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Supplier Capacity Planning in the face of Market Uncertainty

The impact of forecast communication on
capacity planning

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Abstract

The purpose of this paper is to investigate the internal and external processes at Company X, focusing on forecast creation and how the forecast process impact supplier capacity planning. In order to do so, two research questions have been created. How is the forecast developed internally and how is communicated to internal and external suppliers? How is internal and external supplier capacity planning connected to forecast communication? The topic for the study has been developed together with Company X and focuses on an area in which the results can be of value to the company. The study has been performed using a combination of observations and interviews with internal and external actors. Finding from these interviews have been used to develop a discussion on areas identified as especially important. What can be found is that Company X has well developed internal processes, that have been used over a long period of time. No need can be identified to radically change the internal process. Instead, more focus should be put on developing supplier relationships to improve communication and cooperation.

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Abbreviations

BI	Business Intelligence
BWE	Bullwhip Effect
EDI	Electronic Data Interchange
KPI	Key Performance Indicator
LTVF	Long-Term Volume Forecast
MPS	Master Production Schedule
MRP	Material Requirements Planning
MTO	Make-to-Order
MTS	Make-to-Stock
PCC	Program Capacity Check
PPL	Production Plan
RBWE	Reverse Bullwhip Effect
RCCP	Rough-Cut Capacity Planning
SCA	Supplier Capacity Audit
SCM	Supply Chain Management
SDA	Supplier Delivery Assurance Engineer
SRM	Supplier Relationship Manager
S&OP	Sales & Operations Planning
TMF	Total Market Forecast

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1 Introduction

The concept of supply chains has been around ever since the first time a product or service was delivered to a customer. Early on it was rudimentary, an exchange between the manufacturer and customer, but as societies developed the relationship between seller and customer became more complex. The development of industries created region or country specializations, with specializations in different goods or services. Innovation and technological advances have changed the production industry. Meanwhile the development of free-trade agreements and customs unions have changed international trade. Along with societal development, customer preferences have shifted and created demand for a new type of goods and services. This has led to a more integrated global market with converging customer preferences across the world (Basu & Wright, 2017). For companies, the globalization has meant increasingly complex and dynamic markets, and a highly competitive environment for all industries (Crum & Palmatier, 2003). The impact of globalization was realized already in the 1990 in a study by Sheffi and Bovet (1998), highlighting the shift that will occur in demographics and economic power. The benefits of global sourcing have long been known. However, with increased access to low price products and fast transport, demand has become increasingly global (Sheffi & Bovet, 1998). Due to increased competition, awareness of the environment and increased information, Sheffi and Bovet (1998) predicts that companies will increase the speed of innovation across the supply chain. This will be enabled by the development of an integrated and flexible supply chains that will enable flow of products, information and ideas across the entire chain. The ability to quickly respond to customer demand and sourcing will be important indicators of company performance and success.

As a consumer today, there is a massive number of products to choose from and better ability to research products of interest (Basu & Wright, 2017). Most consumers are now conscious enough to compare products between different retailers and chose the one with the lowest price. When customers expect excellence in delivery performance, product availability, low price, as well high responsiveness to their demands, suppliers struggle to provide customer satisfaction (Crum & Palmatier, 2003). The study by Sheffi and Bovet (1998) highlights the impact of this development on the automotive industry, where automotive manufacturers attempt to deliver higher quality vehicles, at a lower price, with short delivery time. With customers expecting continuous price reductions, companies must attempt to satisfy this expectation (Sheffi & Bovet, 1998) and this trend has continued throughout the first decades of the 21st century.

Companies need to display high flexibility in order to adhere to customer demand; however, it is difficult for a single organization to acquire all capabilities to do so (Basu & Wright, 2017). Any high-performance organization must have the competencies that allow them to understand the fluctuations in the market and enable them to forecast these changes to create an agile organization, that is able to respond quickly. If an organization does not display these qualities, they face the risk of customers moving to a competitor (Sheldon, 2006). Therefore, a company must select suppliers that can provide missing skills and competences (Basu & Wright, 2017; Zacharia, Nix & Lusch, 2009). When investigating what capabilities are needed, internal capabilities should be identified to exploit internal supply capacity. Thereafter external partners should be selected to complement the competences not present internally (Feldmann & Olhager, 2008). The collaboration with suppliers has become critical to achieving a flexible and efficient supply chain (Zacharia, et al., 2009). Crum and Palmatier (2003) identify the manufacturing industry, as one industry that has felt the effects of increasingly complex supply chains and long lead times as a result of the globalized economy, strongly.

Supply Chain Management directly affects company performance and depending on how the supply chain is operated the impact can be positive or negative (Sheffi & Bovet, 1998). Basu and Wright (2017) define Supply Chain Management as a concept that aims at optimizing supply chain performance by focusing on critical elements. This implies that an effective supply chain is essential to firm performance, operational excellence and to get a competitive edge (Sheffi & Bovet, 1998). The elements of the supply chain include both internal and external actors located at each end of the chain, suppliers at one and customers at the other. Suppliers and customers must be matched with the internal capabilities of the manufacturing process, achieving this enables the organization to have a twofold focus, satisfying customer needs and keeping costs to a minimum (Basu & Wright, 2017). Manufacturing firms, especially in the automotive industry, demand yearly cost reductions from suppliers, while simultaneously asking for best practice standards in demand collaboration and flexibility. To fulfill the expectations on price, delivery and quality, companies and its suppliers are increasingly dependent on forecast accuracy and demand management. The consequences of inaccurate forecasts such as, undesirable inventory levels and supply chain disruptions have been known for a long time. Inaccurate forecasts also compromise sales and financial performance and in turn affect customer satisfaction (Crum & Palmatier, 2003). Given the clear advantages of an efficient supply chain, companies across all industries have focused on reducing cost and increasing speed in the supply chain (Lee, Padmanabhan & Whang, 2004). The issue raised by

Lee et al. (2004) is that despite this, companies still face difficulty in delivering goods. This is attributed to the fact that a supply chain characterized by speed and low cost is unable to quickly respond to variations in demand and supply (Lee et al., 2004). The focus must therefore be on developing a coordinated supply chain, cooperating with both customers and suppliers. Organizational ability to build strong and mutually beneficial partnerships is a strong determinant of company success (Sheffi & Bovet, 1998).

Recognizing the need for forecast accuracy to minimize risk, companies develop processes to improve and coordinate their demand- and supply planning functions (Sheldon, 2006). One way of accomplishing this is by adopting the Sales and Operations Planning (S&OP) philosophy to achieve integrated business management processes and supply chain excellence by focusing and aligning demand, supply and financial functions within the organization (Sheldon, 2006; Schorr, 2007a; Bowersox, Closs & Cooper, 2010). With increasing pace in both the marketplace and technological development, the S&OP process has evolved beyond operations planning to integrate all organizational functions (Basu & Wright, 2017). Managers are also realizing that the financial benefits from reducing inventories and supply chain costs can only be achieved by improving demand management and capacity planning mechanisms (Crum & Palmatier, 2003). The S&OP process is divided into four steps, the sales forecast, demand plan, supply plan and consolidation and release of final volume plan. All with the aim to create an accurate demand forecast and plan production accordingly. According to Sheldon (2006) the implementation of a robust S&OP process does not replace the need for good judgment and experience. S&OP should not be a source of easy answers but rather to empower the right people to discuss the right topics at the right time and thus increasing the quality of the decisions made throughout the supply chain (Sheldon, 2006).

For the purpose of this paper a case study will be performed at a multi-national company within the automotive industry. The name of the specific company will be kept confidential at their request; therefore, the company will be called Company X throughout this paper and background information will be kept at the industry level.

1.1 Industry Background

The globalization of international trade has impacted all industries including the automotive manufacturing industry. As automotive industries developed from operating nationally to expanding globally, the need for creating efficient supply chains and coordinate the purchasing

of complex components and sub-systems. With global and dispersed supply, information exchange must be frequent and accurate. The concentrated structure of the industry gives a small number of manufacturing firms power over suppliers, often enough to force them to comply to specific standards, information systems and business processes (Sturgeon, van Biesebroeck & Gereffi, 2008).

During the last decades, the automotive industry has shifted from mass production to mass customization; the latter enables companies to provide a high variety of products while maintaining low costs and short delivery times (Vollmann et al., 2005). This shift was accompanied by a change in production planning, from make-to-stock (MTS) to make-to-order (MTO). In MTO driven production, planning is more accurate if the share of customer specific orders increases. The coordination of MTO production processes is complex and require sophisticated planning methods (Meyr, 2004). The supply chain in the automotive industry is characterized by a large flow of material converging towards production and a dispersed flow of final products towards customers that can be situated around the world. This makes the supply chain difficult to coordinate, not only due to the potential bottlenecks in capacity and work force, but also as the supply chain is vulnerable to disruption in the incoming flow of components or parts from suppliers (Meyr, 2004).

The relationships between automotive manufacturers and their suppliers have evolved since the 1980s. From being characterized by short-term contracts, multiple sourcing and little exchange of information. Supplier relationships have been developed to include more extensive use of long-term contracts, more information exchange and closer cooperation. This development is surprising as automotive manufacturers are sacrificing purchasing power to create long-term relationships with their suppliers. However, in the face of economic and market uncertainty, the increased integration of the supply chain makes sense (Helper, 1991).

1.2 Problem Definition

In light of the increased sales in the automotive industry over years following the financial crisis (Oh, 2014), the industry has suffered from supply constraints. With the unexpected increase in demand, Company X has faced significant supplier capacity constraints, causing disruptions throughout the supply chain and impacting customer satisfaction.

The supplier capacity issue has put strain on the purchasing organization to develop solutions in cooperation with suppliers. One source of the problem could be the forecasting process and the suppliers' confidence in it. The unanticipated peak in demand made suppliers realize that they did not have sufficient capacity to cope with the increased volume in the orders. Information gathered internally has showed that historically, the forecasts have been inaccurate, estimating too high or too low demand volumes; this has in turn led to low confidence in the forecast among suppliers.

Actions have therefore been taken to evaluate the Sales and Operations Planning process used to develop the volume forecast in Company X. As projects evaluating the S&OP process have already been initiated, this study will take a different approach, highlighting the topic from another perspective. With the current supplier capacity problem as a starting point, the study, developed together with the purchasing department, will focus on how the forecast and more specifically its accuracy, impacts supplier capacity planning. The theoretical framework including Capacity Planning, Demand Management and Forecasting, as well as the Sales and Operations Planning processes, will enable a comparison between empirical findings and theoretical best practice. Further, a comparison between different types of suppliers will be done to see whether best practices and issues can be identified. Thereafter, current processes will be analyzed to make recommendations for future actions.

1.3 Purpose

The purpose of this study is twofold, first aimed at investigating how the forecast is created at Company X. In doing that, the internal forecast process at Company X will be outlined, clarifying the different steps and responsibilities within the process. Since the company employs the Sales and Operations planning process to create the demand and volume forecasts, this process will be mapped with the purpose of understanding how the forecast is developed.

Once this process has been outlined, the step can be taken to see how the forecast is communicated to suppliers. The purpose of this is to identify how the forecast is received and in turn how it influences capacity planning at the supplier. By identifying this, the impact of forecast accuracy on supplier confidence can be determined. Establishing the level of confidence in the forecast enables the deduction of actions that can be taken by Company X to improve supplier capacity planning. The topic for this study has been developed together with Company X, and is focused on analyzing the forecasting process from the development of

customer demand to first tier suppliers with focus on capacity planning. Therefore, the scope of the study is broad, and rather than doing an in-depth analysis of a single topic, a discussion on different areas within the process will be conducted.

1.3.1 Contribution

The contribution of this study is to increase the knowledge and understanding for the internal forecast process. In order to achieve this the internal forecast process at Company X has been mapped to create an overview and simplification of the complex S&OP process. Therefore, information has been gathered from documented processes and interviews with nine people involved in different stages of the process. From this a number of process maps has been created, this with the aim of providing an overview of the S&OP process to increase the knowledge and understanding internally and externally. The process maps in the empirical framework are created by the authors and is one of the major contribution of this study, to be used by Company X to identify improvements to the process. Another contribution of this study is the investigation of the connection between the internal forecast process and supplier capacity planning. This is done with the aim of increasing the knowledge of the existing capacity problem to identify the causes of the issue and recommendations for potential improvements. The theoretical contribution is largely connected to the case study, providing empirical findings on the operations of a mature S&OP process and a link between this process and external actors. This is something that is missing from existing academic literature on the subject (Tuomikangas & Kaipia, 2014).

1.4 Research Questions

Based on the problem definition and purpose, two research questions have been identified and are stated below:

How is the forecast developed internally and how is it communicated to internal and external suppliers?

How is internal and external supplier capacity planning connected to forecast communication?

1.5 Delimitations

Performing a case study at a large multinational company, a highly complex organizational structure and supply chain are encountered. In investigating the supply chain process at Company X, the focus lies on the forecast process. This means that the study will be limited to the S&OP process and the forecasts used to develop it. In the S&OP process, the financial

aspect will be excluded to limit the scope of the study. For the same reason, the role of marketing in the S&OP process will be not be studied in detail.

In the investigation of the different capacity planning processes at internal and external suppliers, the focus lies solely on the planning stage and on how the forecast from Company X impacts this planning process. Further investigating supplier communication, the study will include all departments that have contact with tier 1 suppliers. However, the decision has been taken to exclude the role of tier 2 suppliers, and the departments in contact with this type of supplier from the study due to time constraints.

Due to the large scale of the company, the forecast process will be limited to only one of the brands within the organization. When investigating the internal process, a number of interviews is performed. When selecting interviewees, the number was limited to key people in the process, as including everyone connected to the process is too large of a scope for this study. Another aspect is that only few suppliers will be evaluated due to the time constraints of the study. Specifically, this study is aimed at investigating the supply chain from a forecasting perspective taking the approach from the S&OP process, from the sales market to tier 1 suppliers. Performing interviews with everyone related to the topic is impossible, therefore generalizations must be made based on the opinions of the interviewees. This also means that there is full understanding for that the findings may have been different if the interview was held with another person.

1.6 Structure of Report

The paper continues with an outline of the methodology used as the approach for this study and to structure the interviews and processes. Following this, is the theoretical framework identified as relevant to perform an analysis of the topic. Thereafter, the empirical findings are presented with information gathered from existing processes, documented company information and interviews. Finally, a discussion regarding the findings will be presented along with recommendations connected to the discussion. To close the paper, a conclusion will be outlined along with recommendation for further research.

2 Methodology

This section will describe the approach that has been used to conduct the study. It explains the procedures and methodology approach in the context of collecting and analyzing information. With the background of the existing problem, the goal was to describe and explain a process in order to make deductions as of the source of the problem and to identify suggestions.

2.1 Research Paradigm: Interpretivism

The research paradigm uses a philosophical framework outlining how research should be conducted (Collis & Hussey, 2013). There are two research paradigms that are used in research, positivism and interpretivism. Positivism rests on the assumption that the social reality will not be influenced by a researcher that investigates it (Weber, 2004). The positivism paradigm postulates explanatory theories that are used to understand an existing social phenomenon, with the goal of discovering theories that are based on empirical research (Collis & Hussey, 2013). As positivism assumes that the social reality can be measured, it is said to be connected to quantitative research methods based on statistical analysis (Weber, 2004).

Interpretivism developed as a reaction to positivism, and believes that the social reality will be influenced by researcher's studying it (Collis & Hussey, 2013). It believes that it is impossible for a researcher to not be a part of and influence the phenomenon that is investigated, as everyone brings their own values and perspectives (Weber, 2004). The focus of the positivism paradigm is to measure reality, while interpretivism focuses on exploring the complexity of a phenomenon and understand it. This suggests that research that is not measured by statistical methods is interpretative and thus linked to qualitative research (Collis & Hussey, 2013)

Because of the nature of this study, a positivistic approach is not suitable to produce the desirable type of findings. Therefore, we adopt interpretivism as our research paradigm, with the aim of achieving findings that are derived from qualitative methods of analysis. However, it must be noted, that several authors have raised a critical voice against this distinction, and its relevance for research. Weber (2004), drew the conclusion that the difference lies in the choice of research method, rather than providing another way to view the world. Positivistic studies tend to use surveys and experiments, while interpretivists tend to use case studies. Thus, further providing support for the use of an interpretivistic approach in this study.

2.2 Research Approach

This study aims to investigate supplier capacity planning processes from a forecasting perspective. This is done by describing the forecasting process at Company X and thereafter investigating how this is communicated and received by its external and internal suppliers. In doing so, we can identify best practices and issues to provide recommendations for future actions within Company X.

Using an applied research approach, this study aims to shed light on an existing problem within the company that is the target of the research (Collis & Hussey, 2013). Applied research is commonly used when a deduction is to be made about a specific problem, in a real-life situation (Adams, Khan, Raeside & White, 2007). Within the framework of applied research, the result of this study can be applied to help understand the capacity issue that Company X is facing. However, as the topic of the study relates to a generally accepted theory, it can be used to improve the understanding of existing concepts within Capacity Planning, Demand Management, Forecasting and S&OP, which is the aim of basic research. The argument can therefore be made, that the study crosses the border to basic research and uses a combination of the two research approaches (Collis & Hussey, 2013).

The use of the deductive approach describes the logic of the research. The study is performed in such a way that a conceptual and theoretical structure is developed and tested by empirical observations. Therefore, the study moves from a general theoretical approach to particular instances, using a deductive approach (Collis & Hussey, 2013). By narrowing real observations to testable hypotheses, the outcome of the study may or may not align with the arguments in theory. Issues that may occur using deductive methods are to a large extent related to ill-advised assumptions leading to flawed conclusions (Adams, et al., 2007).

2.3 Research Design

2.3.1 Research Method and Research Entity

As mentioned above, this study is conducted at a large manufacturing company where the current S&OP is studied with the purpose of understanding the process of creating the demand forecast and tracing it throughout the organization until it reaches the supplier. The main focus is the processes within Company X and how it affects the capacity planning at supplier level, therefore this research is to be considered a case study. The purpose is to provide answers to the research questions for Company X (Bryman & Bell, 2015).

2.3.2 Case Study

Adams et al. (2007) define a case study as “an in-depth study which explores issues, present and past, as they affect one or more units (organization, group, department or person)” (Adams et al., 2007, p. 112). The main purpose of a case study is to examine particular occurrences in specific contexts that can be used to provide a comprehensive view of the processes used in said contexts. Therefore, it is the method of choice by researchers when investigating organizations. Yin (2014) goes more into detail, claiming that a case study is appropriate when the processes in question are complex. In fact, Yin (2014) points out that a case study is necessary in order to gain better insight, as the depth that distinguishes case studies from other methods is essential to reach the desired outcome. The empirical data used to reach this outcome is usually collected by researchers using a combination of observations and interviews, which can be used to enhance the theoretical basis of the research. However, because of its depth, a case study is often limited scope-wise and is not meant for generalization, as they examine the uniqueness of the unit in question (Adams et al., 2007).

Since Demand Management and Capacity Planning are complex processes (Basu & Wright, 2017), a research method in the form of a case study seemed appropriate (Yin, 2014). The complexity of processes increases further as Company X has a global supply chain with a dispersed customer and supplier, something that can cause several disturbances to operations (Basu & Wright, 2017).

2.3.3 The Research Subject

Developing a case study is an understandable choice, as it is the ideal method of examining specific processes in real life to get a better understanding of the object in question (Yin, 2014). Therefore, the empirical data has been gathered at a large multinational manufacturing company. There is a multitude of reasons for choosing this particular company. First of all, this is a large company, with almost 100,000 employees located in nearly 30 countries around the globe and more than 2,500 suppliers worldwide. An investigation on how the demand creation process is managed was considered to be of interest for a company of this scale, as a result of the high degree of complexity that governs a global supply chain. Cross-functional processes, in particular, are accompanied by high complexity that only intensifies if the organization is multi-national and part of a global supply chain (Basu & Wright, 2017). Lastly, since the manufacturing company that was examined has provided us with sensitive and sometimes

confidential information for the purposes of this study, we have come to an agreement to keep the name of the company, its suppliers and the interviewees undisclosed throughout this paper.

The topic of the study was developed together with Company X that expressed the desire to have more information on the forecasting process in the face of capacity constraints and market uncertainty. Therefore, the current forecast creation has been studied with the purpose of mapping the series of activities linked to it and tracing it throughout the organization until it reaches the suppliers. The main focus lies on the process within Company X and how it affects capacity planning at supplier level. The goal is to structure in such a way that will answer the research questions for this particular case and provide Company X with valuable results and recommendations.

In order to handle the disadvantages of the specific case study and provide a more in-depth result, clear delimitations had to be set. The scope of the study had to be narrowed down in order to deal with the limitations. This was done in consultation with our school supervisor and the team we worked with within Company X. A company of this scale has processes that run through multiple functions, which would be impossible to examine all in-depth. So, first and foremost, the focus was placed on one of the brands within the company. Furthermore, the supplier interviews were limited to one internal and two external suppliers and only first tier suppliers were considered, as it is also mentioned in the delimitations of the study.

2.3.4 Qualitative Approach

In research, either quantitative or qualitative methods can be used as an approach to the research questions. In quantitative studies, researchers gather numerical data that is then analyzed using statistical methods. In qualitative methods, qualitative data is gathered and analyzed using descriptive methods (Collis & Hussey, 2013). Qualitative research utilizes distinctive methods for information collection such as, observation, in-depth interviews and text analysis. What differentiates these methods from quantitative research is the possibility for flexibility and openness in the study (Simonsson, Hjorth, Sandberg & Thelander, 1998). As the interpretivism paradigm is used as the philosophy of the study, there is no desire to use statistical analysis of data (Collis & Hussey, 2013). Instead qualitative data will be gathered using observation and semi-structured interviews and then interpreted using qualitative methods. This enables the researchers and respondents to ensure that the questions are clearly phrased and defined in order for the topic to be fully understood (Adams, et al., 2007).

The qualitative approach is especially appropriate for studies that seek to examine an occurrence to fully understand its root cause and the processes surrounding it (Adams, et al., 2007). In studying complex events and situations, it is helpful to use the qualitative research approach as it allows more details to be gathered on the subject to understand it in more depth (Collis & Hussey, 2013). In order to gather the details required for the study, the research questions have been designed using “how” and “why”, to open up for discussion and analysis of the findings (Adams, et al., 2007).

This study aims to investigate complex internal and external processes, by reviewing existing documentation and performing interviews. In the light of this, a qualitative approach is identified as the most suitable method to identify all details in the process. For this paper, the choice has been made to perform a case study to fully understand the problem faced by Company X and how it could be investigated with the use of a theoretical framework. The use of semi-structured interviews with open-ended questions presents the ability to get access to other perspectives and additional insights into the identified problem. Given the characteristics of the study, it is clear that no other method of investigation could have been chosen. However, the criticism towards qualitative studies must be addressed, so that it can be taken into consideration when constructing the study. Points to be discussed include the difficulty in replicating the study, as the findings are impacted by the context and the time-frame, thus displaying low reliability. In general, qualitative studies are said to produce results with high validity but low reliability. Along with these issues, a lack of transparency in the selection of respondents and data analysis can be identified (Collis & Hussey, 2013), this is something that will be present to some extent in this study due to confidentiality.

2.4 Data Collection Method

For this study, both primary and secondary sources have been used. The primary sources consist of interviews performed at Company X and with selected suppliers to the company. These interviews are conducted to gather new information on the current processes at Company X. Secondary sources that have been used have been gathered internally and externally from the company. To provide an overview, documented information about current processes at Company X has been utilized. External secondary sources in the form of books, and academic journals have been used to develop a background and a theoretical framework to the topic.

2.4.1 Observations

Although observations can be used as a single source of data collection, in this study it is used as a complement to interviews and documented company processes. In case studies performed at companies, it is often important to note company operations outside the interviews, such as physical infrastructure, employee behavior and organizational culture. While investigating operations within a company, it is important to be unobtrusive, so that operations are as normal as possible (Adams, et al., 2007). Yin (2014) brings up the concept of “direct observations”, referring to observations that are done in the objects “natural setting”. For this study, we use participant observations, meaning that we have become part of the organization, as employees (Adams, et al., 2007). This choice has been taken to get full insight into the company and reduce confidentiality concerns. This way, we managed to collect data that could not have been received through interviews, either because the interviewees might consider them negligible or because they are intertwined in their everyday life and no longer actively considered.

2.4.2 Primary Source Information

The method used to determine the sample is the Snowball (or Network) sampling. This method is especially useful for non-probability sampling where respondents are difficult to identify. It is more efficient when the members of the target sample are connected through some type of network. The sampling process is initiated by locating a group to be interviewed; this can typically be done using observation methods. This group is then asked to identify other individuals that would be interesting to interview, and the process continues on like a snowball (hence the name) increasing the number of individuals in the sample. Clear advantages of the method are lower sample sizes and costs, the disadvantage is that bias is likely to occur as a person recommended by another tend to be similar to the first person. This must be carefully considered in selecting the sample, as well as in analyzing the results from the interviews (Adams, et al., 2007).

2.4.3 Exploratory and Semi-Structured Interviews

As the study performed is a qualitative study, semi- structured interviews are used to gather qualitative data. This provides in-depth information about company processes, using either face-to-face or telephone/Skype interviews. The aim of these interviews is to get a well-rounded understanding of the forecasting process at Company X and its impact on supplier capacity planning. In any study, formulation of the problem is key to successful research, and part of this is having access to the stakeholders relevant to the study. In order to identify them

exploratory interviews with company supervisors and other employees have been performed in a non-formal setting to determine the scope of the study and to identify relevant stakeholders (Adams, et al., 2007).

The in-depth interviews are often semi-structured to allow a more general discussion to find all relevant information to the topic. Interviews tend to last about an hour to have the time to explore all topics without putting too much pressure on the respondent (Adams, et al., 2007). The questions posed to the respondents are based on the theoretical framework to ensure that the outcome of the interviews is aligned with the scope of the study (Collis & Hussey, 2013). The interview guide can be found for further review in appendix 2 and 3. By performing semi-structured interviews the researchers are able to steer the discussion while allowing the respondent to freely expand on the subject (Collis & Hussey, 2013). However, the bias that may occur in interviews must be considered. The most common bias is that the question or answer is misunderstood, either by the interviewer or the respondent. To avoid this, the questions must be targeted towards the respondents' field of expertise and by creating clear and defined questions. Another source of error is interviewer bias, it may occur through personal bias, or untruthful replies from the respondent. The interviewer must also remember that the respondent may direct their answers to please the researcher. In this study, both face-to-face and Skype interviews are held due to the large geographical distances between business units (Adams, et al., 2007).

2.4.4 Secondary Data

Secondary data is information collected by someone else; an organization, company or another researcher. This type of data is usually in the form of books or articles and accessible from libraries or on the Internet (Adams, et al., 2007). For this study, secondary data is used to support the findings from the primary data as well as providing an overview of theoretical methods and company processes. The drawbacks of secondary data should also be mentioned, initially the quality of the information should be carefully controlled before using it and the authenticity of both the information and the source considered. Source criticism should be considered at every step of the process. Another aspect to consider is the compatibility and relevance of the information to the scope of the study.

For the background and theoretical framework, a combination of peer-reviewed articles and books have been used as a source of information. The books have been identified using library

services and examined for its relevance to the scope of the study. Articles have been identified using academic journals, such as the International Journal of Production Economics, the Journal of Operations Management and the Strategic Management Journal. By using published books, peer-reviewed articles and our knowledge in source criticism, the reliability and accuracy of the sources can be believed to be high. The extensive research field in Supply Chain Management, and in the sub-fields of Capacity Planning, Demand Management and Sales and Operations Planning, ensures the access to multiple perspectives on these processes from a varied group of researchers.

For the identification of current processes used in the empirical framework, an outline of the processes used at Company X was studied. The information on the S&OP process has been carefully outlined by individuals that are knowledgeable and experienced in the existing processes at Company X.

2.5 Reliability and Validity

2.5.1 Reliability

The concept of reliability is strongly connected to the consistency of the study (Adams et al., 2007). Bryman & Bell (2015) interpret reliability as whether or not a study is repeatable and refer to it as a term that is mostly found in the context of qualitative studies. In order to achieve reliability in a qualitative study there are two important factors that need to be taken into consideration, stability and inter-rater reliability. Stability relates to whether the time of the study has an effect on the results, while inter-rater reliability relates to influence the researcher him/herself has on the result, meaning that it tests whether another researcher would come to the same result or not (Cohen, Manion & Morrison, 2011). Even if a study is found to produce reliable results it does not mean that they are valid, but rather that the results are predictable (Adams, et al., 2007). While performing a case study, company processes are investigated at a single point in time. Therefore, it is highly possible that the study would not have come to the same conclusions regarding company processes if the same study would be conducted at a different time. A company is not a fixed entity but evolves, with improvement projects and reorganizations, the structure of the organization may also vary substantially over time. Given this, it can be concluded that a case study rarely displays the criteria for stability. When performing interviews and observations within the organization, the results vary depending on the researchers' perspective, aligning with the adoption of an interpretivism paradigm. The answers and perspective of the respondent also varies over time and depends on the setting in

which the interview is held. However, to improve the reliability of the results, the choice was taken to hold several interviews with people with different perceptions of the process. This enables us to see where the views differ and where information overlaps, to fully understand the processes. Therefore, given that the processes are not restructured within the organization, the holistic view of the research subject would be similar if performed by another researcher in another point in time.

Even though this study fulfills the requirements for internal consistency, it lacks stability and therefore displays low reliability. However, as mentioned above, that was an already known fact about case studies (Collis & Hussey, 2013) when the research method was chosen.

2.5.2 Validity

Validity refers to the credibility of the study's results. Simply put, it measures the genuineness of the research (Adams, et al., 2007). According to Cohen et al. (2011), the validity of a study is divided into internal and external. External validity is referring to the extent as to which the results of a particular study can be generalized. On the other hand, internal validity deals with the methods that were used for the study and whether or not they are effective or even capable of measuring what was meant to be measured. Since this research has been conducted as a case study, the external validity is low. As the subject is a specific company, data connected to the organizational processes has been gathered and therefore the conclusions may only be valid for the particular company. However, several measures have been performed to make sure to achieve the highest degree of internal validity possible. Both observations and semi structured interviews are considered methods highly appropriate for case studies (Yin, 2014). Furthermore, triangulation was used to validate the findings. The concept of triangulation involves the use of two or more methods of data collection and is an especially important tool for researches within social sciences (Cohen et al., 2011). As mentioned above, both observations and interviews were used for data collecting purposes. The two methods complement each other in the sense that the data collected from observations were validated during the interviews and the data collected through interviews were validated by observations wherever possible.

3 Theoretical Framework

Presented here is the theoretical framework that serves as the foundation for the empirical study and analysis. The theory is based on existing research in the field of Demand Management, Capacity Planning and Sales and Operations Planning. The structure of the theoretical framework will emphasize the position of each of these fields of research within the field of Supply Chain Management. The Sales and Operations Planning process serves as the integration mechanism, integrating the fields of Demand Management and Capacity Planning (see figure 1).

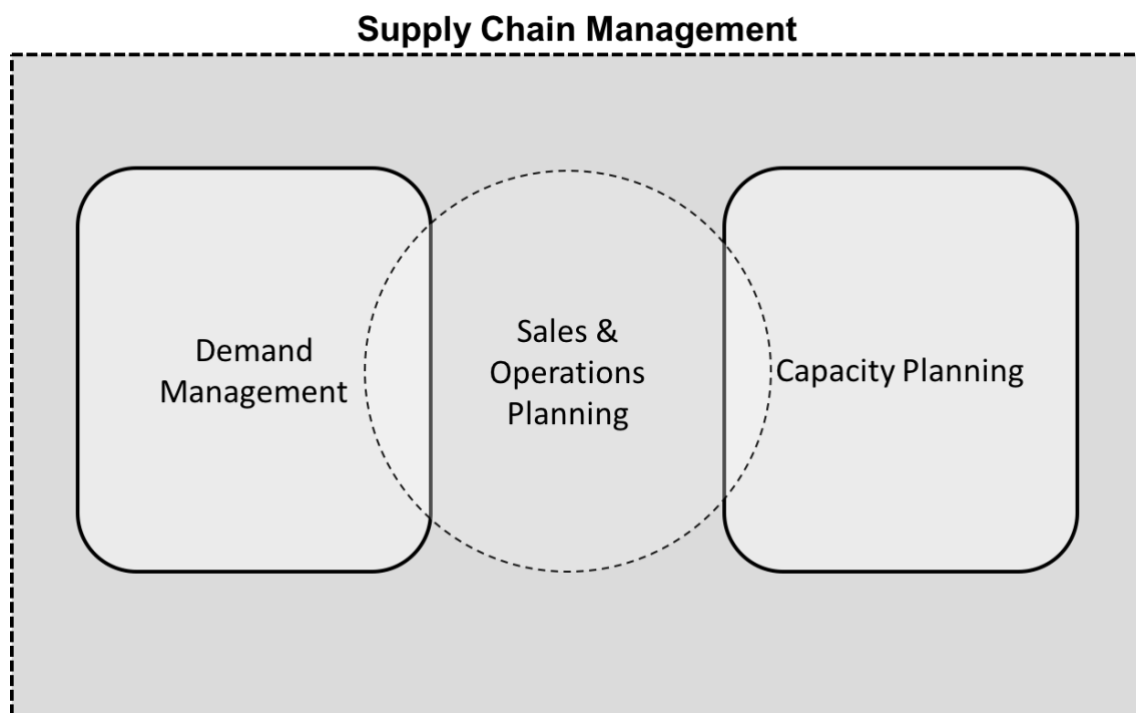


Figure 1: Theoretical Framework

At the company at which the case study is performed, the Sales and Operations Planning process is used to create the demand forecast, and in turn to determine desired supplier capacity. As the S&OP process connects the two main topics of this thesis, demand management and capacity planning, it will be described further from the perspective of these processes. The approach of this study is not simply looking at the internal processes of Company X, but examining how the output of this process, the forecast, impact the way suppliers plan their capacity. The sections below will therefore outline a theoretical framework for the Demand Management and Capacity Planning to be used for the analysis of these processes at Company X and its suppliers. The coordination mechanism, Sales and Operations Planning, has been chosen in part because of its

relevance in theory but mainly because it has been implemented by Company X to produce the volume forecast internally and externally.

Tuomikangas and Kaipia (2014) performed an extensive literature review within the field of S&OP and identified a gap in existing literature. In literature, there is a lack of empirical studies, and in particular case studies and given the complexity of the S&OP process, these types of studies are important to fully understand the process. This study therefore aims to contribute to this gap in literature by performing a case-study at a multi-national company that employs the S&OP process. The S&OP process at Company X is mature and has been developed over time, this study can therefore provide other researchers in the field with an understanding of how the process works after implementation. Thus, enabling researchers to review the process and how it can be used to achieve strategic goals within the company. In addition to this, the study investigates the impact of the S&OP process beyond the confines of the company, a topic that the authors have not found in existing academic literature.

3.1 Supply Chain Management

In any market in which goods and services are exchanged, there are activities that link suppliers to customers. Supply Chain Management (SCM) was created as a tool to balance these links and provide the best value for customer to an as low as possible cost and effort for suppliers. Mentzer, DeWitt, Keebler, Min, Nix, Smith and Zacharia (2001) use previous research to develop the following definitions for a supply chain and Supply Chain Management. A supply chain is defined as:

“A set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer” (Mentzer, et al., 2001, p. 4).

The concept of Supply Chain Management is defined as:

“The systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole” (Mentzer et al., 2001, p. 18).

In manufacturing and production organizations, Supply Chain Management is particularly concerned with the flow of production components through the system to deliver on time to fulfill customer requirements while maintaining low costs (Basu & Wright, 2017). According

to Bowersox et al. (2010) one of the main reasons for unsatisfactory supply chain performance is lack of visibility. Supply chain visibility does not only relate to the ability to track products and inventory within the company but also the access to and proper use of the information on company resources. Increasing visibility throughout the chain can prevent potential disruptions by creating activity and resource plans to counteract the problem (Bowersox, et al., 2010).

Mentzer et al. (2001) traced the increased interest in Supply Chain Management back to the globalization and following global sourcing and pressure for speed, quality and cost in competition. As previously discussed, these factors create more uncertainty in the global economic environment. With global supply chains companies must identify tools such as SCM to help them coordinate the flow of products and services to and from the company (Mentzer, et al., 2001). In order to improve the performance of the business, customer demand must be matched with the capabilities of the company, existing knowledge and resources, flexibility and capacity. If these capabilities are not present internally, the company must seek to find them externally by identifying world-class suppliers (Basu & Wright, 2017).

Achieving a balance between customer service and capacity and resource planning may be one of the hardest tasks for an organization. When the organization is faced with excess capacity and large inventory, managers and the financial departments aspire to reduce inventory to free up capital (Vollmann et al., 2005; Jonsson & Mattsson, 2009). On the other hand, if the organization lacks capacity to fulfill customer demand, firm performance is also impacted. Developing successful supply chains enables organizations to balance capacity and customer satisfaction while improving company performance. In order to properly plan production and capacity, the organization must have access to an estimate of future demand. The demand can only be accurately predicted if customers order in advance and they commit to these orders. This may be possible in the short-term, but as the time horizon increases, the accuracy of the forecast declines. Thus, the creation of accurate forecasts in the medium and long-term is a vital task to properly plan future production capacity (Basu & Wright, 2017). To provide reliable forecasts, the organization must develop an effective communication of information beyond company borders. Sharing information between all participants in the supply chain improves cooperation and thus planning in all time horizons. By providing suppliers with a preliminary supply plan for the coming year, the attention can be put on potential capacity bottlenecks. In the short-term, suppliers receive daily supply plans, that include the orders for the coming time-period, as well as forecasts for coming weeks and months (Meyr, 2004).

In their research, Crum and Palmatier (2003) found that despite the advantages of integrated business process and long-term demand planning such as increasing profitability and customer satisfaction, many companies have not yet implemented these processes. In order to develop an efficient and flexible supply chain, the organization must identify trade-offs where investments and increased costs in areas such as manufacturing or warehousing, might lead to a lower total cost for the organization (Bowersox, et al., 2010). Alongside the increased popularity of Supply Chain Management, Sales and Operations Planning has been recognized as an efficient process for supply chain planning (Feng, D'Amours & Beauregard, 2008). In order to successfully implement processes such as demand management and S&OP, the company must display great competency within areas such as business process integration, employee development and information infrastructure. This in turn translates into investment of time and resources to allocate and develop these competencies, explaining the relatively low usage of these methods. Often companies try to improve their forecasting methods using easier approaches, often relying heavily on information technology. However, for creating accurate forecasts and successful demand management processes, information systems must be combined with human knowledge and experience (Crum & Palmatier, 2003).

3.1.1 Supplier Partnership

Historically, suppliers have often been perceived as opponents to the organization (Basu & Wright, 2017). Purchasing departments have been tasked to secure the best deal, with the highest quality to the lowest costs. Suppliers have recognized the lack of loyalty from organizations and long-term relationships have therefore rarely been developed. With increased demand for performance on the global market, organizations realize the value of securing world-class suppliers, with whom partnerships and information exchange agreements can be formed. The consequences of poor coordination in supply chains have made companies realize the benefits of collaborating with supply chain stakeholders (Basu & Wright, 2017). Companies that share an understanding and respect for each other's knowledge and skill are more likely to develop collaborative relationships. Sharing information and processes improves the performance of the supply chain and strengthens the relationship, thus generating benefits such as reduced cost, improved quality and trust for all stakeholders (Zacharia et al., 2009). By building alliances and long-term relationship, suppliers can become an additional source of market intelligence. Partnership agreements are often characterized by data exchange, using information systems, such as Electronic Data Interchange (EDI), enabling real-time

communication between the company and its suppliers. The success of the partnerships is however solely dependent on mutual trust (Basu & Wright, 2017).

Creating partnerships with suppliers, improves the coordination and flexibility of the supply chain in order to meet customer requirements and generate competitive advantages (Mentzer, et al., 2001). An organization that focus on developing company specific internal supply chain processes, such as forecasting, capacity planning, inventory management and distribution management, can achieve excellence in operations within the confines of the organization. However, in order to optimize customer service and competitiveness, the organization must adopt a total view of the supply chain, working in collaboration with all stakeholders. When establishing collaborative partnerships, all stakeholders must understand the necessity of forecast accuracy and transparency (Basu & Wright, 2017). In developing supplier relationships, trust is a key to developing long-term collaborative partnerships. There are numerous studies that emphasize the organizational benefits of supplier partnerships characterized by trust, and especially its ability in increase competitive advantages (Barney & Hansen, 1994; Jarillo, 1988; Mohr & Spekman, 1994; Sako & Helper, 1998). Jarillo (1988) identifies other benefits from the establishment of supplier trust, such as lower total costs due to specialization and a reduction in risk and uncertainty stemming from dynamic and volatile markets. Trust is something that is built over time, by establishing information sharing practices and showing commitment to the customer-supplier partnership. This is especially important in the automotive industry where the customer tend to have more market power than its suppliers (Sako & Helper, 1998). For suppliers, the commitment of capacity to a customer is a question of risk. If the supplier attaches a large share of their capacity to a single customer they are vulnerable if anything was to disrupt customer demand (von Massow & Canbolat, 2014).

3.2 Sales and Operations Planning

Companies need to develop efficient and well-integrated supply chains in order to be competitive in the global market. As stated by Bowersox et al. (2010) an integrated business management process such as Sales and Operations Planning is necessary for an organization to achieve this. The purpose of the S&OP process is to create a cross-functional process to balance supply and demand as well as connecting the strategic organizational plans with the operational plans (Thomé, Scavarda, Fernandez & Scavarda, 2012a; Lapede, 2006). The concept of Sales and Operations Planning stems from the Manufacturing Resource Planning (MRP) process and has been developed into a formal planning process (Basu & Wright, 2017; Olhager, Rudberg &

Wikner, 2001; Vollmann et. al, 2005) with the aim of creating a coordinated plan to respond to customer demand within the capacity constraints of the business (Bowersox, et al., 2010; Lapide, 2006). The S&OP process runs on a monthly occurrence and is continuously reviewed by managers at an aggregate level to determine alignment to the strategic goals (Sheldon, 2006; Thomé, Scavarda, Fernandez & Scavarda, 2012b; Schorr, 2007a). The development of tactical plans through the S&OP process can help managers steer the business towards competitive advantage by integrating customer focus and the management of the supply chain. By combining the sales, marketing, manufacturing, sourcing and financial plans into one integrated set of plans on both the detailed and aggregate level (Thomé, et al., 2012b). Identifying the gaps between the strategic business plan and the activities within the company is one of the main purposes of the S&OP process in order to run the company as one business (Schorr, 2007a). Due to the ramifications of the decisions made in the S&OP process, both monetary and operational, the ownership of the process should lie on the top-management level, and it should receive the proper attention and careful consideration (Sheldon, 2006).

Vollmann et al., 2005 identifies five steps in the monthly planning process, initially a sales forecast should be developed, thereafter a demand plan is outlined, and this is then used to develop a supply plan. These plans are then followed by a pre-S&OP consensus meeting and lastly a top-executive meeting that determines release of the final plan (Vollmann, et al., 2005; Sheldon, 2006). Lapide (2011) describes a similar outline of the S&OP process, where the process is driven by a baseline forecast that reflects the demand in the marketing and sales plans. This plan drives the supply plan that reflects the activities performed by operations, manufacturing, logistics and purchasing organizations. Other researchers outline the process with different steps, Schorr (2007a) includes an additional step before the development of the demand plan, the product management review, that includes the new product introduction and other activities that influence demand and supply. The product management review is by other researchers included in the creation of the demand plan and not outlined as a separate step (Sheldon, 2006, Lapide, 2011). From studying various companies Sheldon (2006) identified what benefits a company can gain by implementing a successful S&OP process. The main advantages of S&OP are increased communication and cooperation between the demand and supply side of the company; this in turn leads to better customer service by shortening lead times, increasing capacity utilization, more flexibility to market changes, more accurate planning and eventually increased profitability. The benefits for top-management also encourage the use of S&OP, essentially creating discipline in the organization and thus enabling

better risk management and payback on investments (Sheldon, 2006; Crum & Palmatier, 2003; Vollmann et. al, 2005; Basu & Wright, 2017). As stated by Sheldon (2006) with these benefits, it is easy to understand why the S&OP process has become popular amongst manufacturing companies.

Previously, financial, sales and operational plans have been developed in isolation, often with conflicting goals. The process is then usually initiated with the development of strategic financial targets, thereafter sales and marketing plans are developed to meet these strategic goals. In the last stage, the operational plans are developed in response to the sales demand plan (Bowersox et al., 2010). Cross-functional integration often generates conflicts, with sales pushing for selling more products of high variety, while responding to customer demand with short lead times (Vollmann et. al, 2005). While operations instead prefer minimizing product variety and extend lead times to exploit economies of scale (Bowersox et al., 2010). The aim of the S&OP process is to align the different plans created in an organization to improve the efficiency of the supply chain. For the process to work consensus must be reached to create one common plan. If consensus is not reached for the different plans and an agreement cannot be reached, the collaboration often collapses. This results in sales and marketing producing their own numbers, to drive the plans, and thus, operations and finance cannot be sure what numbers should be used to drive their plans. In the end of this process each function has created their own numbers based on a best estimate of the demand numbers, and the final volume forecast will not display high accuracy. Given this process, the suppliers feel unable to have confidence in the forecasted numbers and chose to operate from once again their own set of numbers. This type of process typically results in a bullwhip effect and customer requirements for volume and delivery precision cannot be fulfilled. With unsatisfied customers, the organization loses sales and profitability is decreased (Crum & Palmatier, 2003). Using the S&OP process provides all involved functions with an efficient way of controlling company operations across all stages of the supply chain (Basu & Wright, 2017). Cross-functional planning processes such as the S&OP have shown some evidence to counteract collaboration problems and misalignment. Thomé et al. (2012b) found that if the internal processes are aligned, supply chain integration with both customers and suppliers is improved.

3.2.1 Planning Horizon

In many businesses, the S&OP process is seen as a long-term planning process, this conflicts with the perspective presented by Lapide (2011) that the S&OP is a medium-term tactical

planning process different from the long-term strategic planning process. Following this definition, three planning levels are outlined, strategic, tactical and operational, from long-term to short-term in that order. The time horizon is what the major difference between the planning levels, strategic plans have long planning horizons developing aggregated plans that change at will. Tactical plans are medium term, developed in detail and updated according to a predetermined schedule; the operational plans have the shortest planning horizon, are most detailed and change most frequently. The S&OP process is based on strategic plans, to create a tactical plan that drive operational plans, meaning it connects strategy to execution. Thus, the accuracy and effectiveness of the S&OP process determine how well the strategic goals will be reached. The output of the S&OP process is a set of tactical plans based on demand and supply that should be driven by the goals of the strategic plan. Developed by first generating a demand plan that in turn drives the supply plan in order to create a final S&OP volume plan within the company (Lapide, 2006).

3.3 Demand Management

The use of demand management practices in manufacturing companies is a relatively new phenomenon; just thirty years ago it was more or less unheard of. Crum and Palmatier (2003) discuss the existence of forecasts, in a small number of companies, but the process of forecasting was rather unknown and only to a small extent used to drive financial plans and production planning. As mentioned previously, the increased complexity of the market, with more customization, and demand for speed, flexibility and accuracy, organizations must be able to determine inventory requirements as correctly as possible, demand management is a tool to help provide these capabilities (Bowersox, et al., 2010). At present day, companies develop new models in their supply chain for managing demand. The developed demand plans are used to drive financial plans and supply plans, resulting in demand plans being updated at a higher frequency, with monthly plans rather than annual or quarterly (Bowersox, et al., 2010; Crum & Palmatier, 2003). The collaboration between customers and suppliers has evolved to include communication of demand information and developing strategies for sales and marketing (Crum & Palmatier, 2003). In realizing the potential benefits of collaborative partnerships between suppliers and customers, companies are finding that in order to be successful in collaboration, they must have effective internal processes for demand forecasting. Initiating processes such as Sales and Operations Planning to improve integration between demand and supply and in turn improve forecast accuracy, requires cross-functional cooperation and therefore action must be taken to reduce silo-mentality between departments of the company.

The ultimate objective of integrated business processes is both to ensure that demand, supply, and financial plans are synchronized and executed according to plan. As well as ensuring that the decisions taken with regards to these plans will yield top financial performance for the organization as a whole (Crum & Palmatier, 2003). If demand information is properly shared throughout the supply chain, it also reduces the uncertainty about volumes. Fluctuations in demand decrease the use of safety stock and other methods to secure delivery is made redundant (Crum & Palmatier, 2003).

The demand management process includes four elements, the planning, communication, influencing and managing of demand. Within these elements it is vital to remember that planning demand goes beyond the creation of a forecast and that estimated demand should be communicated to all supply chain partners. The third stage relates more to the marketing function and how customer demand can be influenced by company activities. Lastly, the estimated demand should be matched with current capacity (Crum & Palmatier, 2003). The S&OP process is often used as method for integrating these processes and ensure that they are performed efficiently (Basu & Wright, 2017). In essence, demand management is created by integrating historical forecasts with other elements that could potentially influence sales (Bowersox, et al., 2010).

Another aspect of demand management brought forward by Bowersox et al. (2010) is its use to create forecast consistency through all aspects of business operations. The aggregate plan must reflect both sales, financial as well as operational targets and constraints. Demand management is a component of the S&OP process, developing the unconstrained demand plan. Demand management within S&OP begins with the development of a sales forecast including market demand, pricing and promotional activities along with the mix of products that is predicted to be sold (Bowersox, et al., 2010).

3.3.1 Forecasting

As mentioned previously forecasting within demand management should be treated as an ongoing process, to be updated regularly to maintain high accuracy (Crum & Palmatier, 2003). Forecasting is the process of estimating what is to be sold, at what time and in what market (Bowersox, et al., 2010). Contrary to what most think, forecasting should not be about predicting what the customers are going to buy, but rather affecting their actions and proactively steer demand. This means that marketing and sales departments must analyze the impact of

their strategies on the market. Forecast accuracy refers to the difference in what is projected to be sold and the actual sales. This calculation should be done continuously measuring the forecast error over time using statistical methods (Bowersox, et al., 2010). Being able to forecast demand with 100 percent accuracy is very rare, and even top organizations expect an error between 15-20 percent (Sheldon, 2006). Therefore, the recommendation made by Sheldon (2006) is that it is better to estimate demand a little lower, to avoid having excess inventory that they are unable to sell. However, if the forecast is continuously wrong in estimating future volumes, the confidence in it declines and the forecasts will not be used by the different departments. This creates a vicious circle as little effort will be put on improving the forecast if it is not used. Often when faced with forecast accuracy issues, one or more of the elements of demand planning is not operated efficiently. By using tools such as the S&OP process to integrate the demand management elements, a broader view of demand will be achieved thus improving the quality of the forecasting process (Crum & Palmatier, 2003). To achieve forecast accuracy a business, need to take a long-term commitment to drive the process (Bowersox, et al., 2010). However, it is important to be aware of the importance not only of forecast accuracy, but also forecast allocation. Based on the forecast, supplies are allocated to regions or business areas as outlined in the forecasted demand. However, the actual demand may differ from the forecast, and improper forecast allocation is then a source of supply chain disruption (Ganesan, 2015). The demand planning process enables companies to determine the potential for profits while estimating capacity and financial figures. This makes the forecast one of the most valuable elements in the risk management process (Sheldon, 2006).

3.3.2 Forecasting Techniques

When producing forecasts, companies can employ a number of different techniques dependent on the type of business and the characteristics of the products. Qualitative forecasting is done by using knowledge, experience, and judgement in combination with existing data. It is however, very difficult to predict the future simply by looking at the past. Common approaches within qualitative forecasting is expert opinion and market surveys. Expert opinion is often done by a group of people, using scenario planning to try understanding the impact of future trends on the organization. The second method of forecasting is quantitative and often uses statistical methods such as time series analysis. This approach uses mathematical and statistical analysis to estimate future demand based on historical data. Casual forecasting is the third forecasting method that is commonly used to see what effect a small event may have on demand. This approach put emphasis on analysis past events to understand how they impacted demand

historically. The common-sense approach is the last forecasting method and is a combination of qualitative and quantitative forecasting approaches. As can be understood from the name, the manager uses common sense to interpret existing data using their judgement and expertise (Basu & Wright, 2017).

3.3.3 Demand Sales & Operations Planning

Using Demand Management in combination with Sales and Operations Planning processes improves the performance of the supply chain (Vollmann et. al, 2005). In short, meaning that products are available to satisfy customer demand. As well as potential problems in capacity are communicated to the sales organization so that the correct information is shared with customers. Improving these processes also enhances the performance of the firm in terms of profitability and market share (Crum & Palmatier, 2003; Schorr, 2007c). The development of a robust S&OP process, provides a connection between the demand side and the operational side of the business. Good collaboration between demand and supply, is an important tool to minimize risk. In essence, the S&OP process is about ensuring that goals are shared throughout the organization, but also to make sure that each function understands what effect their decision has on other functions within the organization (Sheldon, 2006).

Sheldon (2006) outlines the inputs used to create the demand plan as the business plan, marketing plan, sales plan and historical data. Schorr (2007c) includes other information that is important to create the demand plan, as amongst other, customer orders, division volume requirements, spare parts and internal needs. For these inputs to be used to create a good demand plan, the information must be of high quality, and it must be carefully linked to the strategic goals of the business plan. Only then can the demand plan be used to improve decision making throughout the business. As the demand plan is the basis for the continued S&OP process, the inputs used to generate it is important to company success. In a high performing organization measurement tools are implemented to ensure that the results of the process match those predicted in the strategic plan (Sheldon, 2006). In his article, Schorr (2007c) outlines four steps to create the demand plan. Initially, a preliminary demand plan should be created based on a prediction on customer demand, this includes a sales forecast and other actions that may impact demand. This is done as a collaborative effort by the sales and marketing function providing a best estimate of future sales. The second step is to communicate the demand plan on both an aggregate and detailed level to other functions such as supply and finance. In doing so each function can evaluate the estimated demanded volumes against the business plan and existing

resources. In the third step of the demand plan process, a consensus demand plan should be developed. The purpose of this step is to align different opinions and perspectives to generate one demand plan that everyone can agree on. Lastly any exceptions should be managed throughout the S&OP process, this includes responding to market fluctuations and allocation of resources (Schorr, 2007c). The demand process is similarly explained by Sheldon (2006), with the development of a preliminary meeting that is reviewed in challenge meetings where the likelihood of the demand plan to be executed according to strategic goals and allocation of resources is evaluated. In the review meeting, information on strategy, the forecast and product management are considered in order to create an unconstrained demand plan (Schorr, 2007c). The control mechanism in the S&OP process, utilizes the challenge meeting to control and balance plans to improve the management of risk (Sheldon, 2006). The output of the demand planning process is therefore, the unconstrained challenged demand plan, developed on different levels of detail for different functions. The unconstrained challenged demand plan shows what the sales and marketing function estimates can be sold in the different markets without considering any constraints within the organization (Schorr, 2007c). Sheldon (2006) describes the unconstrained challenged demand plan as a forecast divided by product groups with a 12-month rolling planning horizon. This plan is then used as the input to the supply plan, enabling the planning of capacity (Sheldon, 2006). Demand plans can also be used to prioritize demand when faced with capacity constraints. The demand plan determines how resources should be allocated between customers when demand exceeds supply (Schorr, 2007c).

According to Sheldon (2006), the demand plan is the most discussed aspect of the S&OP process. Often this is because the forecast is blamed for issues in planning, however, some researcher claim that the forecast is not always to blame. As the forecast is based on customer demand the discrepancy between forecasted and actual volumes is more often due to the unpredictable nature of customers and the difficulty in predicting human behavior (Sheldon, 2006). The main strength of S&OP is that if performed effectively it provides forecasts of higher accuracy. However, since its planning horizon extends over a longer timeframe than the more commonly used production planning tools, it could have a negative effect on forecast accuracy. However, there are several techniques to reduce forecast error, for instance, aggregating demand into family groups will often lead to higher accuracy (Basu & Wright, 2017).

3.3.3.1 Forecasting in S&OP

To develop a forecast within the S&OP process Lapide (2006) highlights two approaches, the top-down and bottom-up forecasting. These approaches can be used to develop the forecasts

used to create the demand plan. By using these two methods in combination; the accuracy of the forecast can be improved. To create a brand level forecast, the top-down approach is suitable to be able to disaggregate the brand level forecast to a SKU (Stock Keeping Unit) level forecast. However, product group level forecast can be developed by aggregating the brand level forecast using bottom-up forecasting. For all departments involved in S&OP to commit to the process, and increase the accuracy of the forecast, every function should be involved in developing and reviewing the forecast. For this to be possible, the forecast must be developed at different levels so that it is presented in such a way that it translates to the "language" used in the specific department. For example, in operations the forecast should be presented at the SKU level, while for sales a brand or product group level is more appropriate. In order to generate different level forecasts a combination of top-down and bottom-up forecasting should be used (Lapide, 2006).

3.3.4 Bullwhip Effect

Forrester (1958) was the first one to refer to the impact of demand variations on the supply chain. However, according to Rong, Shen & Snyder. (2017), the term Bullwhip Effect (BWE) was introduced in 1997 by Lee, Padmanabhan and Whang. The term refers to the fact that fluctuations in demand are amplified as they move upstream within the supply chain causing order variability (Croson & Donohue, 2005; Basu & Wright, 2017). To elaborate, the variability of demand on the customer side of the supply chain is noticeably smaller compared to the supplier end of the chain (Lee et al., 1997; Croson & Donohue, 2005); this effect becomes more significant the more stakeholders the supply chain contains (Lee et al., 1997), as each stakeholder tries to interpret the demand, even small demand changes result in large order variations upstream in the chain (Basu & Wright, 2017). However, the BWE excludes variations that stem from seasonality. More often than not, BWE variability is generated as a result of supply chain stakeholders' behavior to one another (Jonsson & Mattsson, 2009). The process is present in most linear supply chain processes and causes increased costs, lower customer satisfaction (Basu & Wright, 2017), unnecessary stock and lower product quality (Lee et al., 1997).

According to Lee et al. (1997), some of the main causes to the BWE are demand fluctuations, batch ordering and price variations. Jonsson & Mattsson (2009) further expand on the topic, their identified causes are: larger than usual order quantities, small number of customers, lack of alignment between planning and control, insufficient information sharing and price

variability. The variations in orders are amplified exponentially when moving upstream from company to company. Hence, larger order quantities result in higher order variations and more intense BWE. Similarly, when the number of customers is small, orders will have high variability, as small customers will give more flat orders. In addition, when control and planning activities are not aligned among supply chain stakeholders, several imbalances can be created. Manufacturers and wholesalers often enlist different promotions in order to boost their sales. Consequently, customers experience price fluctuations and might actively adjust their purchasing habits to take advantage of benefits, which is another cause of order fluctuations (Lee et al., 1997; Jonsson & Mattsson, 2009). Another reason that leads to the bullwhip effect is lack of communication within the supply chain. Many companies tend to only consider the orders of their direct customers hence ignoring the supply chain as a whole. Lastly, if the manufacturer is unable to satisfy high demand within a specified period of time, and the customer is aware of this, they are likely to act by inflating their orders to secure a higher order fulfillment (Jonsson & Mattsson, 2009).

The improved accuracy of forecasts and real-time exchange of data reduce the bullwhip effect, but also the costs in operations and improved customer satisfaction (Basu & Wright, 2017). In their research, Croson & Donohue (2005) attempt to explore whether sharing inventory information with supply chain stakeholders has an impact on the bullwhip effect. What they find is that downstream information sharing is mitigating the bullwhip effect more efficiently compared to its upstream counterpart; however, the intensity of this mitigation depends on the position of that information in the supply chain. Therefore, supply chain stakeholders that are located in the upper end of the supply chain benefit more from the information sharing.

3.4 Capacity Planning

In this section, different concepts within capacity and production planning will be explained. Capacity Planning is one of the main topics discussed in the paper, and therefore the use of capacity planning and capacity management in daily production is important to understand. The connection between Capacity Planning and Sales and Operations Planning will be explained along with a distinction between internal and external capacity. In the field of Supply Chain Management, the theoretical term capacity is used to describe the sum of products or material that the supply chain can hold. In practice, however, the term capacity refers to the products or material that the supply chain can deliver to the end customers at any given time. It is a common misconception that capacity only refers to the products produced or stored. In reality, all

products traversing through the chain within a specific time period are part of the collected capacity, which is referred to as effective capacity. Hereafter, when capacity is mentioned, what is referred to is effective capacity. Therefore, capacity is not about the amount that can be produced but rather the amount that could be supplied to meet demand (Basu & Wright, 2017).

Capacity Planning is very much connected to Master Production Scheduling (MPS), defined as, "a central module in the manufacturing planning and control system" (Vollmann et al., 2005, p.168). Jonsson & Mattsson (2009) go into more detail and define MPS as "a line on the master schedule grid that reflects the anticipated build schedule for those items assigned to the master schedule. The master scheduler maintains this schedule, and in turn, it becomes a set of planning numbers that drives material requirements planning. It represents what the company plans to produce expressed in specific configurations, quantities and dates" (Jonsson & Mattsson, 2009, p. 450). MPS is, therefore, the core of all capacity planning processes (Tenhiälä, 2011). Through MPS, manufacturing resources are planned in order to achieve on-time customer deliveries and consequently customer satisfaction (Vollmann et al., 2005; Sheldon, 2006). Capacity planning from an MPS perspective is working with estimating resource requirements and scheduling to avoid implications capacity might have on the MPS, which is done in a mid-term time horizon (Vollmann et al., 2005)

3.4.1 Capacity Management

There is a small distinction between Capacity Management and Capacity Planning. While the main goal of Capacity Planning is to perform scheduling and planning in terms of capacity, Capacity Management is more oriented towards the execution of those plans and how they can be completed efficiently. There are a number of factors that can smooth out the execution of said plans. First and foremost, if forecasting and demand management are done successfully, execution of capacity plans could be improved. Furthermore, product mix has a high impact on capacity planning. The less complex the product mix the easier capacity planning and execution is both at production and supplier level. The term product mix refers to the types of products that can be produced in the plant and the rate at which they go through production (Vollmann et al., 2005). Should capacity planning be conducted successfully, "the result is execution systems that are simple, effective and easy to operate with minimal inventories and fast throughput times" (Vollmann et al., 2005, p. 352)

Without an estimation of the product mix and forecasted demand it is difficult to plan production capacity and to determine what resources are required (Vollmann et. al, 2005), especially for the long-term (Olhager et al., 2001). What can be delivered to customers is limited by production capacity; capacity is in turn measured by availability of resources. The primary goal of capacity management is, therefore, to respond to demand. In order to match capacity with the forecasted demand, different time periods need to be considered, ranging from long-term facility planning to short-term order planning (Olhager et al., 2001; Vollmann et al, 2005). The need for more accurate forecasts increases as the planning horizon moves from long-term towards short-term. If actual demand is not known at least a few months before the order is received there is little possibility for the suppliers to adjust their capacity. Effective capacity is also influenced by the product mix that can be produced in the existing plants (Vollmann et. al, 2005). Other determinants of capacity are the operational time of the plant, determined by working hours and number of shifts, and the efficiency of the plant, determined by effective operational time of the plant. This refers to the amount of time the plant is operating without disruptions to the production line (Basu & Wright, 2017; Vollmann et. al, 2005). According to Basu & Wright (2017), the management of capacity can be performed in two ways, either by modifying capacity or by influencing demand. Nowadays, organizations usually manage their capacity by combining the two methods.

3.4.2 Capacity Imbalances

Understanding the market requirements and estimating the demand is especially important when attempting to plan capacity (Jonsson & Mattsson, 2009). This includes considering customer needs and taking them into account in the planning process. Doing so, capacity is planned in a way that is advantageous to the customers (Vollman et al., 2005). Failing to understand market needs is likely to lead to capacity imbalances (Jonsson & Mattsson, 2009). Capacity imbalances can appear in two forms, overcapacity which is created if the available capacity exceeds the demand, and insufficient capacity, which appears when the organizations is unable to meet customer demand. However, as value creation is tightly connected to both production cost and loss of revenue, it is of high importance to avoid these imbalances (Olhager et al., 2001; Vollmann et al, 2005).

According to Jonsson & Mattsson (2009), the manufacturing approach influences the limitations and opportunities within capacity planning. It is important to note that planning for make-to-order (MTO) or make-to-stock (MTS) production has different characteristics. MTS

production has higher possibilities to handle disruptions in production and demand fluctuations, as there is always an inventory of finished goods to act as a buffer (Sheldon, 2006). However, MTO is based on customer demand, hence the alternatives are fewer and the risk of delivery issues increase. The goal of an MTO approach is to minimize the tied-up capital in inventories as well as mitigate the effect of the order backlog. This is done by limiting production so that each item in production is matched with a sales order (Olhager et al., 2001; Sheldon, 2006). However, many organizations use a combination of the two approaches to take advantage of the benefits of both planning methods. Utilizing a combination of the two methods usually translates to adjusting production capacity more frequently than in a MTO approach but not every time there is a fluctuation in demand (Olhager et al., 2001).

In order to counter imbalances in capacity, they must first be identified. This is done by comparing available capacity to capacity requirements. As each actor within the supply chain is affected by different factors, it must adjust the method to discover capacity constraints to best fit their needs (Vollmann et al., 2005; Tenhiälä, 2011). When considering the long-term, Rough-Cut Capacity Planning (RCCP) is a commonly used method because of its simplicity (Tenhiälä, 2011). Its simplicity stems from the fact that RCCP disregards work-in-process (Vollmann et al., 2005). The RCCP method is initiated by the yearlong demand plan (Sheldon, 2006), which is multiplied with the historically required capacity (Jonsson & Mattsson, 2009) and is based on the data from MPS (Vollmann et al., 2005). From an S&OP perspective, RCCP can be used as an input when there are uncertainties in terms of capacity constraints (Sheldon, 2006). According to Sheldon (2006), RCCP is performed with a distinction of product families and the allocation of the products in these families. This is done in order to efficiently plan capacity; including machinery and working hours (Vollmann et al., 2005).

A major concern of many manufacturing companies is ensuring the reliability of material flows, this has been done by applying the Materials Requirements Plan (MRP). It is a technique that combines bills of material, inventory and order data along with production plans in order to calculate material volumes and provide material plans of high detail (Vollmann et al., 2005). MRP makes recommendations about material orders for replenishment purposes when necessary (Jonsson & Mattsson, 2009). With proper coordination of the existing data MRP can achieve balance between inventory and demand. By using MRP information a yearly business plan can be developed to determine and communicate the estimated delivery of each product type (Vollmann et al., 2005).

3.4.3 Capacity Measurements

Demand should be supported by supply (Cecere, Barrett & Mooraj, 2009) measuring capacity is a crucial part of Capacity Planning and Capacity Management and choosing the appropriate measure is critical for reaching the end result. The choice is determined by each specific company's needs (Vollmann et al., 2005), in order to identify opportunities for capacity expansion, supply constraints and demand deficiencies (Cecere et al., 2009). The first step is selecting a measure that can appropriately identify which resources could be in a critical situation. Checking capacity to identify constraints is very resource intensive and if it should be extended to the entire organization requires support in terms of time and investments (Vollmann et al., 2005; Jonsson & Mattsson, 2009). This implies that the unit of measurement for capacity should be carefully considered (Vollmann et al., 2005). A commonly used unit of measurement is capacity accuracy, determining the difference between the forecasted volume and what is actually produced (Sheldon, 2006). The last step is to identify the capacity that is available in production, thereafter planning can proceed (Vollmann et al., 2005).

3.4.4 External Capacity

In most manufacturing industries, there are both internal and external suppliers. External suppliers are suppliers that are not owned by the manufacturing company, but operate as a stand-alone company within the supply chain. Internal suppliers are part of the same organization as the main company, but act as a supplier within the supply chain, providing parts or components to final assembly. When working with external suppliers, the cost focus is more asserted than with internal suppliers where quality is emphasized to a greater extent (Feldmann & Olhager, 2008).

Within the supply chain, capacity planning is an area that has been extensively explored and developed (Ding, Raghavan & Pollard, 2007). Internal and external capacities both play an important role towards efficient operations. Manufacturers are highly dependent on their supply chain partners and managing their own capacity is no longer enough (Sheldon, 2006; Ding et al., 2007). Supplier (or external) capacity is of equal importance and should be taken into account when scheduling production (Ding et al., 2007) Within the global supply chain this can be a challenging, when considering transportation costs and lead time (Sheldon, 2006). As most manufacturing companies work with Just in Time and Lean approaches in production, they are dependent on smooth flows of material to be successful (Sheldon, 2006). Therefore, communication and transparency among supply chain partners is crucial (Ding et al., 2007;

Jonsson & Mattsson, 2009). Production that is exceeding external capacity is equally unfeasible as with internal capacity (Ding et al., 2007), therefore, manufacturers are depended on smooth flows of material in order to be successful (Sheldon, 2006). So, communication and transparency between supply chain partners is crucial (Ding et al, 2007; Jonsson & Mattsson, 2009).

A manufacturing company is highly dependent on the capacity of its suppliers, adjusting supplier capacity is more difficult than changing internal capacity. Therefore, it is crucial that suppliers can efficiently communicate information on capacity to align with manufacturing production planning (Ding et al, 2007; Jonsson & Mattsson, 2009). According to the case study performed by Ding et al. (2007) one way of mapping supplier capacity, is a Supplier Capacity Analysis (SCA). Industries such the automotive industry, studied by Ding et al. (2007), with high product variability can benefit greatly from an SCA when faced with high supply uncertainty.

3.4.5 Reverse Bullwhip Effect

As the bullwhip effect has the customer end of the supply chain as its starting point, it is mainly concerned with demand uncertainty and assumes unlimited supply. However, supply uncertainty may also have similar effects on the supply part of the chain. In the contemporary supply chain, both demand and supply uncertainties coexist at the same time. However, most of the research focuses on demand uncertainty while overlooking its supply counterpart (Rong, et al., 2017). Rong, Snyder and Shen (2008; 2009) also pioneered the research on the impact of supply uncertainty.

The term reverse bullwhip effect (RBWE) refers to the phenomenon in which “demand (order) variability increases as one moves downstream in a supply chain” (Rong, 2008, p.1). According to Rong et. al (2008) supply uncertainty is the main reason behind the RBWE, just as demand uncertainty is the main cause of the BWE. However, the impact of the RBWE on supply chains may be more significant compared to the BWE because of the inventory holding costs (Rong, 2008). A specific point in the middle of the supply chain is, therefore affected by both the BWE and the RBWE, and as such is being faced with higher order volatility (Cachon, Randall & Schmidt, 2007). In many cases that point can be a manufacturer, who is then faced with the issue of capacity constraints on the ground of supply disruptions and difficulties meeting demand variation (Rong et. al, 2017). The existence of both BWE and RBWE is being referred

to as an “umbrella pattern” in the supply chain because the impact is more severe in the middle of the supply chain, hence making the order variability form the shape of an “umbrella” (see figure 2). According to this, order variability is most volatile in the point where the two bullwhip effects meet (Rong, 2008).

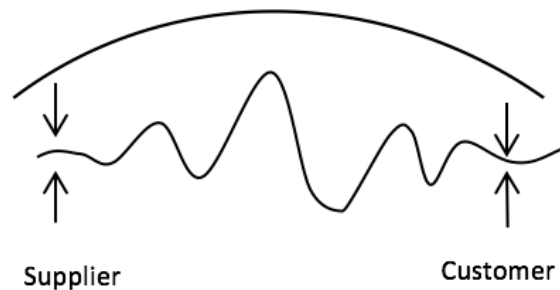


Figure 2: Umbrella Pattern (Rong et al., 2008)

Information sharing is a commonly accepted method of increasing the efficiency of the supply chain. The communication of demand information throughout the supply chain has proven to be an appropriate way to mitigate the effect of the BWE and, in general, increase the efficiency of the supply chain (Rong et. al, 2008). Lee et al. (1997) bring up three methods to mitigate the impact of the RBWE. The first one is to assign supply according to capacity based on each customer’s historic data. Furthermore, one can communicate information about capacity, enabling supply chain partners to plan accordingly. However, when it comes to the RBWE, communicating capacity information has been proven unsuccessful at times (Rong et. al, 2017). The last method proposed is to limit the flexibility a buyer has over orders. This last method is also described as the most efficient one as it restricts order variability from the supplier’s perspective (Lee et al., 1997).

3.4.6 Supply Sales and Operations Planning

The Sales & Operations Planning originated from the MRP techniques as a way to link plans developed by different departments within the organization, and thus coordinating sales, finance and operation processes (Vollmann et. al, 2005; Basu & Wright, 2017). Olhager et al. (2001) and Jonsson & Mattsson (2009) name the supply side of the S&OP process “the production plan”, however this term appears to be overlooking other important activities of the supply side, therefore, we will be using the term “supply plan” as it is more inclusive and is described as by numerous other authors (Vollmann et al., 2005; Sheldon, 2006; Schorr, 2007b; Cecere et al. 2009; Basu & Wright, 2017). The aim of the supply planning side of S&OP is to provide input from operations regarding production, internal and external capacity. The supply

plan is generated from the demand plan and attempts to fulfill estimated demand with current operational capacity (Basu & Wright, 2017; Sheldon, 2006; Bowersox et al., 2010), with the aim of responding to the market's needs while working within the organization's strategic and financial plans (Olhager et al., 2001). In other words, the S&OP process aims to achieve a balance between supply and demand, which is the "key to good business performance" (Vollmann et. al., 2005, p. 61).

In this step of the S&OP process, data from the previously created demand plan is utilized as an input in order to assess the volumes that need to be produced and delivered (Jonsson & Mattsson, 2009). The demand plan is interpreted and an appropriate supply plan is being developed. This means that capacity is readjusted according to the demand plan (Olhager et al., 2001) The aim of this stage within the process is to examine and find the best alternative for production to meet the goals set by sales (Cecere et al., 2009). According to Cecere et al. (2009) the supply plan part of the S&OP process is divided into two steps, initiated with the development of a constrained plan by supply and is followed by the supply review. The first stage is concerned with resource and capacity planning activities, which is done per product family (Vollmann et al., 2005; Thomé et al., 2012a). If the demand plan cannot be met by available capacity, it becomes constrained and cannot be supported (Jonsson & Mattsson, 2009). In that case the supply plan has to be readjusted (Jonsson & Mattsson, 2009). Readjusting the supply plan means that the gaps between demand and supply need to be minimized, hence alterations need to be made to the supply plan. Alterations can include assessing the profitability of potential supply alternatives, examining issues that might come up for each said alternative and ultimately, a recommendation for the favored supply plan (Schorr, 2007d). In case of a capacity demand surplus, resource utilization will be high, leading to lower costs. This, however, comes with the added risk of low customer satisfaction because of, for instance long delivery lead times. On the other hand, in the case of a capacity supply surplus, costs will be higher but high delivery rates will be achieved. This can be interpreted as a trade-off between lower costs and high deliver rates/customer satisfaction (Olhager et al., 2001).

Finally, the last step, the "supply review" meeting is to take place, just like in the demand plan stage (Schorr, 2007d). This evaluates the supply plan's ability to respond to the demand plan, which is done by attempting to identify supply constraints, demand deficiencies and the potential opportunities for capacity expansions (Cecere et al., 2009). Inputs like the overall business strategy, internal and external performance and potential capacity expansion are to be

reviewed in order to do so (Schorr, 2007d). During this meeting, the launch of dependable supply plans is done and suggestions on how to narrow existing gaps are made. It should be noted, that Schorr (2007d) points out that it is the higher management's decision, whether to hold down demand or expand capacity, hence the supply review is to recommend solutions, but the final decision is taken during the following stage of the S&OP process, the top management review. As a result, the supply review step needs to be cross-functional. Engineering, operations and logistics have to confirm that there is sufficient internal capacity to respond to the supply plan, equally, the purchasing department has to assess the capacity on supplier lever and make sure that external capacity can meet the set goals (Schorr, 2007d). On the other hand, Olhager et al. (2001) states that the S&OP process as a whole should be a balance between demand and supply, meaning that adjustments need to be made from both sides in order to achieve proper execution of the plans and, in turn, achieve the strategic goals. In cases where a change in the supply plan is necessary, authorization by top management may be required. These are type of issues that are carried into the top management review (Vollmann et al., 2005).

3.4.7 Reconciliation Sales and Operations Planning

A meeting between the different functions involved in the S&OP process must be held in order to align the demand and supply plans. Involved departments may include; sales, operations, logistics and purchasing, which create a package of information based on the two plans (Schorr, 2007e; Cecere et al., 2009; Jonsson & Mattsson, 2009). This is then communicated towards the top management where finalization of the plans is taking place, and marks the beginning of production and the developments of the delivery plans (Sheldon, 2006; Cecere et al., 2009).

Descriptions of the reconciliation step by Cecere et al. (2009) as well as Jonsson & Mattsson (2009) emphasize that the main target is the achievement of an alignment between the demand and supply plans. As part of this step, there should be a presentation of the demand and supply plans that were decided on during the previous steps of the process, while addressing the strengths, weaknesses, risks and opportunities, with high emphasis given towards risks (Sheldon, 2006; Schorr, 2007e; Cecere et al, 2009). It should be noted that the output of the step is of high importance, which is a decision on the finalized demand and supply plans for the pre-decided planning horizon (Vollmann et al., 2005; Sheldon, 2006; Cecere et al., 2009).

Schorr's (2007e) approach of the S&OP process follows different steps, including an additional step after the supply plan, which is called "the integrated reconciliation meeting" or "pre-SOP

meeting” as mentioned by Vollmann et al. (2005). In this meeting, the decisions on the supply and demand plans are coordinated by representatives of different functions. The expected output of this step in the process is to collect a bundle of information, with the aim of presenting it to the top management (Schorr, 2008, Basu & Wright, 2017). Several authors then, go on to present a fifth step, “the senior management review” (Schorr, 2007e; Schorr, 2008) or “executive SOP meeting” (Vollmann et al., 2008). This is the step where the final decision making is taking place, which aims to reach an agreement for the overall volume target for the pre-decided planning horizon, which is the alignment of the two plans (Schorr, 2008). The effectiveness of this step is highly dependent on the efficiency with which the previous steps have been completed, if the necessary steps were followed properly, this stage should be able to easily provide an answer on the plans (Schorr, 2007a). It, essentially, means that the preliminary decisions that have been taken during the reconciliation meetings are presented to the top management, which is responsible for making the final decision and accept or reject the presented plans. The goal of this final meeting is the release of the final approved S&OP volume plan (Schorr, 2008, Jonsson & Mattsson, 2009).

3.5 Measurement and Communication

Sheldon (2006) and Grimson & Pyke (2007) mention an additional step in the S&OP process, which is the measurement and communication step. In this step, the responsibility of meeting the targets set by the S&OP process often falls on the operations team, while sales and marketing rarely have to adjust their sales plan (Grimson & Pyke, 2007). This perspective is not shared by Olhager et al. (2001), who mention that both sides need to make adjustments in order for the final goal to be achieved. However, Grimson & Pyke (2007) mention that by the time of their study S&OP measurements were not widely spread among organizations, which does not seem to be the case nowadays, where high emphasis is put on measurement of the process (Basu & Wright, 2017)

For the S&OP process to be successful, it is vital to create and implement measurements capable of assessing the efficiency of the process (Lapide, 2004). The measurements provide indicators on how well the business is performing, with the goal of driving continuous improvement (Grimson & Pyke, 2007; Bowersox et al., 2010). The measures can be KPIs that are linked to production, sales, profits and costs, inventory levels, customer satisfaction rate and forecast accuracy, with emphasis being put on areas in which the organization is currently lacking (Sheldon, 2006; Grimson & Pyke, 2007; Cecere et al., 2009). The accuracy of the demand forecast imperfectly tends to be the most important indicator when evaluating the alignment of the S&OP process with the strategic goals of

the organization as a whole, however all indicators should be considered equal (Lapide, 2004; Sheldon, 2006).

4 Empirical Framework

The empirical framework is based on documented S&OP processes at Company X, and interviews held with people involved in this process. Initially the types of forecasts developed within the company will be outlined. This is followed by a description of the S&OP process in Company X. After this, supplier relationships are mapped along with the results of the supplier interviews. The people interviewed internally are presented in the table below.

Table 1: Internal Interviewees

Title of the Interviewee	Area of Responsibility
Sales Support Manager	Demand Plan
Demand Planning Manager	Demand Plan
Commercial Pipeline Development Manager	Forecast
Manager Program and Order	Supply Plan
Process Manager Volume and Order Planning	Supply Plan
Manager Supplier Relations Management	Supplier Relationship Management
Director Program and Order Planning	Supply Plan
Program and Forecast Manager	Supply Plan
Market Analyst Forecast	Forecast

4.1 Forecasts

There are three different forecasts within Company X (see figure, 2), that will be presented in the following sections.

Table 2: Forecasts in Company X

Forecast	Planning Horizon	Description
Total Market Forecast	2 years	Forecast for the total number of products that will be sold by all companies in the industry within a market.
Long-Term Volume Forecast	5 years	The Total Market Forecast extended to cover five years.
Production Plan Forecast	10 years	The Long-Term Volume Forecast extended to cover ten years.

4.1.1 Total Market Forecast

The Total Market Forecast (TMF) was brought up during the interview with sales, market and forecast development. This prompted a further interview with the department developing the TMF. Their knowledge and experience of the TMF process as well as their thoughts and ideas, will be presented below.

The Total Market Forecast is a forecast that measures the total number of products sold by all brands and companies in a market, in the specific industry. The market refers to a specific commercial sales area. The forecast is updated four times a year by Business Intelligence, and stretches over two years, including the current year. The process is similar for all sales areas and starts with an independent analysis of what can be seen and there are several macroeconomic indicators that are used to analyze the market, these will be examined in more detail later. The TMF is the responsibility of the largest brand in each market. The forecast is performed for all markets in a sales area for the different product segments. After an analysis of market indicators is performed, it is transformed into figures that are put into a proposal and sent to the markets. The markets then perform their analysis of the figures and include what indicators they can see in their respective market. The market has one week to answer to the proposal and thereafter they have a discussion with Business Intelligence about the proposed numbers. The discussion is especially important when they disagree on the forecasted demand. The most important aspect of this dialogue is to hear what the markets base their figures on. As Business Intelligence has a higher perspective, determining demand in all markets, compared to the markets that only determine local demand, other approaches can be very valuable. Thereafter, Business Intelligence prepares a final proposal after discussion with the sales areas, divided into Europe, North America, Latin America and International. In this meeting, the sales manager includes different perspectives and experiences to give a good overview of the potential demand. In the meeting, the sales manager has the final say on what numbers should be in the forecast. Lastly, the forecast is presented to the sales, operations and technical departments.

4.1.2 Long-term Volume Forecast & PPL

The Long-Term Volume Forecast (LTVF) and the Product Plan (PPL) are forecasts developed from the TMF, information on this process was mainly gathered in the interviews with sales and demand planning.

The LTVF is an annual process with two releases per year, the time horizon includes the current year and five years forward. The sales function coordinates the process for all brands within Company X, but also coordinate the different sales areas within Company X's brands. The brands are responsible for creating their own LTVF, for their markets on the five-year time horizon. The LTVF is a combination of the TMF and the estimated brand volumes. The brand volumes can be estimated by combining the TMF and the market share for that specific market, and thus generating the volumes that could be sold. The forecast is divided in the product segments. Internally for the Company X brand there is a different need for the split, so the forecast is broken down into product models and vehicle segment. There are strategic benefits from breaking the forecast down to lower levels, as the managers can see the plan per product segment. The LTVF is used as the base for the creation of the demand plan in the S&OP process, and is reviewed when creating the yearly business plan.

The LTVF is used as an input to a process called PPL. This process prolongs the five-year LTVF, to a ten-year forecast. This forecast has very high management attention, with the President for each brand deciding on and approving the forecast numbers. Thereafter the PPL is communicated as information to the CEO. In the ten-year forecast, the volumes are split into product models and component level in the different sales areas.

The purpose and usage of the LTVF and the PPL is to have a forecast spanning to up to ten years that can be used in the product plan, calculating for new projects, profitability, etc. It is also used in the industrial plan for operations and the plants so that they can plan the manufacturing setup balance to meet future demand. Beyond this it is used by purchasing in sourcing negotiations and by the finance function when developing financial plans. However, it becomes very difficult to forecast for more than five years, as there are too many contingencies to account for. When the sales areas perform their forecast they work with assumptions, for example in light of new emission regulations it is common to see a pre-buy effect. Other laws and regulations may have a large impact on sales in the specific sales area, and therefore is very important to be aware of.

4.1.3 The Forecast Process

The forecast processes are all interlinked (see figure 3) and start with TMF in January; this forecast is released in February. The TMF is updated four times a year, and this is released every quarter. The TMF for quarter one is used as an input in developing the LTVF in March,

with the release in April. After the release of the LTVF it is then used to develop the PPL to a ten-year forecast, with a release in May. Thereafter the process starts over again, with the TMF updated quarterly, and the LTVF and PPL released twice annually.

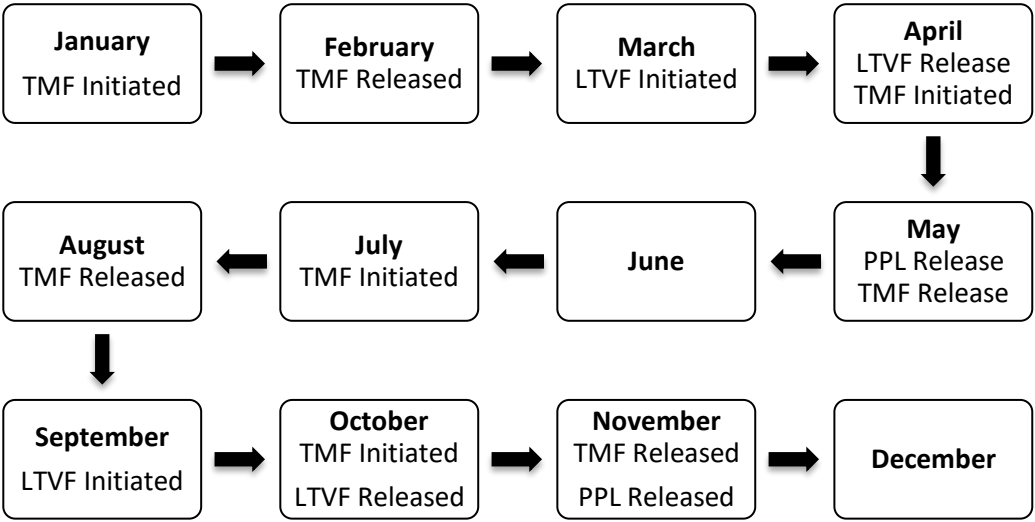


Figure 3: The Forecast Process

4.1.4 Comments on the forecast processes

In many of the interviews the topic of supplier confidence in the forecast was brought up, this indicates that there can be work done to improve the forecast accuracy. One aspect of the forecast accuracy is that the markets and sales areas have been too shy in asking for volumes in the demand plan. This is based on the TMF that showed much lower sales volumes than the actual orders. Once the TMF was adjusted upwards it was too late to change supplier capacity. Connected to this issue, the difficulty to change the forecast when faced with long lead times to change capacity at both internal and external suppliers.

In order to improve forecast accuracy and planning, Company X must ensure that demand is leveled and that the flexibility to meet demand both above and below the forecasted volumes exists for all actors in the supply chain. Another part of forecasting mentioned as an area for improvement is the use of statistical methods in forecasting. Today statistical methods are used to a limited extent in developing the TMF but not in the development of other forecasts. The use of statistical methods when developing the forecast on both the market and sales area level, could possibly improve the accuracy of the forecast and align the way of working with the forecast. Another aspect to consider for the different forecasts is the time-horizon and the development of new technologies. According to research and industrial information the introduction of autonomous and electric vehicles is already introduced and will be launched on

a wider scale in the coming years. As the impact of these technologies on demand is unknown, it is very difficult to forecast years into the future.

From the interview with Business Intelligence, the fact that they are not aware of how the TMF is used after they present it to the different function was raised as an area for improvement. If the purpose of the forecast and its use is unknown to the ones creating it, they cannot be sure that the content is useful or valuable for the rest of the organization. Another concern regarding the TMF is the fine line between communicating what you see and generating concern and worry throughout the organization and preparing the company for what is coming next. Due to the impact of the TMF, there is great concern for how it should be communicated and to whom; this involves a lot of politics and opinions throughout the organization.

Table 3: Comments on the Forecasting Process

Concept	Topic	Interviewee Area of Responsibility
Low Supplier Confidence in Forecast.	Forecast Accuracy	Supply Plan Side
The forecast has been too restrictive asking for volumes.	Forecast Accuracy	Demand Plan Side
The forecast adjustment of volumes was too late given the long lead times for supplier to adjust capacity.	Forecast Accuracy & Supplier Capacity	Supply Plan Side
Demand Leveling to meet fluctuations in demand	Forecast Accuracy, Scenario Planning & Demand Uncertainty	Demand Plan Side
Increased use of Statistical Methods in Forecasting	Forecast Accuracy & Statistical Methods	Demand Plan Side
The impact of new technologies such as autonomous and electric vehicles on demand.	Technology impact on Forecast Accuracy	Forecast
Lack of overview of the S&OP process in its entirety.	S&OP Process Communication	Forecast

4.2 The Sales and Operations Planning Process

The use of the Sales and Operations Planning process at Company X is threefold. The initial stage of the process aims at balancing demand with all aspects of the supply chain capabilities.

This is done in order to decide upon one supply plan that optimize the overall business goals and strategies and drive capacity management and provide directions for sales, marketing and operations.

The Sales and Operations Planning process is performed with a two-year time horizon, with the first year being split over 12 rolling periods. Periods are not directly translated to the months of the year, however, as both are used interchangeably in the interviews they will continue to be so in the study. For the first year, the volume forecast happens every month, except for July, which actually results in 11 monthly loops per year, for the second year the volume is forecasted for the full year. The S&OP process is divided into three stages, see figure 4. The first is to create the demand plan; this plan is thereafter used to create the Supply Plan that results in the confirmation and release of the S&OP Volume Plan. The S&OP process is performed for all brands simultaneously all across the world and follow the exact same structure. The colors in figure 4, corresponds to the different steps in the process, green highlights the actions in creating the demand plan, red shows the supply plan steps and the purple and blue steps represents the reconciliation step.

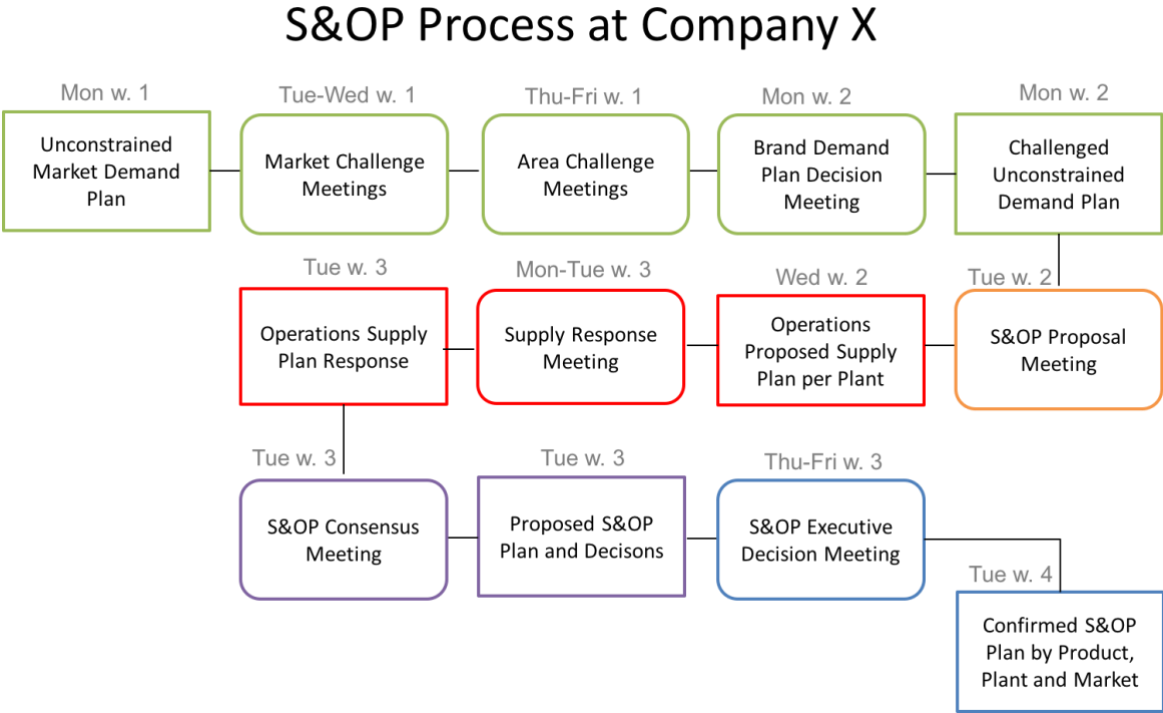


Figure 4: S&OP Process at Company X

The output of this process is the S&OP Volume Plan, also called the S&OP program, that is used by marketing and sales to develop customer relations. This is done by analyzing sales areas and future needs to determine upcoming business activities and plan forecasts. In operations, it

is used to plan and schedule production, product distribution and defining future competence and workforce demands, in addition to this it is also used to create the Electronic Data Interchange (EDI). The EDI refers to the information including orders, forecast information and delivery schedules that is sent to suppliers. These decisions are all evaluated using the S&OP volume plan, which is thereafter used to estimate the financial impact on the organization by the finance function.

4.2.1 Comments on the S&OP process

During the interviews two projects related to the planning-horizon for the S&OP process was brought forward. One project mentioned is the extension of the 12- months rolling forecasting to a 24-months rolling planning horizon. Currently there is much focus on the current year in the demand S&OP meetings, and the second year is not given much consideration. This can be an issue especially from a supplier point of view as the planning horizon is only one year. By extending the process to forecast monthly demand for 24 months rolling, will improve the ability to plan production capacity after the S&OP volume plan. The S&OP process will then be extended to cover three years as mentioned by another interviewee, the third year will then be forecasted on a full-year volume.

Another aspect that was highlighted during the interviews was the involvement of the purchasing department in the S&OP process. In the proposal meeting between the sales and operations functions, today operations have the responsibility for gathering and presenting information from purchasing on external supplier capacity. There is however an ongoing process to include purchasing in the proposal meeting and increase the transparency in the process. There are several benefits to including purchasing earlier in the process. Today the supplier capacity is reviewed in the steps after the proposal meeting, and therefore it has happened that the demand plan has been accepted by operations in the proposal meeting only to be rejected in the consensus meeting in the later stages of the S&OP process. There are therefore potential benefits from including purchasing in the proposal meeting between sales and operations.

Table 4: Comments on the Sales & Operations Planning Process

Concept	Topic	Interviewee Area of Responsibility
Extending the S&OP process from 12-month rolling to a 24-months rolling. This includes the extension of the S&OP process to cover three years in total.	S&OP Process & Planning Horizon	Demand Plan Side, Forecast
Including purchasing and reviewing supplier capacity already in the S&OP proposal meeting.	Involvement of Purchasing in the S&OP process	Demand Plan Side

4.3 The Demand Plan

The demand plan process at Company X has been mapped by performing interviews with individuals involved in creating the plan. The creation of the demand plan consists of a stepwise process from the point where information is received from sales to delivering a challenged and unconstrained demand plan. The information used to create the demand plan is market demand from the dealer or market, for a 12-month period, the product introduction plan as well as the TMF and LTVF. The monthly S&OP volume plan should in the best of worlds align with the volumes estimated by the TMF and the market share ambition. However, due to changes in the market, discrepancies do occur. The forecast in S&OP is very specific to demand, it determines what actions to be taken and what number of products that is actually required for the coming two years.

The demand plan can be broken down into further components to describe the process in detail. The two steps to generate a demand plan, is to first create an unconstrained demand plan and thereafter creating a challenged unconstrained demand plan, as it can be seen in the figure 5. How these plans are created will be further explained in the following sections.

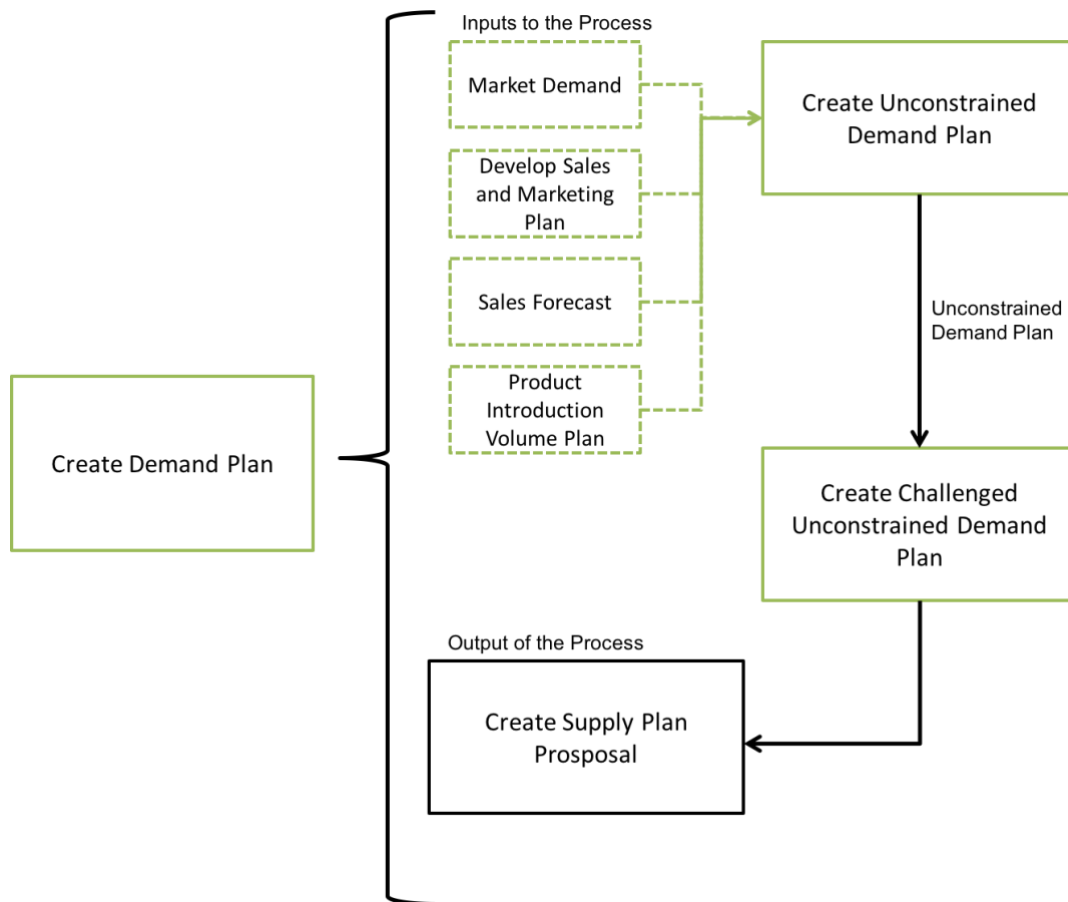


Figure 5: Creation of the Demand Plan

4.3.1 The Unconstrained Demand Plan

The first step in creating the demand plan is to generate the unconstrained demand plan; this is performed on a monthly reoccurrence. This process is in turn divided into three phases, create new demand plan, review new demand plan with market, and consolidating data, an outline of the process can be seen in figure 6. The purpose of creating the new demand plan is to use knowledge from existing markets to create a forecast. Thus, it is a bottom up process with the markets basing their forecast on local knowledge and experience. Each market updates the new demand plan on an agreed deadline. The markets do not take external bottlenecks into consideration at this stage, but use previous confirmed markets plans to estimate the demand. In order to create the demand plan, markets use information from KPIs such as order intake, order book, inventory and invoicing pace. In addition to this, business intelligence information such as the total market forecast is used.

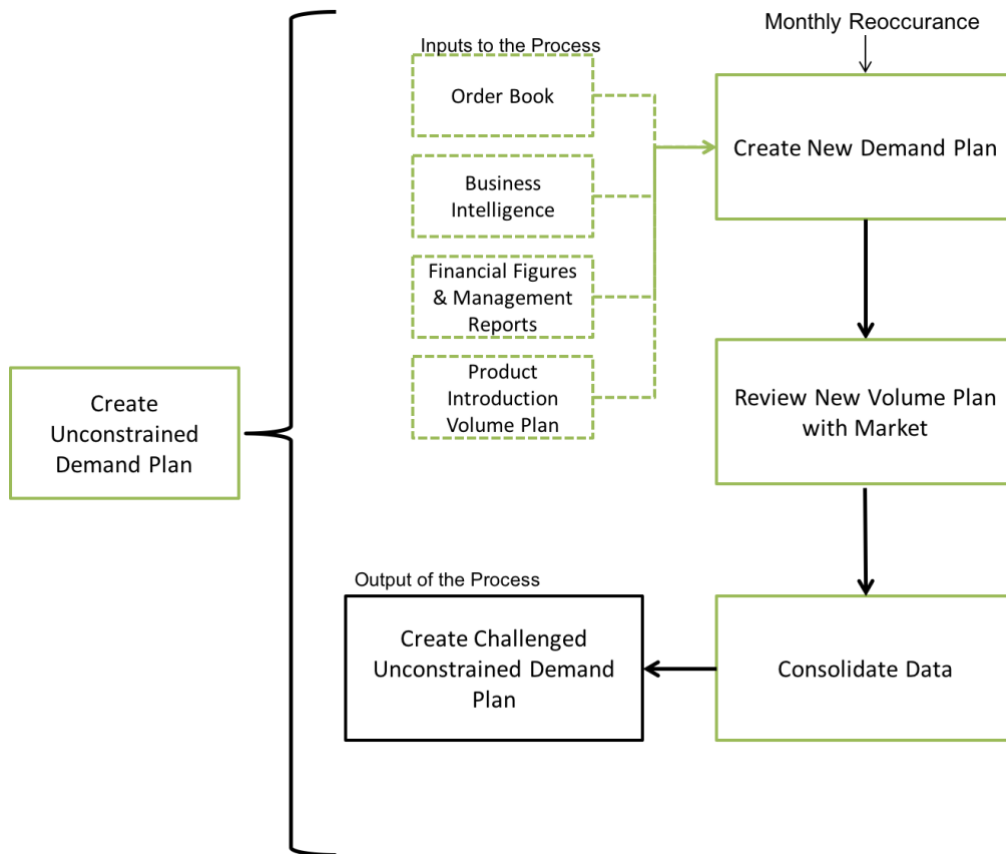


Figure 6: Creation of the Unconstrained Demand Plan

4.3.1.1 Create New Demand Plan

The first step of the S&OP process is done by each market and sales area separately. The sales numbers are estimated at the lowest point at a market level and at the most aggregate level includes total global demand. When developing the unconstrained demand plan, the markets should use the TMF and the market share ambition for the market. However, it is vital that the market considers what volumes actually can be sold in the short-term, referring to the time-horizon of the S&OP plan. Using this approach, the forecasted numbers in the demand plan are not just numbers but based on previously developed forecasts and business intelligence information. In addition to this, other information sources must also be used such as the sales and marketing plan and the product introduction plan. The product introduction plan consists of the plans for product introduction and phase out by product group and market. The initial plan for introducing or removing products in the market is based on market demand and performed by each market separately cooperating with research and development. The keyword in this process is unconstrained, although the market and the sales area are aware of constraints in manufacturing or supplier capacity, it should not be considered at this stage. The markets should ask for the volume they believe they will sell.

4.3.1.2 Review Volume Plan with Market

In the second phase of generating the unconstrained demand plan, the forecasted volumes are reviewed with the market. As the markets have prepared their forecasts, the numbers are communicated to their respective sales area. There are four separate sales areas, Europe, Latin America, North America, and International, each consisting of several markets. Each sales area bases their demand figures on the information from the markets. Once the sales areas receive the market forecasts, this information is compiled to generate a total demand figure that is sent to the demand planning function. In the discussion with the markets, the first challenge meeting occurs, as the sales area controls the numbers to ensure that they are a reflection of real demand. The review consists of identifying major changes or highlighting where data should be explained. In this challenge meeting, the sales areas have access to high level information and support to ensure that the numbers are correct and that they are supported by the KPIs, this is important as nothing stops the markets from setting too high or too low demand figures.

4.3.1.3 Consolidate Data

In the last phase, the data is consolidated by the sales areas to create an understanding for the complete sales area volume. Thereafter, the unconstrained demand plan is created. The demand plan is divided by product type, but it is not divided further, this is done by operations, who further split the forecast to component level for use by manufacturing and suppliers. The unconstrained demand plan is now used to create the challenged unconstrained demand plan.

4.3.2 The Challenged Unconstrained Demand Plan

The second part of creating the demand plan follows on the previous; the unconstrained demand plan is used to generate a challenged unconstrained demand plan. Comparing the two, the unconstrained demand plan is a bottom-up plan on what the commercial organizations believe they will be able to sell, without considering bottlenecks or constraints. Once this plan has been challenged centrally by each business area it becomes a challenged unconstrained demand plan ready to be delivered to operations. An outline of the creation of the challenged unconstrained demand plan can be seen in figure 7.

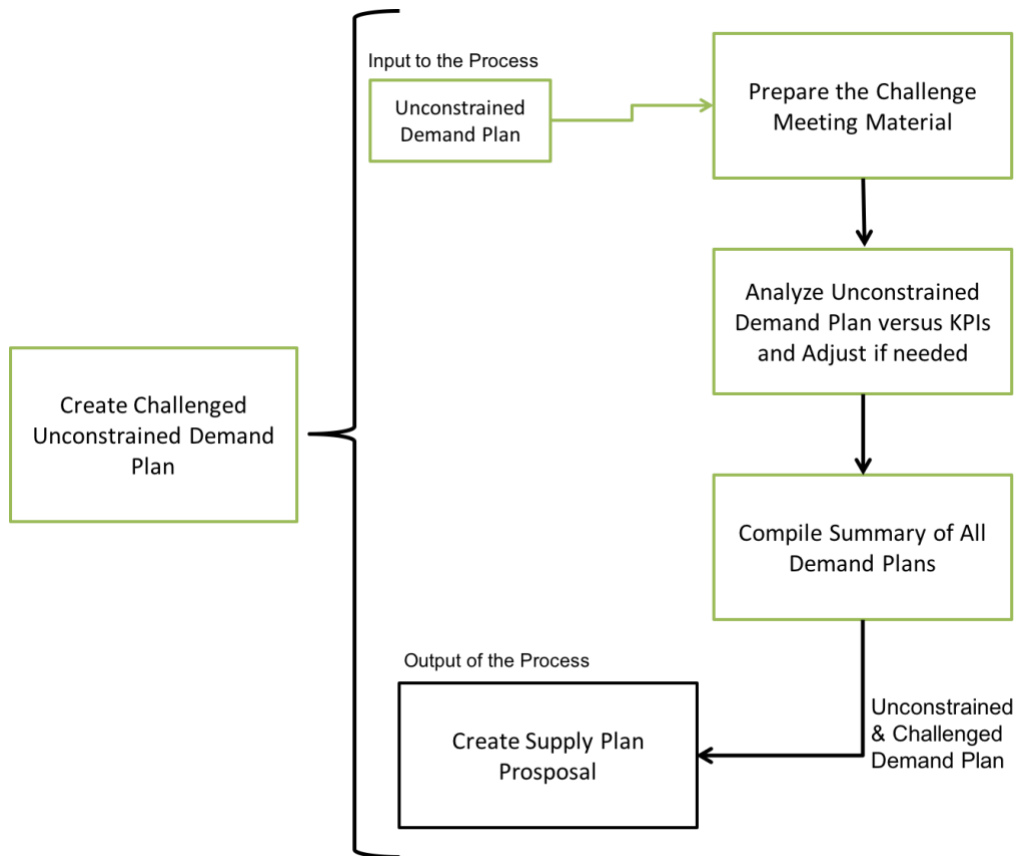


Figure 7: Creation of the Challenged Unconstrained Demand Plan

4.3.2.1 Analyze Unconstrained Demand Plan versus KPIs and Adjust

Each sales area communicates the demand figures to demand planning function. Following this is the second demand challenge meeting where KPIs are used together with market information to analyze the demand plan focusing on the gaps between the established plan and the strategic targets. In this meeting, a total view of demand must be taken. If there is indication that, for example all markets in a sales area are increasing volumes, caution must be taken. Most likely the demand will not increase in all markets simultaneously, and the demanded volumes must be reduced, thereafter if the demand in a market turns out to be higher than expected, the volumes can be reshuffled. The total demand in the unconstrained demand plan is also analyzed and adjusted if needed. This enables the establishment of an optimized unconstrained demand plan. Identified adjustments are done after the after the meeting if they are agreed upon.

4.3.2.2 Compile Summary of all Demand Plans

The last phase of creating the challenged unconstrained demand plan is to compile a summary of all demand plans. This is done in the last challenge meeting, called the brand demand decision meeting. In this meeting the President of Company X's board, meet the President for each sales area to review the demand figures again to see if they align with the KPIs. The purpose of the meeting is to determine the allocation of demand, in order to do so the new

figures are compared to historical data, and all information is reviewed again. The meeting is similar to the other challenge meetings with the exception that the Presidents for each sales area tend to have more information, and financial aspects are discussed to a greater extent. To understand the S&OP process it is important to understand that demand is challenged three times over the course of a week and therefore the result is a carefully considered plan. The unconstrained and challenged demand plan becomes the demand plan that is used for creating the supply plan.

The demand plan is presented in the proposal meeting between sales and operations. The demand plan numbers are sent to operations the night before via EDI, so that operations have a chance to get an overview of existing capacity in order to provide feedback during the proposal meeting. The meeting mainly circles around if the demand can be met, and what can be done to ensure that the actual numbers can be produced. Operations have the total overview of all brands, and can see the total change in volumes as well as where constraints are likely to occur. Along with this they also have a cost perspective, making this challenge meeting very important for the creation of the final S&OP volume plan. In this stage, there is little involvement from the purchasing side, as of now, and therefore supplier capacity is not considered until later in the process.

4.3.3 Comments on Demand Plan

An issue previously mentioned when creating the TMF, is mentioned again in the creation of the demand plan. When markets are asked to create their demand forecast, there is sometimes the perception from the market that they need a certain volume or demand according to the TMF or the market share ambition. This can be a problem as the demand is not what they need to sell, but what they think they can sell. Therefore, it is important to have a discussion with the markets, if they believe that they can sell the forecasted volume in the short-term or if they will just build up inventory. There are no consequences if the markets set a demand figure that is too high or low compared to real demand. The repercussions of an inaccurate forecast are however great throughout the supply chain and especially impact production and suppliers that will plan for an incorrect sales volume. This results in undercapacity or overcapacity in production, with overcapacity being the highest risk as capacity is increased with investments in production facilities and staffing, and results in high inventory. The challenge meeting is the mechanism that ensures that demand is leveled and carefully reviewed before the creation of the demand plan. There is a need for a standardized way of working in the markets when

estimating demand volumes, such as what indicators to look at and how the TMF and market share ambitions should be interpreted.

Table 5: Comments on the Demand Plan Process

Concept	Topic	Interviewee Area of Responsibility
Market Forecasting based on the wrong assumptions.	Demand Plan Accuracy & Quality	Demand Plan Side
The impact of inaccurate demand figures from the market.	Forecast Accuracy & Production Capacity	Demand Plan Side
Aligning the process of forecasting demanded volumes in the markets.	Forecast Accuracy & Organizational Consistency	Forecast, Demand Plan Side

4.4 Supply Plan

After sales deliver their final demand plan, which is the number of products they are planning to sell to all markets. The creation of the supply plan is initiated. The creation of the supply plan at Company X is a combination of two actions; the creation of the supply plan proposal and the creation of the supply plan response. The unconstrained and challenged demand plan and the external supply capacity are used as input for the creation of the supply plan proposal, while production capacity is used as input for both processes. An outline of this process can be seen in figure 8.

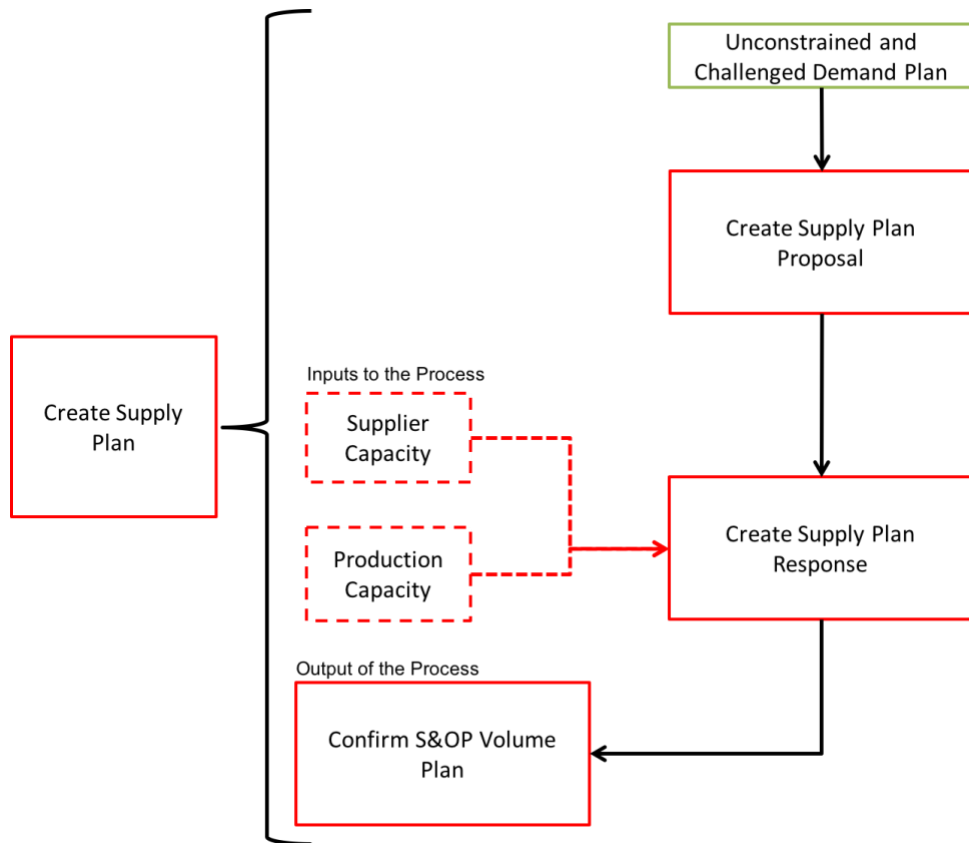


Figure 8: Creation of the Supply Plan

4.4.1 Supply Plan Proposal

The creation of the supply plan proposal is initiated with the analysis of the demand plan material. Its purpose is to review the challenged demand plan according to KPIs related to demand plan data, to prepare for a decision on the supply plan proposal. The process for creating the supply plan proposal can be seen below in figure 9.

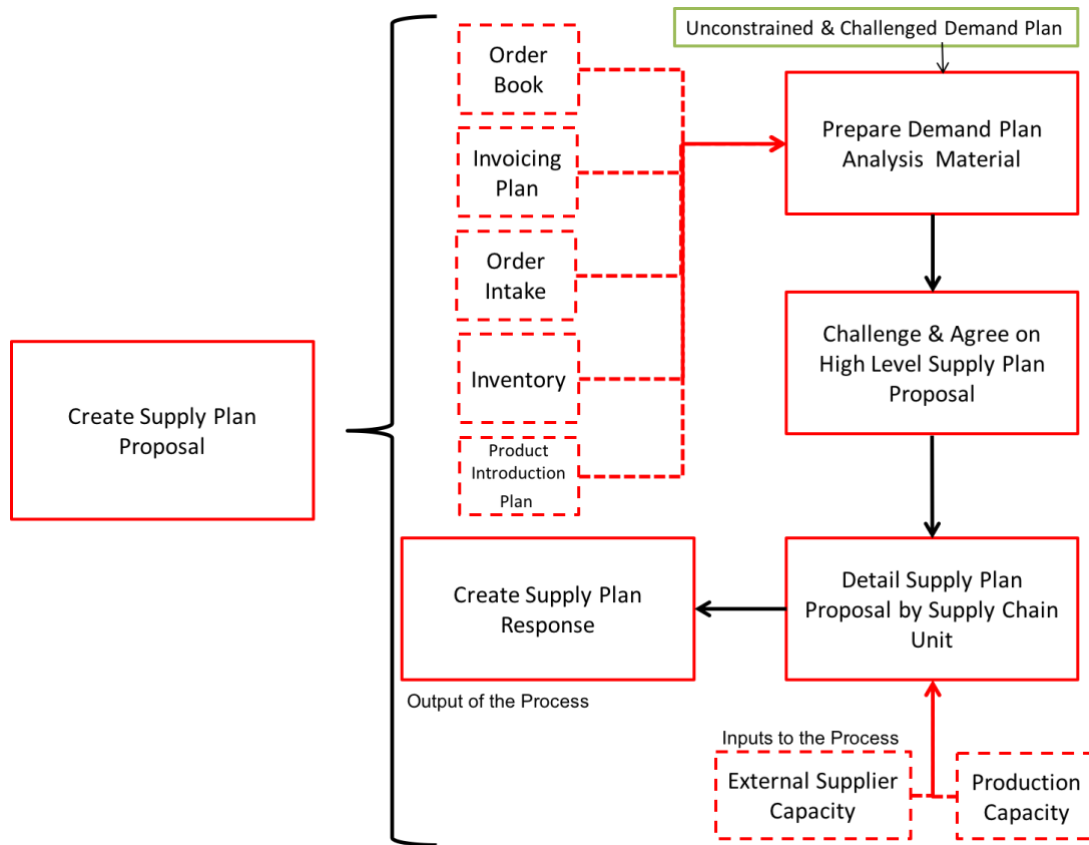


Figure 9: Creation of the Supply Plan Proposal

Once the analysis is complete, the following step is to challenge and agree on a supply plan proposal. In order for the meeting to be effective, known constraints are considered to avoid that an unrealistic demand is put forward, this is in essence an analysis performed to see if demand can be met. Constraints could occur in the form of capacity bottlenecks, working time limitations or supply disruptions. For those issues to be resolved, cooperation between operations, the local plants and purchasing is required to increase the understanding of capacity. The third and final step is to create a detailed supply plan proposal by supply chain unit, using internal capabilities as an input. The purpose is to break down the supply plan volume proposal into component level, so that a response can be given by the stakeholders. The component, or part number level, refers to the individual components that make up the product, an example to explain this, is that the ball bearing in a wheel is a component. During this step, the operations function creates a detailed supply plan proposal per product type, factory and month. This is done to get an overview on if the volumes in the program can be matched with the capacity of production plant.

4.4.2 Supply Plan Response

The next stage, the response, begins after the creation of the proposal (see figure 10). It starts with the consolidation of the detailed supply plan proposal by supply chain unit and preparing the material to be analyzed. The consolidated supply plan is based on variants and sent to each respective plant for a capacity analysis. Variant refers to a division by product type, the level below variant is referred to as component or product type. Each plant performs an analysis of production capacity based on the supply plan proposal. In this process, the plant performs an internal review, on production rates, workforce needs and ability to adjust capacity. The response of each plant is combined with information on external capacity in the second step in order to evaluate if the demand plan volumes can be accepted. In the capacity limit control step, adjustments are also done to account for new product introduction.

The next step is to analyze, evaluate and choose scenarios. The purpose is to adjust and level the supply plan proposal according to known capacity restrictions. At this level, internal capacity is the main concern of the process. The volume changes in the new supply plan proposal are analyzed and alternative production or sourcing scenarios are considered. The final step is to consolidate a supply plan response with the purpose of creating one coordinated proposed supply plan response. A small team consolidates all the volumes to understand the demand from all plants, which contains the volumes for the whole company. The supply plans are created by production plant and are then consolidated by region into a proposed supply plan response. One preferred supply plan scenario will be presented, based on capacity and cost efficiency in the global production and sourcing system. The presented preferred supply plan scenario ends the supply plan step in the process. The final plan is released by the same people creating the proposal. The information is controlled by others before it is released, but it is released through the system.

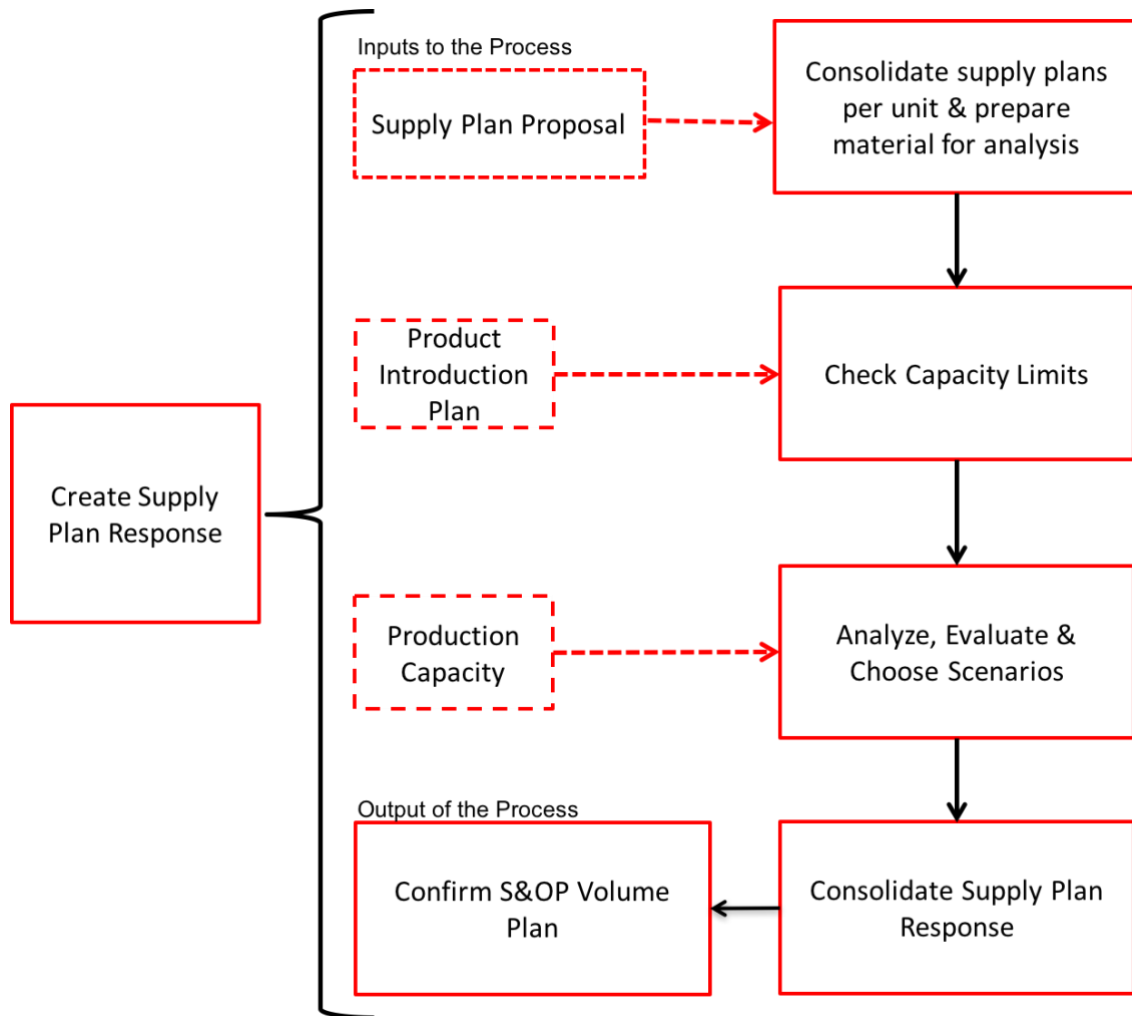


Figure 10: Creation of the Supply Plan Response

4.4.3 The EDI Creation

The difference between the S&OP Volume Plan, or program and the EDI is that the EDI outlines daily requirements matching current production rate. While the forecast in the S&OP process outline the gross requirement for a determined period. Both the S&OP program and the EDI contain forecast information for 12-months rolling, with the difference being that the EDI contains actual orders in addition to the forecast and is adjusted for lead-time and buffers. The information in the final S&OP program is used to create the EDI that is transmitted to the supplier base. The EDI contains order information in the form of delivery schedules, fixed orders, preliminary orders and forecasted orders, with the first showing actual customer orders and thus true demand. The logic of the EDI is based on the current order board, with a division on product variant. The order roof is set by the S&OP program, which is then filled with firm orders and preliminary orders. Firm orders usually cover between two to three weeks of production and the preliminary orders cover 10 to 12 weeks in the case that the order board is

not filled with firm and preliminary orders, forecast orders are used to cover remaining orders slots in the program. The EDI is updated almost daily, as new orders are received replacing preliminary and forecasted orders.

Since the forecast is based on variants, a new mix of variants also results in the forecast being updated because of the product configuration and production characteristics. The division of variants is done by looking at the historic data. Based on this historic data, the system calculates the percentage split per variant. In the case of non-existing historic data, the split is done based on data connected to the specific project. Once the variant combination is calculated by the system a component level forecast can be created, detailing a forecast for delivering gross requirement on a part number level for each period. Thus, the information communicated to external suppliers in the EDI is divided on the part number level.

4.4.4 The Role of Purchasing in the Supply Plan

In the S&OP process, the role of the purchasing organization is to provide a response to the program with regards to supplier capacity. The aim is to have an as accurate response as possible as to if the supplier can manage the forecasted volumes within their capacity. Operations is responsible for consolidating all responses and rolling out the program. As outlined previously, external supplier capacity is an input to the supply plan process, used to determine if the demand plan should be accepted or rejected.

Supplier capacity information is collected both by Supplier Delivery Assurance Engineers (SDAs) and the buyers. Thereafter the supplier response is prepared for each supplier, in this stage the SRM is also involved. Today there is no clear split of responsibility between these roles. There are several tools and processes used by purchasing to determine supplier capacity, such as Supplier Capacity Audits (SCAs) and capacity surveys. The responsibility to collect supplier capacity information mainly falls on the buyer, however, sometimes the SRM also provide information connected to capacity.

The information on the volumes is received through the S&OP program, showing the expected number of products to be sold and thus the production per plant. This information is communicated to suppliers by the purchasing organization to determine supplier capacity. The other source of information to suppliers on forecasted volumes and orders is received through the EDI. The EDI information is more related to delivery planning and orders and is the responsibility of operations. Purchasing is not involved in creating the EDI, as they are not

involved with delivery planning. The EDI is generated by a program that merge enormous amounts of information together with assumptions regarding planning to create the detailed EDI transmission. This means that the information on the EDI and the program is very different, the EDI information is in more detail and more complex, as it is adjusted for lead time, inventory, etc. This means that the information in the program will not be a complete match with the information in the program, and thus the capacity information at the suppliers may not be accurate once the actual orders are received. The forecasted volumes are received through the program for each brand, and it is based on this information that the response is given to accept or reject the program.

4.4.5 Comments on Supply Plan

When the supply plan is communicated to the internal plants it is divided by product variant, and thereafter further divided into component level. However, in production demand needs to be leveled to fit the production schedule, accounting for lead-time and the building of production buffers. The lead-time and part produced for buffers are not visualized in the S&OP process; however, they are visible in the EDI. When the production schedule is created, the point of production may move several weeks and thus requiring suppliers to deliver parts at an earlier day than outlined in the S&OP program. This results in deviations between the information in the EDIs and the S&OP volume plan; hence questions are raised from suppliers as to what numbers should be trusted.

The frequent changes in the forecast can have a high impact on both internal and external capacity. Even if the forecast remains unchanged on vehicle level, more often than not the variants shift. This results in even greater variations on the component level. If, for instance, the variant mix shifts, this greatly increases the number of components required for production and therefore has a significant impact on production structure even though the total volume might remain unchanged. This effect is enhanced exponentially in case both total volume and the variants shift. This process makes plant production planning difficult but also has a very negative impact on supplier capacity planning.

During the interview process insight was provided on the ability of purchasing to review the forecasts for volume planning. Compared to other departments with supplier contact, such as the material planners and supplier relationship managers, who have access to a volume forecast on the part number level through the MRP system and S&OP program, purchasing has little

access to long-term volume forecasts on the part number level. Although purchasing has access to the Long-Term Volume Forecast, only the first year of the forecast is shared from the total five-year forecast. There are several projects ongoing to share more years of the forecast, this would enable purchasing and in turn suppliers to get in indication on coming volumes changes that can be used to improve capacity planning. There are confidentiality issues connected to this, but the advantages of improved planning may outweigh those risks.

Table 6: Comments on the Supply Plan Process

Concept	Topic	Interviewee Area of Responsibility
Buffers in production is not visualized in the S&OP process, resulting in deviations between the S&OP volume plan and the EDI volumes	S&OP Process and EDI in production	Supply Plan Side
Forecast changes twice a month, which affects the variants and therefore the component level forecast	S&OP process and production	Supply Plan Side
Purchasing does not have access to all types of forecasts on the component level.	Improve communication and transparency of the forecasts	Supply Plan Side
Sharing more years of the LTVF with purchasing and suppliers.	Increase communication and transparency of the forecasts	Forecast

4.4.6 Reconciliation of the S&OP Process

The reconciliation step or, as Company X calls it, confirmation and release of the supply plan follows the creation of the supply plan and is a two-step sub-process, which starts with the confirmation of the S&OP volume plan and ends with the release of the final volume plan (see appendix 1). The output of the process is the S&OP volume plan, a detailed plan by month or period describing the volume plan per product, market and supply chain unit. The Sales & Operations volume plan is used in planning both internally and externally. The final S&OP volume plan is also used to generate the EDI, where it is divided into weekly or daily volumes on the part number level for 12-months rolling. The S&OP volume plan is also used to analyze sales areas, manage product distribution, plan account and forecast, collect future business activities and define future workforce demand.

Confirm the S&OP Volume Plan

The first step is to confirm the S&OP volume plan, which is done in a two-step process. It starts with a review of the supply plan in a consensus meeting to identify potential gaps or risks in the supply response. Thereafter, the next sub-process is initiated, which involves requesting the approval of the S&OP volume plan from the senior management committee. The senior management committee evaluates proposed decisions from the S&OP team, which can be either approved or adjusted. In certain cases, it is possible that actions are added in order to cover emerging needs, when all parties leave the meeting, consensus should have been reached.

Release the Final Volume Plan

The second and final step in this process is to release the final volume plan. It takes into account the decisions taken in the previous steps and starts by adjusting the high-level S&OP volume plan. The S&OP plan is adjusted according to the decisions taken in S&OP decision meeting and senior management approval meeting. It is then followed by the allocation of the S&OP volume plan per division and market. Each division then performs the detailed planning per market within the overall S&OP volume plan. The last step is to consolidate, analyze and evaluate each scenario and then adjust the capacity per division and market. With the concluding step of the S&OP process, the S&OP volume plan is released, consolidated and communicated.

4.5 Measurements

There are four Key Performance Indicators (KPIs) that measure the quality of the S&OP process as a whole. They are: S&OP Quality, Delivery Precision, Factory Response Lead Time and Flexibility. S&OP Quality measures the volumes that were decided three months ago versus the last decided program. When it is over 100 percent it means that consumption is more than what has been decided three months ago. Delivery precision measures how the confirmed delivery dates are executed, while Factory Response Lead Time measures how long it takes the plant to free up enough production slots to cover one day of production. Lastly, Flexibility measures the ability to meet the demand requested from the markets, which is affected by a number of factors, including internal and external capacity.

The demand plan is also checked against four other KPIs; Order Intake, Factory Order Book, Inventory and Invoicing. The order intake shows how many orders there are for four weeks rolling. This is compared to the target in the confirmed program, to see if the slots in the program have been filled. If it is above the target line for a long time it is an indicator that the

program volume is too low, and the reverse if it is below target. The factory order book relates to how many orders there are in the pipeline, orders that are on their way to be delivered to the market, which is also measured against the program target. The inventory measures the number of finished products in stock and finally invoicing measures if orders are being invoiced at the right level.

5 Supplier Communication

To provide an overview of how Company X communicates with suppliers, interviews was held with two departments that have extensive communication with suppliers regarding forecasts, volumes, capacity and delivery. These topics being the focus of the thesis these roles have been selected as especially important for continuous communication on capacity. Purchasing also play a large role in supplier communication, however the relationship is more characterized by commercial negotiations and long-term planning for investments. Therefore, this role will not be discussed in this section.

5.1 Supplier Relationship Management

With focus on reviewing how the forecasting process at Company X impacts capacity planning and processes at suppliers, both internal and external. An interview was performed with a manager in Supplier Relationship Management, to further investigate the communication between Company X and its suppliers and consequently their relationship.

Within the organization, there are several teams with Supplier Relationship Managers (SRMs), approximately 30-35 people, which are responsible for all suppliers. The suppliers are divided into two categories, high-profile and low-profile. The SRMs are obliged to share the S&OP volume plan information with high-profile suppliers on a monthly basis. The information that the SRMs share with suppliers is provided by the S&OP organization in a presentation, which also includes the purchasing department. The low-profile suppliers receive volume forecast via EDI; this is information that all suppliers receive and is connected to the order system. The difference between the two categories of suppliers is that the high-profile suppliers receive more information, often in a meeting or phone call. In the EDI, the supplier receives a 12-months rolling forecast that is updated daily, but it is mostly the numbers in the coming days or weeks that fluctuates on a daily basis. The information in the EDI is compiled by the operations department, and is divided into part number level. This is the best and only source that supplier have for the part number level volumes.

Some suppliers are very good at using the information they receive in the EDI; planning production based on the numbers and question it to ensure that the demand is true and confirmed. There are also suppliers that do not put as much effort on interpreting the EDI information. Internal suppliers, on the other hand, are handled differently, they are not managed by SRMs and are involved in the S&OP process, and therefore they are more informed about forecasts and upcoming changes. One aspect of this is that the information shared with external suppliers is subject to confidentiality restrictions. The SRMs are not allowed to send any information to the high-profile suppliers, instead they can only show it in a presentation, and all material has been adjusted for external use. This means that the volumes are highly aggregated to only show demand for the different sales areas. The reason for this is the impact of the information on company stock price and other factors. There are ongoing projects to extend the SRM function to more suppliers, so that relationships can be improved. Supplier relationships require attention and focus by Company X as they are currently not world-class in this area. Company X must become better in utilizing their existing knowledge and to share information by improving communication. Today there are situations where they SRMs know that the information they communicate is incorrect and thus the confidence in the forecasts is low among suppliers. It must be made clearer why the forecasts change and additional information must be provided beyond the automatic EDI, in order to improve supplier confidence.

5.1.1 Comments on Supplier Communication

One source of the low supplier confidence in the forecast was discussed in the interview with Business Intelligence. The financial crisis in 2007 highly impacted the automotive industry and may have led to caution among companies when it comes to increasing capacity to safeguards against similar occurrences. This results in a lower confidence in the forecast and predictions on a sharp increase in demand is not believed. Another reason for the low of supplier confidence in the forecast is that historically the accuracy of the forecast has been low. For a long time before the actual increase in demand, every forecast showed an increase in two months, this increase was thereafter postponed with every forecast, to the point where no one believed it would actually happen. When all of a sudden, demand increased, no suppliers were prepared for the high volumes. This shows that there is much to be done in increasing transparency to build confidence and relationships with suppliers.

The high confidentiality surrounding the forecasts means that little information can be shared with suppliers. There are projects and ideas on increasing the transparency to improve the relationship with suppliers. There are also ongoing projects to see how Supplier Relationship Managers can share the S&OP Volume Forecast with more than the high-profile suppliers. Today there are only few suppliers that get this information from a person and not only EDI information. The forecast information that is shared by SRMs with suppliers is also on a very aggregated level. This means that for the supplier to interpret what it means for their business they must be very knowledgeable in forecast analysis and knowing on exactly what product models their part is fitted. As an example, an increase by 1000 vehicles in a market does not mean that the demand for the supplier's component will be 1000; it depends on the configuration and type of product. For a project aimed at improving supplier relationships to be successful, there must be available material that is allowed to be shared with suppliers. It is important that this material is followed by speaking notes so that suppliers get the same information from everyone. Today the information is shared with SRMs and purchasing in a short meeting, where each person needs to remember and interpret the information before it is communicated to suppliers. This can result in suppliers receiving different information depending on who is delivering it. The ongoing projects aim at harmonizing this process.

Furthermore, through a past project, some key issues regarding supplier capacity constraints were identified. Besides the previously mentioned issues regarding processes, some matters concerning the company's overall strategy was brought up. First, the company lacks a risk prevention mindset to support single suppliers in critical situations, thus when problems occurs all decisions must be taken reactively responding to the already existing problem. there had to be reactive actions to resolve them, which is also another of the identified issues. This means that it takes longer than supposed to implement crisis control teams with an efficient cross-functional setup. This only happened after the number of critical suppliers became overwhelming. The organization's reactive mindset means it takes too long to mobilize required resources to handle the situation. Lastly, there have been difficulties in knowing suppliers' capacities and capabilities, which made it difficult to anticipate bottleneck situations. Thereby, external capacity investments were not triggered in time and the critical situation among suppliers snowballed out of control. Hence, there are suppliers that have been a problem for the last five years, regardless of volumes.

Table 7: Comments on the Supplier Communication Process

Concept	Topic	Interviewee Area of Responsibility
Supplier caution stemming from the financial crisis.	Supplier Capacity and Confidence	Demand Plan Side
An unclear and complex interface towards suppliers	Supplier Communication	Supply & Demand Plan Side
The forecast accuracy has historically been low, reducing supplier confidence.	Supplier Confidence	Supplier Relationship Management & Supply Plan Side
Lack of transparency and communication of forecast information to suppliers	Supplier Communication	Forecast & Supply Plan Side
Sharing S&OP Volume Forecast with more suppliers.	Supplier Communication & Transparency	Supplier Relationship Management & Supply Plan Side
Difficulty in interpreting the impact of the aggregated forecast on supplier production.	Supplier Communication & Capacity Planning	Supplier Relationship Management & Supply Plan Side
Projects aimed at improving supplier relationships and transparency	Supplier Communication & Transparency	Supplier Relationship Management & Supply Plan Side
Not a clear strategy to resolve crisis situations	Crisis resolution/Supplier Relationship	Supply Plan Side
Reactive implementation of crisis control	Crisis resolution	Supply Plan Side
Lack of risk prevention mindset to backup single sourcing	Single Sourcing	Supply Plan Side

5.2 Material Control

There is a department for material control at each plant within Company X, the main purpose of the material controllers is to monitor supplier deliveries to ensure that production does not run out of material. A system called the global inbound logistic management is used to create delivery schedules that is sent in the EDI to suppliers. The information available in the system

on inventory balance, line balance, as well as the dispatch dates and delivery information from suppliers is combined with order status and call off dates to calculate the delivery schedule. The system is monitored daily to see if deliveries are on time and in the right quantity. When a supplier sends their delivery, they should report this through the EDI system, if this is not done, the material controller receives an alarm list. The material planner is then responsible for contacting the supplier to resolve the issue and calculate when production run out of material.

In the communication with suppliers, agreements can be made to change the delivery schedule, for this to be possible there must be enough material in stock so that production is not disrupted. The difference between the EDI and the S&OP volume forecast is that the EDI outlines the daily requirements to match the production rate. The forecast created in the S&OP process instead outline a gross requirement for a period. In production, it is common to plan for buffers to handle demand in case of stop days, vacation or machine failure. The buffer volumes are not visible in the forecast but is only shown in the EDI and delivery schedule. This means that the volumes that the supplier has been informed of in the forecast may be moved several weeks ahead. In some cases, this means that a demand peak can move across the border of the period in the system and occur several weeks before the forecast said it would.

The communication between the material controller and the suppliers are mainly centered around deliveries. Material planners have a report divided by supplier where they measure delivery precision and can take action if they see performance issues to find the root cause. Information regarding volumes over a longer time horizon should be provided by the SRM. However, if the supplier has questions on the EDI and the delivery information they should contact the material planner so that they can help in finding out where the issue may be. For the material planner to know where the problem stems from, requires a long process to see where the deviations in the EDIs actually occur. As the forecast process is very complicated it can be hard for the material planner to find to cause of the problem. The system for controlling delivery schedule quality has been taken out of use as it did not work very well. This means that the material controllers and the operations department do not know what they are sending to the suppliers. If there is a problem with the EDI or the delivery information, they are made aware of it by the suppliers that contact them if something looks off. Measuring the delivery schedule quality could be important to improve internal processes.

Table 8: Comments on the Role of Material Controllers in Supplier Communication

Concept	Topic	Interviewee Area of Responsibility
Discrepancies between the forecast and the EDI due to buffers in production.	Supplier Communication & Forecast Accuracy	Supply Plan Side
The complex forecast and EDI creation process makes it difficult to find errors.	Supplier Communication & Forecast Accuracy	Supply Plan Side
EDI Quality and thus delivery schedule quality is not measured.	Supplier Communication & EDI Accuracy	Supply Plan Side

6 Supplier Interviews

Presented in the following section are the results from the supplier interviews performed with both internal and external suppliers to Company X. The aim of the interviews is to further investigate the impact of the forecast process, the S&OP process, on capacity planning.

6.1 Internal Supplier

The internal supplier is a production facility within in Company X and is responsible for forging, machining and assembly of components for the product. The plant is part of the S&OP process within the supply plan stage. It is the responsibility of the plant to determine if available production capacity can be matched with the volumes in the demand plan. Therefore, it is involved in the “S&OP Proposal Meeting” with the goal of producing a proposed supply plan for the whole production facility. Because this is an internal plant, the process of receiving forecasts and capacity planning differs from external suppliers as the local plant process is highly connected to the Sales and Operations Planning process.

It is important to highlight that despite the fact that the internal process goes through a number of steps; it is performed in a short time span. The S&OP process is run simultaneously all around the world, and thus it is important to complete this process in a timely manner. The creation of the proposed supply plan for the internal plant is done as a result of a specific sequence of local processes. The local process starts with the program planner receiving the program volumes from the supply plan team within the operations function at 15:00 on Wednesday. Initially the volumes are received and translated into a format that can be used and analyzed in the plant. In essence, this means translating the volumes into the different product types produced at the plant. The volumes received in the program reflects the core volumes, the demand from

customers, however they are not adjusted for lead time and therefore not ready to be used for production planning. These numbers are presented to the higher management at the plant, including the supply chain director and the plant vice president. Although the volumes are not adjusted for lead time they are often well balanced, as the supply plan organization at the operations department for the Company X has already made an estimation of plant capacity and split the volumes by product category before sending the program volumes to the plant. This is something that differs between the brands within the Company X, some volumes are not as balanced and therefore harder to interpret. The purpose of the initial review with management is to see the changes from the last program and what effect the change will have on production. One aspect of the S&OP process is that the plant must accept the full program for two-years forward. For the internal plant that has existing processes, tools and the information to make this decision, the capacity planning can be done relatively accurately. External plants may however lack both the tools and the information for them to respond to the full program.

A number of tools are used locally to interpret the volumes, such as pivot tables for displaying the volumes and a Program Capacity Check (PCC) tool, which adjusts the volumes for lead time. In the review meeting with the top management, pivot tables are used to show the program volumes, this information must thereafter be adjusted for both lead time and buffers to be used to create the actual production schedules. After the review meeting with the top management, the full global volumes are further split into different product configurations depending on the characteristics of the product and the production line set up. In order to fit the volumes to production they must be analyzed by using the PCC tool, adjusting for lead time and buffers. In order to fit the product variation to the different production lines a good knowledge and understanding of the production set up is necessary. Another aspect to consider when planning production is the nature of the demand, if demand consists of a constant flow of products or if the products ordered in batch volumes. This depends on what brand within the Company X the products are delivered, some brands have more constant, balanced demand, while others order in batches as they have a buy-from-stock setup. This is in essence dependent on the purchasing behavior of the customers.

Once the volumes have been broken down to component level and adjusted with the use of the PCC tool, the next step in the process is to extract the volumes in a spreadsheet where they are translated in to assembly rate per period. In order for this information to be accurate, an overview of the changes from the last program must be known. It is important to get the right

information in this stage, to inform, in as much detail as possible, the production units about the volumes, so that they can answer to if they can manage the volumes or not. Up until now an analysis has been performed of capacity on a high level, with meetings with production planners, trying to make sure that the program volumes for the first quarter match the actual orders as closely as possible, to reduce the volume fluctuations in production. On Thursday at 12:00, the information on production rates, and the main differences from the previous program gathered until now, is released and distributed to the production units within the plant. Where the volume information is analyzed per department in order to check if they are capable of meeting the new demand. The information is presented in a spreadsheet that outline the weekly production rate for the coming month. If the production units believe that demand can be met with the existing production capacity, they respond that they accept the program.

Once that analysis has been performed, the local program which includes the average rates for production plus comments regarding the main important differences compared to the last program, is distributed. Along with this, support documents are also handed out for different functions such as production planning and finance. The volume information is often in line with the actual order board, the order board reflect the actual demand in form of orders and can be seen on Friday for all the brands within the Company X. The reason for the adjustment of the volumes before they are presented to production, is that the production units are not interested in the period demand, but rather the required production rate. This way the production unit can plan the rate of production within the period themselves. The production setup is highly connected to suppliers as they need to deliver according to when production needs the components rather than when the end customer expects delivery. The ability to meet the program is measured and visualized by comparing the volumes to the existing capacity and the buffer volumes.

The PCC tool is also used to see the plant capacity with different number of shifts, from 2-shift production to 5-shift production. This is done to visualize capacity constraint risks, as when production runs on 5-shifts, capacity cannot be increased further. Production capacity is affected not only by the number of shifts, but also by machine failure and supplier capacity. The plant's ability to meet the volumes greatly affects all supply chain units involved, including external suppliers. Suppliers are located all over the world and therefore disruptions can be amplified when lead times are included. Due to the fragility of the supply chain, any risks related to supplies or receive volume forecasts early to plan production accordingly. Major

changes of capacity, such as purchase of new machines, sourcing decisions or major changes to the workforce, can take years to implement.

The different production units should be done with their analysis on Friday morning, the answers are collected and presented in the production program answer meeting on Friday at 14:00. In this meeting, the different departments are informed of the core volumes from the program and how this demand is balanced with the figures in the order board. KPIs related to forecast accuracy is presented, to see if the orders match the forecast, often it is found that the forecast volumes are too conservative and estimate demand too low. In this meeting, the ability to match volumes with production capacity is measured along with the impact of stop days and vacations on production. This information is added to the local program and presented to internal stakeholders. This way, everyone has the same information, and can see what analyses and calculations have been made, to understand what will happen and get a sense of in what direction the company is moving. They can also understand the reason why the plant gave that particular response to the program.

Thereafter, the internal program conference takes place. The same material as with the production meetings is being used with the addition of the program issue log, outlining potential setbacks within the current program. The goal of this meeting is for the joint internal plant to answer to the new program request. The last step of the local processes is to present the internal plant program answer material to the responsible team. This team then represents the plant as the consensus meeting and the program conference with operations. During this meeting, the final decision to load the volumes into the system and run the program is taken. The decided volumes are directly communicated to the finance department to calculate if they follow the financial plan. The overall plant business is tightly linked to the decided program and therefore it is important to follow the financial plan accordingly. One important thing to take into consideration is that not all production plants are the same, each plant is using their own local processes to handle the program. There are certain differences in the plants and the markets that are serviced by each plant.

6.1.1 Production Planning

The actual production planning is performed weekly based on the information in the loaded program, which includes the order board, with the actual decided and preliminary orders. The information in the order board is already split by flow, so the analysis performed includes

determining the optimal start of production given the lead time and the customer delivery date. The orders for the nearest two to three months are carefully controlled against the program volumes. Depending on to what brand the product should be delivered and to what market, the start of production and planning horizon is affected. For markets with long transport time, the start of production must be moved forward, this means that orders for the Asian market is moved up by eight weeks and for the US market, five weeks. This can create problems as the production is moved across period borders in the S&OP program. When planned production moves, this affects the suppliers as their EDI will not reflect the volumes in the forecast. If an increase in demand was shown to happen in period five, the actual EDI may request these volumes in period one due to lead time and buffers in production. This could result in the EDI showing a lot lower volumes in the later quarters as the volumes have all been pushed forward, sometimes as far as five to six months ahead of the information presented in the forecast.

6.2 External Supplier – Supplier A

The external supplier that was interviewed is a one-product company that supplies a component used in production. It is a relatively newly created company that supplies component to the entire industry. The interview has been performed with a representative from the commercial side of the company, and thus technical details from production may be less in focus. The results from the interview will be presented in two sections, the first focused on the communication and analysis of the forecast, the second will focus on capacity planning at the supplier's plant.

6.2.1 Forecast Communication

The volume forecast, detailing demand on the component level, is only received in an EDI message that is sent directly into their system from Company X. Upon receiving the EDI there is no communication with Company X, they simply receive the information about the ordered volumes for the coming 12 months rolling. The time horizon and information in the EDI varies dependent on from what brand within the Company X it is received.

Information about forecasts and volumes has also been received from a supplier relationship manager at Company X. In a monthly meeting between the SRM and the representatives from sales and material planning at supplier A, a discussion about volumes and practical issues was held. The SRM wants to make sure that supplier A can see the upcoming changes in demand, in this case the large increase, and if they can see that in the EDI numbers. The SRM acts as an intermediate with whom volume and practical issues could be discussed, someone able to give a heads up on coming changes, and who could help with certain problems. As Company X is a

large company with many internal business units, the SRM was able to step in and help when issues with deliveries or payments occurred. The SRM can also be helpful when the supplier face issues related to the internal organization at Company X. This often happens when communicating with different brands within Company X as they have different systems that cannot communicate with each other. The SRM have a good overview of both the internal organization and who to contact as well as good communication with external suppliers. This was a valued two-way communication as compared to the EDI that only provides one-way information. It is important that the role of the SRM is kept independent and objective. Compared to receiving the information from a buyer, supplier A felt they could be more open with the SRM due to the nature of their roles. The role of a buyer is to negotiate prices and having a commercial relationship with the supplier and thus certain information may be sensitive to share. Today, they have less contact with their SRM and only receive information via email, this is a contact that they miss, as the information is now completely neutral with no personal contact.

Compared to the information received in the EDI, the SRM provided a bigger picture. The EDI numbers only communicated what is ordered and demanded by Company X, and is updated almost daily as the orders are changed. Any information regarding future orders or volumes is communicated through the EDI or in the contact with the SRM. The EDI is delivered into the business system, from where the numbers are extracted daily and used to plan production, in material planning and to review future plans. As they have suppliers delivering components to their production, the EDI numbers are also used to plan order volumes from their suppliers. Using the EDI number in combination with the system a longer time horizon can be achieved, this review is performed quarterly and includes an analysis of sales numbers and the forecasted volumes in the EDI. This is done to get an overview of future volumes to improve and facilitate production planning and material supply in the long-term. From experience, supplier A have learnt that the volume forecast in the EDI can be trusted for the first two quarters, when it comes to the third and fourth quarters in the 12-months rolling forecast, the accuracy declines rapidly. As the EDI is not complete for the last quarter, the supplier must make their own estimation and add volumes for the forecast to be more correct. For this estimate the information received from the SRM is used together with the EDI and a market analysis. This process enables the supplier to make a good estimation of coming volumes, but if the material from Company X would be more accurate and stretch over a longer time horizon, of course planning can be improved further.

The forecast communication is similar among all supplier A's customers, most work in the same way, which in essence good. Order and volume forecasts is received via EDI, this makes communication easy for the customers but can be frustrating for the supplier as they cannot respond to the information. One thing that does differ between supplier A's customers is the accuracy of the forecast, the level of confidence they can put in the forecast numbers, which is something that has been established from experience.

6.2.2 Forecast Accuracy

There is no formal measurement of the accuracy of the forecast received from Company X. As the EDI numbers are updated almost daily, it is difficult to know what numbers to use as the actual forecast, this would mean measuring against a moving target. Receiving updates to the EDI several times a week poses a dilemma in production as they must always be prepared. Then of course too high fluctuations cannot be handled on a daily or weekly basis, as there is no excess capacity or workforce available in the short-term. One measure that is used is the delivery precision based on the firm orders received from Company X. As the forecast is a mix of firm, preliminary and forecasted orders and the numbers for the nearest weeks and months it must be reliable as it relates to actual customer orders. If supplier A would not have any confidence in the EDI numbers they would be unable to plan production. For the third and fourth quarter of the EDI information, however, the confidence is lower. The estimated volume numbers can be seen to decrease already in the third quarter, and often in the fourth quarter the volumes have dropped by half, supplier A knows that these numbers are not reliable. The forecasts they receive from the SRM is often more accurate for the full rolling 12-months, however this is not as detailed as the EDI, and is not split by component level.

Therefore, the first step of improving supplier A's confidence in the forecast from Company X is to improve the information in the EDI so that the volumes are more accurate over the full 12-month period. The time horizon of how often and quickly the EDI numbers are updated can also be improved. With updates received more or less on a daily basis, it is difficult to plan production and it is easy to see that it is a system rather than a person who performs the calculations that lead to the changes in orders. Of course, there is an understanding for that orders and forecasts can change, but a monthly update that could give an indication of in what direction Company X is heading would be very valuable. This meeting would preferably be with a person to allow for two-way communication. The information could then be incorporated

in the planning process to see what type of products are increasing in demand, or if certain markets are increasing or decreasing. The sooner supplier A can receive the information, the precision in planning can be improved, this is also of value for Company X as they are dependent on each other.

6.2.3 Capacity Planning

The capacity planning is performed by representatives from logistics, material planning and production planning that daily extract incoming data on orders, outbound and incoming transports and production status in order to steer capacity in the best way possible. In production, there is always a base throughput of volume and then the EDI information is used to align that capacity for the coming week. In case of larger fluctuations in order volumes, there will be a need to increase or decrease the workforce and the number of shifts.

In order to estimate how quickly the capacity can be adjusted, a definition of the short-and long-term horizon of capacity planning must be determined. Small changes in volumes without changes to the workforce or shifts can be done weekly and thus is defined as the short-term. Larger changes to capacity involving hiring staff and increasing the number of shifts can be done on a monthly basis and can thus be determined as mid-term. More extreme fluctuations in demand that requires expansion of the production facility takes over a year to implement, and is defined as the long-term planning horizon. If expansion of capacity should be achieved by building new production lines or rebalancing the production set-up, continuous communication with Company X is required and this is often done as a project. The main concern of supplier A is to get their suppliers to follow the demand fluctuations. A disruption to the supply chain, no matter where it occurs has a massive effect on the entire supply chain. The ramifications can be unimaginable, with companies affected worldwide. Today the entire industry faces capacity constraints due to the high demand in the market. When reviewing production to see if constraints are likely to occur the first signals are if the orders do not match available capacity. This indicates that the capacity should be expanded or compressed. In order to identify this earlier, the numbers received from the customers must be of higher accuracy and received earlier. Company X has a tool called the supplier capacity audit (SCA) that is used to measure and map supplier capacity. Supplier A is not able to nor willing to share this information with Company X, both as they have other customers that would oppose this and that they are unwilling to share information for the risk of it being used against them in negotiations.

In order to extend the communication of information regarding capacity, risk and deliveries to Company X, there is a cross-functional meeting every second week. In this meeting representatives from engineering, quality, and purchasing is involved from both companies. Production-and material planning is not involved in this setting, material planners are however in daily communication regarding deliveries as discussed earlier. In this meeting, risks and quality questions can be discussed and solutions can be found to problems with delivery or supply.

6.2.4 Concluding Remarks

To summarize, the conclusion that supplier A draws from the communication with Company X is that the SRM is a very important role that is highly appreciated. This is an area in which they would be happy if Company X placed more resources to expand this role, now the SRMs have many suppliers to attend to and the time per supplier is quite short. As supplier A has not yet faced difficulties in delivering the desired capacity, they have been receiving less attention than suppliers with more capacity problems. One opinion expressed was that the supplier fear that this means they receive less support and information from Company X, and thus creating problems in the future. This is connected to the role of the SRM, supplier A wants to increase communication with Company X related to capacity and forecasts. It is also important to keep the SRM role neutral, and not involve purchasing. This way, the different objectives of the roles can be kept separate with focus on practical issues and volumes with the SRM and focus on price, negotiations, and quality with the buyers.

Today almost the entire automotive industry face capacity constraints, the high demand makes everyone struggle with deliveries. However, in order to expand capacity with more actions than just increasing the workforce or the number of shifts, investments must be made to building production lines or replacing machines. This cost cannot be carried by the supplier alone, and there is no automotive manufacturer willing to commit to that large investments in the long-term, thus creating an eternal dilemma. Everyone knows that at some point the market will turn, and do not want to be stuck with overcapacity.

6.3 External Supplier – Supplier B

Supplier B, is the second external supplier that was interviewed and supplies several components used in production at Company X. The interview has been conducted with a representative from the commercial side of the company, that has in turn discussed the questions with representatives from production planning. As with the first interview, the results from the

interview will be presented in two sections, the first focused on the communication and analysis of the forecast and the second will focus on capacity planning at the supplier's plant.

6.3.1 Forecast Communication

Supplier B has two sources of volume forecast information. Similarly, with supplier A, the EDI is received on a daily basis including orders, a volume forecasts for 12 rolling periods and delivery schedules. The EDI information includes the firm, preliminary and forecasted orders on a part number level. The delivery schedule is also included in the EDI detailing where the components should be delivered. The S&OP program in turn displays the aggregate volumes, which also used in production planning. In addition to this, monthly meetings are held with the designated SRM from Company X. In the meetings with the SRM, the S&OP program is presented, showing the volume forecast for the full year. The meeting allows for a two-way dialogue regarding the forecast, capacity or any other issue the supplier may have. Furthermore, in addition to the recurring monthly meetings, meetings are scheduled when the EDI displays large upcoming variations, to confirm that the received volumes are realistic. Once demand has been confirmed, the material controller is contacted to reach an agreement on the delivery schedule. In addition to the scheduled meetings, the commercial side at supplier B has continuous communication with buyers at the purchasing department and material controllers at Company X. By doing this supplier B can ensure that the volumes in the EDI are correct and are therefore better prepared for fluctuations in demand.

The software used by Supplier B to receive and analyze the EDI performs most tasks automatically, and does so quite efficiently. As the EDI volume information is received on a daily basis, the system flags for unexpected peaks in demand and sends an alert to the logistics department, which then can perform the necessary actions and plan accordingly. One of the issues that can impede smooth operations and lead to issues is that, from experience, the EDI information cannot be trusted further than six months. The interviewee claimed that forecasted volumes are displayed accurately for the first two quarters of the 12 rolling periods. In the third quarter the volumes drop to unrealistically low volumes, in the fourth quarter the volumes are completely inaccurate, presenting volumes even lower than the previous quarter and also placing the total weekly volume on the first day of the week. Another issue raised by supplier B, is the number of days before the shipment date that the order is frozen. Freezing the order means that no changes can be made by Company X to the quantities demanded. Currently the ordered volumes can be changed up to three days before the shipment date, as this time is shorter

than the lead time in production it forces supplier B to hold stock at all times. If this period could be extended to a week before the shipment date, the supplier believed it would increase efficiency and improve performance.

6.3.2 Capacity Planning

Production capacity planning is performed by the operations department, including production, material planning and logistics, at supplier B. The process is initiated when the EDI is received; production planners verify the capacity to see if available capacity covers the demanded volumes. Production is thereafter planned for the different time periods and internal production is launched. Additional planning takes place in case there is a need for external operations. When internal capacity is not sufficient to cover the demanded volumes, supplier B outsource certain production activities to other companies.

Supplier B is satisfied with their production planning, the automated system is able to support production, plan capacity and help avoid bottlenecks by providing alerts when risks are detected. The system uses various indicators such as the ordered volumes and available inventory to identify capacity issues; however, reactive planning is done by the production manager. The EDI information is the main source of information to production planning as it includes actual orders, this information is reviewed daily to ensure that the planning of production capacity is accurate. When production is planned, a fluctuation of around 10 to 15 percent is being considered, however, the fluctuations are often higher than expected. Based on the personal experience of the interviewee at supplier B, over the last periods demand fluctuations have increased dramatically, to the point where they can have a serious impact on production planning and in turn deliveries.

6.3.3 Concluding Remarks

In general, supplier B has confidence in the information provided in their communication with Company X. The contact with the different departments at Company X is highly valued and the recurring meetings with the SRM help maintain a well-functioning relationship between the two companies. The supplier also feels comfortable discussing delivery issues with the material controllers, which is another indicator of good relationship between the companies. Lastly, compared to supplier A, supplier B is comfortable discussing commercial and capacity issues with the purchasing department at Company X. The supplier values a good relationship with the buyers, as they realize the importance of cooperation in the case of investments. If a large

investment is required at the supplier's plant to increase long-term capacity, the discussion will have to be held with purchasing.

When it comes to production planning, the process is done more or less automatically by the software used at the supplier. One issue that comes up in this stage is the low confidence in the EDI information for a longer period than six months. The system cannot automatically plan production as the volumes must be confirmed by the material controller and SRM to ensure that they reflect real demand. This is closely related to the frequency of volume fluctuations, and the period before the shipment date that the orders are frozen. Therefore, production planning is performed to account for a certain degree of volume fluctuations. These issues were mentioned as the most important for supplier B.

7 Discussion

In the following section the results of the empirical study is discussed from the perspective of the theoretical background and the information gathered in the interviews. The purpose of the discussion is to answer the research questions. The discussion is divided into a number of categories identified as the major areas for discussion in the empirical findings. The discussion aims at highlighting the connection between the different processes and how they impact one another. Thereafter a number of recommendations are presented for future actions based on the discussion.

7.1 The Internal Processes

7.1.1 Forecasts

One of the main topics raised in the initial stages of the study, was that the large increase in demand and the following capacity constraints had not been seen in the forecasts. As the forecasts had not anticipated the increase in demand correctly, suppliers were unprepared for the high volumes demanded. However, the forecasts have for a long time shown a demand that ends up being lower than the actual orders, and thus when the increase was shown in the forecast, suppliers did not have confidence in that these numbers were actually accurate. Connected to this issue, is that the forecasts were adjusted too close to the actual increase for suppliers to be able to make large adjustments to capacity. Therefore, it may be that the departments creating the different forecasts have been too shy in asking for volumes. However, referring to theoretical studies showing that even organizations that are excellent at estimating

demand, can expect an error of between 15 to 20 percent. This led Sheldon (2006) to make the recommendation that when developing a forecast, it is better to estimate demand a little lower, to avoid the high cost of excess inventory that cannot be sold. Thus, comparing the actual forecast process at Company X with literature on forecasting, the process seems to adopt the recommendations from researchers within the field.

There are however, ways to improve the accuracy of the forecast, one is the use of statistical methods to analyze the forecast error over time. Increased use of statistical methods both when developing the TMF and especially in the creation of the demand plan in S&OP, could allow for a better analysis of data and thus more accuracy in the forecast. Company X can also develop another approach to forecasting, Bowersox et al. (2010), claim that forecasting is not predicting what customers will buy but rather to affect what they will buy and steer demand. This would mean that sales and marketing would have to analyze the impact of their strategies on the market. If this approach would be adopted by Company X it could mean that the estimation of demand can be improved. By steering demand, the forecasted volumes can be leveled, so that the demand is balanced over time. This could reduce forecast fluctuations in the forecasts and in the S&OP program. For Company X to improve forecast accuracy and planning, the flexibility to meet demand must be present at all stages of the supply chain, something that could be achieved if demand is balanced over time.

However, it is vital to be aware of the significance not only of forecast accuracy, but also forecast allocation. In the S&OP process, when the departments responsible for the different markets communicate volume forecast to their respective sales area and to demand planning, the allocation of volumes is determined based on past experience. From the information gathered in the interviews it appeared that the allocation of volumes to each market is rather arbitrary with the thought that volumes can always be redistributed at a later stage when the forecast has been confirmed by orders. However, according Ganesan (2015), inappropriate forecast allocation can be a source of supply chain disruption and should be carefully considered before proceeding with the forecast.

Often, the forecast is blamed for planning issues, as mentioned before this is also the case at Company X. However, as mentioned by Sheldon (2006) the forecast is not always the single source of the problem. The forecasted volumes are based on customer demand and low forecast accuracy can more often be due to the unpredictable nature of customer behavior. During

the study, the impression was that internally the accuracy of the forecasts and the S&OP program has been identified as one of the main sources behind the capacity constraints. However, when interviewing external and internal suppliers the impression was rather that the accuracy of the EDI information was more to blame for the problems with capacity planning.

7.2 Sales & Operations Planning

According to literature on S&OP, the purpose of the process is to increase communication, cooperation and align the objectives of the demand and supply side of the company. These and other benefits from the process thus lead to improved customer satisfaction and profitability. The S&OP process at Company X has been developed and aligned with theoretical best practice within the research field. However, in the study, some areas within the S&OP process has been identified that can be further developed. Initially, the degree of cross-functional communication could be increased, so that everyone involved have an overview of the process as a whole and the responsibility of the involved departments. In the development of the demand plan, the role of marketing could be more prominent to see the effect marketing activities have on demand. In the supply plan stage, the role of purchasing as a source of information on external capacity could be promoted further to increase the knowledge of supplier capacity. When performing interviews with stakeholders in the S&OP process, there is an expressed interest in increasing communication across departmental borders to get a full understanding for the S&OP process. The communication of the S&OP program information and forecasts also differs extensively between internal and external suppliers. Both because internal suppliers are highly involved in creating the S&OP volume plan, and because external suppliers are subject to high confidentiality.

7.2.1 Demand Plan

One thing that was mentioned in the interviews with the demand side of S&OP was the lack of a standardized way to create the market forecasts. The markets can set the forecasted volume according to their own understanding of demand. To make sure that the market forecast is accurate, the demand volumes are adjusted in a number of meetings. The consequences of inaccurate demand are large for production both internally and externally. As production is planned according to the forecasted volumes, the repercussions from overestimating demand are high both in terms of investment cost and high inventory holding costs. This calls for the need of a standardized way of creating market forecasts, such as how to interpret the Total Market Forecast and market shares.

There are several ongoing projects to develop the S&OP process, both related to the time-horizon. The first is focused on extending the 12-months rolling forecast to cover 24-months, and the other aims at extending the entire S&OP process to three years, with the third year being forecasted as a full-year volume. The purpose of these projects is to move the focus of the process from the first year, to also consider the second year in the planning process. Today the high focus on the current year can be an issue from the supplier point of view, when planning production and capacity in the long-term. Although these projects address an important topic related to the planning horizon, the main issue raised by suppliers is rather the accuracy of the EDI information. When the EDI is received by suppliers it should contain volumes for the full 12 rolling periods. However, in the last three months the volume information is not complete which makes it hard to plan for the long-term as it is the supplier's only source of volumes on the part-number level. This would imply that the development of the EDI is more valuable to suppliers than the development of the S&OP process.

7.2.2 Supply Plan

When production is planned according to the S&OP program, demand needs to be leveled to account for lead-time and production buffers. The adjustments done in production result in demand for the products used in production moves up to account for the additional lead-times and planning. Thus, the demand displayed in the EDI sent to supplier can vary significantly from the demand in the S&OP program. This could then mean that the volume that the supplier was informed about would be needed in period five, may actually be ordered in period one. This results in questions from the suppliers at to what numbers should be trusted and increases the difficulty to plan ahead.

Another thing that impacts the suppliers' ability to plan capacity is the frequent changes to the EDI, as the product mix changes when orders are placed, the volume fluctuations on the component level can be large. Faced with almost daily updates to the EDI, suppliers sometimes struggle to deliver according to schedules. This is also influenced by the time in which the order can be changed, often being only three days before the shipment date. As the production lead time for many products often exceeds three days, it can be very difficult to meet the new volumes without holding large inventory.

7.2.3 Purchasing

Another aspect that was highlighted during the interviews, and mentioned above, is the involvement of the purchasing department in the S&OP process. If purchasing would be involved already in the supply plan proposal, information about external capacity would be known in time for the plants to plan their own production. By knowing whether the program will be accepted or not in an earlier stage, the production plants would have to put less effort in trying to fit the volumes within their capacity. Therefore, there are ongoing projects to involve purchasing more in the S&OP process.

7.3 External Processes

7.3.1 Forecast Communication & Accuracy

For an organization to provide a reliable estimate of demand, it must develop effective communication of information even beyond company borders. By sharing information with suppliers, cooperation and in turn planning can be improved. If suppliers are given access to information regarding the expected volumes the managing of potential capacity bottlenecks could be improved. Basu and Wright (2017) state that the development of a successful supply chain enables an organization to balance capacity and customer satisfaction while improving company performance.

7.3.2 Electronic Data Interchange Quality

Information regarding forecasted volumes and orders are communicated to suppliers either through a Supplier Relationship Manager, EDI or both. The S&OP program information, showing forecasted volumes on an aggregate level is communicated by the SRM, while part number level information is sent via EDI. These volumes consist of both firm, preliminary and forecasted orders and it is used to plan daily production. However, suppliers need to forecast their production and supply requirements over a longer time-horizon. Due to the low accuracy of the EDI in the long-term, it must be used in combination with the S&OP program information and existing knowledge of the market for the suppliers to generate their own forecast.

The information on the volumes in the EDI is often very different to the S&OP program, this is due to lead-time and buffers in production. As the production schedule moves the planned volumes across the periods, the volumes end up being pushed forward. This could be a reason why the EDI often show inaccurate numbers in the last quarter. To improve the quality of the

EDI it is vital to be aware of what information is being transmitted to the suppliers. Previously a tool was used to control the quality of the delivery schedule in the EDI, however the tool seldom worked well enough for it to be used. This means that if there is a problem with the EDI, the suppliers must contact their assigned material controller in Company X and inform them of the problem. A tool measuring the quality of the delivery schedule and the EDI transmission could be important to improve the internal process and supplier relationships.

For the suppliers to be able to have increased confidence in the EDI information received from Company X, the first step would be to make sure that the volumes are accurately displayed over the full 12 rolling months period. Secondly the frequency of the changes to the EDI can also be improved, with, more or less, daily changes in the demanded volumes it is difficult to accurately plan production. Another aspect that can be improved is to have increased communication with the SRM about the changes to get an idea of the market situation. Having a meeting with a representative from Company X allows for a two-way communication and suppliers can discuss concerns or raise potential questions. To summarize, if the supplier receives highly accurate information about volumes earlier, planning can be done with higher precision, benefiting the commercial relationship between the supplier and Company X.

7.4 Supplier Relationships

According to Bowersox, et al. (2010), one of the main reasons for unsatisfactory supply chain performance is lack of visibility. By increasing the visibility and transparency of supply chain information, the risk of disruptions could be decreased. Over the last decades the relationship between supply chain partners has evolved. Especially supplier relationships are to a higher extent characterized by long-term contracts, cooperation and information sharing. Building relationships with suppliers, means sacrificing some power in negotiations, however in times of market uncertainty it is highly motivated. Building relationships improves the flexibility of the supply chain and the ability to handle demand fluctuations (Helper, 1991).

To build a successful partnership, Basu & Wright (2017) mention mutual trust as the single most important aspect. Jarillo (1988) mention that trust is built over time by establishing processes for information sharing and showing commitment to the relationship. For suppliers, committing a large share of capacity to a single customer is a large risk, if anything would disrupt customer demand (von Massow & Canbolat, 2014). In today's market climate, with high demand uncertainty, Company X is acknowledging the value of improving

supplier relationships and has initiated a number of projects to do so. The focus of the projects is to improve the utilization of existing knowledge in the company and improving communication and information sharing. One of the projects reviews the possibility to share the S&OP program with more suppliers. The responsibility of improving supplier relationships is largely part of the SRM role, the idea has been explored to extend the SRM responsibility to buyers. In their communication with the suppliers, the SRMs need to provide information beyond the automated EDI and make clear why the numbers change, otherwise trust cannot be generated. Although there are projects aimed at improving supplier relationship by communicating more information, they are still restricted by confidentiality. Since confidentiality restricts the amount of information that can be communicated to the suppliers, the projects must ensure that the material can be shared with the supplier, and that it includes speaking points so that all suppliers receive the same information. The SRM role is very valued by the suppliers that have access to it. However, one external supplier expressed the importance of keeping the SRM role neutral and separate from purchasing, as they then felt freer to share information on volumes and capacity.

Previously, Company X has had a reactive approach to risk prevention, and thus the reaction time to supplier related issues, has been long. Only after the capacity problem had become overwhelming, teams were created to work together with supplier to solve it. As Company X has not focused on building relationships with suppliers, there has been difficulties knowing their production capacity and capabilities. In turn, this inhibited the ability to anticipate capacity constraints. This means that the capacity issue is not only caused by the high demand but also by the low focus on supplier relationship management. Improving supplier relationships also includes committing to investments to increase capacity in the long-term. If demand increases from the customer, the supplier cannot bear the cost alone and most automotive manufacturers are unwilling to commit to large investments. This was mentioned by one of the external suppliers as an eternal dilemma as everyone knows that the market will at some point turn.

7.4.1 Trust, Confidence and Confidentiality

The topic of trust between suppliers and Company X, the supplier confidence in the forecasts and the high confidentiality, are related to much of the discussion above. One reason for low forecast confidence could be the large impact of the financial crisis in 2007 on the industry. As many companies were affected by the low demand, the willingness to believe in high demand peaks and make investments to cover the high volumes may be low. Companies with this

experience tend to act with caution when making investments to increase capacity. Another reason why supplier confidence in the forecast may be low, is that the forecast accuracy has historically been low. For a long time, the forecast predicted a demand increase that never came, it kept being postponed until no one thought it would actually happen. Then when the demand suddenly increased and suppliers were not prepared for such a peak in volumes. This shows that much can be done to increase transparency, trust and to build supplier relationships.

7.5 Recommendations

In the following section, recommendations based on the previous discussion will be outlined. The purpose of the recommendations is to provide Company X with our ideas on what actions could be taken to further investigate existing processes and improve performance. We provide recommendations for the main issues identified during the discussion, however, specific recommendations might solve more than one of said issues, as the underlying reasons behind them are of similar nature.

The first recommendation focuses on communication, as this is related to most the topics reviewed in the discussion. Something highlighted during most of the interviews on the internal forecasting process, is the low degree of cross-functional communication in the S&OP process. Each department only has limited contact with other departments involved in the process. Thus, creating a lack of understanding of the process as a whole and the responsibility of each department. However, as the S&OP process spans over the whole organization and includes a large amount of people, having continuous communication with everyone would be impossible. To improve internal communication related to the S&OP process our suggestion is to increase the knowledge and understanding of the S&OP process. By sharing the information with everyone in the involved departments, knowledge and thus confidence in the process can be increased. This would in turn mean that more people are incentivized to use the program and improve company performance.

The next recommendation is connected to external communication, as this is something that was brought up as an area for improvement. With ongoing projects aimed at improving supplier relationships and thus transparency in communication, this seems to have already been solved. However, the confidentiality surrounding external communication is a large obstacle to increased communication. Forecast information shared by suppliers is either limited to a one-year horizon or highly aggregated. If external communication is to be improved, the

confidentiality must be loosened. The reasoning behind the high confidentiality is related to corporate valuation and the financial market. Therefore, our suggestion is to review the policies on confidentiality and perform an analysis on whether the high confidentiality hurts the company more than it protects it, or if it is justified. It may be possible that by loosening the confidentiality, better relationships with suppliers can be created and thus costs related to planning and purchasing could be reduced. Another aspect of loosening the confidentiality restrictions, is that more years of the forecast can be shared with the suppliers and thus the accuracy of long-term capacity planning can be improved. For Company X, this could result in capacity constraints and potential disruptions being discovered earlier along with counteractions to avoid these problems.

Forecast accuracy is mentioned as one of the main sources of the capacity constraint, and thus our third recommendation will focus on this. Initially, the difference between the forecast in the S&OP process and the forecast presented in the EDI must be made clear. As the EDI numbers have been adjusted for lead-time and buffers it will not match the S&OP program forecast, this must be communicated to both internal and external actors as there is still much confusion regarding what numbers to trust. Internally the problem is also that the quality of the information in the EDI cannot be seen before it is delivered to suppliers. This means that the suppliers must contact someone at Company X if they identify something questionable in the EDI. Secondly, because the information in the EDI is based on the S&OP volume plan, the quality of the forecast used to create it must be improved. This could be done by applying a standardized way to develop market forecasts and increasing the use of statistical methods in forecast creation. By applying these recommendations, the estimation of demand can be harmonized across all markets, improving the accuracy of the demand figures and thus there would be less need for adjustment during the challenge meetings. In the development of the demand plan in the S&OP process there are no or few statistical methods used, if the common-sense approach, outlined in the theoretical framework, would be employed, a combination of the current qualitative method of forecasting can be merged with quantitative forecast methods to improve the analysis of historical data and in turn forecast accuracy.

The next recommendation relates to the role of purchasing in the S&OP process. In the current process the role of purchasing is to provide information on external supplier capacity. This information is used as an input to the supply plan response that occurs after internal capacity has been determined. Our recommendation is to provide this information earlier in the process.

Today the supply plan proposal process is performed to see if the demand plan volumes can be met, however in the last stage of the process, the program can still be rejected due to limits to external capacity. If the supplier capacity is known earlier it can be taken into consideration when evaluating internal capacity. For purchasing to know how the S&OP program and EDI information is perceived by suppliers, a measurement of forecast accuracy performed by suppliers could be valuable. Suppliers currently find it difficult to measure the accuracy of the EDI information due to the frequent updates of the information. An additional recommendation is therefore that Company X and suppliers to develop a way to measure forecast accuracy together as it is useful for both parties for planning purposes.

Finally, the role of Supplier Relationship Managers (SRM) to supplier relationships should be reviewed. One of the points that was brought up during supplier interviews, was the importance of keeping the role of the SRM neutral and limiting the commercial presence. This way the SRM could act as an impartial mediator between the supplier and Company X's commercial departments. Important issues that a supplier might be facing can then be discussed freely with the SRM, without the suspicion of the information provided on capacity being used in negotiations. The SRMs also have a good overview of internal processes and can be of help when suppliers face problems with the internal systems at Company X regarding delivery and payments. Given that the number of suppliers interviewed is limited and only one expressed the desire for a neutral SRM role separated from the commercial side as Company X it is something that might not reflect the opinion of all suppliers. The recommendation is however, to take this into consideration in the ongoing projects related to supplier relationships. It is however clear the role of the SRM is highly valued by suppliers and there could be value in extending it to even more suppliers.

8 Conclusion

In the global economy, all companies are part of a vast supply chain and the vulnerability this implies becomes apparent when faced with market uncertainty. Today the automotive industry has the pleasant situation of growing demand, however, when this results in supply constraints, companies are unable to deliver the desired volumes. The motivation behind this study is therefore, to identify factors that may explain part of the reason why this situation occurred. With the focus on forecasting, it required us to study both internal and external processes.

What we found is that the internal forecast processes are highly structured and developed from an established theory called Sales and Operations Planning, this then answers the first part of our twofold research question. The remaining study is focused on communication with internal and external suppliers and their capacity planning. Forecast communication was found to be different dependent on what category the supplier was placed in. Internal suppliers are part of the Sales and Operations Planning process and thus have access to detailed and long-term volume forecasts. External suppliers do however, not have access to the same information due to confidentiality constraints. There is also a difference among the external suppliers as some are categorized as high-profile and some as low-profile, with more forecast information provided to those distinguished as high-profile. It was found that the amount of forecast information and its accuracy has an impact on long-term supplier capacity planning.

The findings of the study and the discussion can provide Company X with an insight as to how the problem emerged, within the confines of this paper. The process maps that have been created for this paper, allows for a review of the process to create an understanding and thus allow for improvements. However, some findings contradict the early assumptions as to why the problem occurred. In the introductory interviews and discussions, it was believed that the capacity constraints were mainly the result of inaccurate forecasts. The findings do however suggest that there are more aspects that has had an influence on the existing situation. The fact that we as students could take another approach to the topic, is believed to have been valuable. This because we did not have preconceived notions as to the source of the problem and thus could be open to other perspectives.

Based on the discussion and recommendations we could identify three aspects important to understand the source of the problem; communication, supplier relationships and confidentiality. To secure a well-functioning supply chain in a volatile market, integration of supply chain actors has become increasingly important. With the development of new technologies such as the electrification of propulsion systems and autonomous driving, the future direction of the industry is even more difficult to predict. However, by improving cooperation and transparency in communication with supply chain actors, the impact of supply chain disruptions can be controlled. The future of the industry looks promising despite the highly volatile market. However, it is impossible to predict how the society's move towards electromobility and autonomous driving will impact the industry as a whole.

8.1 Recommendations for Future Research

The purpose of this paper is to investigate processes specific to a company, therefore continued research on the specific processes may prove difficult. However, we encourage a continued internal review of the processes following our recommendations and other identified improvement areas. As for continued academic research, the field of Sales and Operations Planning is thoroughly researched, however, we can identify a need for more studies as to how it works in practice. The theoretical evidence on the advantages of the S&OP process is extensive but would be nicely complemented by empirical evidence. This is something this study aims at contributing to, as well as increasing the understanding of the connection between forecast processes and supplier capacity planning.

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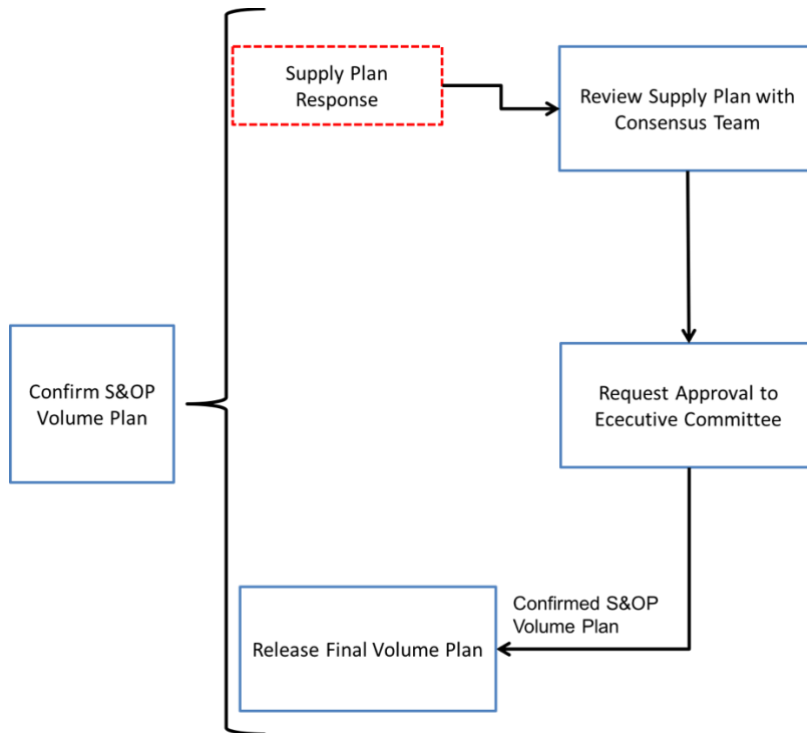
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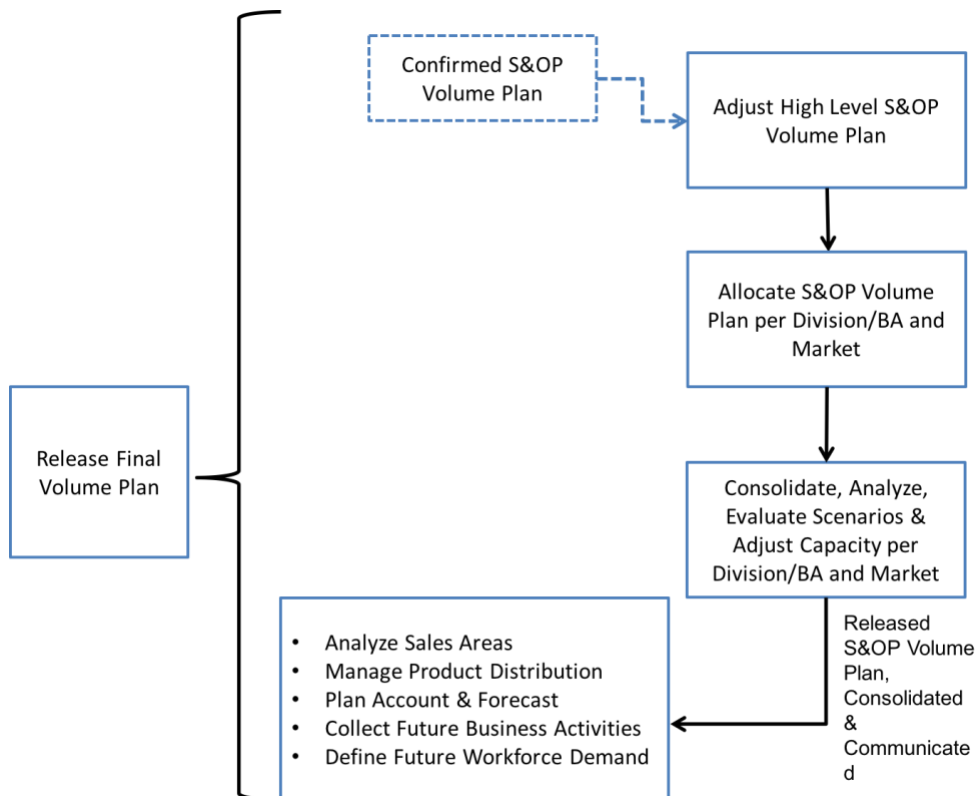
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Appendix 1 S&OP Processes

The process for Confirming the S&OP Volume Plan



The process for the Release of the Final Volume Plan



Appendix 2 Interview Guide - Internal Interviews

The interview guide contains the topics discussed in the interviews.

- The S&OP Process
 - Demand Plan
 - Supply Plan
 - Reconciliation
- Forecasts
 - The different types of forecasts
- Measurements and Communication

Appendix 3 Interview Guide - External Interviews

The interview guide contains the topics discussed in the interviews.

- Forecast Communication
- The Forecast Process
- Forecast Information Systems
- Supplier Capacity Audit
- Capacity Planning