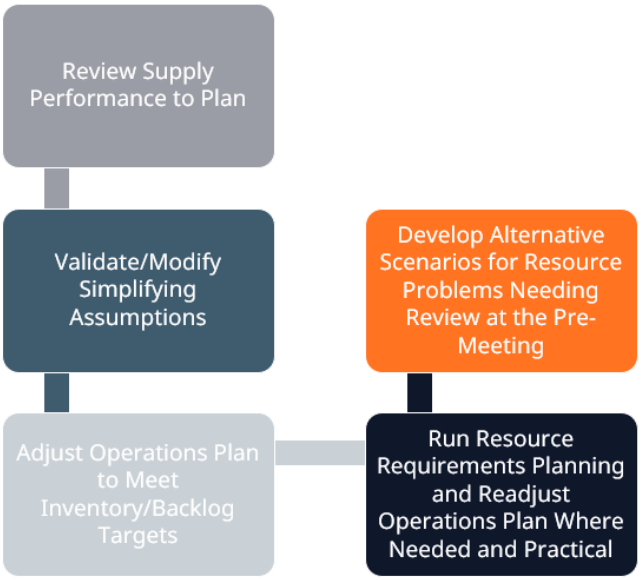


Figure 2 - S&OP Supply Planning Sub-Processes (R. A. Stahl & Wallace, 2008a)

In the first sub-step, the actual performance of the supply chain is compared against the last month's supply plan. The focus during this step is to identify variations in the supply chain internally and externally. If a gap is identified, actions must be taken to resolve the root cause to avoid similar issues in the upcoming S&OP cycles. In the following step, the main assumptions of the S&OP teamwork against validated and modified if required. These assumptions can typically be resource requirements needed to produce a specific product, production lead time, or any other supply chain-related assumption.

In the third step, current inventory amounts are analyzed, together with the previous month's actual sales and production data. These numbers are compared against the new sales forecast generated in the demand planning phase. After this, the responsible team will have visibility if the inventory and the backlog estimate will be higher or lower than the company’s inventory and backlog target. Moving on to the fourth step, where the output from the first sub-step validate/update the simplified assumptions are utilized. These outputs support generating an estimated workload for each resource based on the forecasted sales demand for different products. This process also

enables the supply team to compare their required resource capacity versus the available resources. Hence, issues or risks can be flagged early enough, when they can analyze whether the plan is doable to execute (R. A. Stahl & Wallace, 2008a).

Finally, in the last step alternative scenarios are developed to solve identified supply capacity unbalances. Some concrete actions companies can do here to increase the capacity are to work overtime, add employees, increase shifts, move some of the load to an alternative plant, or use subcontractors. If there still is a capacity overload, the following action would be to decrease the demand. All the alternative scenarios must be well documented since they must be presented at the pre-S&OP meeting (R. A. Stahl & Wallace, 2008).

2.4.5 Pre-S&OP

Once the previous process steps are completed, representatives from different departments reconcile to solve the potential chasm between demand and supply, related to current business plans, policies, and strategies. During the pre-S&OP meeting, a collective proposition and general recommendations and suggestions are prepared for the executive S&OP meeting, as well as the agenda for the executive S&OP meeting (Seeling et al., 2022b).

According to Ávila et al., (2019), representatives gather around the table to start developing the final S&OP plans related to demand and supply, which will serve as a baseline for the next S&OP cycle. The plans must ensure that the organization's strategic business goals are satisfied without jeopardizing the harmony between demand and supply. To ensure that different demand and supply planning scenarios must be generated to resolve potential risks or any other event that might have a direct negative impact on the business performance. By creating scenarios, the team can also identify potential business opportunities, which can be part of the proposition proposed during the executive S&OP meeting (Ávila et al., 2019a).

Bower (2005) claims that the pre-S&OP meeting is where identified issues are addressed. Through various metrics and methods like gap analysis, the organization's performance can be measured and monitored. If any gap is identified between expected results or actual results and business targets/goals, the gap must be earmarked with a monetary value and then prioritized from the highest to lowest value. He further highlights that it is up to the team participating in the pre-S&OP meeting to propose resolutions and generate ideas and alternative scenarios to mitigate or close the potential identified gaps (Bower, 2005b).

Some concrete actions executed during the pre-S&OP meeting are according to R. A. Stahl & Wallace, (2008) to review constraints related to resource, capacity, or demand. If constraints are detected one way to mitigate the constraints is to prioritize the demand. Additionally, it is essential to oversee and plan inventory levels, manufacturing, shipments, order backlogs, and sales to be able to propose or make necessary changes to the demand and supply strategies. Some of the expected tangible outcomes of the pre-S&OP meeting are firstly to generate an adjusted financial plan, which highlights the financial view for the business moving forward. Moreover, a suggestion or proposal whether there is a need to adjust the operations plan and/or sales plan either by increasing or decreasing. Eventually, if no adjustment is required the proposal would be to make no changes and keep the current demand and supply volumes. Also, decisions related to resources must be tackled, whether it is to reduce/add employees, outsource activities, add machinery, add/reduce work shifts, or offload work to another plant with free capacity (R. A. Stahl & Wallace, 2008a).

At the pre-S&OP meeting, attendance of several functions is required to get a holistic overview and alignment from a demand, supply, capacity, resource, and financial point of view. The main representatives at this meeting are typically the process owner, and line managers from sales, supply management, product development, finance, project management, operations, and service (Ambrose & Rutherford, 2016b).

2.4.6 Executive-S&OP

The last step in the overall S&OP process is called executive S&OP, where senior leaders evaluate and review the suggested S&OP plan from the previous step Pre-S&OP meeting. Additionally, during this phase, important decisions are made, and the final S&OP plan is approved. Executive S&OP is typically occurring during the last week of each month (Anonymous, 2023). An executive S&OP meeting is not limited to but can consist of three common steps. The first step is to review the S&OP plans and recommendations suggested in the previous process steps. During the review, executives must assess whether the plans are reasonable and possible to execute. The plans must be aligned with the company's overall strategic goals, and all potential challenges or risks related to the plan should be thoroughly reviewed and highlighted. Once the plans are reviewed key decisions must be made related to production, operations, or sales that can have an impact on financials. Lastly, the final plan is approved and distributed to the organization (Anonymous, 2023).

Stated by Cecere et al., (2009), the goal of the executive S&OP meeting is to reach a consensus on the final S&OP plan. Additionally, the past month's performance should be reviewed, and lessons learned should be adopted in the upcoming cycle. The measures that executives should focus on are profitability, cash flow, inventory levels, revenue, customer service, and accuracy of the sales forecast. These measures should be evaluated based on actual versus expected analysis. Furthermore, R. A. Stahl & Wallace, (2008) point out objectives like approving adjustments in procurement or production rates since these are tied to high costs. Also, the recommendations and policies suggested in the pre-S&OP meeting must be reviewed and necessary adjustments to balance demand and supply are approved or modified. During the executive meeting fundamental decisions related to challenging projects, concerns related to new products, or issues regarding customer service should also be addressed (R. A. Stahl & Wallace, 2008a).

After the potential modifications and adjustments are completed during the meeting the outcome is an approved business plan. This plan includes everything from sales, marketing, order backlogs, deliveries, inventory levels, and production rates. It is essential that all planning and execution activities are well in line and synchronized with the approved business plan from the executive S&OP meeting. Another important aspect is that the decisions are recorded, and the MOM is well documented so that the approved plan can be easily and consistently shared with the whole organization (Bower, 2005b; Boyer, 2009a; Wallace & Stahl, 2006b).

According to Ambrose & Rutherford (2016); R. A. Stahl & Wallace (2008) it is essential that all departments, for example, sales, supply chain, operations, logistics, marketing finance, etc., are all represented during the executive S&OP meeting. Typically, it is the heads of each department that participate. Furthermore, it is also wise to include the person in charge of the pre-meeting since he or she can easily explain the recommendations and suggestions made during the pre-meeting. The executive meeting facilitator is typically the S&OP process owner or an executive representative from either operations or the supply chain. Either of these bears the responsibility of summarizing and coordinating of the main advices and action points for decision-making collected from the previous pre-S&OP meeting (Dunn, 2019).

2.4.7 S&OP process success factors and enablers

Mr. Lapide (2004) debates about S&OP success factors in his article published in the Journal of Business Forecasting. Below in Figure 3 a consolidated list of the main success factors of S&OP are highlighted.

SUCCESS FACTORS OF SALES & OPERATIONS PLANNING (S&OP) PROCESS

1. Ongoing, routine S&OP meetings
2. Structured meeting agendas
3. Pre-work to support meeting inputs
4. Cross-functional participation
5. Participants empowered to make decisions
6. An unbiased, responsible organization to run a disciplined process
7. Internal collaborative process leading to consensus and accountability
8. An unbiased baseline forecast to start the process
9. Joint supply and demand planning to ensure balance
10. Measurement of the process
11. Supported by integrated supply-demand planning technology
12. External inputs to the process

Figure 3 - S&OP Success factors (Lapide, 2004b)

First, he highlights the importance of establishing proper meeting procedures and routines, including recurring meetings with a monthly cadence. Furthermore, the meetings must be well prepared and structured, follow a defined and agreed agenda, and a strict schedule. The meetings should at least cover the last cycle plan versus actual performance and consensus of demand and supply plans so that the monthly plans can be published and distributed to the whole organization.

Another important aspect is that each function, people involved in the monthly S&OP cycles, and those responsible for the planning must do the groundwork before the monthly S&OP meetings. For example, demand and supply plans must be compiled and synchronized for leaders before the meetings. To get this working systematically the S&OP process must be executed by a multidisciplinary team consisting of employees from sales, supply management, marketing, finance, and customer service. However, just having a cross-functional team participating in the meetings is not enough, people must actively participate and manage their areas of responsibility to contribute to the overall process.

It is essential as well that the representatives involved in the process have the authority to make decisions on forecasts or supply plans. Normally, executives transfer the re-

sponsibility of decision-making to their subordinates. Because of this, a conclusion must be reached during the S&OP meetings, hence, it is recommended not to ask executives for blessings or approvals after the meetings. The S&OP process must be a synergistic process where every individual must manage to rapidly create, update, check, and revise plans to ensure acknowledgment from the whole company.

One of the core success factors highlighted by Lapide (2004) is how important it is to have a baseline demand forecast. This forecast works as the baseline for all planning, and from this, the final demand and supply plans are developed. The baseline forecast should be unconstrained and is usually created with a statistical forecast approach. The demand and supply planning should be done as a joint exercise, otherwise, the process can become inflexible, and opportunities or risks may not be detected. To continuously improve the S&OP process it is essential to measure its performance of it. A common measurement is the accuracy of the demand forecast. Nevertheless, more measurements like variance in supply plans, forecasts, or financial plans should be established to support the process to reach the next level.

Several organizations use Microsoft Excel spreadsheets when running their S&OP process, the issue with spreadsheets is to synchronize and compile them into one file or plan. To solve this problem organizations most likely buy software for demand planning, this can help temporarily, but to completely support the S&OP process an advanced planning system integrated with data from the demand, supply, and financial side is needed to take the process to the next level. Finally, it can also be very beneficial to increment the S&OP process with external data sources. Usually, only internal data sources are used like sales data, purchase orders, inventory levels, shipments, and manufacturing inputs. However, companies can generate a lot of added value and insight by adding external inputs to their S&OP process. External inputs can be information shared by suppliers or contractors, market intelligence, or other customer behaviour patterns. All factors mentioned in this section can be used by organizations to

benchmark how mature their S&OP process is and how it can be improved further (Lapide, 2004b).

According to Tuomikangas & Kaipia, (2014), one of the key enablers of successful S&OP is performance management. The authors highlight that S&OP performance management can be categorized into three subgroups: financial, process, and operational performance.

Grimson & Pyke (2007b) also emphasize the importance of measuring the efficiency of the S&OP process. Additionally, they claim that metrics are vital for continuous improvement during the implementation of S&OP. The metrics or KPIs can differ between companies and industries. Anyhow, some of the most common measurements for the supply side are order fulfillment, inventory levels, quality, capacity utilization, delivery reliability, or cost variation. For new product releases, follow-up metrics can be the cost of development, time for ramp-up, or time to market. When it comes to sales, common metrics are demand accuracy, volume growth, or market share. Senior leaders are especially interested in the last group of measurements related to finance, where gross margin, ROI, net sales, order intake, or market value are typical measurements. On the other, Grimson & Pyke (2007b) state that metrics related to the S&OP process efficiency are quite uncommon.

If a company wants to continuously improve its S&OP process, it must also measure the performance of the process itself. From an historical perspective performance indicator have mainly focused on individual steps of the process, like forecasting accuracy for sales and different ways to calculate and highlight actual demand volumes versus planned sales volumes. Due to changing business environments, increased market complexity, and harder competition companies have switched focus towards measurements, focusing on the S&OP program, to stay competitive. A good example is to measure the gross margin, where both the demand and supply sides are incorporated into the metrics (Muzumdar & Fontanella, 2006b).

Different systems and tools can support companies in getting live data and updates on key performance indicators. Typically, the KPIs are related to supply chain flows, value streams, profitability, customer satisfaction, gross margin, volume growth, or order fulfillment rate. Generally, these KPIs can be visualized through dashboards in tools like PowerBI or any other applicable reporting solution. The metrics must be reviewed continuously and revisited and changed according to needs and requirements, this is the key for S&OP to be and stay successful in the long run (Hart, 2023).

To take the most out of S&OP and increase the possibilities to generate the expected benefits it is important to run the process through adequate alignment, communication, and collaboration within the whole organization. Even though it is essential to get inputs from all teams involved in the monthly S&OP process it's recommended to assign one person who is responsible for driving the S&OP process forward. This will result in improved communication and feedback loops, enhanced decision-making, and stronger negotiation. He further states how important it is to share feedback and information across different departments and involved stakeholders. The S&OP team can take advantage of feedback from customers, suppliers, or any other stakeholder and for example, increase customer satisfaction and improve product quality and lead time (Kelwig, 2023).

2.5 Linkage between S&OP and Supply Chain Management

S&OP can be seen as a fundamental part of supply chain management. The process helps supply chain management with visibility of demand, volume, and mix. Without this information, the SCM organization would have a hard time planning the production, resources, logistics, and purchasing activities as well as the possibility to react upon demand volatility and adjust itself according to volume changes. Hence, S&OP enables supply chains to operate more effectively and with less possibility of interrup-

tion anywhere in the supply chain flow (R. A. Stahl & Wallace, 2011b). In Figure 4 below, the linkage between demand, finance and supply planning is outlined.

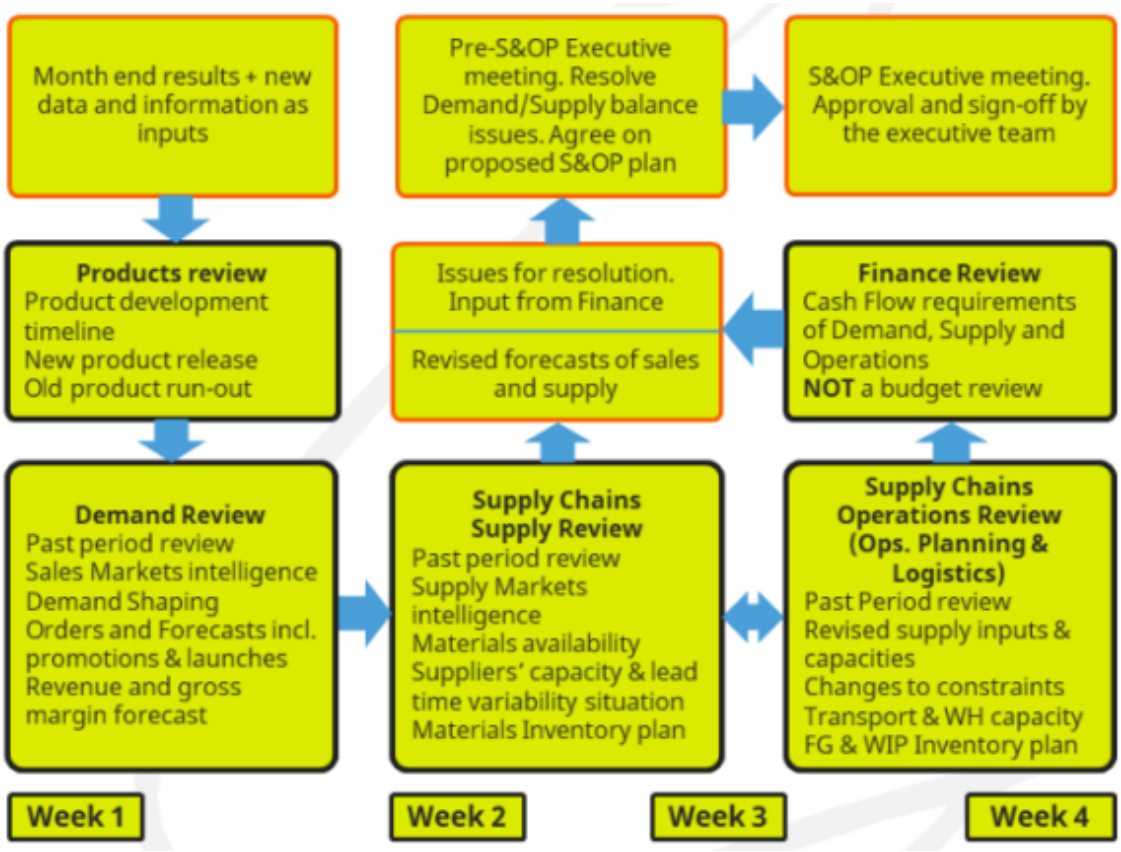


Figure 4 - Linkage between S&OP and supply chain planning (Oakden, 2021)

From Figure 4 above we can see how closely supply chain management, typically responsible for supply planning is with the other elements of S&OP.

Bower (2006) states that S&OP can generate great value in different aspects of supply chains. Firstly, improved demand forecasting practices will lead to more sufficient and accurate supply chain planning, which eventually results in happier customers. He also highlights the reduction of inventory levels by dividing it into two aspects, minimizing obsolete inventory and decreasing the overall inventory (Bower, 2006b).

A typical supply chain has stakeholders in two directions. Suppliers looking backward, and customers looking forward. If the organization located in the middle of the chain fails with S&OP, the likelihood that any of the other supply chain stakeholders either when looking backward or forward will get accurate information to work against is close to zero. Hence, if S&OP is executed effectively, the greatest benefit for the supply chain is improved customer satisfaction and customer service (R. A. Stahl & Wallace, 2008a).

If customer service is seen as the greatest benefit to customers, S&OP also contributes to benefits for suppliers. These benefits can be very similar to what the company itself can achieve. Some of these benefits S&OP can generate for external suppliers are through the visibility of better possibilities to plan production and other supply chain activities upfront, which results in a stable manufacturing flow. Furthermore, S&OP supports suppliers in determining their inventory levels better and helps them to react better to small or drastic changes in either volume or mix, which will enable them to act before it is too late or too expensive to adjust. Hence, S&OP and especially sharing volume and mix forecasts with external suppliers can improve both the internal and external flows in the supply chain (Dederichs, 2024).

S&OP can also contribute to more sustainable supply chains by connecting the dots between sustainability activities and other supply chain operations. Practically, S&OP can minimize waste if there is a harmony between demand and supply. By generating accurate demand forecasts and coordinating the supply side, companies can reduce waste and resource utilization and prevent excess inventories. Furthermore, S&OP enables possibilities to improve the planning of logistics operations, which naturally results in a lower carbon footprint. S&OP can also improve the collaboration between vendors on sustainability practices. Fundamentally, S&OP can have a central role in improving sustainability in supply chains, by supporting companies to run profitably whilst reducing their overall environmental footprint (Thieuleux, 2023b).

2.6 S&OP Roles and Responsibilities

Muzumdar & Fontanella, (2006b) emphasize the importance of having support from the executive level, without this backing, there is a high probability that S&OP will fail. Another essential aspect is to build a cross-functional team around S&OP involving responsible persons from sales, marketing, finance, supply chain, project management research and development, and technology. Having a cross-functional team improves collaboration and communication practices and generates better visibility across the organization (Muzumdar & Fontanella, 2006b).

According to Boyer (2009), there is a small team running the main activities in the S&OP process and typically consists of representatives from IT, demand/sales, operations, accounting, and a top management representative. Since S&OP at its best is a very data-driven process, that needs adequate data, data processing, system knowledge, and reporting competencies it is necessary to involve an IT expert. The demand manager is responsible for generating sales information in a functional and practical format that supports the process. This person must have a good understanding of different business systems extensive knowledge of working with spreadsheets, and superior expertise of the business and products.

From supply chain management a person who has a broad proficiency in procurement, production, material planning, scheduling, logistics, and inventory management. A person from finance and business control should also be involved to ensure that the financial aspect is considered in the S&OP process. He or she ensures that the S&OP process is designed so it supports financial planning and reporting. Finally, the S&OP process should be led by a process owner who typically reports directly to someone in the executive team (Boyer, 2009). Figure 5 below highlights the high-level responsibilities and common actions executed during each S&OP process step.

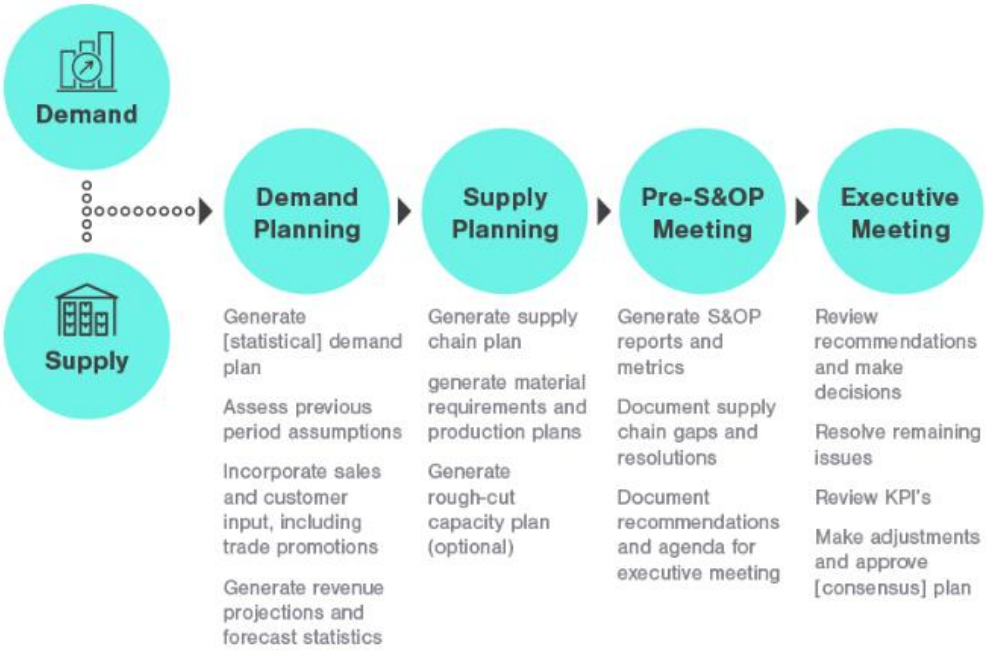


Figure 5 - S&OP responsibilities at each process step (Food, 2022)

One common reason why S&OP stalls in many companies are according to Singh (2010), that there is no defined team for it. Hence S&OP does not receive the same recognition as functions like sales or supply chain management. Usually, organizations have small cross-functional teams running the S&OP process, but some companies also just have ad-hoc teams picked from different departments. Either way, many times S&OP S&OP-related tasks are not their main responsibilities. A proper S&OP process requires a lot of planning, analysis, and follow-up which demands great commitment and permanent team members. Another essential aspect is that S&OP requires a proper structure and authority for decision-making. All these aspects together with clearly assigned roles and responsibilities are key enablers for S&OP (Singh, 2010b).

As specified by Messias (2018), each S&OP team member must know what's expected from them in each step. An RACI matrix can be used to support a company to clarify and highlight the roles and responsibilities of each team member and team within the S&OP process. He also highlights that the RACI model must be created by someone or

persons who understand the company's S&OP structure, process, network, and responsibilities. Furthermore, he describes the RACI model as an effective tool to support identifying and visualizing the roles and responsibilities for a specific deliverable or project. RACI stands for responsibility, accountability, consulted, and informed (Messias, 2018).

2.7 S&OP in an Engineer-to-order environment

S&OP has since been acknowledged as a business process, gained maturity, and enhanced remarkably but unequally between industry sections. According to Kristensen et al. (2018), a common design concept of S&OP is suited for most industries. Anyhow, the nature across businesses impacts the final design (Kristensen & Jonsson, 2018b).

Phenomenons like COVID-19, globalization, digital transformations, and competitive markets put high pressure on organizations to sustain profitability and ensure their effectiveness (Buer et al., 2018). In line with both Kristensen et al. (2018) and Shurrab et al. (2020) companies operating in an ETO environment usually face high complexity in operations compared to MTS (make-to-stock) environments. Additionally, most of the existing research on S&OP is designed and based on mass production or high-volume businesses, like wholesale or food production. Due to this the current directions and guidelines available on S&OP design for ETO environments are restricted. And no guiding framework exists (Shurrab et al., 2020a). The available frameworks, for example, the five-step process, support organizations in high-volume businesses to determine the inventory levels and manufacturing volumes based on their demand forecasts and planned capacity levels. Contradictory, in an ETO environment, the current S&OP frameworks do not clarify or support organizations when the operations are executed based on client orders, and the forecasting precision is weak (Adrodegari et al., 2015).

An engineer-to-order environment is a manufacturing strategy. One of its main characteristics is that the products are customized based on customer requirements, and no actions are carried out before the customer has submitted a purchase order. On top of manufacturing ETO products also requires design and engineering activities. For the above reasons, an ETO environment results in wide product diversity and low volumes for each product (Duchi et al., 2014).

Challenges emerging in an ETO environment are mainly the variation of the volumes in sales. It is challenging to mitigate the sales fluctuation and predict the future. Another challenge is the long lead times for both components, raw materials, and manufacturing times. For this reason, ETO products usually have longer lead times. Organizations utilizing an ETO strategy tend to have a competitive edge in capabilities such as new product releases and technologies (Vollmann et al., 1997).

The nature of ETO environments generates significant complexity in planning. Hence, it is essential to utilize specific tools and special applications to perform detailed planning (Wikner & Rudberg, 2005). Some examples of the tools are advanced planning and scheduling systems, production planning, and collaborative planning (Buer et al., 2018b). It is important to master how the planning environment and the requirements work to select and implement a suitable planning practice. A lack of synergy between the planning environment and production can influence a company's performance negatively (Jonsson & Mattsson, 2003).

3 Methodology

This chapter outlines the research design and method utilized during the research. Furthermore, the different data collection methods and data analysis techniques are presented. The sampling technique is highlighted, and the credibility is evaluated through the validity and reliability section. This chapter aims to guarantee transparency so that everyone reading this understands how the research was executed and how the data was collected and analyzed.

3.1 Research design and method

The objective of this research is to get a deep understanding of how S&OP can be performed in a project-based complex environment, its benefits, challenges, and associated roles and responsibilities. Hence, a case study design was adopted to achieve the objectives of the thesis and answer the research question. A qualitative method is selected to collect data and evidence to solve the research problem. Both primary and secondary data sources are collected and analyzed. McCombes (2023) describes a case study as comprehensive research of a particular case, like an individual, a society, a gang, a situation, an occasion, or a business. They are frequently used in many research areas, for instance in business, social, and academic research. Generally, a case study design is associated with qualitative methods, yet occasionally, quantitative, or mixed methods are used. A case study is particularly useful for defining, assessing, analyzing, and interpreting a research problem from different perspectives (McCombes, 2023).

To get a comprehensive overview of S&OP in a project-based environment and support the case study the following qualitative methods are used: semi-structured interviews, observations, and assessing secondary company data.

3.2 Data collection

When a researcher undertakes a case study approach it is essential to collect data from various sources. Either by using a quantitative method like questionnaires and raw data or through any of the following qualitative methods: interviews, focus groups, or observations. A mixed method combining qualitative and quantitative methods can increase the validity of the case study. Even though using a mixed method might support the researcher better to gain a broader perspective of the subject, than when using a standalone method (Mason, 2017) & (Stake, 1995).

For the semi-structured interviews is essential to select the population and the right participants to be interviewed. Hence, the selected sampling technique used to conduct the semi-structured interviews is the quota sampling method. Quota sampling is according to Duane (2005) a non-random sampling technique where the contributors are selected based on fixed skills and attributes representing the whole population. One of the strengths of a quota sampling method is that the sample can be managed and guarded for specific characteristics. Since, quota sampling doesn't use random selection, and the researcher chooses who to include in the sample, one of the consequences can be selection bias (Duane, 2005).

In this research, a semi-structured interview approach was used during the interviews to retrieve data for the case study. It allows the respondents to express their thoughts on the subject openly, and a few questions are prepared before the interviews to guide the discussion in the wanted direction. The semi-structured interviews were carried out during the second half of 2023. The respondents are all professionals with responsibilities varying from planning to mid-executive roles. They all have a central role in the company’s monthly S&OP cycles, which gives an extensive view of the complete S&OP process. The interviews were held virtually through Microsoft Teams and face-to-face. In total 10 interviews were conducted. Before the interviews, some premade questions were carefully thought out. These were mainly based on the research objectives and questions and could vary slightly depending on the role of the interviewee.

All the answers, feedback, and main outcomes received during the interviews were stored and compiled. These were then analyzed and used as one of the core sources to reach the research objectives. In table 3 below the interviewed persons from the case company are presented.

Role	S&OP responsibility	Department	Gender	Year of experience	Interview duration
GM Supply Planning & Development	Supply Planning for Auxiliary equipment	SCM	Male	> 10 years	30 min
GM Supply Strategic Supply Management	Sourcing	SCM	Male	> 10 years	23 min
GM Logistics	Logistcs	SCM	Female	> 10 years	19 min
GM Procurement	Procurement	SCM	Female	> 5 years	22 min
Demand Planner	Demand Planning	Sales Management	Female	> 10 years	31 min
Volume Planning Manager	Supply Planning for Gensets	Sales Management	Male	> 10 years	32 min
GM PMO	S&OP Procss Owner	EEQ Project Management	Male	> 10 years	29 min
Project Manager Resourcing	Supply Planning for Manpower	EEQ Project Management	Male	> 10 years	28 min
Business Development Manager	Front sales	Sales	Male	> 10 years	20 min
Senior Solution Architect S&OP	IT / S&OP Architect	IT	Male	1 year	26 min

Table 3 - Interviewed persons

The table highlights the persons role in the organization, their S&OP responsibility, to which department they belong to, their gender, years of experience in the company and the length of the interview.

Another form of data collection method used during this case study was observations. By adopting this method researchers can according to Hennink et al (2020), methodically discover and document persons opinions, reactions, actions, and synergy. During an observation, the researcher should observe, listen, cross-examine, and record individuals' reactions, opinions, attitudes, body language, etc (Hennink et al., 2020).

Different observations made during 2023 were also part of the data collection method. The observations were primarily observed and collected during meetings, workshops, benchmark sessions, and casual conversations. The main observations were discovered

throughout the meetings carried out as part of the case company's monthly S&OP cycles. In Table 4 below, the different observations are highlighted.

Type	Observations	Notes
Demand review meeting	Who is leading, who is speaking, interactions, communication flow, inputs & outputs, how bottlenecks are resolved, decision making	How the process is executed, current challanges, opportunities and responsibilities
Demand scenario meeting	interactions, communication, decision making, visibility, transparency	How is the alternative demand planning scenarios generated and based on what grounds
Capacity planning meeting	Who is leading, who is speaking, interactions, communication flow, inputs & outputs, how bottlenecks are resolved, decision making	How the process is executed, current challanges, opportunities and responsibilities
Pre-S&OP meeting	Who is leading, who is speaking, interactions, communication flow, inputs & outputs, how bottlenecks are resolved, decision making	How the process is executed, current challanges, opportunities and responsibilities
Executive S&OP meeting	Who is leading, who is speaking, interactions, communication flow, inputs & outputs, how bottlenecks are resolved, decision making	How the process is executed, current challanges, opportunities and responsibilities
S&OP Benchmarking with other business units	how is the other business units operationg, can something be copied, what challanges do they face	Identify new ways of working and opportunities
S&OP development meeting	Identify process bottlenecks, issues, risks and improvement areas	identify current bottlenecks and how these potentially can be solved
Informal discussions	painpoints, what is working well, benefits, challanges, improvements	Identify issues and opportunities

Table 4 - Observations

Through the observations, the researcher received a detailed understanding of the case company's S&OP process, potential obstacles, possible improvements as well as roles and responsibilities for the different stakeholders involved.

In addition to the primary data collected through the semi-structured interviews and observations, different secondary data sources were also collected and analyzed in the case study to gain a deep understanding of the case company's monthly S&OP cycle and supply planning process. The secondary data used varied from records available from similar business and industry sectors, blog posts, online journals, and other publications. Internal data retrieved from the case company's intranet was also used, like business presentations, organization charts, process guidelines, and annual reports. Above all existing data and information connected to S&OP and supply planning were analyzed to support reaching the objectives. These were different presentation materi-

als, S&OP meeting cadence templates, and old process charts. The core sources used to extract them were Microsoft Teams, SAP, SharePoint, and Intranet. In the table below different secondary data types and their respective data source are presented.

Data Type	Data Source
Monthly S&OP data	Excel, PowerBi & Microsoift Teams
Planning Parameters	SAP, Excel, Logistics software, Sharepoint, Microsoft Teams
S&OP summaries	Excel, PowerBi & Microsoift Teams
Consolidated S&OP Plans	Excel, PowerBi & Microsoift Teams
Planning Scenarios	Excel, PowerBi & Microsoift Teams
Pre & Executive S&OP decisions	Excel, PowerBi & Microsoift Teams
Annual Reports	Company Intranet
Organization Charts	Company Intranet
Process Charts	Company Intranet

Table 5 - Secondary Data

3.3 Data analysis

The obtained data from the data collection were mainly analyzed through thematic and content analysis, to analyze the content and identify patterns and similarities in the data. Data from the semi-structured interviews and observations used both thematic analysis and content analysis. The data from the literature review and secondary company material were analyzed with the content analysis method. Table 6 below presents the data analysis type for each data collection method. Furthermore, the content of all the collection methods is highlighted in the last column named content.

Collection Method	Data Type	Type of Analysis	Content
Literature review	Qualitative	Content Analysis	Literature, concepts, frameworks and theories of S&OP, process steps, benefits, challanges, enablers, roles and responsibilities
Semi-structured interviews	Qualitative	Thematic Analysis & Content Analysis	Interviews from key S&OP contributors in the case company
Observations	Qualitative	Thematic Analysis & Content Analysis	S&OP meetings: demand review, demand scenario, capacity planning, financial review, pre-S&OP, executive S&OP. S&OP improvement workshops, benchmarking and blueprinting sessions
Secondary company data	Qualitative	Content Analysis	S&OP montly cycle data: demand inputs, supply inputs, outcomes, summaries, suggestions, planning scenarios Company reports, documents, process charts, organization charts

Table 6 - Data analysis and collection methods

3.4 Validity and reliability

Both validity and reliability are essential quality features for qualitative research and support the separation of low-quality and high-quality research from each other. Validity and reliability facilitate convincing the audience that the obtained results are reliable and credible. Ensuring that this quantitative research was both reliable and credible, the research questions and objectives were clear and logical. Several data collection methods were used to ensure that the data were reliable. The sample size was sufficient and had several representatives with similar roles, responsibilities, and accountabilities. All departments and S&OP process steps were covered in the interviews and observations.

Furthermore, to ensure the credibility of the research a comprehensive case study method was selected to give detailed insights into the research subject. During the semi-structured interviews, a pre-made interview protocol was designed and used as support during the interviews. To ensure that the questions were clear to avoid errors and participant bias, which can be a threat to the credibility of the research. The questions were asked and reviewed before the interviews with several employees who did

not take part in the official interviews. All participants were also informed about the topic and how the interview would be conducted to make sure everyone was aligned. All interviews and observations were also recorded to avoid losing valuable information or misinterpretations in the future.

Furthermore, to increase the reliability existing company material and relevant theories were analyzed on top of the findings obtained from the interviews and observations to endorse the results from the empirical study. Additionally, to strengthen the validity of the research the results were compared and connected with existing theories to indicate that the research easily can be generalized.

4 Detailed case company introduction

This intrinsic investigation is completed for an international company operating in the energy and marine markets, offering sustainable solutions and world-class services for customers worldwide. They have three independent businesses consisting of several business units. This research is conducted for the business operating in the energy market, specifically for the business unit offering engine power plant solutions to its customers. In 2023, the case company had a total order intake of approximately 7 billion and net sales of 6 billion, while the operating result was around 4 billion.

With the support of innovative technologies and services, the case company tries to empower sustainable communities. Their vision is to work for a completely renewable future in the energy sector by providing flexible balancing solutions to promote decarbonization. The company's main customer segments are the industrial sector, utility sector, mining sector, data centers, municipals, and independent power producers. During 2024 the company expects the demand to increase compared to the previous year.

The business unit's delivery projects can vary in nature and scope, depending on whether it is an EEQ project (engineered equipment delivery), extended EEQ project, or EPC (engineering, procurement, and construction) project. Due to specific customer requirements, country regulations, and grid code requirements, the nature of the business environment is engineer-to-order. Furthermore, the business unit faces high complexity, demand fluctuations, and weak forecasting precision. Some essential equipment is manufactured in-house, but most products and systems are sourced from external suppliers.

In Figure 7 below the case company’s engine power plant organization chart is highlighted. Where S&OP is highlighted as one main function, even though no fully allocat-

ed team or department runs the process. It is a cross-functional effort with members from almost all the other departments highlighted in Figure 8 below.

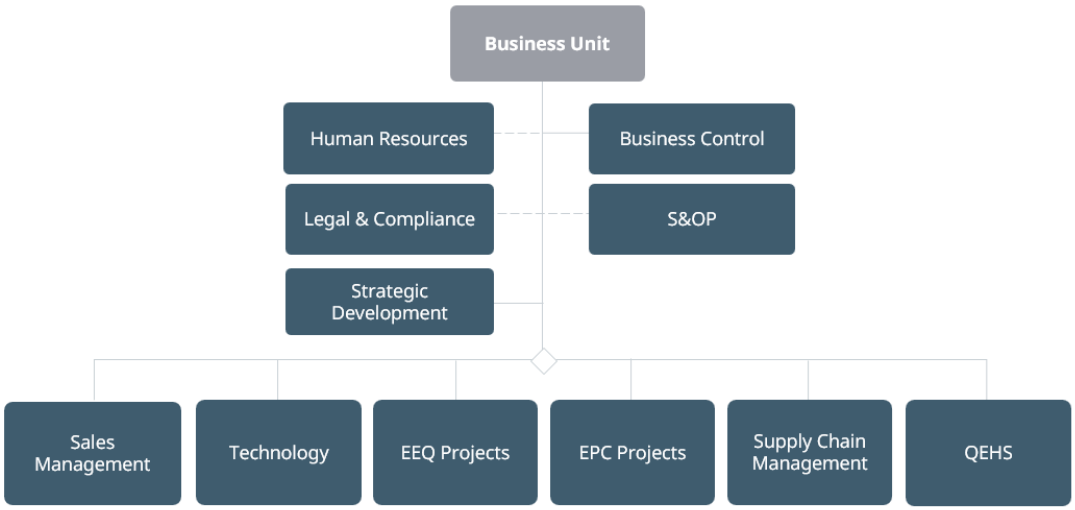


Figure 6 - Case Company Organization Chart

At the end of 2022, the case company initiated and implemented an S&OP process for the engine power plant business. To improve project portfolio management, collaboration, and risk management, avoid cost overruns, improve capacity utilization, and boost overall profitability. The process is performed in monthly cycles and consists of 4 main steps: demand planning, capacity planning, pre-S&OP, and executive S&OP. Due to low demand volumes in 2023, the performance of the current S&OP process has not been properly tested. If the demand volumes increase during 2024, the current process set-up can be too time-consuming and might not have the required resources, commitment, data, performance management, and systems to support the company in the future. It might simply be too challenging to evaluate the feasibility of the demand plan. Due to some of the identified process bottlenecks during this research, for example, many manual inputs, ad-hoc team, data accuracy, data availability, missing connectivity between systems, and lack of performance management. In Chapter 5.1 the case company's S&OP process is described in detail.

At the end of 2022, the case company announced and introduced a transformation program. To drive a healthier business and new ways of working together. This realignment program consists of three building blocks, which are highlighted in Figure 9 below.

Figure 7 - Case Company realignment focus work packages: new ways of working, Sales and Operations Planning and Performance Management.

As highlighted in Figure 9 above, S&OP is one of the three building blocks. Sales and operations planning is a strategic priority and a must-win battle for the case company. With the implementation of the process, the case company desires to improve project portfolio management, collaboration, and risk management. Synchronously, avoid cost overruns in projects to boost profitability. The goal is to implement the S&OP process during 2023 and then continuously improve the process.

5 Results

In this chapter, the empirical results are presented. First, the case company's S&OP process is described and mapped. Each process step is outlined in detail. The gained benefits are presented in Chapter 5.2, and the identified challenges are highlighted in Chapter 5.3. The result section ends with S&OP roles and responsibilities. Everything in this chapter is based on the interviews, observations, and reviews of existing case company material.

5.1 Case company S&OP process overview

The objective of this chapter is to give a comprehensive presentation of the case company's S&OP process, how each process step is executed, the people involved, and the inputs and outputs for each step. The S&OP process overview is one of the outcomes of the interviews, observations, and review of secondary company material. The company currently uses a planning horizon of five financial quarters forward, and the S&OP process is performed in monthly cycles.

In Figure 10 below the four L1 (Level 1) S&OP processes are highlighted. The S&OP process consists of four major process steps, which are demand planning, capacity planning/supply planning, pre-SOP, and Executive S&OP. The data-gathering step is not an official step and happens on an ad-hoc basis.

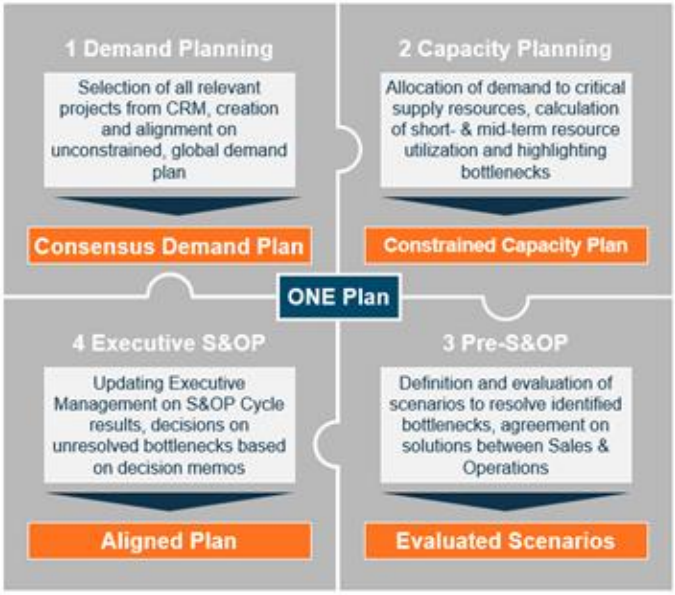


Figure 8 – Case company Level ONE S&OP process chart.

Each level-one process highlighted in Figure 10 above has several subprocesses, and they must be carried out thoroughly and in a disciplined manner. Figure 11 below provides further insight and a deep dive into the subprocesses of the case company's S&OP process. Each of these process steps, will be thoroughly explained in the upcoming chapters.

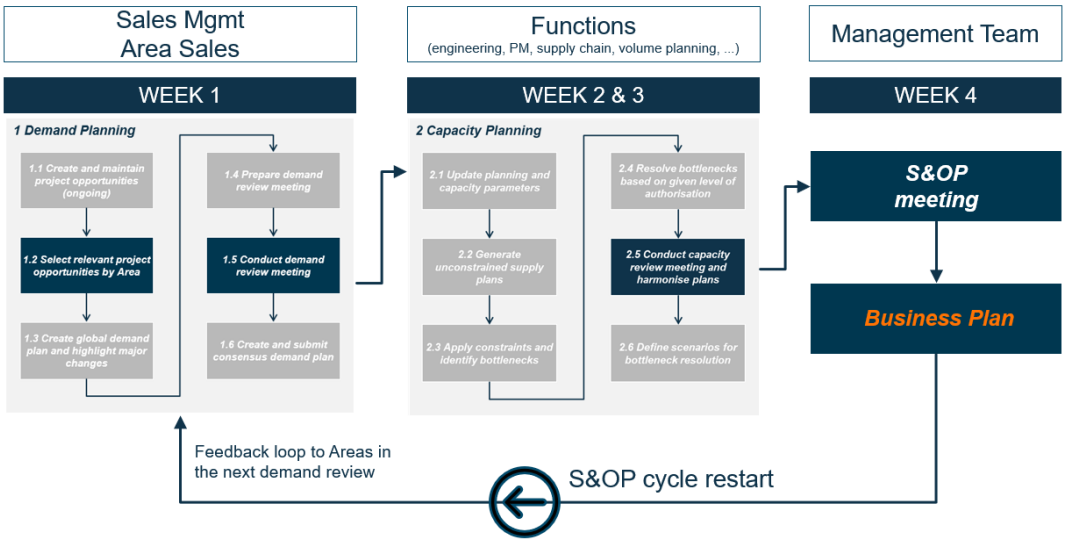


Figure 9 - Case company Complete S&OP process flow.

5.1.1 Demand Planning

The monthly S&OP cycle starts with demand planning during the first week of the cycle. This process step is led by the demand planner working in the sales management team. The demand planner is responsible for running each subprocess executed as part of the demand planning process, these are highlighted in Figure 12 below.

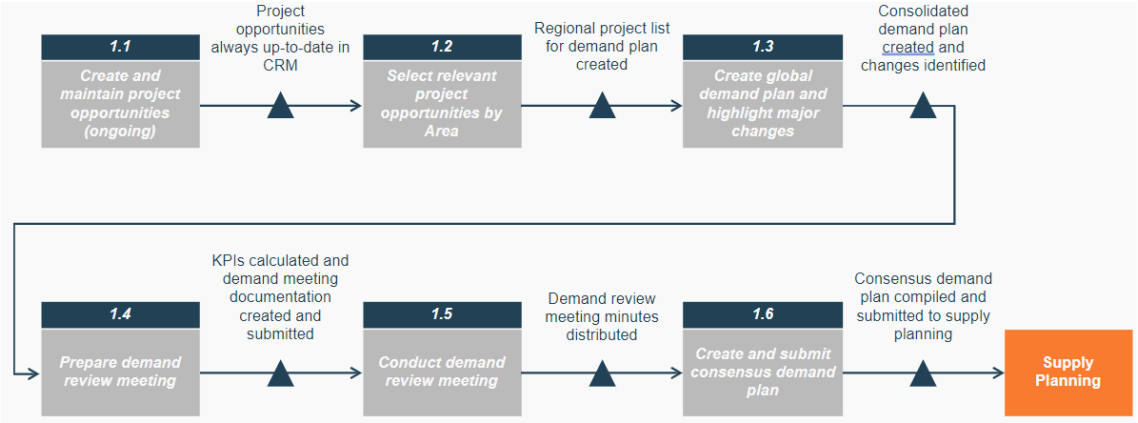


Figure 10 - Demand Planning Process

The first step 1.1, creating and maintaining project opportunities, is an iterative process where the BDMs (Business Development Managers) representing the front sales ensure that all potential sales opportunities, are created in CRM (Customer Relationship Management) and the existing ones are updated when required, and new information appears. The company's sales pipeline consists of all potential sales opportunities, but only the sales projects with the highest probability of materializing are included in the demand plan. During step 1.2, relevant project opportunities are selected by the area/regional teams for the regional demand plan. The regional teams review the complete sales pipeline and pick the most likely sales deals with a close date within the 5-quarter planning window, to be included in the demand plan.

After this, the areas review the regional demand plan and further finetune it. There are currently three areas Americas, Europe & Africa, and Middle East & Asia. The sales opportunities that eventually are included in the global demand plan are also lifted to the

sales state “forecast”, the project opportunities left out of the forecast are not deleted from the sales pipeline but are considered “backup projects”. It is common from cycle over cycle that some opportunities are lifted from back-up to forecast or degraded from forecast to back-up. Once the Area sales teams have selected the opportunities, they strongly believe that the demand planner uses these inputs and creates the consolidated consensus demand plan. Every month, a comparison with the previous demand plan is generated.

Before the demand review meeting is held, some essential preparations are undertaken. First, highlights from the current month’s demand planning cycle are presented. Typically, the number of sales opportunities included in the demand plan is highlighted, the monetary value of these, and how many Gigawatts they equal combined. Key changes compared to last month are highlighted for each Area. Both in the number of opportunities, net sales, number of key equipment, and Megawatts. Sold deals are emphasized and suggested/proposed actions for the upcoming cycle are presented. In Figure 13 below an example is presented of highlights from a demand review meeting.

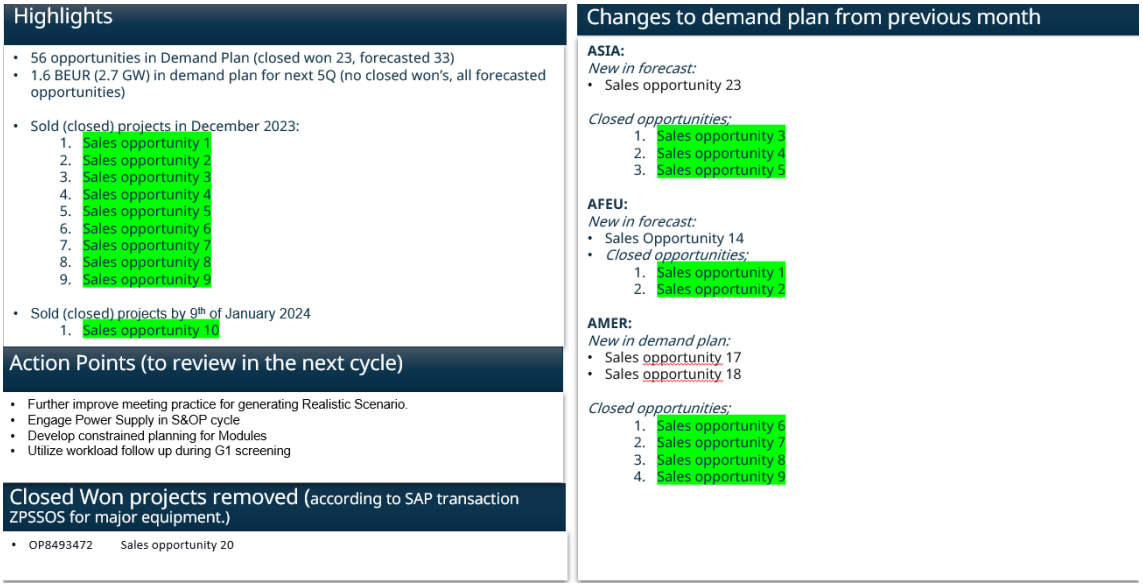


Figure 11 - Demand Review meeting highlights

The consensus demand plan is visualized in different ways to highlight aggregated volumes in terms of net sales, count of sales opportunities, and Megawatts. These aggregated volumes can then be filtered and shown per sales area, scope type, or by sales stage. One example of an aggregated volume visualization is shown in Figure 14. Figure 14 highlights in the x-axis the scope type, and the bars symbolize the aggregated net sales for the demand plan while the legends (colours) indicate the aggregated sales stages. These numbers are fabricated and do not reflect the reality of the business.

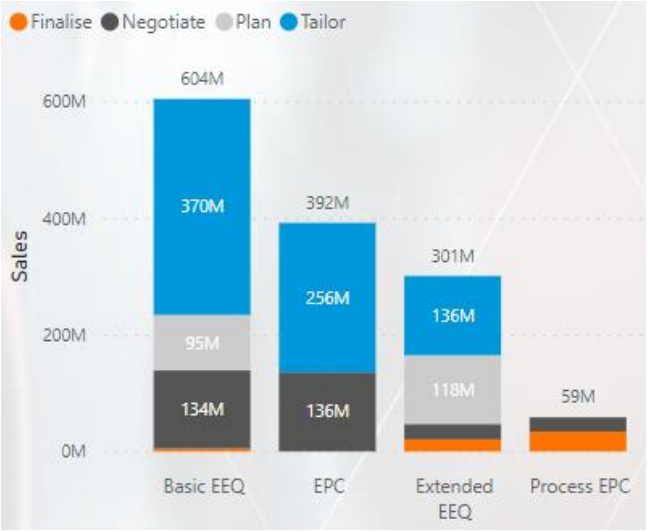


Figure 12 - Demand Plan Aggregated volume visualisation example.

Once the demand review meeting is completed, the meeting notes and the consolidated consensus demand plan are submitted to the organization. This demand plan is then used as a base to build different demand scenarios, presented in the following chapter 5.1.2.

5.1.2 Planning scenarios

It is an important part of the case companies' monthly S&OP process to plan against different demand plan scenarios. On average, the demand plan typically consists of 40-60 sales opportunities varying heavily in terms of scope, value, and delivery schedule. Unexpectedly losing or winning an unplanned sales deal, especially a large one, can

significantly offset business volumes, destabilize capacity utilization, or result in unplanned delays that ultimately impact business performance. To mitigate that the demand volumes must be carefully evaluated against a different mix of projects. Evaluating different demand scenarios versus the supply capacities will enable more flexibility to prepare and plan the required capacities to fulfill the demand.

Once the monthly demand plan is published two additional demand scenarios are generated. A key learning the S&OP team has identified is that the first version of the demand plan that is submitted tends to be quite optimistic. Many sales opportunities have unrealistic closing dates, effective dates, and delivery dates. Unrealistic dates can, for example, be identified through the stage of the opportunity. If an opportunity has a close date within one to two months but is still in a plan stage it is very unrealistic that it will materialize within a couple of months. Unrealistic dates can also be identified through repeated customers, where historical data can support identifying patterns and how long time it takes for the customer to get funding etc. Another reason why the first version of the demand plan tends to be too optimistic is that each sales area has KPIs and targets, hence, many times the demand plan can consist of “unrealistic” sales opportunities to meet the sales targets.

The first scenario is a realistic scenario called scenario (R). This scenario is developed through a realistic scenario meeting and consists of all the forecasted sales opportunities included in the first demand plan. The difference between the initial demand plan and the realistic scenario is that the closing and effective dates are adjusted based on customer insight, country-specific events like the presidential election, global issues, historical data, and gut feeling. Typically, the dates are pushed into the future this results in a more realistic short-term demand volume estimate that will push the wave of supply volumes beyond the critical planning window. The realistic scenario is also used as the base input for capacity/supply planning in the case company. All alternative scenarios generated during the supply planning phase if any imbalances between demand and supply are detected, use this realistic scenario as a base. In alternative scenarios,

the delivery dates can be modified by preponing or postponing equipment deliveries for sales projects. This exercise aims to balance the throughput and have a stable and equal production volume internally and externally.

A second scenario is also generated, and this is mainly executed to support financial planning and forecasting to get a financial overview and outline for the next five quarters. As one can understand, this scenario is more conservative than the first demand plan and the realistic scenario. In the conservative scenario, some sales opportunities are less unlikely to materialize at all or within the planning horizon. During some cycles, additional scenarios can be generated, based on needs. These scenarios are mainly for the simulation of supply capacities for potential new markets or large tender programs to simulate the supply capabilities if the company would win x amount of these deals. In Figure 15, below the cumulative value for five financial quarters forward for each scenario is presented. The numbers are fabricated and do not reflect the actual/forecasted outlook of the business.

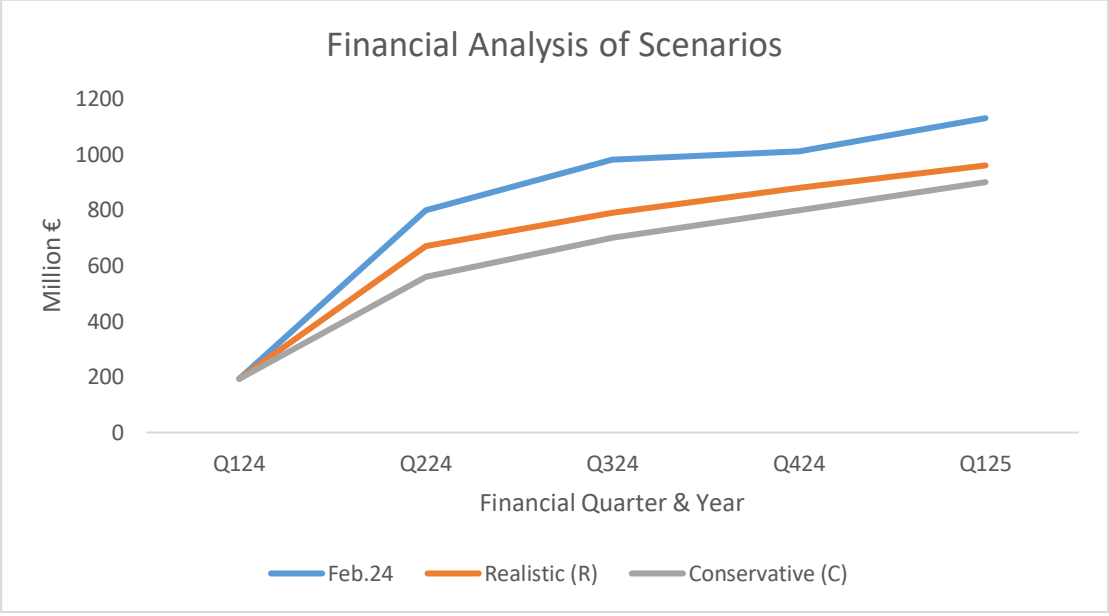


Figure 13 – Scenario analysis fictive cumulative value five financial quarters forward.

This overview, highlighted in Figure 15 above, gives a good indication of which direction the business is heading. It has, during many consecutive S&OP cycles, been noticed that many sales opportunities are pushed forward due to the volatile nature of the market. On the contrary, it has also been observed that the conservative scenario many times can be too conservative. Hence, this visualization is excellent since it's typically very likely that the actual sales generated from the demand plan lie somewhere in this window between the blue and the grey lines.

5.1.3 Capacity Planning

The S&OP process continues with the capacity planning phase during weeks two and three. During capacity planning, teams working in operations (Project Management, Engineering, and Supply Chain Management) evaluate the feasibility of the demand plan. Key questions that, must be answered here are: can we, with current supply capabilities and available resources, fulfill the demand plan and or the different demand scenarios? Is it possible to find alternative solutions when imbalances occur to deliver according to customer expectations?

The capacity planning is divided into three major resource areas: Manpower, Gensets, and Auxiliary equipment. Manpower represents both internal project team resources and external engineering resources that are supposed to execute the sales opportunities in the demand plan when they materialize. The gensets are the most crucial products in a power plant, these products are also produced internally (in-house). The auxiliary equipment consists of all the external supplies, that are essential in project deliveries. The gen-sets are always under the case company's responsibility, while the scope of auxiliary equipment can vary a lot from project to project depending on project type, country, and customer. Only critical auxiliary equipment is considered in the S&OP process, these are equipment with either capacity or lead time constraints.

All three resource areas mentioned above are continuously monitored and can change cycle over a cycle. That means that there might be additional resources added to the

monthly process, for example, if the lead time increases drastically for equipment that has been excluded from the capacity planning earlier it should be added. Hence, all resource areas and types are compared against some conditions and criteria. If any of the following conditions are met for any resource it must be included in the capacity planning phase: the resource is a bottleneck, the resource can't be offloaded, long lead time, expensive to underutilize, or capacity changes.

Like the demand planning process, the capacity planning process consists of many sub-processes. These subprocesses are highlighted in Figure 16 below.

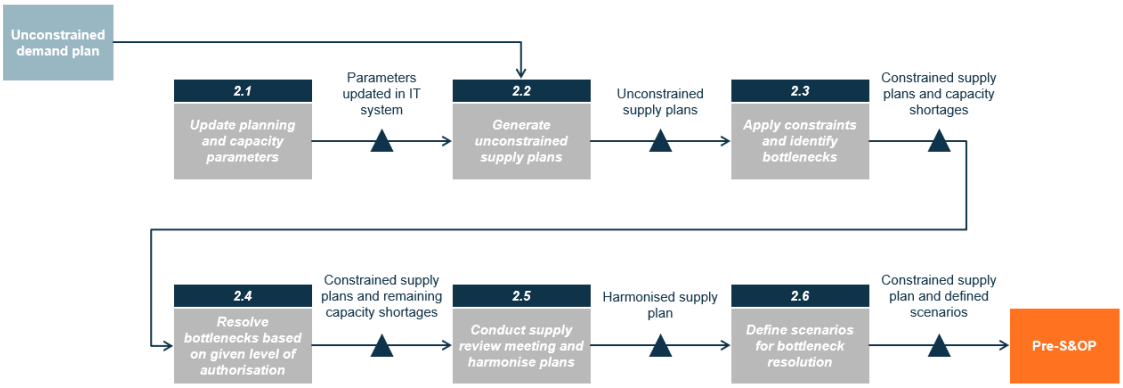


Figure 14 - Capacity/Supply Planning Process

The capacity planning process starts when the consensus demand plan and different demand scenarios are handed over to the operation teams from the demand planner. One activity that can be completed before this is 2.1 update planning and capacity parameters. The planning parameters are updated in IT systems whenever possible, but some of the parameters are also updated manually in Excel spreadsheets. These planning parameters are mainly capacities for manpower, gen-sets, and auxiliary equipment, but also lead times for equipment and logistics, actual manpower utilization, and external supplier allocations are updated every month.

The first planning step is to generate unconstrained supply plans for all three planning areas manpower, gensets, and auxiliary equipment. The demand plan and alternative

scenarios are translated into workload for each resource/product and evaluated against all critical supply resources. When unconstrained supply plans are produced, the initial assumption is that the resource capacity is infinite. Moving forward in the process next action is to apply capacity and lead time constraints and, by doing that identify potential bottlenecks and issues. Once the constraints have been applied, and bottlenecks and issues identified, the operation team must resolve these by suggesting alternative solutions, either by, for example, preponing, postponing production by offloading volume to an alternative source (vendor), or adding more resources.

Once the bottlenecks are resolved constrained supply plans are generated. At the following step 2.5, all three supply planning areas meet by conducting a supply review meeting, where the supply plans are harmonized. The final supply planning scenarios for bottleneck resolution are defined and agreed upon in step 2.6. Finally, the constrained supply plan and defined scenarios, as well as recommendations for the Pre-S&OP meeting are published. These constrained supply plan recommendations and suggestions given by the operations team work as one of the core inputs for the Pre-S&OP meeting described in chapter 5.1.5.

Figure 17 below illustrates the three different supply planning areas the final supply plan is generated, based on. All three supply planning areas will be described more in detail in the next three chapters.

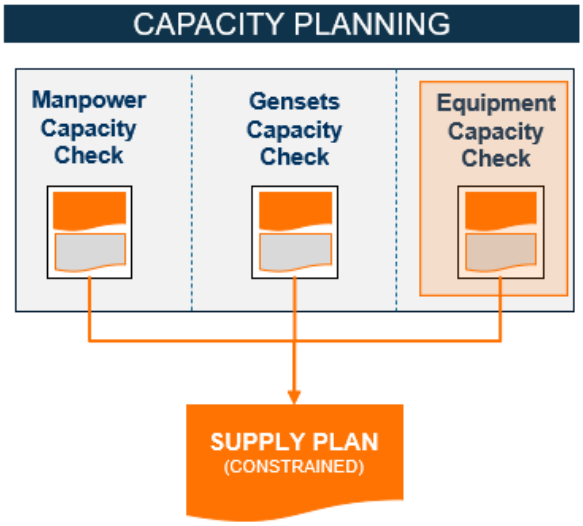


Figure 15 – The three different supply planning areas

5.1.3.1 Manpower

The first identified critical resources in the supply planning process are internal and external Manpower resources. These resources are crucial project team members who are needed to execute and deliver the customer projects. Since many products and systems delivered in the projects are tailor-made according to customer requirements a lot of engineering is required. Hence, it is also essential to have available capacity from external engineering resources. This activity is led by the S&OP process owner, having a dual role, and also working in project management as a general manager. The activity is also strongly supported by an assigned project manager, together with the general managers for each engineering discipline.

It is through developed project and resource archetypes possible to simulate how much manpower it requires to fulfill the sales projects in the demand plan and scenarios. The available resources at hand can vary from month to month since the critical resources also work on already-sold projects that currently are being executed and delivered to customers. All critical resources report their actual working hours for execution projects, which enables the possibility to calculate the free/available capacity

for each month. Hence, it is possible to say that the future estimation of workload for manpower is generated from the demand plan, and the available capacity is generated through analysis of the project execution portfolio.

In Figure 18 below, a simulation of the total aggregated workload needed based on the demand plan for project managers and chief project engineers versus the actual available resources is presented. The blue bars indicate the resource requirement per month generated from the demand plan, while the orange line highlights the available resource capacity.

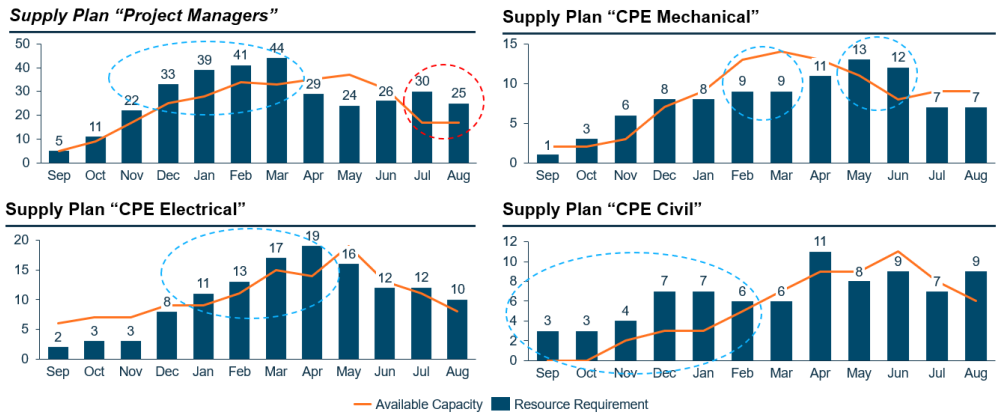


Figure 16 – Internal manpower constrained supply plan visualization

As seen in Figure 18, there are some unbalances where there is a gap between available resources and the resource requirement. These gaps are highlighted with light blue circles. The red circle indicates that there is an underutilization in July and August for project managers. For the project team organization, the next step here would be to figure out how to solve these imbalances between demand and supply. If a resource type is either over or under-loaded, as in Figure 18, different options can be utilized to rectify the situation.

These options can be to use overtime, add more resources, add shifts, offload work to another resource, use subcontractors, adjust the delivery schedule for sales opportunities, or negotiate the effective date of the contract with the customer. If none of the

above options solves the problem there will be an imbalance between demand and supply, and hence, the demand plan is not feasible to execute. The last option when there is zero possibility to increase the supply capacity, is to reduce the demand. The supply plan and potential resolutions to solve imbalances for manpower works as the first of three inputs to the supply review meeting where the supply plans are harmonized into a consolidated supply plan before the pre-S&OP meeting. The second input to the supply review meeting is the gensets described in the next chapter.

5.1.3.2 Gensets

The second supply planning area is the gensets. This equipment produced internally has a long lead time, and capacity constraints and constitutes a large part of the total customer delivery scope value. There are two different product families large bore and medium bore. Each product family consists of several product types or product mixes serving different purposes like fuel types, efficiency, plant configurations, or load type (base load, balancing, or peak load). Responsible for the supply planning of gensets is purely the genset volume planning manager, in close cooperation with sales, finance, and supply chain management.

As for the manpower, the aggregated future volumes are generated from the demand plan or scenarios. In Figure 19 the aggregated volume is presented for the large bore product family. This figure shows how the anticipated future demand for the equipment is distributed each month. The blue bars indicate that the equipment is ordered from the factory, while the green bars illustrates that there is available capacity to satisfy the demand volumes with missing orders.

Figure 17 - Aggregated volume view for large bore product family

As one can see from Figure 19 above the demand is low some months, even zero for a couple of months. Since these equipment's are produced internally, there is also here an imbalance between demand and supply, and it is also expensive to keep the factory underutilized. Hence, as part of subprocess 2.4 highlighted in Figure 16 on page 61, one action can be to generate different planning scenarios by changing the delivery dates for some sales opportunities by preponing or postponing the manufacturing to stabilize the production volumes to get a more equal divided manufacturing flow.

That is a very challenging task due to long lead times for some of the key components required to produce the gen-sets. Sometimes, the gen-sets are even ordered from the internal factory without a firm customer order to ensure on-time delivery of components. Naturally, this can be very risky and costly since the customer for the preordered equipment that was intended might cancel or postpone their order. Typically, during these kinds of circumstances, the equipment is reallocated to another customer, if possible, otherwise, they are stored until it's possible to allocate them to a delivery project.

Another visualization of the supply plan is presented in Figure 20 below. In this figure, the constrained supply plan is visualized in an aggregated view for the medium bore product family, where the capacity constraints have been applied on top of the demand generated from the demand plan.

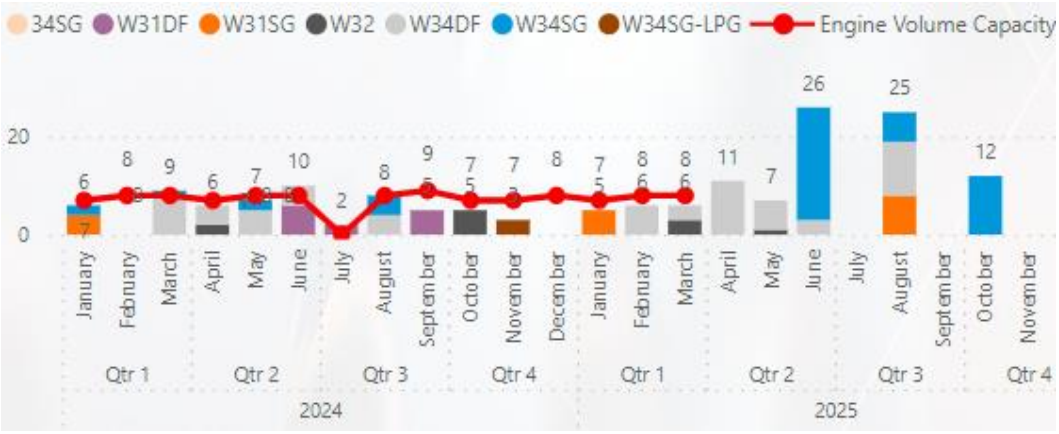


Figure 18 – Constrained supply plan visualisation for medium bore product family

The bars indicate how the aggregated demand is distributed month by month, per quarter, and year. The different colour legends show the product types or the product mix, while the red dotted line is the available capacity for each month. In July the capacity is zero since it is summer vacation time in Finland. So, the demand for two pieces should be moved to another month. The demand is also higher than the available capacity in June, and an alternative scenario must be generated to solve these bottlenecks. The realistic scenario described in chapter 5.1.2 is one example of an alternative scenario, where the delivery dates for the gensets are changed, to better reflect the reality. The resolutions and supply plan for gensets work as the second input to the supply review meeting, where all the supply plans are harmonized into one consolidated supply plan. The last supply planning area is the auxiliary equipment which will be further described in chapter 5.1.3.3.

5.1.3.3 Auxiliary Equipment

This last supply planning area is different compared to manpower and the gensets. The auxiliary equipment is ordered and delivered from external suppliers. Depending on the project scope, the magnitude of the auxiliary equipment varies a lot. If the project, for example, is an EPC (engineering, procurement, and construction), the amount of different auxiliary equipment is much higher compared to a Basic EEQ project.

The auxiliary equipment can be categorized into three main disciplines: mechanical, electrical, and civil materials. Each discipline has its constraints, and they are a bit different compared to each other. For electrical equipment, the current constraints are mostly related to long lead times and component shortages. While civil materials like steel structures and wall panels only have capacity constraints. In the mechanical discipline, both lead time and capacity constraints are present. It must also be highlighted that not all auxiliary scope items/equipment are considered and reviewed during the supply planning process, many are also left out of the process completely. Only equipment with an identified constraint is monitored throughout the process. Every month, an internal alignment meeting within supply management is held to review which equipment to include or exclude. That means that the equipment types can vary from cycle to cycle.

Another important planning aspect where the auxiliary equipment differs from the other supply planning areas is that both the unconstrained and constrained supply plans for auxiliary equipment, are solely based on the adjusted realistic scenario where the delivery dates for the gensets are modified. The reason behind this is that many of the auxiliary equipment with capacity constraints are delivered together with the gensets. Likewise, if a sales project has an F incoterm like FOB or FCA the customer is responsible for the transportation, and customers usually want to pick up all auxiliary equipment that is ready for delivery when the gensets are ready. Hence, it makes sense that the planning of auxiliary equipment is based on the delivery dates of the gensets.

Otherwise, the creation of the unconstrained supply plan for auxiliary equipment works similarly, as for the manpower and genset, the demand volumes are generated from the revised realistic scenario. Then the distribution of the aggregated volumes is visualized, it is also possible to view demand volumes for specific products or aggregated views per suppliers. The auxiliary equipment is in an early stage and allocated to external suppliers to ensure production slots and, by that secure capacity.

Supply constraints are then applied to the unconstrained supply plan, where product and supplier-specific capacities are inserted together with the latest lead time information. The external supplier capacities can also differ from month to month because they also have other customers that consume capacity from their factories. In Figure 21 below a constrained supply planning view of the cooling radiators is presented. The orange bars symbolize the future demand distribution, while the blue bars show the ordered volumes for cooling radiators. The red line is the capacity available from the external suppliers. Figure 21 is also an aggregated view of all cooling radiator suppliers, where the available capacity (red line), for example, is a combined available capacity from multiple vendors.

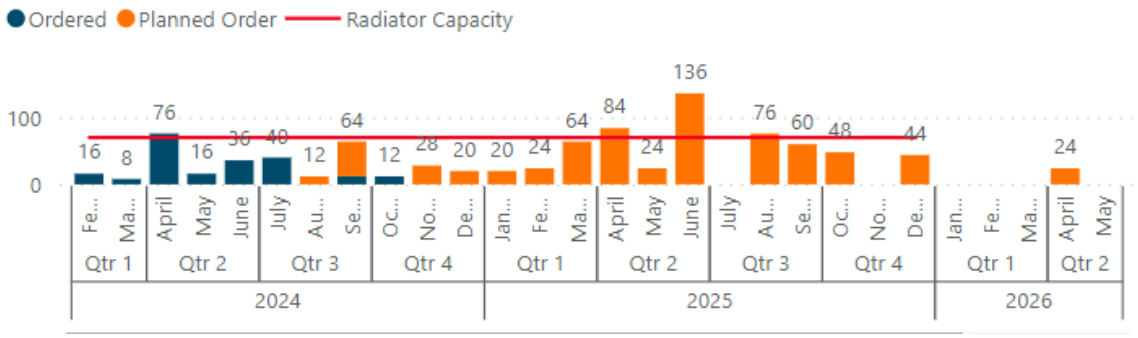


Figure 19 – Cooling radiator constrained supply plan visualization

If bottlenecks remain after the supply constraints are applied to the demand they must be solved/mitigated. By generating alternative supply planning scenarios, where, for example, load leveling or production smoothing has been utilized to have a more equal volume and manufacturing distribution. Even though the auxiliary equipment is externally sourced it is important to keep the demand and supply in balance. Both heavily overutilized and underutilized suppliers might have an impact on the project deliveries in the end, both from a monetary value and from a risk perspective. Some of the suppliers are extremely dependent on the case company, and if the demand volumes are too low, some suppliers might face bankruptcy.

The lead time for all auxiliary equipment involved in the supply planning process is also compared against the obligations in the customer sales contract, meaning the contractual delivery time. If the lead time for any of the auxiliaries is longer than the contractual delivery date they are highlighted. Figure 22 highlights the view where the equipment lead time is compared with the contractual delivery time. As noticed from Figure 18 there are some sales opportunities containing equipment that has a longer lead time than what has been promised to the customer. That is also a bottleneck/issue that must be solved, either by preordering these materials, or negotiating with the customer for extended delivery time, or eventually finding an alternative supplier that can deliver within the required time frame.

Opportunity Name	Scope	Delivery Date	Incoterm	Project del time	Equipment	Equipment lead time	Equipment status	Equipment lead vs. Project del time
Sales opportunity 1	Basic EEQ	15.9.2025	FCA unloaded	8	Electrical 1	7.50	CRITICAL	0.50
Sales opportunity 1	Basic EEQ	15.9.2025	FCA unloaded	8	Electrical 2	8.00	DELAYED	0.00
Sales opportunity 2	Process EPC	31.8.2024	DAP	6	Electrical 1	7.50	DELAYED	-1.50
Sales opportunity 2	Process EPC	31.8.2024	DAP	6	Electrical 2	8.00	DELAYED	-2.00
Sales opportunity 2	Process EPC	31.8.2024	DAP	6	Electrical 3	12.00	DELAYED	-6.00
Sales opportunity 3	Extended EEQ	30.6.2025	CIF	5	Electrical 1	7.50	DELAYED	-2.50
Sales opportunity 3	Extended EEQ	30.6.2025	CIF	5	Electrical 2	8.00	DELAYED	-3.00
Sales opportunity 4	Extended EEQ	30.4.2025	FCA unloaded	3	Electrical 1	7.50	DELAYED	-4.50
Sales opportunity 4	Extended EEQ	30.4.2025	FCA unloaded	3	Electrical 2	8.00	DELAYED	-5.00
Sales opportunity 5	Extended EEQ	28.2.2025	CIF	7	Electrical 1	7.50	DELAYED	-0.50
Sales opportunity 5	Extended EEQ	28.2.2025	CIF	7	Electrical 2	8.00	DELAYED	-1.00
Sales opportunity 6	Extended EEQ	30.11.2024	CIF	6	Electrical 1	7.50	DELAYED	-1.50
Sales opportunity 6	EPC	30.4.2025	DAP	6	Electrical 1	7.50	DELAYED	-1.50
Sales opportunity 7	EPC	30.4.2025	DAP	6	Electrical 2	8.00	DELAYED	-2.00
Sales opportunity 8	EPC	30.8.2025	DAP	6	Electrical 1	7.50	DELAYED	-1.50
Sales opportunity 8	EPC	30.8.2025	DAP	6	Electrical 2	8.00	DELAYED	-2.00

Figure 20 - Auxiliary equipment rough lead time check

One can also see from Figure 22 above that all critical equipment from a lead time perspective is from the electrical discipline. Typically, it is fine with the customer to deliver electrical equipment later than other auxiliaries and gensets since they are usually needed at a later stage at the construction site because the installation and commissioning of electrical equipment usually happen in a late stage of the construction lifecycle. The planning of auxiliary equipment always happens last of the three supply planning areas because it’s dependent on the outcome of the planning for the genset, where the adjusted delivery dates for the gensets are used as a base for auxiliary planning.

The planning of the auxiliaries is led by the general manager for supply planning and development, with support from many other team members in supply chain management, like supply chain managers, strategic purchasers, category managers, general manager logistics, and procurement managers. The outcome of supply planning for auxiliaries works as the last input to the supply review meeting, where all the supply plans are harmonized into one supply plan.

5.1.4 Financial Planning

Financial planning or analysis is an essential part of the case company's monthly S&OP cycles. The objectives of financial planning within the S&OP cycle are to visualize and evaluate the financial impact of the demand plan and different planning scenarios, like the realistic and conservative scenarios, plus assessing the impact of eventual additional supply planning scenarios. When talking about the financial impact, the case company needs to visualize and evaluate the order book and demand scenarios across various dimensions such as revenues, margins, risks, cost-to-serve, and working capital. Also, different views like profit and loss are generated every cycle based on execution projects and sales projects in the demand plan.

The financial planning is led by the director of finance and control with the support of a team consisting of business controllers. The financial plans, impact of the demand, and outlook for the business are visualized interactively and work as input to the pre-S&OP meeting. In Figure 23 below, the cumulative net sales for the business unit are presented. It shows both actual net sales, order book, and the forecasted net sales from the demand plan both for EEQ and EPC projects. The blue bar indicates the actual sales, the orange is the net sales from the order book, the light grey is the forecasted net sales for EPC projects, and the dark grey forecasted net sales for EEQ projects. These financial figures are fabricated and do not reflect reality whatsoever.

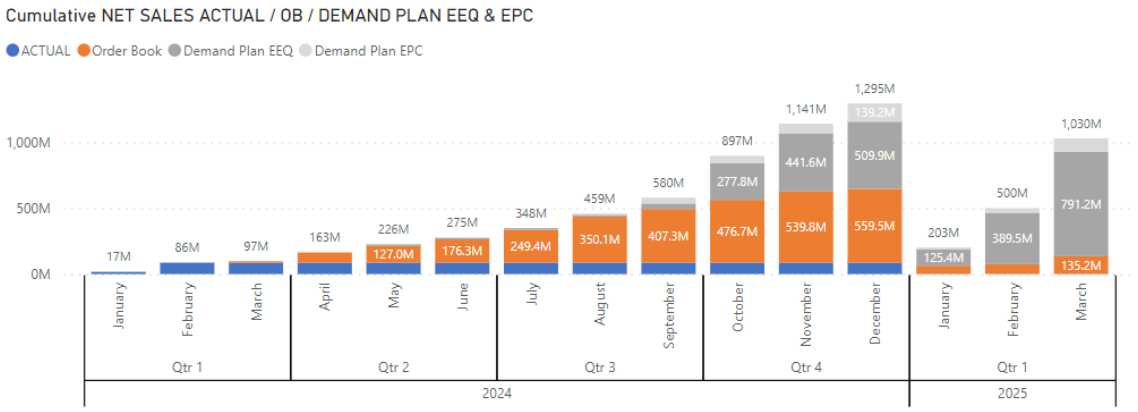


Figure 21 – Cumulative net sales visualisation

Another financial key performance indicator that is closely monitored during the financial planning of the S&OP process is the actual project margin and forecasted sales margin generated from the demand plan. Figure 24 below points out the cumulative margin. As in Figure 23, these financial values are fabricated and do not reflect reality. Again, in Figure 24, the aggregated cumulative values are represented both by the actual project margin, order book margin, and forecasted sales margin generated from the demand plan for both EEQ and EPC projects. Similarly, as in the net sales visualization in Figure 23, the blue bars present the cumulative actual margin, the orange bars are the margin from the order book, light grey is the forecasted margin for EPC projects, and dark grey forecasted margin for EEQ projects. The black line represents the adjusted margin, is an assumption and direction for sales projects, and is different depending on the sales area. These financial figures are fabricated and do not reflect reality whatsoever.

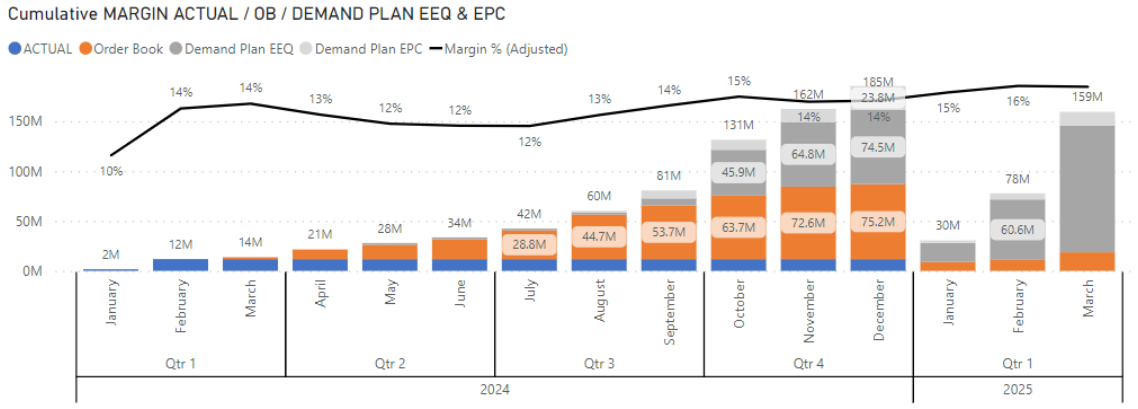


Figure 22 - Cumulative sales margin visualisation

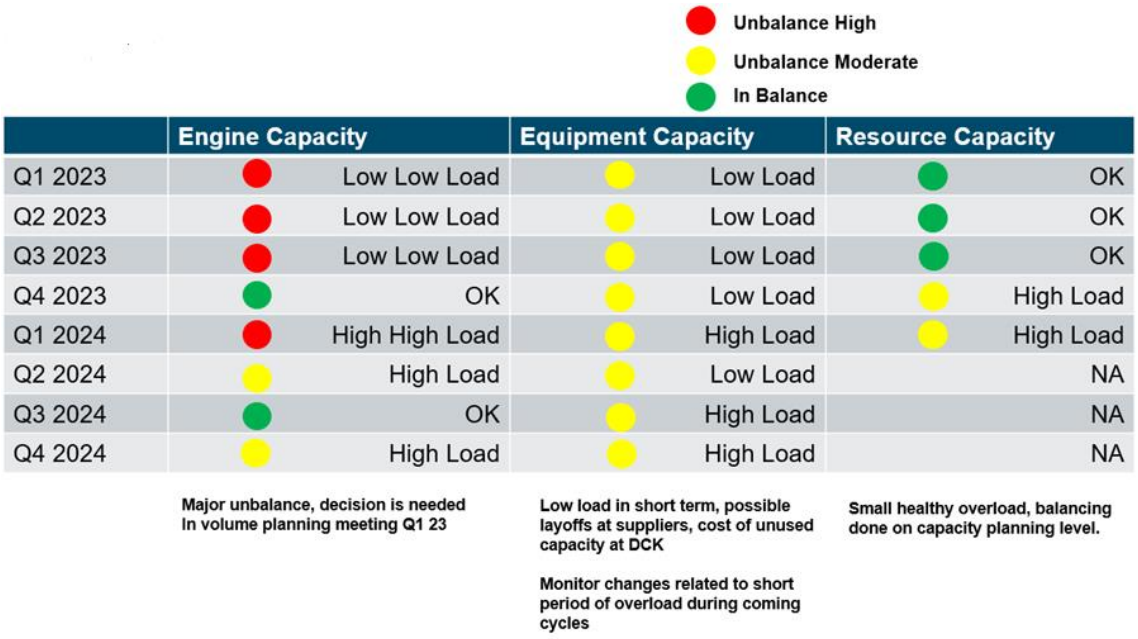
Both the revenue and margin recognition presented in Figures 23 and 24 above are recognized based on some key assumptions. In EEQ projects the revenue and margin are recognized at the forecasted delivery date, while in EPC projects 30 percent is recognized at the forecasted delivery date, and the remaining amount is spread over the next 11 months. When the financial planning together with the supply plans are ready the next step in the case company's monthly cycle is to keep the pre-S&OP meeting presented in the next chapter.

5.1.5 Pre-S&OP

When supply planning and financial planning are completed, and all resources have been evaluated against the demand plan and scenarios, it is time to run the Pre-S&OP meeting. This meeting is facilitated by the S&OP process owner and key representatives from demand planning, all supply planning areas, and financial planning are present at this meeting. The main objectives of the meeting are to view holistically all identified bottlenecks related to demand, supply, and financial planning.

Typical situations that are discussed during the pre-S&OP meeting can be that too high demand volumes require the same specific resource. Either a specific engineering resource, the same mix of gensets, too high volumes of auxiliaries, or too high volumes must be delivered from the same supplier due to requirements from customers. In the

end, the goal of the pre-S&OP meeting is to confirm whether the demand, supply, and financial plans are feasible. In Figure 25 below an example of the summary of the harmonized S&OP plan is presented.



	Engine Capacity	Equipment Capacity	Resource Capacity
Q1 2023	Low Low Load	Low Load	OK
Q2 2023	Low Low Load	Low Load	OK
Q3 2023	Low Low Load	Low Load	OK
Q4 2023	OK	Low Load	High Load
Q1 2024	High High Load	High Load	High Load
Q2 2024	High Load	Low Load	NA
Q3 2024	OK	High Load	NA
Q4 2024	High Load	High Load	NA

Figure 23 - Pre-S&OP harmonized S&OP plans example

From Figure 25 above, it is possible to conclude that the demand plan in the example cycle is feasible, and the demand volumes can be delivered, it would even be possible to deliver more. On the contrary, there might be consequences like capacity cost pressure as not all resources are loaded, and they are very unbalanced. That is a topic that requires more attention, resolutions, and clear decisions on the way forward at the executive S&OP meeting. Additionally, looking into Q1 2024 there is a very high load for gensets, which is a clear bottleneck. The resolution for this would either be to increase the genset capacity or reduce the demand. That is also a decision that must be taken during the executive S&OP meeting since both options are very costly. Increasing the capacity for gensets would be expensive and risky versus dropping sales volumes. The outcome in the form of suggestions and recommendations together with the proposed S&OP plans works as input for the executive S&OP meeting, discussed in the next chapter.

5.1.6 Executive S&OP

At the executive S&OP meeting a summary of demand planning and capacity planning are presented to the participants to ensure that they understand the feasibility of the S&OP plans. All potential bottlenecks are presented together with the proposed solutions and the financial impact of these. During the meeting, the management team is trying to catch the big picture: what do we plan to sell? How are we supposed to deliver? How much resources do it require? And what is the financial impact?

This meeting is the last step of the monthly S&OP process, where the outcomes work as inputs for the next planning cycle. All preparations for the executive S&OP meeting are done separately and prior to the meeting by different cross-functional teams. All involved teams play a key role in providing the required input and analysis of whether the S&OP plans are realistic and feasible. Proposals for discussion and approval are developed and distributed before the meeting. The meeting participants should be allowed time to read and familiarize themselves with the S&OP content for better decision-making since there is usually very little time during the executive meeting to deep dive into all the details.

A typical executive S&OP meeting agenda consists of a walkthrough of the process, developments, and way of working. It continues with the demand plan, scenarios, and different demand trends. After the supply plan is presented, constraints are highlighted, and the financial impact and overall financial outlook are emphasized. The meeting ends with key decisions and action points.

During the meeting, all decisions, actions, and highlights must be summarized to provide the big picture of the business outlook. The core focus in the meeting should be on aggregated volumes and supply capabilities, if any critical issues related to the mix like individual projects, resources, or equipment have arisen in the previous process steps this can be highlighted and discussed. Anyhow, the focus should not be on details.

A good example of this can be if one or several large backup projects are lifted to the demand plan and create an unbalance between demand and supply.

The financials are also closely monitored during this phase. Where revenues and margins are followed. The meeting ends when business decisions and the way forward are decided, and the business plan is either approved or rejected. In Figure 26 below an example of the outcome in terms of decisions and actions from an executive S&OP meeting is presented.

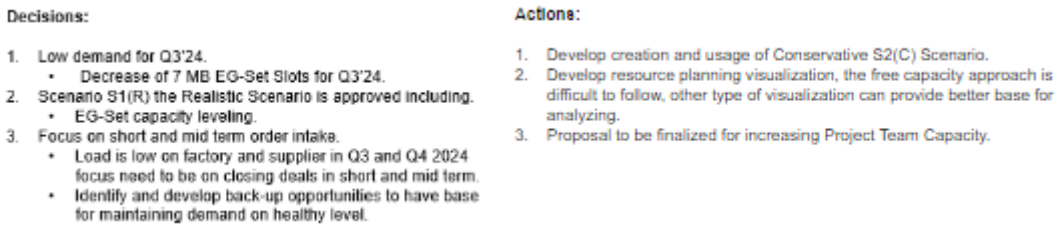


Figure 24 - Executive S&OP decisions and actions example

The next S&OP cycle starts with the demand planning process, and the feedback and decisions done and agreed upon during the executive S&OP meeting are used as inputs and action points for the upcoming cycle. That can, for example, be to analyze an alternative scenario or the approval of adding more resources (hiring additional employees).

5.2 Benefits

In this chapter, the identified benefits and advantages the case company has gained through the implemented monthly S&OP cycles are presented. To obtain and receive responses regarding benefits the following question was asked to the interview participants: What are the advantages/benefits of S&OP for your company? The retrieved responses have been categorized into two categories, financial & general and business alignment, and people.

5.2.1 Financial and general

Many of the responses can be categorized as financial benefits or the result of them benefits the financial side of the company. Below are a couple of interview answers that are directly or closely connected to financial benefits:

1. *"Improved utilization of capacity"*
2. *"More focus on capacity utilization in our own factories".*
3. *"Reduced supply chain risks, through better visibility and proper supply planning"*
4. *"S&OP enables bundling opportunities in project purchasing".*
5. *"We will be able to match realistic demand & supply with financial figures".*

The first point highlighted is the improved utilization of all resources, which boosts the company's ROA (return on assets). The company has improved through S&OP to better utilize its internal and external resources. More focus is put on resource and supply planning to ensure that there are enough resources available to deliver what is promised to the customers. Months when the volumes are low, activities and preventive actions like level loading are executed to have a more equal balance between demand and supply. The upfront demand and supply planning supports the company into efficient use of its resources, which increases profitability and customer satisfaction.

Some persons also highlighted in the interviews, that S&OP has reduced the supply chain risks. A reason behind this is that the supply chain now has better visibility of the future demand volumes and which auxiliaries the sales projects consist of. Risks can be detected much earlier than before and mitigation actions can be done to avoid these risks. Through better risk mitigation and planning in the supply chain, the sales figures and customer experience can increase, due to improved supply chain operations, like reduced lead times and/or supply chain costs. A clear benefit of S&OP for the company is lower supply chain costs. By proper planning of deliveries, costs for logistics can be heavily reduced by combining shipments and deliveries from suppliers and ports. Another aspect where S&OP has contributed to savings for the company is that it has en-

abled the possibility to bundle products in project purchasing. Through better visibility of the scope items and their forecasted requirement dates, it has become easier to receive discounts from suppliers when purchasing is done for products from many projects simultaneously.

The case company also has an inventory of components used in auxiliary modules. Also, here S&OP supports determining proper inventory levels, to avoid too high or too low inventory levels. Due to the low volumes in 2023, the inventory level has been reduced and thus, some savings have been made. Other more general benefits that have been observed during the S&OP cycles is that the quality of the demand plan is today compared to one year ago more realistic and trustworthy, which enables more accurate planning and better higher probability of delivering the projects according to the customer requirements.

Finally, S&OP has improved portfolio risk management and the flexibility of the organization. After the introduction and implementation of the monthly S&OP process, the company has a healthier portfolio with higher margins compared to before S&OP was introduced. A healthier portfolio also means higher profitability and the company has through new ways of working, better alignment and transparency, and a proper S&OP planning process been able to minimize cost-overruns in the projects.

5.2.2 Business alignment and people

Most of the interviewees mentioned benefits related to alignment, people, improved accountability, and ways of working. Some of the retrieved answers from the interviews are highlighted below:

6. *"Structured way of working which improves our data quality, our estimates and in the end our business results. We can focus on the right things".*
7. *"One plan, giving alignment. Forecasting and data-based decision making".*
8. *"A clearer picture of what is coming and giving the direction".*

9. *Greater alignment between what we want to sell and what is our capability to deliver".*
10. *"Clarity, transparency, and alignment of the short-mid-term demand plan. Greater commitment to resourcing. Lower number of corridors talks about what is important and what not. structured decision making".*
11. *"Improved transparency of sales pipeline and better visibility on resource needs".*
12. *"More clarity on what to focus on and how to achieve it, and all are aligned to the common goals".*

As one can notice from the listed answers above many of the participants highlighted benefits like improved alignment between departments, better clarity, transparency, and visibility. First, it has been concluded from the interviews and other observations that the S&OP process has improved and streamlined the communication flow in the company. Before S&OP all departments and functions had their list of sales projects they were working with, today through S&OP the whole business is working with one consensus plan. Employees working in other functions than sales also stated that both the visibility of demand and the increased transparency from the sales towards the rest of the organization have improved a lot. The organization is generally better aligned, and everyone is working towards the same strategic goals.

Furthermore, S&OP has boosted the ways of working, by enabling the organization to focus on tasks and activities that make the difference. With a better visibility and understanding of the demand mix, project portfolio, and over- and underutilized resources, it is possible to understand where the focus should lie. Improved collaboration between the departments also results in better work enjoyment for employees.

The responsibilities and especially the accountability of responsibilities have also improved through S&OP. Due to clearly defined responsibilities, people are more accountable for their work and decisions. S&OP is also a cross-functional process, and

typically someone else is depending on your output to move forward in the process. Hence, it would be noticed quickly if someone would neglect their responsibilities.

5.3 Challenges

This chapter categorizes and outlines the identified challenges and pain points associated with the monthly S&OP process. Four main categories were identified data and tools, performance management, demand, and supply.

5.3.1 Data and tools

Accurate and available data and supporting tools are keys to enabling a successful S&OP and data-driven decision-making. This area is where the case company has the biggest challenges and obstacles. Several challenges related to data, systems, and tools were identified during the interviews, and all interviewees mentioned data, data accuracy, and tools and systems as the main pain points. Some of the answers obtained from the interviews are presented below. The question was simply: what challenges do you currently face in your S&OP process?

13. *"CRM Data and the accuracy of data"*
14. *"It is a challenge for the organization since S&OP demands discipline in maintaining & updating the data, decisions based on supply & demand plan might create insecurities".*
15. *"Too many manual inputs and different spreadsheets"*
16. *"No linkage between system"*
17. *"With no material numbers, it is hard to automate the supply planning process"*

The data accuracy and availability are a challenge for the case company. The data accuracy and maintenance in CRM varies and depends on region/areas and opportunities. Many times, the dates are inaccurate and unrealistic, which also is a consequence of the volatile market situation and customer behaviours. A concrete remedy for this is to

generate a realistic scenario to manipulate and make the data more realistic either by pushing the dates forward or by expediting. The sales data is the core input for the whole S&OP process, and no global guidelines and systematic approach to maintaining project sales data in CRM like probability and dates exist.

Data availability and accuracy are also a problem for supply planning. The case company does not use material numbers, and all purchase orders are manually created. Without material numbers, there are no material master data available in any system which would automate the data gathering process for lead times and capacities. It would further enable a more automated way to analyze and visualize the supply planning process, and the possibility of forecasting volumes for logistics. Hence the data gathering and crunching of product data and purchase order info is a manual process that must be done every month to support the supply planning process.

The case company uses many tools and systems and almost all functions like sales, project management, contract management, documentation management, engineering, procurement, and logistics have several tools that they use in their daily work. One issue with this is that there is no end-to-end data flow available, many systems are linked, and data is integrated from systems to systems. Like Clarity, which is a resource planning and project management software, which contains sales data from CRM. The biggest challenge here is that there is a broken link between CRM and SAP, which is an issue. Due to this, it's not possible to automatically detect when a product is ordered for a project, like showcased in Figure 21 in chapter 5.1.3.3, the capacity graph shows both ordered radiators and estimated demand volumes. The process of identifying the ordered radiators and other products is manual work. Missing end-to-end linkage also makes it hard to compare, for example, the offered/sold price versus the actual price paid to the supplier. Another example is the planned delivery date in sales versus a specific equipment's actual delivery date. There are many more examples, and having an end-to-end data flow would benefit the case company.

A different pain point is that logistics data like shipment data, and project schedule data such as core project milestones are not integrated nor used as planning parameters in the S&OP process. Delivery and operational data would be crucial to include to increase the supply planning maturity and planning accuracy, to properly ensure that the demand plan is feasible from a supply chain perspective.

Even though the case company has many systems and tools they don't use any advanced planning system for S&OP, the process is semi-automated where the inputs mainly are manual, and the visualizations are illustrated in PowerBI. Hence, there is no system-supported option or solution to simulate the end-to-end impact of changes in the S&OP plan at any stage. If there is a change in the plan the inputs must be manually changed and then simulated in PowerBI, in other words, this means that there is limited possibility to make data-driven decisions due to poor data quality and availability.

5.3.2 Performance Management

The second area that was identified as a paint point and challenge during the interviews is the performance management aspect, an S&OP process must be measured to enable continuous improvement. Below are some more responses to the interview question highlighted in the previous chapter, and are related to performance management:

1. *"No measurement for demand plan accuracy"*
2. *"The S&OP process don't have defined KPIs".*
3. *"No measure available for resource/capacity utilization"*

No metrics and KPIs exist to measure the performance of the process. First and foremost, it is very challenging to measure the sales forecast accuracy, because the dates like closing date, effective date, and delivery date are constantly pushed forward and the sales opportunities in the demand plan are continuously changed or replaced with back-up projects. Likewise, for the supply planning process, there are no measure-

ments of resource utilization in either manpower, genset, or auxiliary equipment. The capacity utilization is not measured systematically and there is little visibility on adherence to all the defined S&OP processes.

Besides the lack of core KPIs and metrics, the case company currently doesn't have a systematic way to compare previous cycles' demand plans, supply plans, and S&OP plans versus actual performance. Some manual comparisons and memos are generated monthly but an automated way and governance for it is missing. In supply planning the supplier allocations are not always aligned with the category team and supplier strategies, and no follow-up on allocated supplier versus actual supplier is performed. Furthermore, the dates like closing date, effective date, and delivery date are not compared with actual dates, to see how accurate the dates were in the sales phase. Understanding how accurate the delivery dates in the sales stage are versus reality would be a necessary input to take the supply planning to the next stage. All this means that the project delivery accuracy is not reported and maintained in any system either.

For financial performance, some KPIs are measured and followed like order intake, net sales, and margin. Measurements for the complete S&OP process and operational measurements are anyhow still missing.

5.3.3 Demand

From the interviews, it can also be concluded that there are challenges and pain points related to demand planning. First, there are no existing processes, guidelines, or rules on how and based on what the sales projects are selected into the demand plan and treated as "forecasted" projects. So, there is a lack of a standardized process, clear prioritization logic, and rules both globally and regionally. Through analysis and observations, it has also been noticed that the demand is very volatile, and it is hard to accurately forecast the demand due to these sales fluctuations, there are so many external factors affecting the customers, and hence the case company's sales forecasts. The external factors can be many like political, economic, or strategic. It is, hence, hard to

analyze and understand customer behaviours, which makes it difficult to generate accurate demand forecasts. In figure 27 below an analysis of 7 different sales opportunities have been conducted. It indicates how many times the close date, effective date, and delivery date have been updated for each sales opportunity and how many times they have been included in the demand plan.

Opportunity Name	Stage	# of Close Date updates	# of Effective Date updates	# of Delivery Date updates	# of times in Demand Plan
Sales Opportunity 1	Tailor	1	1	1	2
Sales Opportunity 2	Negotiate	10	10	9	12
Sales Opportunity 3	Plan	5	5	5	6
Sales Opportunity 4	Finalise	4	3	4	5
Sales Opportunity 5	Negotiate	4	4	2	5
Sales Opportunity 6	Negotiate	9	8	5	11
Sales Opportunity 7	Tailor	2	2	2	2

Figure 25 - Demand volatility analysis

From Figure 27, it is easy to see that the dates are changed with a quite high frequency, which also makes it harder for supply planning to make accurate plans when the dates are changing over time.

As mentioned in Chapter 5.3.1 most of the challenges in the demand planning processes are related to data, data accuracy, and global guidelines. On top of that, many of the inputs are manually maintained, and information in the systems might be missing. Many still prefer to use email for communication internal and external communication, and hence don't update CRM with critical data or more nice-to-know information related to sales opportunities. The gensets are also very much dictating the constrained demand plan (realistic scenario) since it is generated based on the genset availability and dates, which also can be seen as a lowlight or issue. Another observation noticed from one of the interviews was that in some of the regions/areas projects with a considered low probability of materializing can be included in the demand plan to match the sales budget target.

Finally, there are currently no prioritization rules for the project mix in the demand plan. Typically, the capacity is reserved for customers on a first come first served prac-

tice, capacity slots for gensets and some auxiliaries are looked for customers if they pay an advanced reservation fee or when the project is signed. In case there are capacity constraints in a certain month there are no guidelines for how to prioritize the projects with delivery in this month. It rather works so that it is taken for granted that the signing process for some of these projects will be delayed, and thus the delivery is moved forward, and the problem is solved.

5.3.4 Supply

One of the key findings on current challenges of the supply planning side of the process was that there is limited supplier collaboration, no forecasting process or practice exists, and hence no forecasts of future volumes are shared with suppliers. That is an activity that is essential to secure capacity from external vendors. For some equipment, some manually consolidated supplier forecasts exist, but there should be aligned ways of working and clear instructions for the suppliers on how to utilize the provided forecast. For example, to establish a two-way communication loop where the suppliers confirm if the forecasted volumes are feasible for them or not. That enables the case company to mitigate the issue by, for example, onboarding a new alternative supplier supplying the same equipment before it is too late.

Updating and maintaining the planning parameters are very manual and require data crunching from different systems which takes a lot of time and requires precision. The reason behind this is described more in chapter 5.3.1 data and tools. Another challenge and potential risk for the future is that if the demand increases in the upcoming year(s) there are no dedicated supply planners nominated. For gensets, the volume planning manager works full-time to plan the deliveries of gensets and ensure that there is enough capacity available when needed. But, for auxiliary equipment and manpower, there are no persons fully nominated for the planning part. All involved have many other responsibilities and if the demand increases a lot, this can be a potential bottleneck in the process.

Furthermore, there is a lot of variability in the lead times for auxiliary equipment, many of the products are tailor-made for the customers, and the lead time can vary by several months depending on the complexity of the products. That is something that, is not captured, and a standard lead time is used as input for all products and projects when comparing the lead time for the products versus the contractual lead time (explained in Figure 22 in chapter 5.1.3.3). That can result in potential risks with on-time deliveries once the project becomes active.

Another challenge that has partly been solved with the supplier allocation activity is that there are no clear rules or logic to allocate resources, especially to large and complex projects during the sales cycle. Many of the allocations are still evaluated every month and there is little automation to allocate projects automatically to equipment in the scope, such as country, incoterm, customer type, or if a supplier has low volumes allocated. There is no functionality available that automatically collects and analyzes the planning data from various systems, all tasks and inputs are done manually.

From manpower, only project managers and engineering resources are considered in the process, even though other resource types can be bottlenecks like project planners, project controllers, transport managers, purchasers, or contract managers. Finally, another pain point is that logistics is not very involved in the current supply planning process. Currently, only transportation lead times and transit times are collected and used in the monthly S&OP cycle. Anyhow, the demand for logistics is not visualized or considered, meaning transportation volumes, number of containers needed to deliver the demand plan, number of shipments, or break-bulk volumes. Hence, it remains unknown if there are any bottlenecks related to the available capacity for logistics from the third-party logistics providers or stuffing and containerizing at the ports.

5.3.5 Overall S&OP

Many of the challenges in the overall S&OP process have already been highlighted in the previous four chapters, like missing KPIs, manual inputs, data quality, and missing dedicated S&OP members and all these also reflect on the overall process. A couple of more findings related to the process in general will be further highlighted in this chapter. The first point noticed is the lack of medium to long-range planning in demand and supply planning. The process rather focuses on short-term planning due to the defined planning horizon, which is a result of the fluctuating and volatile market.

Guidelines and defined feedback loops are missing from supply to demand to communicate potential shortages. Shortages are mainly discussed during the Pre-S&OP meeting, but besides that, there are no standardized feedback loops from supply to demand. Another point noticed is that no cross-functional process exists to solve and find resolutions to identified bottlenecks. Each team handles and solves their bottlenecks differently and in silos. Due to the low volumes in 2023 the process has not been completely tested and validated how strongly it works when several bottlenecks exist.

Running additional supply planning scenarios when the volumes increase would result in more objective decision-making based on the evaluated scenarios and decision notes. Since, currently when bottlenecks rarely occur, the decision-making is often escalated to top management, because underutilization of internal resources is extremely costly. If the volumes increase the process might also be too time-consuming and heavy to run, and an advance planning software would be beneficial.

It can be seen from Figure 11 in Chapter 5.1, where the complete S&OP process flow is presented, that demand planning takes place in week 1, capacity planning week 2-3, and pre-S&OP and executive S&OP week 4. In recent cycles, when more demand planning scenarios are generated it has also been observed that the demand planning phase takes considerably longer than one week, and the time for supply planning is reduced due to this.

5.4 S&OP Roles and Responsibilities

Based on the conducted interviews and observations the main S&OP stakeholders have been identified and mapped. The mapped stakeholders can be found in Appendix 1 – S&OP identified stakeholders list. Where stakeholders are mapped according to stakeholder group, role in the organization, and their S&OP role group. The stakeholder group is mainly related to what concrete action each identified stakeholder is responsible for, some examples are supply planning, core project team members, or IT systems and data. It must be further highlighted that on top of the listed stakeholders in Appendix 1, there are many indirect or passive contributors missing from the list.

The stakeholders can also further be categorized into S&OP roles where the majority are key contributors, but other roles can be steco members, decision/validation makers, or specific process leaders. Generally, the stakeholders can be grouped into direct or indirect contributors. Where the persons having a direct role are contributing to the S&OP process by giving inputs, updating planning parameters, producing materials, participating in meetings, consolidating recommendations/suggestions, or making decisions. While the passive contributors don't contribute directly to the S&OP process and are rather only interested in the outcome of the S&OP cycle, since the outcome of the S&OP plan has a major impact on their daily work.

In Figure 28 below the direct contributors to the monthly S&OP process that were identified through the interviews and observations are presented. The stakeholder mapping in Figure 28 has been completed in Miro, which is a tool for mapping and visualization.

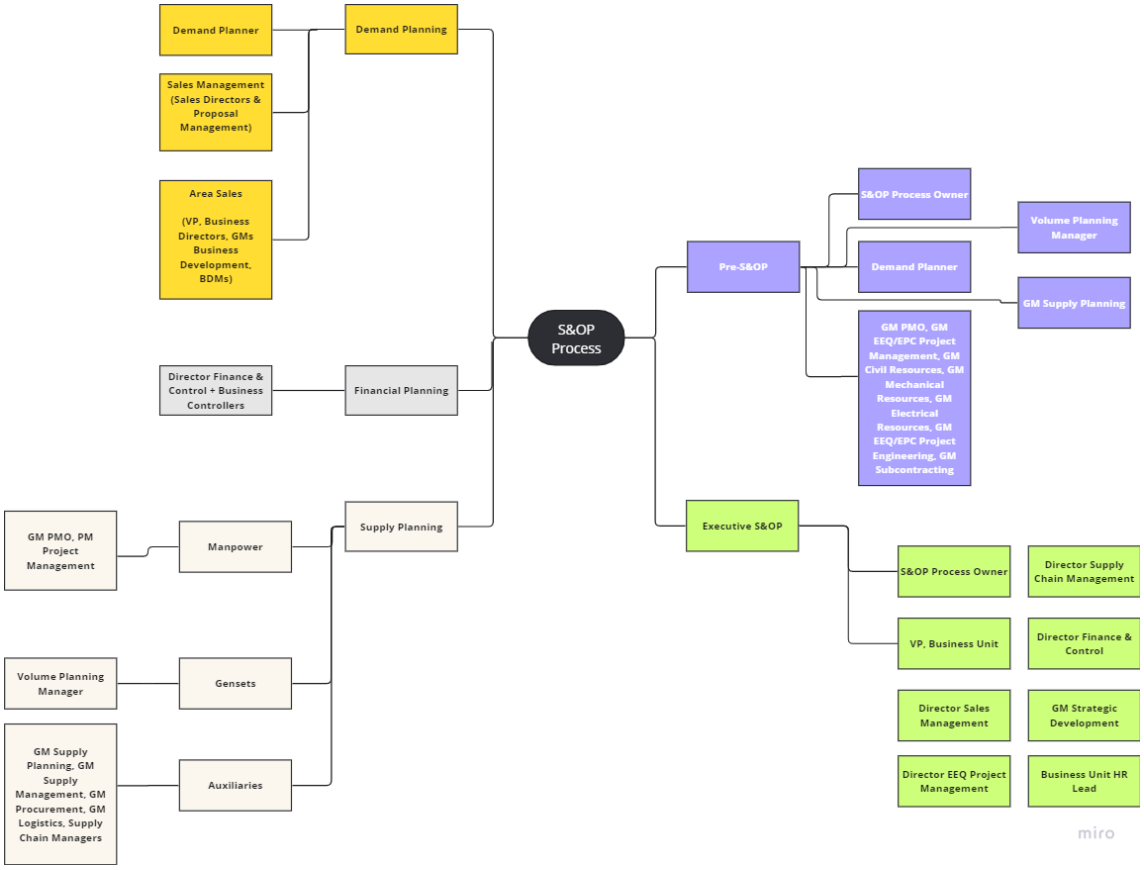


Figure 26 - S&OP Process main stakeholders and roles

The figure above illustrates each subprocess of the monthly S&OP process, which are demand planning (yellow), financial planning (grey), supply planning (alabaster white), pre-S&OP (purple), and executive S&OP (light green). All direct contributors for each subprocess mentioned above are also listed and visualized in Figure 28. As can be seen from the figure the case company does not have a designated S&OP team running the monthly cycles, all direct contributors have dual tasks.

To even go further into the roles and responsibilities within the monthly S&OP process of the case company a high-level RACI model for the process has been generated. A RACI model or matrix can be utilized to describe, specify, and illustrate responsibilities and roles within a process. The abbreviation stands for R = responsible, A = accountable, C = consulted, and I = informed and the purpose of creating a RACI matrix is to showcase and divide the roles and responsibilities of all process steps. If you are re-

sponsible for a process step, you perform the concrete actions that the process step aims to solve. While the accountable person ensures that all required actions are completed. Persons that are marked with a (C) in the matrix must be consulted on actions and decisions. Finally, the informed persons are interested in the outcome or informed about the outcome of the process step. The high-level RACI model developed for the case company's S&OP process is described in the next chapter.

5.4.1 S&OP RACI model

In Figure 29 the high-level S&OP RACI model for the case company is presented, the figure is divided into demand planning, capacity planning, and S&OP meeting. Where financial planning and executive S&OP are part of the S&OP meeting section, and pre-S&OP part of capacity planning. Furthermore, the roles and responsibilities are highlighted through a RACI matrix at the bottom of the figure. Where the responsible, accountable, consulted, and informed persons/roles are presented for each high-level process step.

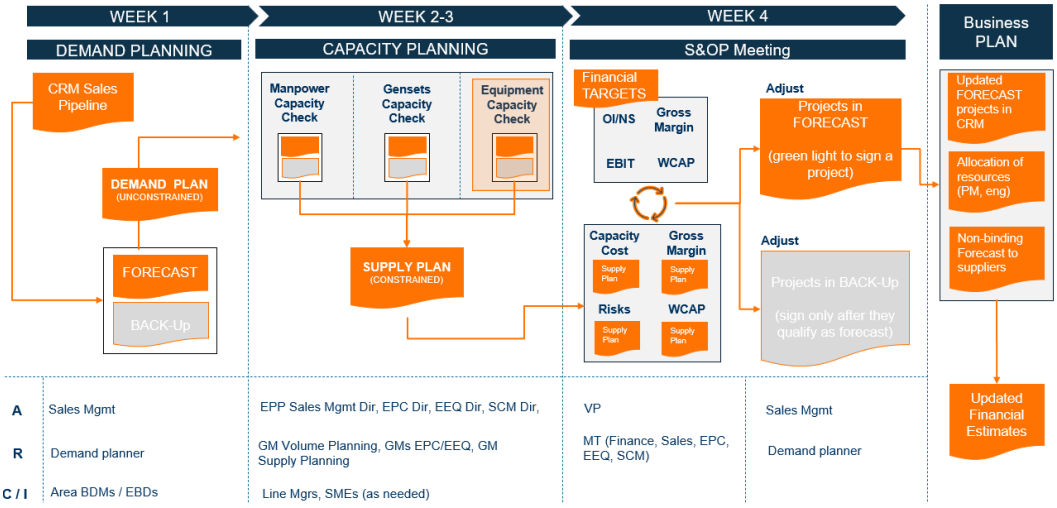


Figure 27 - S&OP High level RACI model

If we start from demand planning, the demand planner is responsible for executing the actual actions, to complete the process. Actions that the demand planner performs

monthly are to consolidate the sales forecast from all the areas into one consensus demand plan, facilitate demand review meetings, and generate different demand scenarios. Accountable for demand planning is the sales management department, consisting of sales directors, sales proposal management, and the demand planner. Completing the demand planning is an important aspect of consulting and informing the area business development managers and Business directors, who represent front-line sales. Hence, it is crucial to consult with them when creating and generating the demand plan.

As highlighted in Chapter 5.1.3 capacity planning consists of 3 planning areas manpower, genset, and auxiliary equipment. Starting from manpower those responsible for manpower planning are the General Managers in EEQ/EPC project management, as they are the line managers for project managers and all working with engineering. The accountable for manpower in the process are the directors for EEQ/EPC projects. For gensets the responsible person is the volume planning manager, and accountable is the line manager of the volume planning manager working as a director for sales management. Finally, for the auxiliary equipment, it is the general manager for supply planning and development who is responsible, and the director of supply chain management is accountable for the process. In the pre-S&OP meeting, the responsibility is on the S&OP process owner and the accountability of that process is on the GMs responsible for each capacity planning area.

In all capacity planning areas and pre-S&OP, the line managers and some subject matter experts are occasionally consulted. All line managers and team members are informed of the outcome. For financial planning the business controllers are responsible, the director of finance and control is accountable, and mainly sales are consulted, and the whole organization is informed. In the executive S&OP process, the Vice president of the business unit is accountable, while the management team consisting of the directors leading the core functions is responsible for the executive S&OP. Since the business plan is the outcome of the executive S&OP all stakeholders are informed.

5.4.2 Supply Planning RACI model

A separate RACI model for auxiliary equipment has also been developed since the roles and responsibilities were a bit unclear, it is presented in Figure 30 below. This RACI matrix contains more details and several process steps compared to the high-level model presented in the previous chapter.

S&OP Supply Planning RACI	Frequency	SCM Dir	GM Supply Planning	Supply Planning Manager	GM Supply Management	Category Managers	Strategic Purchasers	GM Supplier development & Quality Assurance	GM Procurement	GM Logistics	Supply Chain Manager	Global SCM Organization
Update Planning Parameters	Monthly	I	A	R	I	I	I	I	I	I	I	I
Supplier Allocation	Monthly	I	C	R	A	C	C	I	I	I	I	I
Monthly Supply Plan	Monthly	A	A	**R**	**C**	**C**	**C**	C	C	**C**	**C**	I
Supply Plan Review Meeting	Monthly	I	A	**R**	C	**C**	**C**	I	I	I	I	I
Category & Supply Management Meeting	Quartly	I	I	I	A	**R**	**R**	**I**	I	I	C	I
Define critical equipment to be mapped in Supply Plan	Quartly	I	C	C	A/R	C	C	C	C	I	C	I
Participate in Pre-S&OP Meeting	Monthly	I	A	R	C	C	C	C	C	I	C	I
Non-binding Forecast to Suppliers	TBC				A	A	R					

A = Accountable
R = Responsible
C = Consulted
I = Informed

Figure 28 - Auxiliary Equipment detailed planning RACI

The first action in the matrix is updating of planning parameters, the planning parameters are mostly updated on manual spreadsheets. These inputs are equipment lead times, production capacities, transportation lead times, and the outcome of the supplier allocation activity work as a planning parameter. The supply planning manager is responsible for this activity, while the GM for Supply planning is accountable. All other supply management stakeholders are informed.

Supplier allocation is an activity where the sold scope items are pre-allocated to external suppliers. For this activity, the supply planning manager who is responsible, and the GM for Supply Management is accountable. Both category managers and strategic purchasers give input to the allocation process, hence they are consulted. The rest of the stakeholders are informed. Generating the monthly supply plan for auxiliary equipment

is another activity that both the supply chain management director and GM for supply planning and development are accountable for, while the supply planning manager is responsible for creating it. Most of the stakeholders are consulted before the plan is approved.

At the Supply plan review meeting, the supply plan is reviewed and modified. In this activity, the supply planning manager is responsible, the Supply Planning GM is accountable, and the rest of the stakeholders are either consulted during the meeting or informed about the outcome of the meeting. On a Quarterly basis, an alignment meeting between supply management and sales takes place called a category and supply management meeting. At this meeting supply management and sales align S&OP inputs and outputs, so the focus stays on the right things. Category managers and strategic purchasers are responsible for this meeting, while the GM for supply management is accountable. The supply chain managers working closely with sales are consulted and all others are informed.

Every quarter, there is also a review meeting, where decisions are taken on which equipment to include and follow in the S&OP process. Both accountable and responsible for this step is the GM for supply management, where many of the other stakeholders are consulted. At the pre-S&OP meeting, the GM for supply planning and development is accountable and usually participates in the meeting. The supply planning manager is responsible for preparing and generating the supply plan that works as an input to the pre-S&OP meeting and is hence responsible for that. All other stakeholders are consulted or informed. Non-binding forecasts to suppliers is an activity that is planned only.

6 Discussion

The main goal of the case study was to investigate how a sales and operations planning process can be executed, and the potential benefits, challenges, and roles and responsibilities associated with each process step in a complex project-based environment. In this chapter, the findings and results will be discussed and compared against the findings from the literature review and existing theories.

Starting from the overall S&OP process, the typical design and process steps in S&OP can be concluded from the literature review that several authors (Ambrose & Rutherford, 2016a; Ávila et al., 2019b; Falck & Småros, 2013b; Grimson & Pyke, 2007a; Lapide, 2004b; R. A. Stahl & Wallace, 2008b) agree that it consists of the following steps: data gathering, demand planning, supply planning, pre-S&OP, and Executive S&OP. Comparing this statement against the case company's S&OP process presented in Figure 6 on page x and the detailed process version in Figure 7 on page x. It's easy to understand that the case company's S&OP process is aligned with the literature when it comes to process steps. However, the data gathering is not specified as an own step and happens on an ad-hoc basis. Another point here is that the supply planning or capacity planning step is divided into three different areas manpower, genset, and auxiliary equipment.

The existing S&OP frameworks in literature, for example, the five-step process mentioned above according to (Adrodegari et al., 2015; Kristensen & Jonsson, 2018a; Shurrab et al., 2020b), only support organizations in high-volume businesses with stable volumes. The case company faces high complexity, high demand fluctuations, and weak forecasting precision and the existing frameworks do not support organizations facing these challenges. The fact that the case company has adopted a five-step S&OP process that initially is intended for companies operating in a mass-production environment, might be one of the reasons why the case company struggles to acquire all the expected benefits from the process.

Regarding roles and responsibilities in S&OP Muzumdar & Fontanella, (2006b) emphasize the importance of cross-functional teams and involvement from sales, IT, supply chain, marketing, project management, research and development, technology, and finance. Comparing this with the roles and responsibilities in the case company it is possible to say that they have a cross-functional team with members from the essential departments. However, IT, R&D, marketing, and technology functions are not direct contributors to the process, they rather have an indirect role.

Another key aspect several authors (Boyer, 2009a; Muzumdar & Fontanella, 2006b; Singh, 2010b) highlight is the importance of having sponsorship and involvement from the executive level. That is something where the case company has succeeded since the vice-president is the chairman of the executive-S&OP meeting together with other executive-level participants.

Singh (2010) claims that one common reason why S&OP stalls in many companies is that there is no defined S&OP team. Hence, S&OP does not receive the same recognition as functions like sales or supply chain management. Usually, organizations have small cross-functional teams running the S&OP process or have ad-hoc teams picked from different departments. Either way, many times, S&OP-related tasks are not their main responsibilities. With this statement from Singh (2010), it is possible to see similarities in the case company. The case company only has a demand planner who is fully allocated to S&OP. All other core team members have several other responsibilities. We also know from existing theories that S&OP requires a lot of planning, analysis, and follow-up activities which demands time and great commitment from the team members. That can also be one of the reasons why the case company's S&OP process fails to deliver some of the anticipated benefits.

An area where the case company has succeeded is that each team member and department know what they are accountable for, and through the RACI matrix, the roles

and responsibilities are clear for everyone, which according to Singh (2010), is one of the key enablers for S&OP.

Comparing the anticipated benefits companies can gain from S&OP outlined in Chapter 2.3 versus what the case company has achieved through its own S&OP process there are several points to discuss. According to (R. A. Stahl & Wallace, 2008a), S&OP benefits can be divided into hard and soft benefits. Whereas the hard benefits are those that both can be measured and are directly connected to an organization's financial performance. The soft benefits are more related to organizational alignment, improved communication, teamwork, accountability, and decision-making.

Here it's evident that the main benefits the case company has achieved is on the soft side. S&OP has generated better visibility, transparency, clarity, and alignment between departments. All business functions work together with one consensus S&OP plan, which has reduced silos between departments. It's fair to say that the soft benefits the S&OP process has generated for the case company are very aligned with the anticipated soft benefits from existing frameworks and theories.

However, on the hard benefits, there is a major gap between the case company and existing theories. Firstly, due to insufficient performance management in the case company's S&OP process, it is hard to analyze how S&OP has improved the financial performance of the case company. On the other hand, there is evidence indicating that S&OP has improved capacity utilization, and reduced business risks, especially in the supply chain which both directly impact the financial side. Furthermore, the improved visibility has resulted in savings through bundling in project purchasing and logistics. All existing theories also highlight the aspect of reduced inventory levels, this is also an area where S&OP has supported the case company to determine its standard auxiliary component inventory levels. That is also an area where S&OP has contributed to savings.

Moving over from the benefits to the challenges, the results from the case study indicate that the case company faces many challenges that must be resolved if it wants to improve its S&OP process. The key challenges identified through the interviews and observations have been summarized and are presented in Figure 31 below.

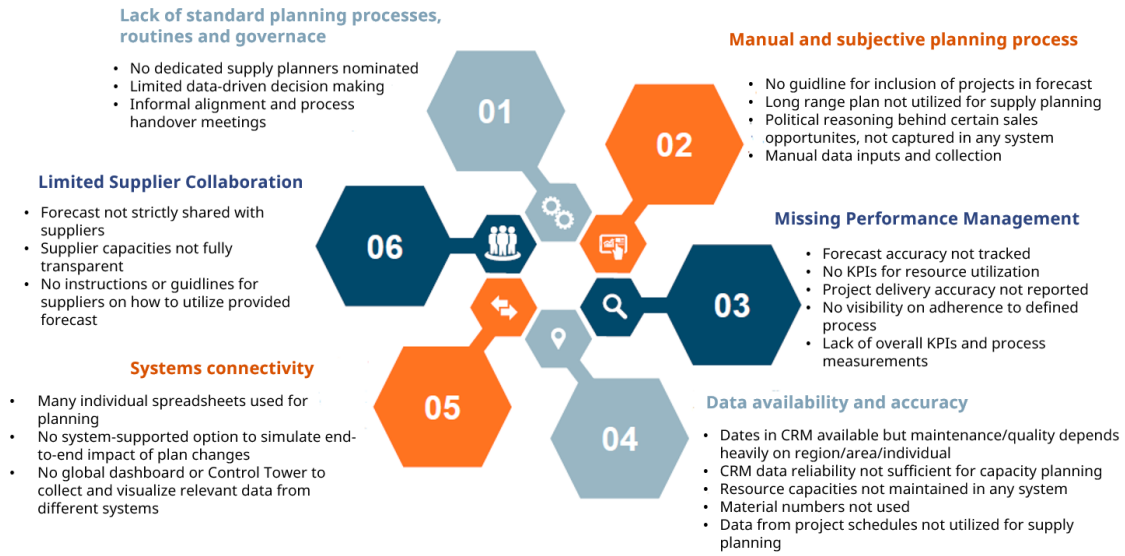


Figure 29 - Summarized view of identified S&OP challenges

These identified challenges have been categorized, into the following six groups: lack of standard planning process/routines/governance, limited supplier collaboration, systems connectivity, manual and subjective planning process, missing performance management, and data availability and accuracy. Each specific challenge is listed under the categories in the figure above. Based on these findings' recommendations have been suggested to the case company aiming to resolve the challenges. The recommendations to the case company are presented in the next chapter, where improvement proposals aiming to solve the major challenges visualized in Figure 31 are presented.

6.1 Case company recommendations

Based on the literature review and the obtained results in the empirical case study some recommendations and improvement actions have been proposed to the case company, to take the S&OP process to the next level, and eventually solve some of the

current and potential future bottlenecks and challenges in the process. The actions proposed have also been categorized into groups to further point out what they would improve.

The first identified category is performance management where the proposed actions to improve the case company's performance management in the S&OP process are presented below.

Performance Management

- Establish clear business KPIs and performance measurements.
- Measure the demand planning accuracy.
- Measure capacity utilization rate.
- Develop metrics and follow-up visualizations on planned versus actual performance.

As noticed from the empirical results in Chapter 5.3.2, some of the identified challenges were related to performance management. Currently, there is a lack of KPIs and measurements to assess how well the business and the process are doing. From the literature review, many authors (Grimson & Pyke, 2007b; Muzumdar & Fontanella, 2006b; Tuomikangas & Kaipia, 2014) highlighted that one of the key enablers of S&OP is performance management. If the company wants to continuously improve its S&OP process and reach the next level it must implement key metrics for demand planning accuracy, capacity utilization, and gross margin. Measuring the capacity utilization for all resources, especially for the own factories and internal manpower resources would benefit the company.

It would be necessary to have financial, process, and operational measurements. Especially, on the process and operational side measurements are currently completely missing. Another suggestion would be to start measuring how accurate the planning process is by developing metrics and follow-up activities of planned versus actual per-

formance. On the operational side, additional KPIs like order fulfillment rate and customer satisfaction could be measured. On the sales side, besides of the demand planning accuracy, measuring the volume growth and trends would be very useful to follow..

The second identified group of improvement proposals falls into the category of data and tools. On the data side, particularly the case company has a lot of challenges to solve, which has been noticed and highlighted in chapter 5.3.1. Below are the proposed improvement activities related to the data and tools presented:

Data and tools

- Investigate the potential of an advanced sales and operations planning tool.
- Develop a common database for S&OP data.
- Investigate the possibility of implementing material numbers.
- Incorporate data from master schedules for improved supply planning accuracy.
- Establish clear data linkage between business systems and tools for improved end-to-end traceability.

It has been acknowledged through the case study that most of the current obstacles in the S&OP process are related to data availability and data accuracy. As well as a lack of coordination and integration between business tools and systems. Furthermore, the company still uses spreadsheets which requires plenty of manual inputs and data gathering from different applications and tools. In available S&OP literature from various authors (Grimson & Pyke, 2007b; Lapide, 2004a; Singh, 2010b; R. A. Stahl & Wallace, 2008a, 2011b; Thomé et al., 2012)agree how important data availability and accurate data are for a solid S&OP process. Reliable data is the core foundation for S&OP to work sufficiently and support companies to become more competitive and profitable.

The first suggested action made to the case company is to investigate the potential and possible implementation of an advanced planning system for S&OP. If the business volumes would increase in the upcoming years, it will be a real challenge to manage and

execute the monthly cycles with the current way of working. It would be too complicated and time-consuming with the manual inputs and spreadsheet planning. Hence, the case company should consider investing in an advanced planning system.

Another improvement proposal is to develop and create a database for all relevant S&OP data. That would support the analysis of cycle-over-cycle comparisons if the data were available in a well-structured database. A database would support the performance management side of the process and would enable the possibility of measuring different KPIs. One more idea would be to explore the opportunity to start utilizing material numbers for the auxiliary equipment. Currently, all planning parameters are manually updated for the auxiliary product, this process could be completely automated if material numbers would be used for the products. It would also improve the linkage between systems and enable better end-to-end traceability.

Incorporating data from master schedules like shipment dates and other key project milestones would also be a valuable process improvement. That would increase the planning accuracy and by that take the process to the next level. To further automate the process, it would be required to strengthen the data linkage and integration between various business tools and systems. That would result in improved end-to-end traceability.

Both R. A. Stahl & Wallace, (2008); Thieuleux, (2023) point out that collaboration with external stakeholders can improve the internal and external supply chain flows and contribute to a more sustainable supply chain. Sharing information and visibility of future volumes with suppliers is hence also a key factor for improved customer satisfaction. The collaboration with external suppliers is an improvement area for the case company. The next category of improvement proposals for the case company are categorized into collaboration. The two suggested actions are highlighted below.

Collaboration

- Establish equipment forecasting practices to ensure volumes from external vendors.
- Build an S&OP lessons-learned culture.

The first concrete action the case company really should consider is to strengthen the collaboration with external vendors. Currently, no equipment forecasts are submitted to suppliers. Forecasting towards the supplier would ensure volumes and shrink the lead times for auxiliary equipment. That is crucial for the projects to meet the demanding customer requirements and expectations. It would as well be a more straightforward process to assess the feasibility of the demand plan from a volume/capacity point of view, by having clear volume/capacity confirmation from the vendors. Finally, to improve the internal collaboration around S&OP a lessons learned forum could be established to ensure that mistakes, issues, and challenges are recorded and avoided in the future. That would also support the continuous improvement journey for the company's S&OP process.

Some other improvement areas were also recognized from the interviews, and these have been categorized as overall S&OP improvement proposals. These are related to both the S&OP team/organization but also suggestions that could improve and add more value to the overall process. All the proposals are listed below.

Other overall S&OP

- Evaluate/Consider additional critical project team resources in the capacity planning process.
- Develop a way to assess volumes and capacities and other capabilities for logistics.
- Hire a dedicated supply planner.
- Benchmark the S&OP process against other companies operating in similar project-based environments.

First, the case company should evaluate and consider additional critical project team resources on top of project managers and chief project engineers. Other resource types like project controllers, supply chain personnel, or contract managers can potentially also be bottlenecks. Moreover, it was identified that there is a clear disconnection between S&OP and logistics. Logistics is an essential part of customer delivery projects, where both inbound and outbound logistics are included. The fact is that the total value of transportation usually is a substantial percentage of the total contract value. Recent impacts on logistics like COVID-19, the Ukraine war, trade wars, Suez Canal obstruction, and the recent cargo attacks from rebel groups also affect the price, shipment frequency, availability, and capacity of logistics. For all these combined reasons the case company should integrate logistics planning for volumes, capacities, and other capabilities for logistics, to ensure that the projects in the demand plan can be delivered.

Currently, there is no nominated person for supply planning, which can be seen as a process bottleneck. Increased volumes and more resources to be evaluated during the supply planning phase, also mean more planning parameters and additional scenarios which certainly would require one FTE (full-time equivalent). The last suggestion for the case company is to benchmark its S&OP process against similar companies working in a project-based environment. This activity could give valuable information and best practices from other companies that potentially could be utilized to improve the process further.

7 Managerial implications

This chapter intends to interpret and convert the central findings of the literature review and the empirical results into actions and advice for managerial implication. It further delivers beneficial information and supports companies to improve their S&OP process, defeat different challenges, and how take advantage of opportunities. The chapter starts with a summary of the key findings identified during this research, and how they are important for managerial implications. In the next section, 7.2 recommendations for the company managers are outlined based on the findings. In this section, a gap analysis is generated to assess the case companies' current S&OP process.

Additionally, the potential issues related to the implementation of the proposed recommendations are discussed in section 7.3, limitations, and generalization of the study. Finally, this whole chapter ends with the generalization section, where the possibility of adopting the findings and results of other similar organizations is investigated and discussed.

7.1 Key findings summary

The case company has adopted a five-step S&OP process, which is aligned with the existing theoretical frameworks. However, the data gathering is not specified as a step and happens on an ad-hoc basis, and the supply planning or capacity planning step is divided into three different areas. The five-step S&OP methodology was initially designed for high-volume and mass-production environments. That can be one of the reasons why the company struggles to acquire all the expected benefits.

Regarding the roles and responsibilities in S&OP, the study revealed that in a complex project-based environment, it is essential to have a cross-functional team with representatives from all relevant departments of the organization. Active participation and involvement from the executive level is required, since in a complex environment many hard decisions that potentially can have a huge financial impact must be taken during

the S&OP cycles. It is also recommended that a fully designated S&OP team with members from all relevant departments be fully allocated to run the S&OP process. In a complex project environment, S&OP requires a lot of planning, analysis, and follow-up activities which demands time and great commitment from the team members. Due to extreme demand volatility and complex solutions and products that require a lot of engineering, there are more planning parameters compared to a high-volume business, and it can be hard to get them and even harder to have accurate parameters. Lack of material numbers/codes for customized products is an issue, and hence, the lead time and price for the same products with different configurations and quality standards can vary a lot. That creates complexity in the planning process.

The results from the empirical study also imply that the case company has managed to achieve several benefits through its own S&OP process, both hard and soft benefits. Recognized benefits from S&OP in the case company are presented below:

- Improved visibility, transparency, and clarity.
- Improved alignment between departments.
- ONE consensus S&OP plan à reduced silos between departments.
- Improved capacity utilization.
- Risk reduction/supply chain risk reduction.
- Reduced inventory levels.
- Cost savings à S&OP has enabled bundling opportunities in project purchasing and logistics.
- Increased customer satisfaction.

Even though the S&OP process has generated several benefits, the results from the case study also indicate that the case company faces many challenges that must be resolved, if it wants to improve its S&OP process. The key challenges identified through the interviews and observations can be categorized into six main areas that require further attention:

- Lack of standard planning process/routines and governance.
- Limited supplier collaboration.
- Systems connectivity.
- Manual & subjective planning process.
- Lack of performance management.
- Data availability and data accuracy.

Figure 31 on page 97 describes all these challenging areas in detail, where specific bullet points of challenges are listed under each area.

7.2 Recommendations

Based upon the main theoretical and empirical findings, actionable recommendations have been generated for managers in the case company, especially for those heavily involved in the S&OP process and the decision-makers. A gap analysis was conducted to highlight the identified improvement areas. Many improvement areas and recommendations are based on the identified challenges listed in the bullet points above. In the next chapter, 7.2.1, the gap analysis is presented and explained in detail.

7.2.1 Gap analysis

A gap analysis was utilized to detect and highlight gaps between current ways of working or practices and eventual remedies to close the gap between the current and desired state, improve the process, and overcome the current S&OP challenges. Analyzing the gaps can help the case company understand and outline areas that must be addressed and investigated further. In table 7 below the gap analysis is presented. It includes the objective (improvement area), current state, desired future state, gaps, and remedies to close the gaps.

Objective	Current State (FROM)	Desired Future State (TO)	GAPS	Remedies
Increase supplier collaboration	No forecasts are shared with external suppliers, hence the supplier capacities are not transparent.	Establish a standard supplier forecasting practice, where the suppliers confirm their capacities. That requires transparency in both directions demands transparency from the case company and capacity transparency from the supplier.	Lack of available data and accurate data. No forecasting method, guidelines, or template exists. High complexity, and it's challenging to utilize historical data due to the extreme fluctuations in the demand volumes.	Investigate and evaluate the possibility of using material numbers. That would enable data availability and accuracy. Establish a common forecasting method and create guidelines for suppliers on how they should utilize the provided forecast. Establish a two-way communication loop between the case company and suppliers to ensure transparency in both directions.
Improve linkage between systems	Manual inputs and spreadsheets are used for planning, and no system-supported option exists to simulate the end-to-end impact of plan changes.	Minimize the effort required to gather inputs from various systems manually, and avoid manual planning in spreadsheets. Having a clear linkage between various business tools and applications to ensure end-to-end data traceability.	Disconnected systems and tools. Many departments have their own tools and applications where they generate and insert data, and these systems are not linked together.	Establish clear linkage between data from various systems and business applications to enrich the data flow and end-to-end traceability. That will also enable the possibility of simulating the end-to-end impact of S&OP plan changes.
Improve performance management	Forecasting accuracy is not tracked, and no KPIs exists for resource utilization. No follow-up on planned versus actual	Measure forecasting accuracy and resource utilization, such as over/underutilization, and establish a way to measure the previous S&OP plan against actual performance.	Lack of forecasting accuracy definition and measurement. Very hard to measure demand accuracy, since the dates and sales opportunities are constantly changing. No way to measure resource utilization for auxiliary equipment since the supplier capacities are not fully transparent due to missing forecasting practices. Time-consuming and manual work to compare previous S&OP plans against actual performance.	Incorporate a coefficient of variation to measure the demand volatility, which can support measuring the accuracy. If objective 1: increase supplier collaboration, and objective 3: systems connectivity, are resolved it will be possible to measure resource utilization and comparison of previous S&OP cycles.
Increase data availability and data accuracy	Missing key data elements, such as shipment plans, lead times, and transportation time. Poor accuracy of sales data such as closing date, effective date, and delivery date.	Incorporate project plans in S&OP with shipment dates and contractual delivery dates and obligations. Store lead times and transportation times in a tool or database for easy access. Ensure that sales data are accurate and updated according to the latest information/intel.	Project plans are generally missing in the sales phase, or are created in a late stage (typically before signing). These are either not stored in any system or database. Lead times for equipment are not available in any system and can vary a lot depending on complexity.	Create project plans with shipment dates and contractual obligations in an earlier stage, and store them in a database, so they are easily accessible. If lead times are unknown or vary, historical data from purchase orders and previous delivery times/lead times can be utilized as intel and base.
Dedicated S&OP Team	S&OP is managed by an ad-hoc team and only a fully allocated demand planner exists.	Having fully dedicated and allocated S&OP to run the process.	All key contributors in the case company's S&OP process have other responsibilities. S&OP duties are managed on an ad-hoc basis.	Hire key resources.

Table 7 - S&OP gap analysis

The remedies or actions proposed to close or mitigate the identified gaps between the current and the desired state can be initiated as process development actions for the case company. Additionally, the identified gaps elaborate on research question number

three: “What are the current barriers and challenges of S&OP in the case company to prevent them from reaching the next level? “.

7.3 Limitations and generalization of the study

Some of the proposed recommendations and remedies can be challenging to implement. Many of them, for example, establish a fully allocated S&OP team, link data, and systems, and start utilizing materials numbers allocated with a cost both money-wise but also from a time and team utilization perspective. If the company starts using material IDs in SAP, it would also require data creation and maintenance, and additional resources and expertise might be needed. People also tend to be very busy, so time allocation for development activities can be low on their priority list.

Even though the findings generated from this study are based around the case company, other companies operating in a similar environment can acquire beneficial insights and guidelines that might be relevant for them, which can improve their S&OP process. Other similar companies might struggle with the same challenges and can hence benefit from this study. Anyhow, all organizations have their characteristics and ways of working, so the general recommendations and principles ideas can be adopted, but each company must implement and design its own S&OP process.

8 Conclusion

The last section wraps up the central findings obtained during the thesis. First, the research questions will be answered, and the main findings will be summarized. Lastly, future research directions and recommendations will be outlined.

8.1 Research questions

The first objective of the research was to map and describe how the S&OP process is executed in the case company, who is involved and what are the inputs and outputs for each step. The second objective is to explore from academic literature what benefits S&OP can generate for companies and benchmark these benefits against the case company's achieved advantages. On the contrary, another objective was to identify the biggest hurdles and challenges that the case company currently faces in its S&OP process. Furthermore, the S&OP stakeholders in the case company will be identified, and mapped, and a high-level RACI model for the process will be generated. Finally, based on the findings recommendations and improvement proposals will be given to the case company. To achieve the research objectives the following research questions must be answered:

Research question 1: How is the current S&OP process executed in the case company?

The answer to this question can be found in Chapter 5.1. Where the high-level process is presented in Figure 10 on page 54, and the detailed process is in Figure 11 on page 53. The S&OP process consists of the following major steps: demand planning, capacity planning/supply planning, financial planning, pre-S&OP, and Executive S&OP. These steps are executed in monthly cycles, with a planning horizon of five financial quarters forward. The objective of the S&OP process is to ensure that the company can meet the demand while balancing supply capabilities and evaluating the financial impact. All steps are described in detail in chapter 5.1. To briefly summarize each step starting from the demand planning. Demand planning is the process of creating a demand plan

and scenarios based on the sales pipeline and adjusting the dates and probabilities of sales opportunities. During the supply planning step, the demand plan and scenarios are evaluated against the supply capacities and constraints of manpower, gen-sets, auxiliary equipment, and alternative supply scenarios to resolve bottlenecks. Financial planning aims to visualize and assess the financial impact and outlook of the demand plan and scenarios, and the alternative supply scenarios, across various dimensions such as revenues, margins, risks, and working capital. The Pre-S&OP meeting is the meeting where the demand, supply, and financial plans are harmonized and reviewed holistically, and the feasibility, consequences, and recommendations of the plans are presented and discussed. Finally, the Executive S&OP is the last step of the monthly S&OP process, where a summary of demand and capacity planning is presented, potential bottlenecks and their solutions are discussed, and decisions are made based on the feasibility and financial impact of the S&OP plans.

Research question 2: What benefits have the case company gained from its S&OP process?

The benefits the case company has gained from its S&OP process are highlighted in Chapter 5.2. These benefits can be divided into financial/general benefits and advantages related to alignment and people. Improved utilization of resources, reduced supply chain risks, lower supply chain costs, and better portfolio management have been recognized as financial benefits for the case company. Furthermore, on the alignment and people side benefits like increased collaboration, improved accountability, clarity, transparency, and visibility of both demand and supply were identified.

Research question 3: What are the current barriers and challenges of S&OP in the case company to prevent them from reaching the next level?

The identified challenges are presented in chapter 5.3. They are categorized into five main categories: data and tools, performance management, demand, supply, and over-

all S&OP process. The case company faces challenges with data accuracy and availability, the use of multiple tools and systems with no end-to-end data flow. Performance management is also a challenge, with no defined KPIs or metrics to measure the performance of the process. The demand planning process lacks a standardized process and clear prioritization logic, the demand is also volatile and hard to accurately forecast. In the supply planning process challenges like limited supplier collaboration, manual updating and maintaining of planning parameters, and variability in lead times for auxiliary equipment were identified. Figure 31 on page 97, summarizes all identified challenges and in chapter 6.1 improvement proposals aiming to solve these challenges have been made to the case company.

Research question 4: What are the roles and responsibilities in the case company's S&OP process?

In Chapter 5.4, the roles and responsibilities are presented. Both direct and indirect contributors have been identified in the case company's S&OP process. All identified stakeholders have been listed and can be found in Appendix 1 – S&OP identified stakeholder list. Additionally, the direct contributors or main stakeholders and the roles for each S&OP process step have been mapped and visualized in Figure 28 on page 88. To further highlight the roles and responsibilities a high-level RACI matrix was created for the process, it can be found in Figure 29 on page 90. A detailed RACI model was also generated for the supply planning process of auxiliary equipment.

Summarizing the key takeaways from roles and responsibilities one can point out that, the case company has many S&OP contributors/stakeholders. Anyhow, there is only a small team that is directly contributing to the process by gathering data, preparing the materials, evaluating the scenarios, and participating in the meetings. The outcome of the monthly cycle is shared with the whole organization; hence many indirect contributors exist. With the support of a RACI matrix, the accountability areas, roles, and responsibilities are clear in the case company.

8.2 Future research direction

This case study examined how the S&OP process is executed in the case company, what benefits it has generated, and current challenges. The results were then compared against existing frameworks and theories identified from the literature review. It would have given an extra dimension to the research if the results had been compared and benchmarked against other companies' benefits and challenges operating in a project-based environment. It would have been interesting to see if similar companies have identical or comparable challenges and achieved benefits.

Through the literature review, it has become evident that frameworks, guidelines, and concepts for S&OP in an engineer-to-order environment are missing. That is a research area where there is a gap in the academic literature, and a future research direction would be to create an S&OP framework and guidelines that companies facing high complexity, fluctuating demand, and weak forecasting precision can utilize, and use as support when balancing their demand and supply. Another area that would be interesting is to investigate how other companies measure the performance of their S&OP process. In existing theory, there are very rare to find any information or guidelines on how to measure the performance of S&OP.

Finally, it should be explored how an advanced planning system could support companies operating in a project-based environment. Would some of the identified challenges and bottlenecks automatically be solved with an advanced planning system? Would there be fewer and less manual work, and what other benefits and opportunities could it generate?

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Appendices

Appendix 1. S&OP identified stakeholder list

Stakeholder Group	Role	S&OP Role
CRM / IT Systems & Data	CRM Product Owner	Key contributors
Demand / Resource	Director	"S&OP validation board"
Demand forecast accountable	Energy Business Director	"S&OP validation board"
Executive S&OP	President & EVP, Energy	Steco
	Vice President	Steco
Front-line Sales	Business Dev. Mgr	Key contributors
	Business Dev. Mgr, Sales and Commercial	Key contributors
	Sales Director, Special Projects	Key contributors
	Senior Business Dev. Mgr	Key contributors
Front-line Sales / Sales Support	GM Sales, Contracts & Projects	Key contributors
IT Systems & Data	Contract Manager	Key contributors
	Enterprise architect for Energy	Key contributors
	General manager / cloud security	Key contributors
	Senior Architect, Product Data	Key contributors
	Senior Data Architect	Key contributors
	Solution architect	Key contributors
	Solution architect CRM	Key contributors
	Solution architect Data	Key contributors
On call support	Assistant	On call support
	Exec. Assistant	On call support
Performance Mgmt	Director, Area Business Control	"S&OP validation board"
	Director, Business Control	"S&OP validation board"
	GM, Strategic Relations & Business	Key contributors
	Sr Manager, Commercial Analyses & Strategy	Key contributors
Process Design	Service Designer	Service designer - support
Resource Planning	Director	"S&OP validation board"
	Director, Power Systems & Control	"S&OP validation board"
	Director, Solution Design & Product Mgmt	"S&OP validation board"
	Director, Sustainable Fuels and Environment	"S&OP validation board"
	GM, Civil	Key contributors
	GM, Electrical & Automation	Key contributors
	GM, Mechanical	Key contributors
	GM, Plan Expertise	Key contributors
	GM, Subcontracting Mgmt	Key contributors
S&OP Project Team	Demand Planner	Sales / demand planning lead
	GM S&OP	Project lead
	GM, Project Mgmt	Resource Planning Lead
	GM, Sales Development	CRM & Sales Process Lead
	Program Manager	IT & systems Lead
	Senior Mgr, Performance Mgmt	Performance Mgmt Lead
Sales Process Development	Director	"S&OP validation board"
Sales Support / Demand planning	Director Business Support	"S&OP validation board"
	GM Sales Support	Key contributors
Sales Support / Process Development	GM, Technical Sales Support	Key contributors
Sr Leadership Team	Director	"S&OP validation board"
	Project Coord., Change Leadership	Key contributors
	Talent Development Lead	"S&OP validation board"
Supply Planning	GM, Project Proc. & Logistics	Key contributors
	GM, Supply Mgmt	Key contributors
	Manager, Planning & Dev.	Supply Planning Lead
	S&OP Specialist	Key contributors
	Supply Chain Planner	Key contributors
	Volume Planning Mgr	Key contributors