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ENGINEERING AND MANAGEMENT

Defining Sales and Operations Planning Process in an Environmental Management Company

Master’s Thesis

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SUMMARY

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Sales and operations research publications have increased significantly in the last decades. The concept of sales and operations planning (S&OP) has gained increased recognition and has been put forward as the area within Supply Chain Management (SCM). Development of S&OP is based on the need for determining future actions, both for sales and operations, since off-shoring, outsourcing, complex supply chains and extended lead times make challenges for responding to changes in the marketplace when they occur. Order intake of the Case Company has grown rapidly during the last years. Along with the growth, new challenges considering data management and information flow have arisen due to increasing customer orders. To manage these challenges, Case Company has implemented S&OP process, though initial process is in early stage and due to this, the process is not managing the increased customer orders adequately. Thesis objective is to explore extensively the S&OP process content of the Case Company and give further recommendations. Objectives are categorized into six different groups, to clarify the purpose of this thesis. Qualitative research methods used are active participant observation, qualitative interviews, enquiry, education, and a workshop.

It is notable that demand planning was felt as cumbersome, so it is typically the biggest challenge in S&OP process. More proactive the sales forecasting can be, more expanded the time horizon of operational planning will turn out. S&OP process is 60 percent change management, 30 percent process development and 10 percent technology. The change management and continuous improvement can sometimes be arduous and set as secondary. It is important that different people are required to improve the process and the process is constantly evaluated. As well as, process governance is substantially in a central role and it has to be managed consciously. Generally, S&OP process was seen important and all the stakeholders were committed to the process. Particular sections were experienced more important than others, depending on the stakeholders' point of views. Recommendations to objective groups are evaluated by the achievable benefit and resource requirement. The urgent and easily implemented improvement recommendations should be executed firstly. Next steps are to develop more coherent process structure and refine cost awareness. Afterwards demand planning, supply planning, and reporting should be developed more profoundly. For last, information technology system should be implemented to support the process phases.

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Tutkimusjulkaisut S&OP-aiheesta ovat lisääntyneet merkittävästi viime vuosikymmeninä. Myynnin ja toimintojen suunnittelu (S&OP) on saanut kasvavaa huomiota, ja se on osa-alue toimitusketjujen johtamisessa. S&OP:n kehittäminen perustuu tarpeeseen määrittää myynnin ja toimintojen tulevaisuutta, sillä ulkoistaminen, monimutkaiset toimitusketjut ja pidentyneet läpimenoajat luovat haasteita vastata markkinoiden muutoksiin. Tässä työssä tutkittava yhtiö on kasvanut nopeasti viime vuosina onnistuneiden liiketoimintosuunnitelmien ansiosta. Tilausten kasvusta johtuen uusia haasteita on noussut tiedonhallinnassa ja tiedonkulussa. Tehokkaamman haasteiden hallinnan takaamiseksi tutkittava yritys on ottanut käyttöönsä myynnin ja toimintojen suunnitteluprosessin. Prosessi on alkuvaiheessa ja tästä johtuen se ei hallinnoi kasvaneita tilauksia riittävän tehokkaasti. Diplomityön tarkoituksena on tutkia laajasti S&OP-prosessin sisältöä kohdeyrityksessä ja antaa tulevaisuuden kehitysehdotuksia. Tavoitteet ovat luokiteltu kuuteen eri ryhmään. Tutkimus on laadullinen, ja käytettävät tutkimusmenetelmät ovat aktiivinen osallistuva havainnointi, kvalitatiiviset haastattelut, kysely, koulutukset ja työpaja.

On huomattava, että kysynnän suunnittelu koettiin haasteelliseksi kohdeyrityksessä ja se on ilmennyt vaativaksi osa-alueeksi myös muissa S&OP-prosesseissa. Aktiivisemmalla myynnin ennustamisella voidaan laajentaa toiminnan suunnittelun aikajännettä. S&OP-prosessista 60 prosenttia on muutosjohtamista, 30 prosenttia prosessin kehittämistä ja 10 prosenttia teknologiaa. Muutosjohtaminen ja jatkuva kehittäminen esiintyvät teoreettisessa kirjallisuudessa menestystekijöinä, ja tästä johtuen niitä ei sovi asettaa toissijaisiksi tavoitteiksi. On tärkeää, että eri sidosryhmät voivat jatkuvasti arvioida ja parantaa prosessia. Prosessijohtaminen on myös olennaisesti keskeisessä roolissa, ja se on hallittava tehokkaasti. Yleisesti S&OP-prosessi koettiin tärkeäksi sidosryhmissä ja kaikki sidosryhmät osoittivat sitoutuneisuutta prosessiin. Tietyt osa-alueista koettiin tärkeämmäksi kuin muut, riippuen sidosryhmien näkemyksistä. Kehitysehdotukset ovat arvioitu saavutettavien hyötyjen ja resurssivaatimusten perusteella. Kriittiset ja helposti implementoitavat kehitysehdotukset tulisi ottaa käyttöön ensimmäisenä. Tulevaisuudessa tavoitteena on kehittää prosessin rakennetta ja kustannustietoutta. Jälkeenpäin on tarkoitus kehittää tarjonnan suunnittelua ja raportointia. Tietotekniikkajärjestelmien implementointi on myös suositeltavaa, jotta prosessin eri vaiheita voidaan tukea, automatisoida ja optimoida tehokkaasti.

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Abbreviations

APS	Advanced planning system
BI	Business intelligence
BSC	Balanced scorecard
BU	Business unit
CPFR	Collaborative planning, forecasting and replenishment
CPG	Consumer package goods
CRM	Customer relationship management
DP	Demand planner
ERP	Enterprise resource planning
IRR	Internal rate of return
ITS	Information technology system
KAM	Key account manager
KPI	Key performance indicator
MAD	Mean absolute deviation
MAE	Mean absolute error
MAPE	Mean absolute percentage error
MASE	Mean absolute scaled error
MES	Manufacturing execution system
MPC	Manufacturing planning and control
MPS	Master production schedule
MRP	Manufacturing and requirements planning
NPI	New product introduction
NPV	Net present value
PMI	Purchasing management index
PTF	Planning time fence
RMSE	Root mean squared error
ROA	Return on assets
RRP	Resource requirement planning
S&OP	Sales and operations planning
SCM	Supply chain management
SKU	Stock keeping unit
SMAPE	Symmetric mean absolute percentage error
SP	Supply planner
SQL	Structured query language
TPM	Trade promotions management

1 INTRODUCTION

1.1 Background

The concept of sales and operations planning (S&OP) has gained increased recognition and has been put forward as the area within supply chain management (SCM) (Grimson & Pyke 2007, p. 329). Sheldon (2006, p. 40) mentions that S&OP is one of the most talked process in business and it is an integrated business management process developed in the 1980's. Development of S&OP is based on the need for determining future actions, both for sales and operations (Ventana Research 2006, p. 4–5). S&OP research publications have increased significantly in the last decades (Thome et al. 2010, p. 360).

Case Company has grown rapidly during the last years, because of the successful business units and increased order intake. Along with the growth new challenges considering data management, decision making and information flow have arisen due to increasing customer orders. Challenges in company's sales department, productions, supply chain, finance and customer care have been under investigation – different departments should be communicating to each other more effectively and instantaneously without major or separate effort to communication. To manage these challenges Case Company has implemented S&OP process, though initial process is at an early stage and due to this, the process is not managing the increased customer orders adequately. In the consequence of abovementioned development trend, company wants to conduct a comprehensive study.

Case Company is currently redefining S&OP process to gain comprehension for aforementioned challenges as well company wants to restructure and explore the validity of S&OP's process content. Also suitable information technology system (ITS) is monitored and compared, hand in hand with the process measurement aspect. This is a compelling challenge due to the special environment of the Case Company, which has process, manufacturing and service industry features.

Challenges should be tackled before they become significant in the imminent present of cross-functional decision making forum – S&OP process. Case Company wants to study and understand the S&OP literature and the best practices to modify its S&OP process. Understanding the role of operation management in S&OP process is a vital step towards a successful process.

1.2 Objective

Thesis objective is to explore extensively the S&OP process content of the Case Company. Objectives are categorized to seven different groups, to clarify the purpose of this thesis. *First,* process related planning groups are observed. *Second*, demand management's role in the S&OP process is clarified. *Third*, supply management role in the process is investigated. *Fourth*, process structure efficiency is evaluated. *Fifth*, objective is to clarify how the entire process should be monitored. *Sixth*, which ITS features the process requires. *Last*, Case Company's entire S&OP process is compared to theoretical success factors and other corresponding industries' S&OP processes. Financial aspect of the S&OP process is not part of the thesis, though all the controlling decisions are partly based on cost effective solution.

First the product planning groups are investigated, are they wide enough and at the appropriate level. The planning point of view is as well investigated. *Second*, the role of demand management in S&OP process is investigated – what is the function of sales department in S&OP process. The frequency and level of demand planning is defined. Essential point is to describe the appliance of forecasting in S&OP process.

Third objective is to define the role of supply management in S&OP process. Clear frame conditions are defined for the process, for example, storage capacities, external treatment capacity, balances, treatment capacities and other affecting factors. Finnish Ministry of the Environment defines the allowances for waste treatment for each business in the environmental protection act, which are strictly obeyed and so it also controls S&OP process. Even though, the act is not presented in the thesis, it is a directing boundary condition for S&OP process.

Fourth objective is to define the process structure and planning scope. The effectiveness of optimizing the decisions across business areas and functions is investigated. What is the process maturity and what are the next steps? The vital steps to go through entire S&OP process are presented. The tacit knowledge is translated into knowledge of the organization, so that the right decisions can be executed without the immediate presence of a deep talent specialist. Entire S&OP process has to be done consciously according to formalized process structure.

Fifth step is to define how the process should be monitored – monitoring applies initial key performance indicators (KPI) suggestion with responsible persons. Suggestion is based on the clarification work and what functions and stakeholder feel important for the process. *Sixth*, objective is to describe the possibilities of ITS to the Case Company. The information technology systems features relevancy for the process is investigated.

Last, theoretical S&OP process success factors are investigated and presented. Main features of Case Company's S&OP process are compared to the theoretical success factors and to other environmental management companies S&OP process. On the basis of the aforementioned objectives two research questions were defined at general level as follows:

RQ1: What aspects are vital for S&OP process, which of these should be developed?

RQ2: What are the future recommendations for the Case Company?

1.3 Limitations

S&OP process is discussed with several terms depending on its hierarchical nature. Thesis explores S&OP process as periodic planning process in a tactical level, also referred as executive S&OP. In this thesis by S&OP process is meant tactical level and monthly executive S&OP process. Many research papers divides S&OP process into three different processes: strategic, tactical and operational process, hereinafter strategic and operational processes are delimited, though the linkages and dynamics between S&OP process and operational and strategic framework are explored.

Thesis is not describing what should be done to gain two to four maturity levels in an organization, instead thesis specifies how the S&OP process will gain a step forward. Sourcing is delimited from the empirical part of the thesis due to the nature of Case Company's business. Case Company's business units are

1.4 Research methods

Literature review is done from the written material of the subject. Most related theory was studied in the begging of the thesis. The empirical part of the thesis is executed as qualitative research. Qualitative research methods used are active participant observation, qualitative interviews, enquiry, education and a workshop, which is held in the end of the thesis project. Different interviews were conducted for management, sales, operation, customer service and treatment centers. Interviews were held in the beginning of the thesis project, September and October 2014. General theory of the S&OP were educated before the participators were interviewed, to give more holistic picture about the entire process. An inquiry was sent to two environmental management companies in Scandinavia. Questionnaire was answered by persons who are responsible for companies' S&OP process. Enquiry answers were received in April 2015. Workshop was facilitated by the help of a big four consultation company. Workshop participant group was broader than interviewed group, meaning that the key stakeholders were participating to both interviews and workshop. Workshop participators were from management, customer service and logistics, sales, treatment, and environmental construction BU. Workshop results will be used as ground pillars, when creating future development aspects. 14 people across different units participated to the workshop held in April 2015.

1.5 Structure

In the table 1. Is presented the structure of the thesis by chapters' inputs and outputs. Theoretical review is presented in the chapter two, which begins with the presentation of key linkages and fundamentals. Demand and supply planning theories are described as well in chapter two. Afterwards process structure and planning parameters theory is presented. At the end of the chapter two information technology and performance measurements in S&OP contest are demonstrated. In the last subchapter 12 theoretical success factors are listed.

Empirical part of the thesis defines the S&OP structure before restructuring, presents the development aspects and recommendations into the future. In the third chapter the profile of the Case Company and the initial state of the S&OP process in the beginning of the thesis project are presented. Chapter four describes what developing aspects were implemented during the thesis work and presents recommendations for the future. In the beginning of the chapter four production planning group, demand and supply planning are investigated. In the middle of the chapter structure, data, process performance development and recommendations are presented. In the end of the chapter to-be state and state of S&OP process in other environmental management companies are illustrated. Conclusions are presented in the fifth chapter and the thesis is summarized in the sixth chapter.

Table 1. Input and output chart of the structure

Input	Knowledge processing methods	Output
Background of S&OP theory Backgrounds of the company, which have led to the thesis project	**Chapter 1: Introduction** Knowledge development	Objects of the research Research questions Delimitations Research methods, execution and structure of the study
Research questions Delimitations Methods Theory about S&OP groups (general, demand and supply planning, structure, ITS, performance measurement, and success factors)	**Chapter 2: Theoretical review** Processing, refining and structuring theoretical information	Answer to the object, what are the success factors in theory? Object of describing the relevant theory related to Case Company, is achieved
12 success factors Refined theoretical information Case Company's information	**Chapter 3: Defining the S&OP structure of the Case Company** Refining, structuring and processing the empirical information based on the existing theoretical information Based on the interviews and active participation the initial state is defined	Description about Case Company The initial state of the Case Company's S&OP process, according to theoretical groups
The initial state of the Case Company's S&OP process Theoretical information Development of reporting systems Research questions Delimitations	**Chapter 4: Process development and Recommendations into the Future** Based on the interviews, inquiry, workshop and active participation the desired state is defined. Analyze of the theoretical and empirical information	To-be state of the process Evaluation and importance of the defined S&OP sections' areas by stakeholders State of the S&OP in other environmental management companies
Objective of the research Research questions and answers to them	**Chapter 5: Conclusion** Presentation, comparison, and analyze of the information Developing conclusion	Research results Prioritization matrix Relevancy of the results
Research questions Delimitations Methods Delimitations Refined theoretical information Research results Relevancy of the results	**Chapter 6: Summary** Summary of the information	Potential further researches Result discussion with the theory Significance of the results Summary about thesis End of the thesis

2 THEORETICAL REVIEW

2.1 Sales and Operations Planning Overview

Past trends in commerce, such as globalization and outsourcing, have created increasingly intricate supply chains (Ventana Research 2006, p. 3–4). Cohen and Roussel (2004, p. 14–17) mention outsourcing as a key strategy to coordinate complex global supply chains. The concept of Supply Chain Management (SCM) thus emerged as a response to challenges in integrating business processes (Feng et al. 2008, p. 200–201). Alongside with this integration, companies are gaining operational Excellence by implementing lean production principles, different tools, process methods and information systems. (Grimson & Pyke 2007, p. 324–326).

Singh (2010, p. 23) states that, successful companies have realized that they need a structured process for creating realistic sales and operations plans, in order to be able to compete in complex environment and respond to the marketplace more rapidly. The concept of sales and operations planning (S&OP) has gained increased recognition and has been put forward as the area within SCM (Grimson & Pyke 2007, 329). Sheldon (2006, p. 40) mentions that S&OP is one of the most talked process in business and it is an integrated business management process developed in the 1980's. Development of S&OP is based on the need for determining future actions, both for sales and operations. This is due to the fact that off-shoring, outsourcing, complex supply chains and extended lead times make challenges for responding to changes in the marketplace (Ventana Research 2006, p. 4–5).

Long-term planning is considered highly important in order to have an adequate time period to make capacity decisions when demand is either increasing or decreasing (Jonsson and Mattsson 2009, p. 120). S&OP is a process to develop tactical plans that provide management the ability to strategically direct its operational businesses and to achieve competitive advantage on a continuous basis (Thome et al. 2012, p. 360). S&OP goal is to recognize short-term local demand and supply signals and utilize them to reconcile the long-term planning - business planning and strategic planning (Cohen and Roussel 2004, p. 7)

General key linkages

Sales and operations planning is the key business planning process to control and balance customer demand and supply capabilities. Process is organization wide and its main objectives are balancing horizontally demand and supply together, and vertically facilitating hierarchical coordination – long-term strategic planning, business planning, detailed scheduling and daily short-term operational planning. (Wagner et al. 2013; APICS dictionary 2013.) How S&OP connects day-to-day operations and strategic planning is demonstrated in figure 1. S&OP process integrates all the business plans, sales, marketing, development, manufacturing, financial, sourcing and supply chain, into one consolidated set of plans. S&OP is a routine on-going planning, monitoring and evaluation process that covers a specific planning horizon, usually 1–24 months depending on the available data and business environment (APICS dictionary 2013; Grimson and Pyke 2007; IOMA 2003; Lapide 2002; Dwyer 2000).

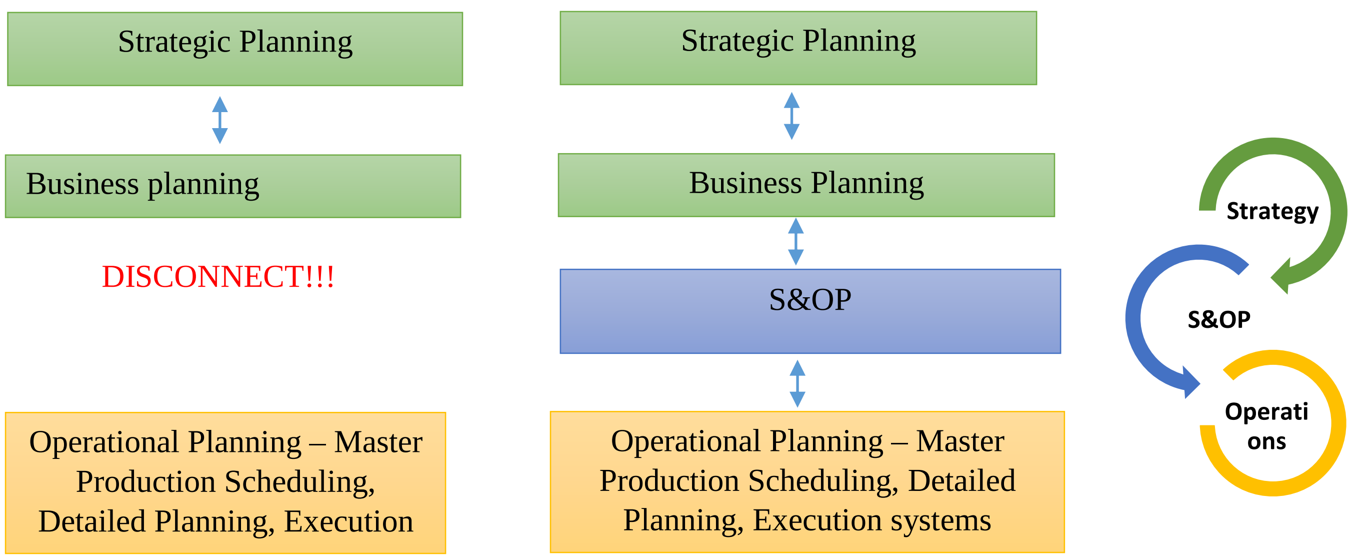

Figure 1. S&OP connects day-to-day operations and strategic planning. (Wallance & Stahl 2008, p. 12)

In S&OP process strategic and financial plans of the business are linked to the week-to-week, day-to-day, or shift-to-shift activities such as customer orders, order entry, master scheduling, purchasing tools, acquiring material (Wallance & Stahl 2008, p. 20–22). Many other researches presents S&OP as a link between strategic and detailed operational planning due its position in master scheduling in manufacturing planning control (MPC) systems. Figure 2. illustrates the alignment of S&OP process between horizontal and functional dimensions, S&OP process is located between strategic, functional and detailed planning. As figure 2. presents S&OP is a process that integrates cross-functionally marketing, resource, financial, supply, sourcing, production, development, sales and demand planning into an one consolidated plan, and which also observes the vertical alignment – it combines the company's strategic and business plans with the operations of each separate department. (Proud 2007, p. 199.)

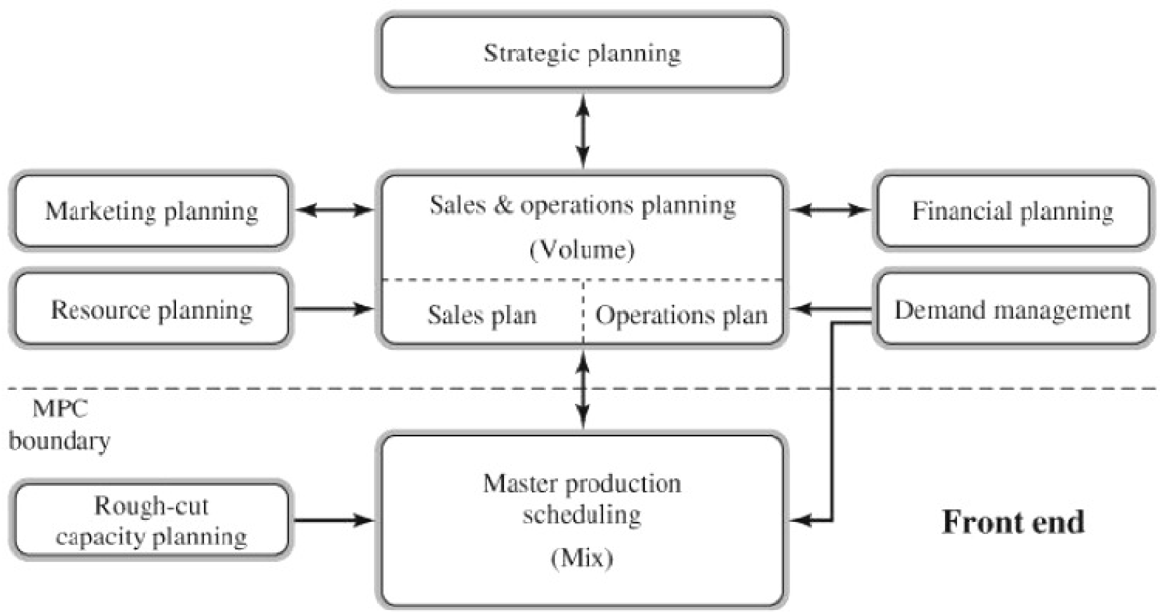

Figure 2. Key links in S&OP (Vollman et al. 2005).

Vollman (2005) argues that the linkage from S&OP to the master scheduling enables the connection from strategic to the operational planning execution. Fundamental of master production schedule (MPS) is that it should be executed in a disaggregation form. Aggregate units, outputs of tactical S&OP, are used as inputs when modifying more detailed MPS. In MPC systems S&OP is typically the highest planning level, due to its holistic alignment (Olhager & Selldin 2007; Olhager et al. 2001). Palmatier & Crum (2003, p. 130) states that soundly integrated planning and control system includes both aggregate and detailed planning methods. On the other hand, many researches state that detail level decisions are executed elsewhere, though in connection to S&OP. As previously mentioned the exploration is delimited from a detail-level in the further discussion, though S&OP is not going to succeed without the proper linkage to the detailed planning.

When S&OP process achieves high maturity and it is executed soundly the process gains the following linkages (Grimson & Pyke 2007; Nakano 2009; Thome et al. 2012):

- Strategic plans into executable form of operations
- Reviews company's performance measures for continuous improvement
- Creates cross-functional and integrated planning process
- Links strategy, business and operations
- Creates value and links company performance.

Four fundamentals of S&OP

The four fundamentals of the S&OP process are demand, supply, volume and mix. One of the most important elements of S&OP process is to provide foreseeable predictions, if supply and demand is likely to get imbalanced. These early warnings alert people involved that demand and supply are going to be unsynchronized. Like with demand and supply volume and mix separately needs to be treated as two different fundamentals. It is much easier to deal with the mix issue, if volume is managed effectively. On the other hand, mix complication become immediately more unmanageable, if the volume is not planned well. Lots of companies get themselves in trouble, because they are not able to distinguish the volume problem from the mix-related issues. Volume is the big picture and mix is the details and the mission of S&OP process is to balance supply and demand at the volume-level. (Stahl and Wallance 2008, p. 7.)

Many companies look at the volumes only once or twice per year, as they do business plan. They concentrate on the mix issues, because the mix, individual products, is in the pressure and it is experienced as consequential and eminent. Due to this many companies define their volumes – sales rates and production rates – once per year, when they do the annual budged. Although, during an average year volume tends to fluctuate more often than once per year, thus quarterly and monthly variations are general. Focusing on the mix, predicting details, not putting enough effort to the big picture is a common problem what today's companies face. (Stahl and Wallance 2008, p. 8.)

S&OP is about getting the volume in place and after that the mix – focusing on manufacturing plan and control. Volume refers to rates – over all rates of sales, rates of production, aggregate inventories and order backlogs. Companies which have planned volume through the year have found that the challenges with the mix becomes less overwhelming. Resulting less inventory, better and more rapid shipments. (Stahl & Wallance 2008, p. 8.)

2.2 Demand Inputs

Sales Forecasting

Two fundamental inputs to S&OP are demand and supply, which is explained by the most important mission of S&OP – balance supply and demand and keep them in balance. (Stahl & Wallance T. 2008, p. 45) Stahl & Wallance (2008, p. 39–40) states that common forecasting issues are: who does it, at what level it is done, and how often. It is highly important that forecasting level is defined so that it is not too detail-specific nor too pervasive. Forecasting the entire company will not provide the eligible information for operations. On the other hand, forecasting at detail-specific level can make the forecasting more complex. For example forecasting at stock keeping unit (SKU) level may cause more error and require a lot more effort. From the other point of view it is better to store master data at detail-level, which makes it possible to retain specific demand from certain customers and utilize the data when necessary. S&OP is generally applied to product family level rather than to SKUs, because S&OP creates plans for the next 1–24 months (IOMA, 2003; Lapide, 2002, p. 13; Dwyer, 2000, p. 31). Figure 3. describes the product structure level of forecasting.

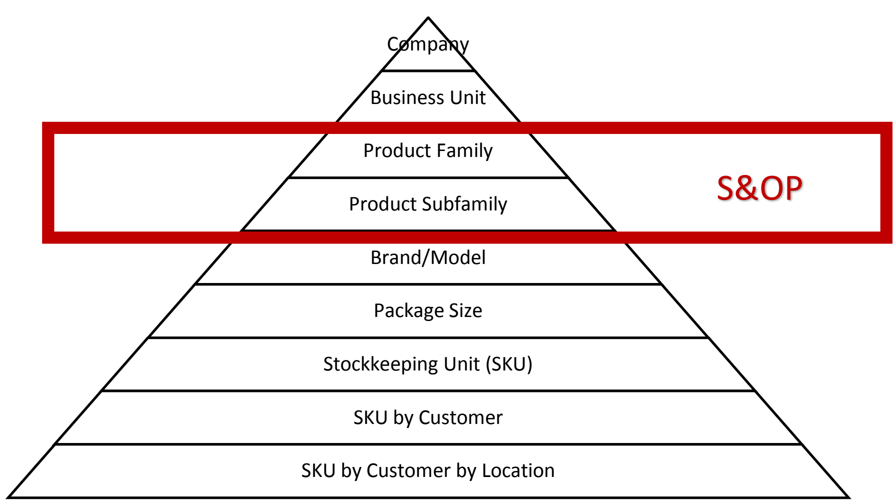

Figure 3. Product structure level (Wallance & Stahl 2008, p. 40)

Demand planning consist of new product requirements, bids, price changes, forecast updates, and creation of consensus forecast. This phase is approved by the senior sales and marketing executives before it is used as an input for supply planning. The sales and marketing is responsible of demand planning, and owns the forecasts. (Wallance & Stahl 2006, p. 55–59.) Lapide (2002, p. 12) states that marketing intelligence typically includes pricing, promotion, competitor actions, which affects the demand. The forecast needs to be aggregated from the detail level.

Planning Time Fence

Planning Time Fence (PTF) is the cumulative lead time of planning an order, ordering a raw material, shipping the material and producing it. Inside the PTF, company must forecast at the detail-level. Outside of the PTF, company should forecast at the consolidated volume-level, not including rare circumstances. Rare circumstances refer to a raw material, which would take longer to source than the PTF. It is not reasonable to extend the PTF, if the lead time of few products exceeds PTF. A company should forecast and master schedule the special individual products in a detail-level. For example, if planning time fence is four weeks, and the lead time of a rare raw material is six months, then unique raw materials PTF is six months, and other raw materials PTF remains at four week. This could be the case of a rare wood material, which is grown only in particular rainforest, and so harvesting, transportation, processing and shipment requires six months. (Stahl and Wallance 2008, p. 41.)

Independent and Dependent Demand

Dependent demand is related to components or subassemblies, which are depending on the finished products. Dependent demand can be affected through process development, for example how many components finished product requires (Sanders 2013, p. 23). On other hand *independent demand* is driven straight from the customer to company, and it is often independent from the actions of the company (Vollman et al. 2005, p. 18). Optimization involves proper demand management – customer demand is more or less controllably depending on the industry, and can be optimally planned in conjunction with supply (Lapide 2006b, p. 18).

Constrained and unconstrained forecasts

Stahl and Wallance (2008, p. 46) states that *the unconstrained forecast* produces the amount what company could produce, if they would have unlimited capacity and future sales would not be constructed by the lack of availability. *The constrained forecast* represent the expectation of sales, if production, inventory, and other restrictions are taken into consideration. Many companies apply both to demonstrate the possible sales with ample supply, but Stahl and Wallance highlights that constrained forecast must be a factor in the calculations for future inventories and backlogs:

$$\text{Ending inventory} = \text{Beginning Inventory} - \text{Constrained Forecast} + \text{Operations Plan} \quad (1)$$

Constrained forecast is used for operations planning to avoid negative inventory and revenue as well as for generating from actual sales, not from what company can theoretically sell. On the other hand, Lapide (2004, p. 17–19) states that unconstrained forecast should incorporate all known factors that could impact future demand, including new product introductions and promotions, and so be used as baseline for forecasting. Unconstrained forecast is a good motivator and it is a valuable input for flexible supply chains. (Stahl & Wallance 2008, p. 46.)

Sell-To and Sell-Through, Judgmental and Statistical Forecasts

Sell-to and sell-through forecast plays a vital role in retail industry. Sell-to forecast is what a company thinks it will ship to customer and sell-through forecast is what company will think that company's customer will sell to its customers, ideally this forecast is determined with the help of customer. Sell-through forecast plays a big role in demand planning, but sell-to forecast is used for supply planning process. (Stahl & Wallance 2008, p. 46–47.)

Judgmental forecasting also called qualitative or managerial forecasting are subjective adjustments based on the experts and consumers – they are appropriate when past data is not available. Judgmental methods are based on the personal insight, panel consensus, delphi method, questionnaires, historical life-cycle analogy and market research. Judgmental forecasting is applied usually for mid- and long-term forecasting. Statistical also called quantitative forecasting methods are based on the past data – they are appropriate when past data exist. Examples of statistical forecasting methods are moving averages, simple exponential smoothing, last period demand, simple and weighted N-Period moving averages and multiplicative seasonal indexes. Statistical methods are generally used for short- or mid-term forecasting. (Waters 2003, p. 234–235.)

Judgmental and statistical forecasting have their own strengths and weaknesses, because they bring different information to the forecasting process. Judgmental forecasting can have biases for example optimism and pessimism, but it is based on the latest changes in the forecasting environment (Armstrong 1998, p. 270–274). On the other hand statistical forecast are objective and consistent, always generating the forecast from the same database, however statistical forecast is as valid as the data, which they are based on. Judgmental and statistical forecast should be integrated to gain the maximal forecasting accuracy. A universal practice to integrate the methods is to adjust the statistical forecast with judgmental adjustment. Sanders & Manrodt (1994, p. 94–96) stated that nine percent of 96 U.S. corporations did not make a single adjustment to statistical forecasts and 45 percent always made judgments to statistical forecasts. However, judgments must be done correctly otherwise they harm the forecasting accuracy. (Sanders & Ritzman 2001, p. 405–406.)

Top-Down, Bottom-Up, and Middle-Out Forecasting

According to compensating error theory aggregated demand, where random variations and errors tend to cancel each other out, is less fluctuating than demand of individual components. So, generally a forecast at the aggregate level is less fluctuating than individual components' forecasts. Compensating error theory is illustrated in figure 4. The concept of top-down forecasting is based on this theory, it is more accurate to forecast first at the aggregated level and then at the disaggregate level. Although, according to Lapide (1998, p. 28–29) top-down forecasting works only, if aggregated group is made out of components, which have the similar patterns of variation. Bottom-up forecasting is more advantageous when individual components have different patterns of variation. At this concept of forecasting, first the individual components are forecasted separately and afterwards the components are integrated together to create an aggregate group forecast. (Lapide 2006a, p. 14–15.)

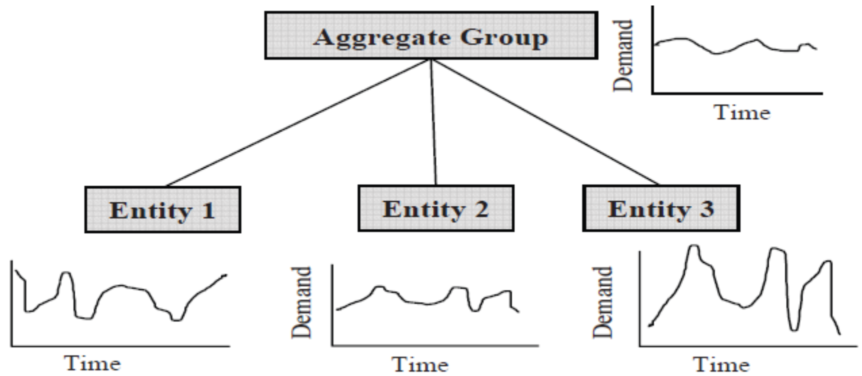

Figure 4. Aggregate forecast's and individual forecasts' volatility (Lapide 2006a, p.15).

Middle-Out forecasting is an integration of both the top-down and the bottom-up forecasting, where both concepts are used. In cross-functional S&OP process accountability and commitment towards forecasting needs to be gained, because complex environment organizations need to aggregate, disaggregate and even translate the forecasts to each one's most preferable form. For example, sales looks often currencies and supply chain looks SKUs. If an organization needs to revise a demand forecast the revision needs to percolate up and down, using top-down, bottom-up, and middle-out forecasting methods. To do this a formal set of relationships and a forecasting hierarchy needs to be created, in terms of best understanding. When generating various forecasting views, various rules should be embedded to the forecasting hierarchy. (Lapide 2006a, p. 16.)

2.3 Supply Inputs – Resource Planning

The sales forecasting is used as an input for supply planning in order to plan the volumes to be produced for each planning period during the entire planning horizon (Jonsson & Mattsson 2009, p. 194–198). Main objective for supply planning is to minimize operational costs, maximize customer satisfaction, and minimize inventory. Manufacturing department is responsible for giving the capacity information related to ability to produce the required amount in demand plan. Sourcing departments responsibility is to answer, if the suppliers have required capacity. Logistic needs to answer, if the fleet capacity is enough for planned deliveries. Supply department is responsible for adequate inventory is supply. Having too much capacity has to be avoided, this will instantaneously lead to higher costs and low capacity utilization. (Schorr 2007d, p. 8–10)

Supply planning must identify demand shortfalls, possibilities for capacity expansion, boundary conditions, and supply constraints, in order to support the demand plan (Cecere et al. 2009, p. 3). Affecting inputs such as manufacturing strategy and business strategy, overall business planning must be reviewed in supply planning. (Schorr 2007d, p. 4–6) Initial supply plan is created through resource planning process, which includes aforementioned inputs, demand plan and production plan. (Grimson & Pyke 2007, p. 340).

Operations

Operations include production, supply chain, purchasing and logistic. The mission of the operations is to evaluate and modify the operations plan so that it is executable. Operations plan or production plan agrees the rates and volumes of production to support the demand plan and reach the inventory and order backlog goals. In some companies estimating a plan is easier than in others for example some production resource may align with product families and some may not. Stahl and Wallance presents two resource modules*: aligned* and *nonaligned*. In some cases, particular departments can process certain products and so fit in with the product families – product 1 is made in department X and product 2 is made in department Y, resources are aligned. On the other hand, if the products do not match with the departments, resources and product families are nonaligned, see figure 5. (Stahl & Wallance 2008, p. 47–48.)

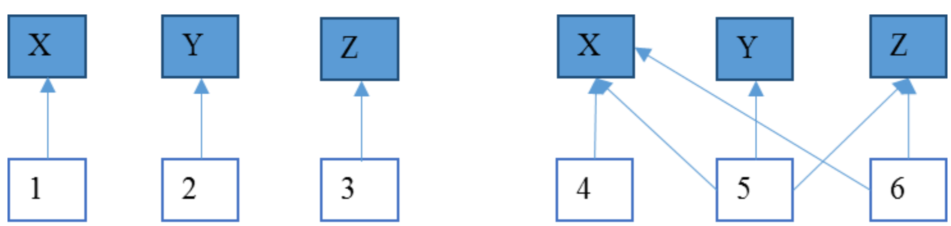

Figure 5. Aligned and nonaligned resources (Stahl and Wallance 2008, p. 48).

Resource Requirements Planning

Resources represent the supply side of the business. The process enables operations to relate the required capacity (demand) to available capacity (supply). When meeting the demand and keeping the operations plan in order – managing inventories and order backlogs in their desired level – and translating operations plan into units and work hours of each resource, the process called resource requirement planning (RRP) is used, also referred as rough-cut capacity planning. RRP can be used at the department level as well down to individual pieces of equipment. This process can be carried out for material requirement planning from suppliers, warehouse space planning and for operations out of production such as product design and drafting – it operates at the mix level in conjunction with master schedule. When operations plan is rearranged into department workloads and most often modified into hours, it should be displayed so that the operations can identify where the challenges are. (Wallance & Stahl 2008, p. 49.)

Operating approaches

The operating approaches describe the supply and demand strategies to each product family, strategies describe whether the given family are make-to-stock, make-to-order, or finish-to-order and what are the desired inventory and backlog levels, as what are customer service level goals. To track the customer service level the following measures can be applied: customer orders shipped on time, reclamation level, line-item fill rate, and completed orders. It is important to start from rough estimates and measures, and afterwards sharpen the process up. These approaches are important, because they keep the customers satisfied and manage inventories and order backlogs effectively, as well they play a key role in the logic of spreadsheets and they visualize the need of continuous improvement. (Wallance & Stahl 2008, p. 49–53.)

2.4 Structure of the S&OP process

The structure of the S&OP process has been defined by many authors (Wallance 2006; Lapide 2002; Jonsson & Mattsson 2009; Cecere et al. 2009; Grimson & Pyke 2007; Ivert & Jonsson 2010; Chen-Ritzo et al. 2010). The structures differ depending on the author, what process steps they are highlighting, and the aspect of their research. For example, Cecere et al. (2009) and Chen-Ritzo et al. (2010) present few more steps than other authors. It is recognized that the structure of the process have improved during the last decade. The process structure is not straightforward, it is characteristic to industry (Cecere et al. 2009, p. 2–3). The goal of S&OP process is to match supply and demand as described above, so the structures have also lots of similarities. Different process structure steps and phases according to authors are gathered in the table 2. In this thesis S&OP process phases are dealt into data gathering, demand planning, supply planning consensus, and after the consensus phase.

Table 2. S&OP process structures (Cecere et al. 2009; Wallance 2006; Lapide 2002; Ivert & Jonsson 2010; Grimson and Pyke 2007)

Authors/ Process Phases	**Cecere et al. (2009)**	**Wallance & Stahl (2008)**	**Lapide (2002)**	**Ivert & Jonsson (2010)**	**Grimson & Pyke (2007)**
Data Gathering Phase	1) Collect sales and market input	1) Data gathering			
Demand Planning Phase	2) Develop a demand plan 3) Demand consensus refinement 4) Shape demand based on what-if analysis on demand for supply	2) Demand planning: Inputs sales actuals and statistical Forecast from phase	1) Preparation for the S&OP meeting	1) Consensus forecast	1) Sales meeting
Supply Planning Phase	5) Develop a constrained plan by supply 6) Conduct a what-if analysis based on supply to determine trade-offs on the measurements and identify demand shaping opportunities	3) Supply planning: inputs supply actuals from phase 1) Management forecast from phase 2)	1) Preparation for the S&OP meeting	2) Preliminary delivery Plan 3) Preliminary production plan	2) Supply meeting
Consensus Phase	7) Review and gain agreement through a consensus meeting	4) Pre-meeting: inputs capacity constrains from phase 3) 5) Executive meeting inputs: Recommendations and conflict resolution from previous phase Output: Decisions and game plan	2) At the S&OP meeting	4) Adjust delivery plan and production plan 5) Settle delivery and production plan	3) S&OP team meeting
After the Consensus Phase	8) Publish the constrained plan 9) Measure and communicate the plan		3) After the S&OP meeting		4) Implement and distribute the plan 5) Measure process performance

Ivert & Johnson (2010, p. 661) have presented five main phases in S&OP process based on Wallace and Stahl (2004), Grimson and Pyke (2007), and Jonsson and Mattsson (2009). In the newer edition Wallance and Stahl (2008, p. 54–66) presents a five-step monthly S&OP process, see figure 6. The five different phases are data gathering, demand planning, supply planning, pre-meeting, and executive meeting. The entire elapse – from the start of the month to the end of the fifth process step executive meeting – should take about ten to twelve working days, which locates the executive meeting to the third week of the month. The process is mid- to long-term planning process, which forecasts the patterns and trends outside of the PTF. The process is not about detailed planning.

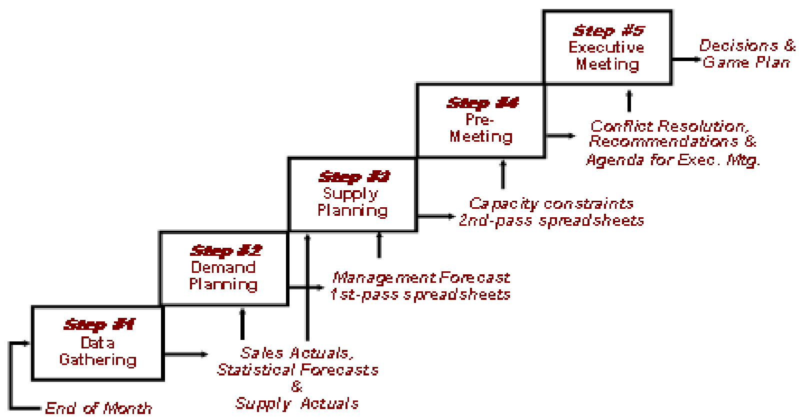

Figure 6. Monthly S&OP process (Wallance & Stalh 2008, p. 54)

Lapide (2002) represents a three-step process. The planning process structure consists of the following steps preparation for the S&OP meeting, at the S&OP meeting and after the S&OP meeting. The preparation for the meeting covers data gathering, demand and supply phases. Cecere et al. (2009, p. 2–3) highlights the what-if analyses on supply and demand planning phases, what-if analyses are covered more deeply in the chapter 2.5. Addition to Wallance's process module, Cecere (2009), Grimson and Pyke (2007) and Lapide (2002) represents extra steps after the executive meeting – the consensus phase, which are categorized into the *after the consensus phase*. The presented steps are publish the consensus plan, measure the process performance and communicate the plan. When going through the S&OP process steps, the main thing is that the entire process works well – not hitting the occasional time frame (Wallance & Stahl, 2008 p. 55). Overall processes have the same ground pillars and main activities, with exception of few specifications.

Data Gathering Phase

Wallance (2008, p. 55) states that data gathering phase should take place in the beginning of the month straight after the executive meeting. Phase consist of three elements: 1. Updating data from the month that just ended, for example actuals sales and production. 2. Gathering information for sales and marketing, to modify and update a new forecast, could include for example statistical data, judgmental adjustments, and sales analysis data. 3. Distributing the data from this phase to appropriate people. Data gathering phase should be completed within two days after the end of the previous month. Cecere et al. (2009, p. 3) mentions demand data gathering from the sales department as the first step of the process and highlights focusing on the purchasing behavior patterns and competitive analysis.

Demand Planning Phase

The demand planning phase usually starts when marketing and sales department produces a forecast for the coming planning period. The forecast refers to product families and extends usually to a full budget cycle in the future. (Ivert & Johnson 2010; Cecere 2009; Wallance & Stahl 2008; Grimson & Pyke 2007) Process input for demand phase is the output of data gathering phase, for example sales actuals and statistics (Wallance & Stahl 2008; Cecere et al. 2010). Cecere et al. (2009, p. 3) divides the demand planning phase into three steps. After having the input from data gathering phase it is marketing and sales department's duty to build an unconstrained forecast using statistical analysis and managements inputs – quantitative forecasting methods and adjustments. After generating quantitative forecast, it should be adjusted with all known demand impacts and exceptions (Lapide 2002, p. 12; Cecere et al. p. 3).

The output of the demand planning phase is an unconstrained demand plan, which defines how much company is planning to sell (Schorr 2007c; Grimson and Pyke 2007; Lapide 2002). What-if-analyses, gap analysis and scenario analysis are part of the most advanced processes, Schorr (2007c, p. 8–10) and Cecere et al. (2009, p. 3) present these in the demand planning phase. Here unit and financial demand plans are developed and demand shaping – product promotions, contract compliance, revenue management, timing of product introductions – are analyzed, as well as scenarios are delivered with the base-level forecast. Cecere et al. (2009, p. 8) states that the main demand shaping tool for chemical industry is price management and it plans to sell excess capacity in lean times and profitably allocate capacity in high season. Theoretical steps in demand planning phase are (Grimson & Pyke 2007; Schorr 2007c, Cecere et al. 2009, Bower 2005).

1. Use quantitative forecasting methods and adjust forecasts with qualitative methods
2. Create an unconstructed demand plan (what company wishes to sell and deliver)
3. Include gap analysis, what-if analysis, and scenario analysis (in advanced S&OP process)
4. Demand review meeting (demand managers validation)
5. Outcome: unconstrained demand plan

Supply Planning Phase

Cecere et al. (2010, p. 3) states that demand planning phase output is the input for supply planning phase. Two steps in supply planning phase are presented. First, supply plan should be developed by analyzing best alternatives for the business based on the KPIs. Key objective is to identifying the shortfalls, constrains, and capacity opportunities for the consensus phase. Agility to operations should be developed to minimize the effect of forecasting error. Second, demand based what-if analyses are evaluated and the demand shaping opportunities are analyzed based on the holistic KPIs, for example profitability, revenue, working capital, and customer service. After the evaluation and analyze the supply based what-if analyzes are developed.

Schorr (2007d, p. 8–10) presents that, such as the demand review meeting was held in the demand planning phase, a supply review should take place. Operations department should own the supply planning phase and the meeting's objective is to establish a valid supply plan. The aim is to establish a valid supply plan based on the scenarios created previously in the process. Outputs of the supply planning phase are high-level supply plan, as well as future capacity issues, including product development trials, testing production, and run downs on standard manufacturing resources (Mentzer & Moon 2004; Dougherty & Gray 2006).

Theoretical steps in supply planning phase (Grimson & Pyke 2007; Schorr 2007d; Cecere et al. 2009; Wallance & Stahl 2008)

1. Evaluate the demand shaping scenarios (the output of demand planning phase)
2. Create what-if analysis based on supply and develop supply scenarios
3. Analyze the gaps and the best alternatives for the business point of view (use KPIs)
4. Supply review meeting
5. Output: initial supply plans, scenarios, and recommended actions to close gaps

Consensus Phase

Wallance & Stahl (2008, p. 60–62) includes pre-meeting to the process as the fourth step. Pre-meeting is also referred in literature as partnership, pre-S&OP, compromise, reconciliation and preparing meeting (Dougherty & Gray 2008, p. 28). Objectives of the pre-meeting are making decisions regarding the balancing of demand and supply, resolving problems and differences, so that recommendations can be made at the consensus meeting, identifying topics where agreement cannot be gained, developing scenarios and setting agenda for executive meeting. (Grimson & Pyke 2007; Schorr 2007d; Cecere et al. 2009.) Wallance & Stahl (2008, p. 62–64) describes the consensus meeting as executive meeting where objectives are reviewed and accepted or modified. The plan made in the pre-meeting and product family decision are put forward. The meeting is authorizing the production rate changes, reaching the consensus where the pre-meeting was not able to, relating the currency specified S&OP information to the business plan, reviewing the policies and strategies to balance the supply and demand. The KPIs are reviewed in the executive meeting, for example customer service performance, special project, and other challenges are observed to make the required decisions. Meeting frequency varies across companies. Some authors presents more frequent time frame for meetings than monthly (IOMA, 2005; Kruse, 2004; Lapide, 2002; Slone, 2004). As well as, according to interview of Pyke & Grimson (2007, p. 325) companies are shifting to more frequent meeting schedule.

Theoretical steps in consensus phase (Grimson and Pyke 2007; and Schorr 2007d; Cecere et al. 2009; Wallance & Stahl 2008)

1. Goal is to reach the consensus between supply and demand plan, which is in conjunction with strategy and business plan, balancing the demand and supply
2. Convert initial supply and demand plan into monetary terms and compare it against with business plan, strategy, and performance metrics
3. Include discussion of issues, risks, capacity trade-offs and opportunities
4. Output: final top-manager game plan

After the consensus meeting

Cecere et al. (2009) and Pyke & Grimson (2007) presents that final plan should be published and measured. For distribution, primary recipients should be sales department and operations team, so that the required operation targets can be reached. In general, sales team is infrequently asked to adjust sales plans compared to operations (Pyke & Grimson 2007, p. 660). Cecere et al. (2009, p. 3) mentions measuring the process by business based metrics such as cash flow, forecast accuracy, expected vs. actual profitability, revenue, inventories, and service. The variance between measures varies by industry. Grimson and Pyke (2007, p. 660) states that measurement is vital for implementation and continuous improvement. Although, measures vary according to product line, process and industry.

Process Planning Parameters

In the literature are many different recommendations for S&OP parameters, all vary inside one scope. Objective of this chapter is to revise the parameters' scale used in S&OP process. Johnsson and Matsson (2009, p. 330–335) state that parameters can be divided into following categories: planning horizon, planning frequency, planning objects, and time fences for change in plans, see table 3. Grimson & Pyke (2007, p. 330–335) suggest 1-18 month for planning horizon and Schorr (2007a, p. 8–11) 18-24 months. Jonsson & Matsson (2009, p. 334) planning horizon should be as long as it takes to acquire capacity to answer the demand opportunities. Lapide (2004a, p. 17–19) frequency of planning should be rolling monthly, on the other hand as stated before Grimson & Pyke (2007, p. 330) suggest more frequent planning than monthly. S&OP planning objects are aggregated product family level and the product families should have similar characteristics – demand behavioral and resource requirements (Sing 2009, p. 24–27). Units of capacity depends on the business but they are measured monthly (Sing 2009, p. 24). Jonsson & Matsson (2009, p. 370–375) states that time fences for change in production plans should be as long as it takes to get access to things needed to execute the changed plan, as well flexibility of operation.

Table 3. S&OP parameters

Planning horizon	1-2 years
Planning frequency	Rolling Monthly
	Market volatility related
Planning objects	Roughly – not detailed
	Aggregated product family level
	Products with similar characteristics
Time fences for change in plans	As long as planning time fence
	As long as lead time of capacity change
	The Flexibility of operations

S&OP Maturity

There are many different maturity models presented in the literature. Thomé et al. (2012) investigates maturity models and comes up with seven different maturity models. These seven models are Wing and Perry (2001), Ventana research (2006) Cecere et al. (2009), Grimson and Pyke (2007), Viswanathan (2009), Feng et al. (2008) and Lapide (2005). In this thesis we present Lapide (2005), Grimson and Pyke (2007) and Cecere et al. (2009) models, because maturity of ITS can be compared effectively within the models.

Lapide (2005, p. 18–24) presents four-stage maturity model, see appendix 1. He focuses on three areas: meetings, process, and technology. First stage one, is where the process is in most initial stage and the stage four is the ideal process, where all sub-processes works seamlessly, technology support S&OP process, and external stakeholder are participating to the process. Grimson & Pyke (2007, p. 333–340) uses Lapide's module as a ground pillar to their own model. In the attachment 2 is Grimson & Pyke's (2007) integration framework, as what they call their maturity model. In this module stage one is where no S&OP process exists and the final stage five is a proactive model similar to Lapide's stage four.

In the model presented by Cecere at al. (2009, p. 2–6), see attachment 3, the linkage of ITS is taken more deeply into account. In the first stage reacting, process is driven by the sales or operations basis leading to imbalance and the S&OP process goal is to develop an operational plan. The final stage is orchestrating where highly developed ITS communicate seamlessly together vertically and horizontally. Here S&OP process goal is to drive optimized demand response. For conclusion all three maturity models consider the following areas of the S&OP process: meeting and organization, cross-functional integration level, technology and performance metrics.

2.5 Information technology systems

It is really important to recognize that all technology must be considered together within the S&OP process' maturity level. Lapide (2005, p. 18) reminds that according to Cecere et al. (2009) companies have spent 12 billion in supply chain planning activities in between the years 2003–2009. All though, spending enormous amounts of money to S&OP software, surveyed companies are not seeing the benefits they expected, because many did not change the process for fully leverage the enabling technology. Afterwards they recognized that the software technology itself is not really useful. The technology becomes useful when one starts to improve the process. Without the technology S&OP process cannot support the scale needed to achieve its all benefits. Overall, technology becomes necessary.

Lapide's (2005, p. 19) supply-demand planning architecture is presented in figure 7. S&OP system is based on the existing IT technology, with integrations to demand planning systems and supply planning systems, like enterprise resource planning (ERP) system, manufacturing and requirements planning (MRP), and manufacturing execution systems (MES), as well customer resource management (CRM) system. S&OP process needs to be integrated three types of software applications supply planning, demand planning, and S&OP workbench applications. Payne (2011) present more modern architecture for S&OP, see figure 8.

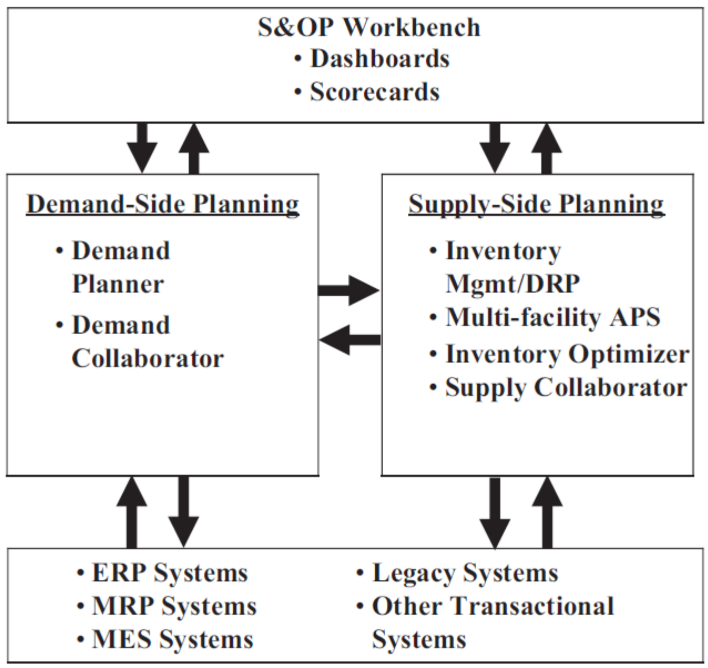

Figure 7. Lapide S&OP architecture

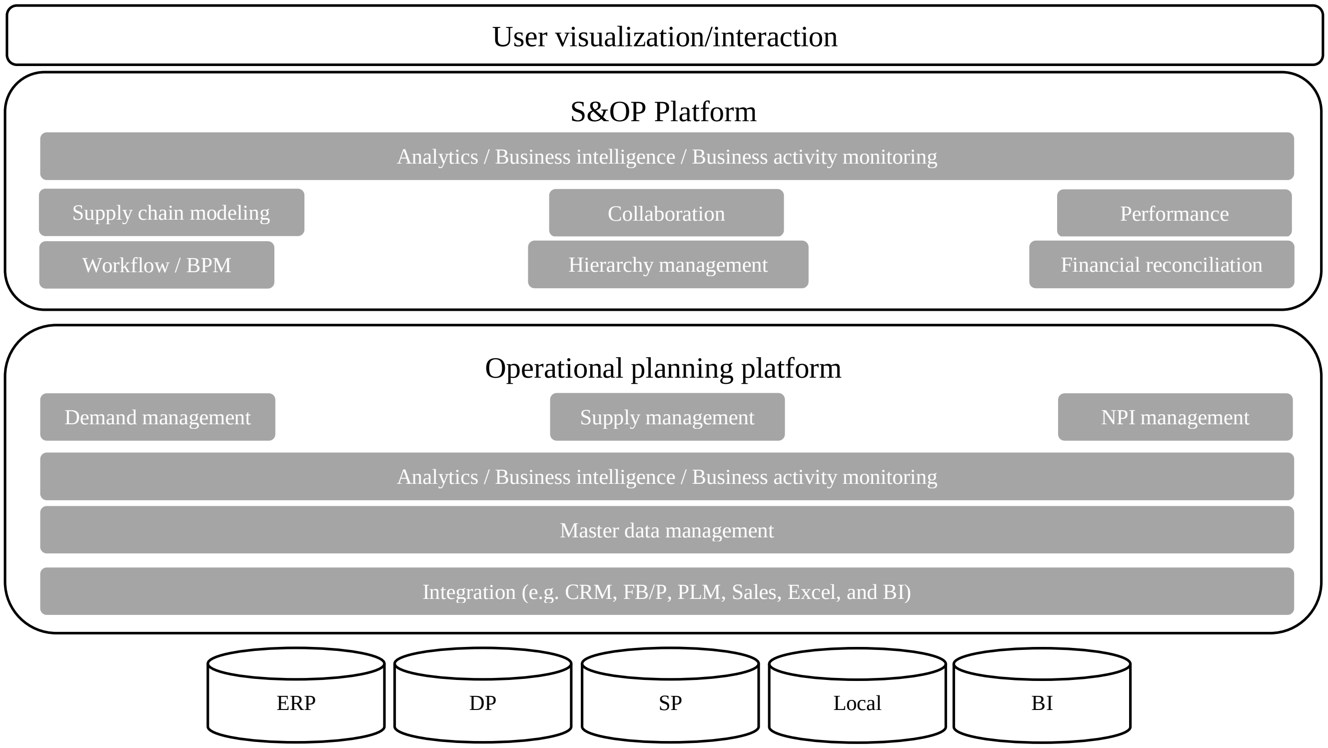

Figure 8. Payne Reference Architecture for stage 3 S&OP

Operational planning platform consist of demand and supply management systems, new product introduction management (NPI), analytics, business intelligence (BI), and master data management. S&OP platform is similar to Lapide's architecture. In the top is layer for end-user providing visualization. All this technology has to be built to support the S&OP metric framework. Analytic tools are different in demand planning, supply planning, and S&OP platform level. Generally, demand planning platforms (DP) focus on predictive modules, supply planning platform (SP) focus on optimizing costs, inventories and capabilities. S&OP platforms are tools for collaborating, visualization, integrating data, and simulations, like what-if scenario analysis. (Payne 2011)

Demand planning software

There are many statistical forecasting tools and a multitude of open source software. Though, it cannot be stated that forecasting accuracy has gained during the past years among with the technology development. Quantitative tools and other group of software is used to integrate different forecast into a single consolidated forecast. Tools that can assist the consolidation are ERP, CRM, SCM, and BI systems, or combinations from these systems. (Wallance & Stahl 2008, p. 67.)

Supply planning software

Lapide (2005, p. 18–19) supply plan system components support the development of supply side inputs to the S&OP process. For example, generating inventory and production plans to best meet the unconstrained demand plan. There is variety of supply planning systems, like ERP and other SCM systems, they concentrate on the operational-level, when S&OP system are concentrating on tactical and strategic-level, so ERP and SCM systems seldom answer the need for S&OP process. ERP and SCM produce information to advanced planning and scheduling (APS) systems. According to the Association for Operations Management (APICS, 2007) APS is included to group SCM software and is defined as: "*any computer program that uses advanced mathematical algorithms or logic to perform optimization or simulation on finite capacity scheduling, sourcing, capital planning, resource planning, forecasting, demand management, and others."* In the figure 9. is presented APS software modules in supply chain planning and S&OP environment.

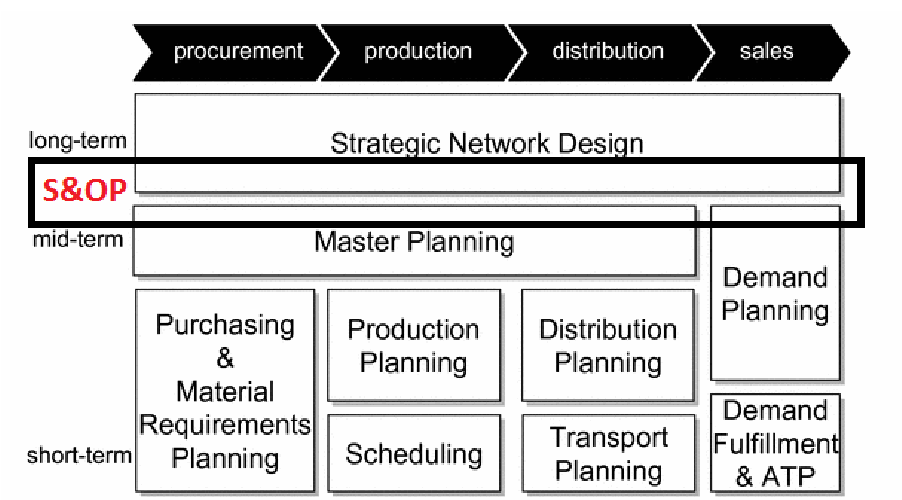

Figure 9. S&OP system alignment in supply chain planning matrix (Meyr et al. 2005, p. 100)

Strategic networks design's key objective is to optimize supply planning, inventories to utilize capital and minimize operating costs and maximize profit. Basically the design the supply chain and describe the material inflows between suppliers, customers and all stakeholders are defined. Master planning task is to synchronize the flow of materials with the supply chain and coordinate procurement, production, and distribution. Demand planning aim is to plan strategic sales, long-term demand estimates, and mid-term sales plans. Other software modules are functioning at the operational level, like short-term machine scheduling, shop floor control, transportation resource allocations, order handling, and many other tasks. (Meyr 2005, p. 99–101.) According to Ivert and Jonson (2010, p. 662) challenges in supply side have been data integration from the multiple sources, for example demand plan, ERP, master scheduling, and loading integrated data into optimization tools.

S&OP applications

According to Lapide (2005 p. 20) first objective of S&OP workbench is to visualize dashboards to display metrics from supply-side and demand-side. As well as, the possibility to provide what-if-scenario analyzes. The second type of requirement is to measure the process itself. Final requirement is that the S&OP workbench should be well integrated to supply and demand planning systems, so that changes in either system will automatically reflect to the S&OP plan in the workbench. See more about the measures from the chapter 2.6. Chermack (2011, p. 16) defines performance-based scenario planning as: "*A discipline of building a set of internally consistent and imagined futures in which decisions about the future can be played out.*"

Payne (2011, p. 3–5) describes S&OP architecture to be split into two different platforms: operational platform and S&OP platform, see figure 8. Demand and supply planning is managed in operational platform, when collaboration, reconciliation, performance and high-level activities are managed through S&OP platform. Payne represents key functional and technology components what are expected from a mature S&OP platform, as follows:

1. Collaboration support: supporting external and internal stakeholder process in a global organization.
2. Assumption management: saving and managing the assumptions on which bases the scenarios are planned.
3. Hierarchy management: translating baseline plan into multiple views, aggregations and middle-out forecasting.
4. Supply chain modelling: the ability to create long-term demand and supply balancing analysis without changing back to the operation planning systems.

5. Financial impact analysis: translating scenarios into finance metrics and identifying what can be achieved through different option (for example ROI, net present value, profitability, and cash flow).
6. Workflow management: controlling the business process of S&OP.
7. Performance management: viewing key performance indicators vertically through supporting processes and horizontally through operational and strategic activities related to S&OP.
8. Scenario management: scenarios which include financial metrics and further on develop a suggestion to managers. As well as, ability to modify, control and manage the scenarios in different parts and levels of a multi stakeholder organization.
9. Integrations: connecting operations, finance and execution planning capabilities.

Master data

Wallance and Stahl (2008, p. 103–105) state that S&OP process requires master data, which includes descriptive data about product families, resources, subfamilies, for example from the product side: target customer service levels, target inventory and backlog numbers, dollar numbers from financial plan, data needed to unit-to-dollar conversation and from the resource side, output capacities, conversation factors and RRP validation data to the mix assumptions. As well as, actual data from sales, production, inventory levels, customer order booked, prior period's forecasts and production plans, customer service level from prior period. Data sources are ERP, CRM, demand planning systems, APS, legacy systems and others, like mentioned before. The main point is to automate the feed into the spreadsheets or S&OP system.

Benefits and disadvantages of APS

Invert and Jonsson (2010, p. 668–672) have studied the benefits using the APS systems in S&OP process. The results from the study are presented in the attachment 4. Results of the literature view were investigating 18 potential benefits in the field of decision support (1–10), planning efficiency (11–14), and learning effects (14–18). The study was conducted in demand planning, supply planning and central planning organization involved to S&OP process. In general, decision support scored high, planning efficiency not as high than decision support. Learning effect scored the lowest compared to other two field. From decision support field visualization aspects and information access scored the highest. Survey result was that time spend on planning does not decrease after implementing APS, rather workload might increase. Smith (2008, p. 10–12) presented survey of dissatisfaction with the S&OP technology, where most people answered that it is difficult to do what-if analysis (33 %), supporting applications are not integrated with one another (31 %), and S&OP application is too complex to implement and maintain (18 %). See the other dissatisfaction areas from appendix 4.

2.6 Performance Measurement

Measurement

Melnyk et al. (2004, p. 211) metrics communicate the internal and external performance of all stakeholders and staff, as well measurements educate and identifies the improvement gaps. Measurement of S&OP process is the factor, which allows the success in continuous improvement (Lapide 2004, p. 19). Vollman et al. (2005, p. 130) state that without performance monitoring the value of S&OP process becomes certainly questionable.

Scorecards can be utilized in the S&OP, for example Kaplan and Norton (1996) present balanced scorecard, which is more of a strategic measuring tool but it considers the operational and tactical aspects as well, see attachment 5. When scorecards are used in S&OP process, they should focus more on operational than strategic challenges. Key performance indicators tend to be financial at the strategic level and closer the unit when it is at the operational level (Hope & Fraser 2003, p. 109–111). S&OP scorecards are usually used in the actual meeting rather than manage strategic plans of a company. Companies should include a separate scorecard for measuring the strategic performance in the S&OP process (Bower 2005; Ventana Research 2006).

Measuring demand accuracy is one of the most popular measurement in S&OP processes (Lapide 2004; Bower 2006; Sheldon 2006), because improvement forecast accuracy plays a vital role in seamless supply and operations planning. Reduced forecasting error affects stock-out, inventory costs, customer service, shipments, financial planning and capacity utilization improvements (Bower 2006, p. 22). Sheldon (2006, p. 125) recommends using operational, business, and demand planning accuracy. The importance of planning accuracy in S&OP is well illustrated by Vollman et al. (2005, p. 394–395): *As a prerequisite to control, the sales and operations planning process should be widely understood in the firm. The planning process must be transparent, with clear communication of expectations, to control actual results.*

Performance against the sales and operations plans should also be widely disseminated. When actual results differ from plans, the source of these deviations must be analyzed and communicated.

Singh (2010, p. 26) states that sales department is measured usually by new customers and revenue, and supply departments are measured on fulfilment and costs. See appendix. 5. where the common KPI's presented in literature are listed. Sheldon (2006, p. 127–128) presents that *demand plan* is usually measured by accuracy in product family level. Muzumdar & Fontanella (2006, p. 36) states that demand should be measured with customer profitability, volume growth, gross margin and order fill rates. Whisenant (2006, p. 17–19) presents revenue forecast accuracy for demand-side metric. According to Lapide (2005, p. 19) usual demand-side metrics are expected unfulfilled customer demand and customer order backlogs. Other metrics for the sales department include market share, sales growth, forecast accuracy and variance to baseline forecast (IOMA, 2005; Wing and Perry 2001; Sheldon 2006). Lapide (2005, p. 20) forecast measures should include measures such as variance to baseline forecasts and budgets as well the adherence to preliminary sales and operations plan.

Supply plan is usually measured with return on assets (ROA), profitability, revenue and working capital (Cecere et al. 2007, p. 3). Whisenant (2006, p. 17–19) presents supply-side metrics inventory and supply chain costs. Lapide (2005, p. 19) include supply-side metrics usually consist of expected plant utilizations, production capacity shortages, and critical component shortages/surpluses. *Business plan* with accuracy of monthly profit plan. Commonly used metrics for *operations plan* are for example line fill, obsolete inventory, inventory on hand, expediting frequency, stock-outs, variance to standard costs, quality and capacity utilization (IOMA 2005; IOMA 2004b; Wing and Perry 2001; Sheldon 2006).

Customer service with percent of complete orders on the initially agreed time frame. Cecere et al. (2010, p. 4) Basic *finance metrics* include market share, sales, stock price, revenue, profit, earning per share and inventory return. Basic cash flow metrics used in S&OP process are internal rate of return (IRR), return on investment (ROI), cash-to-cash cycle, gross margin and net present value (NPV). It is important to start from roughly estimates and measures, and afterwards sharpen the process up. (IOMA 2005; Wing and Perry 2001; Sheldon 2006; Whisenant 2006).

The common problem with the S&OP scorecard is the lack of ownership and responsibility to the metrics. The KPIs should be measuring everyone who is participating in the S&OP process. (Grimson & Pyke 2007, p. 337.) Milken (2008, p. 7–9) presents S&OP scorecard example, which measures five categories:

financials, demand production, inventory, and logistic, see figure 10. Palmatier & Crum (2003, p. 144–145) states that S&OP measurement should link to finance and shareholders, employees and productivity, technology, innovation, product development, and internal improvement. These are the same aspects, which are in the balance scorecard BSC: finance, internal process, learning and growth, customer perspective. Strategic measures should be included in the separate scorecard as aforementioned.

FIGURE 6
SAMPLE S&OP SCORECARD

Period Ending:		KPI ScoreCard							
Business A		Previous Month	Target	Upper Limit	Lower Limit	Reporting Month	Status	Trend Rolling 12 Month	Owner
Financial	Total Sales ($M)								J. Doe
	Contribution Margin ($ / lbs)								J. Doe
Demand	Total Demand (M lbs)								J. Doe
	Demand vs. S&OP								A. Smith
	Forecast Accuracy (Lag 1)								B. Johnson
Production	Total Production (M lbs)								E. Green
	Production vs. S&OP								B. White
	S&OP Capacity Utilization								E. Green
Inventory	Total Finished Goods Inventory (M lbs)								R. Done
	Inventory vs. S&OP								R. Done
	DII (PIT) Raw Materials								R. Done
	DII (YTD) Raw Materials								R. Done
	DII (PIT) Finished Goods								R. Done
	DII (YTD) Finished Goods								R. Done
	DII (PIT)								M. Labadie
	DII (YTD)								M. Labadie
	Non-Saleable Inventory (K Lbs)								J. Doe
Logistics	On-Time Shipping								E. Green
	Actual Ship Qty. vs. Order Quantity								J. Doe
	Total Fixed Distribution Cost ($K)								R. Done

Figure 10. KPI Scorecard sample for S&OP Process (Milliken, 2008)

Metric formulas

In this section most common accuracy and variance metrics are presented. These were felt important according to the Case Company's business, and like aforementioned, demand planning metrics plays a significant role (Lapide 2004; Bower 2006; Sheldon 2006). According to Hyndman (2006, p. 43) there are four types of forecast-error metrics, which are scale depending, relative-error, percentage-error and scale-free metrics. In scale-dependent errors the forecast error is presented in the formula (2) $E_t = Y_t - F_t$, where Y_t is actual value and F_t forecasted value. It is on the same scale and can be applied to anything, for example from ships to screws. However, measures cannot be used to comparison between series that are on different scales. (Hyndman 2006, p. 44) Two most common scale-dependent measures are based on the absolute errors formulas (2), (3) and (4), and squared error formula (5):

Scale-dependent error (E_t)	$E_t = Y_t - F_t$	(2)
Mean absolute error (MAE)	$MAE = \frac{\sum_{t=1}^{N} \lvert E_t \rvert}{N}$	(3)
Mean absolute deviation (MAD)	$MAD = \frac{\sum_{t=1}^{N} \lvert E_t \rvert}{N}$	(4)
Root mean squared error (RMSE)	$RMSE = \sqrt{\frac{\sum_{t=1}^{N} E_t^2}{N}}$	(5)

N is the number of data values on the sets. The use of absolute values or squared values prevents negative and positive errors from offsetting each other (Hyndman 2006, p. 44). Scale dependent measures are popular because they are easily interpreted and computed, especially MAD. (Online Open access text books 2015)

Accoring to Hyndman (2006, p. 45) relative-error metric is scale independent. See formula (6) where *Et* is the forecast-error obtained from benchmark method, usually naive method is used where Y_t is equal to the last observation – it uses the actual value from the prior period as the forecast $F_t = Y_{t-1}$. The percentage error metrics is the formula (7). Percentage errors and relative-error are scale-independent, which is their advantage, and so they are frequently used to compare forecast between different data series. Though, percentage errors and relative-errors have disadvantage, when there are zero values or values close to zero in a series, which is frequent for intermittent data. In this case measurement is undefined or infinite. The most commonly used measure is mean absolute percentage error (MAPE), formula (8).

Relative-error metric (R_t)	$R_t = E_t / Y_t$	(6)
Percentage error metrics (P_i)	$P_i = 100E_t / Y_t$	(7)
Mean absolute percentage error (MAPE)	$MAPE = \frac{\sum_{t=1}^{N} \lvert \frac{E_t}{Y_t} \rvert}{N}$	(8)

The MAPE puts a heavier penalty on positive errors than on negative errors (Hyndman 2006, p. 45). Due to this observation the usage of the symmetric mean absolute percentage error (SMAPE) was proposed by Armstrong (1985, p. 270) the further version of SMAPE was introduced by Makridakis (1993, p. 528) with absolute value corrections to denominator, see formula (9). Here A_t represents the actual value.

Symmetric mean absolute percentage error (SMAPE)

$$\text{SMAPE} = \frac{1}{n}\sum_{t=1}^{n}\frac{|F_t - A_t|}{(|A_t| + |F_t|)/2} \tag{9}$$

In this paragraph scale-free errors methods are presented. The mean absolute scaled error (MASE) formula (10) was introduced by Hyndman and Koehler (2006, p. 682–684) and it can be used to compare a single series and multiple series forecasting accuracy. Hyndman (2006, p. 46) states that it is the best accuracy metric for intermittent-demand studies, because it never gives infinite or undefined values. Except in the case where all historical data is equal (Hyndman and Koehler 2006, p. 682). Here $e_t = Y_t - F_t$ and the denominator is the average forecast error of the one-step (naive method), which uses the actual value from the prior period as the forecast: $F_t = Y_t - 1$.

Mean absolute scaled error (MASE)

$$\text{MASE} = \frac{1}{n}\sum_{t=1}^{n}\left(\frac{|e_t|}{\frac{1}{n-1}\sum_{i=2}^{n}|Y_i - Y_{i-1}|}\right) \tag{10}$$

Hoover (2009, p. 21–22) states the importance of weighed metrics, when forecaster wants better results for more relevant series. The accuracy metric reflects the items relevancy through assigned weight. For example, customers which produce different revenue, can be weighed according to revenue percentage. Other factors which can be considered as weighting factors are inventory holding costs, return on invested assets, expected sales levels, contribution margin, customer-relationship metrics, expected service level, and inventory.

Statistical dispersion points out the distribution in a statistical data. Statistical dispersion is measured with positive real number. Number is zero when there is no diversification in the data, and it increases when the data becomes more diverse. The measure of dispersion is as the same unit that quantity being measured, if the data quantity is tons then the dispersion measure is as well in tons. One measure of dispersion is, for example, sample standard deviation. (McQuarrie 2000, p. 25.)

Variance

$$Var(X) = \sigma_x^2 = \mathrm{E}[(X - \mu)^2] \tag{11}$$

Standard deviation $$\sigma = \sqrt{\mathrm{E}[(X-\mu)^2]} \quad (12)$$

If the X takes random values from the data and the data is finite, then standard deviation for X is the following:

$$\sigma = \sqrt{\frac{1}{N}\left[(x_1-\mu)^2 + (x_2-\mu)^2 + \cdots + (x_N-\mu)^2\right]}, \text{ where } \mu = \frac{1}{N}(x_1+\cdots+x_N) \quad (13)$$

2.7 Lessons Learned – Success Factors

Boyer (2009, p. 4–10) presents 10 proven steps to successful S&OP process, which are distinct into two phases – designing and process.. Charantan and Sandeep (2013, p. 11) investigates eight building elements of enterprise performance, which are results from constantly scanning the developing market place. Their research is based on the experience in customer packaged goods (CPG), retail, pharmaceutical and high-tech industries. Charantan and Sandeep believe these elements help mitigate the adverse impact of general S&OP challenges and achieve superior performance improvements. Smith et al. (2012 p. 12) studies integrated business planning, where S&OP and collaborative planning, forecasting and replenishment (CPFR) where linked together. They explore 16 companies presenting leading-edge collaborative practice. Same success factors apply as well individually to both S&OP and CPFR process development. Dougherty and Gray (2006, p. 167–297) studies 13 companies from across the globe and puts together key lessons to be learned. In the table 4. most common success factors are presented from aforementioned research papers.

Table 4. Success factors (Boyer 2009; Lapide 2014; Dougherty & Gray 2006; Smith et al. 2010; Charantan & Sandeep 2013)

12 common success factor	Boyer (2009)	Lapide (2014)	Smith et al. (2010)	Dougherty & Gray (2006)	Charantan & Sandeep (2013)
Inter-organizational and cross-functional teams	x	x	x	x	x
Change Management	x	x	x	x	x
Process governance	x	x	x	x	x
Information – Accurate, metrics and usability		x	x	x	x
Analytics, Linkage to ERP and IT	x		x	x	x
Continuous Improvement	x		x	x	x
Effort in Designing	x	x		x	
Commitment	x		x	x	
Time-horizon				x	x
Segmentation					x

Inter-organizational and cross-functional teams

A design team will take care of all the process workings. The team is suggested to be a group of six people, which include roughly top management leader, a person from IT, demand planner, operation planner, a person from accounting, a person from sales. (Boyer 2009, p. 6.) As well as, according to Smith et al. (2012, p. 12) 81 percent of the case companies experienced inter-organizational and cross-functional teams are a way to successfully launch the S&OP process. Functions' participation and enthusiasm must be guaranteed, particularly during the times of personnel, product, organizational, or other significant changes (Dougherty & Gray 2006, p. 50). The S&OP process must have cross-functional participation, including all involving departments (Lapide 2014, p. 15). Aligned sub-processes cannot be under estimated, and the linkages of S&OP process and other enterprise-wide processes must be mapped. For example new product introduction (NPI) and trade promotions management (TPM) should be linked effectively into S&OP process with operational and strategic dimensions. (Charantan & Sandeep 2013, p. 12.)

Change management – educate everyone involved

Charantan & Sandeep (2013, p. 16–17) states that S&OP process is 60 percent change management, 30 percent process development and 10 percent technology. Senior executives often end up with a fallacy of change management, after they discover that S&OP is more getting right kind of information in exact time rather than a practice of change management. Effective organizational change management implementation requires recognizing the changes in wide business environment and creating vital adjustments for company's needs. As well as, educating employees to the changes and achieve employees assent to appropriate amendments. Change management leads to renewed processes by taking small and tangible steps in the organization. Smith et al. (2012, p. 12) stated that 56 percent of 16 companies experienced change management as a vital requirement for successful S&OP process.

Educating everyone involved does not mean that top tittle persons have a good S&OP knowledge, so everyone who affects the S&OP output should be educated. This is typically 10 percent of the company population. (Boyer 2009, p. 6) Also, Dougherty and Gray (2006, p. 51) states that education plays a critical role in S&OP structuring. People are the most important resource in the organization, so it is necessary to educate them. Education should be done in multiple levels of the organization to ensure a common understanding of principles, objectives, terminology and required resources, tasks and activities. Educate the users, all people who are affected by the S&OP should understand the S&OP document and have the awareness of how their decision process interdependences with S&OP process output. (Boyer 2009, p. 9.)

Process Governance - Documentation

According to Charantan and Sandeep (2013, p. 13–14) successfully developed S&OP process cannot be long-lasting without proper process governance, which begins with planning, defining who will do what, when, where, how and why. It is important that different minds are required to improve the process and that the process is constantly evaluated. See figure 11. describing governance process, which includes process planning, execution, improvements, and control. Lapide's (2014, p. 14) first presented success factor is ongoing routine meetings, stating that meeting should be held irrespectively whether or not the participants believe the meeting should take place. Boyer (2009, p. 6) make a schedule and monitor – attendance is one of the most important keys to success, and as well is monitoring the tasks allocated in the meetings. It is essential that everyone knows the S&OP process dates and what duties and inputs are expected from one another. Smith et al. (2010, p. 12) S&OP process should be administrated through periodic reviewing process.

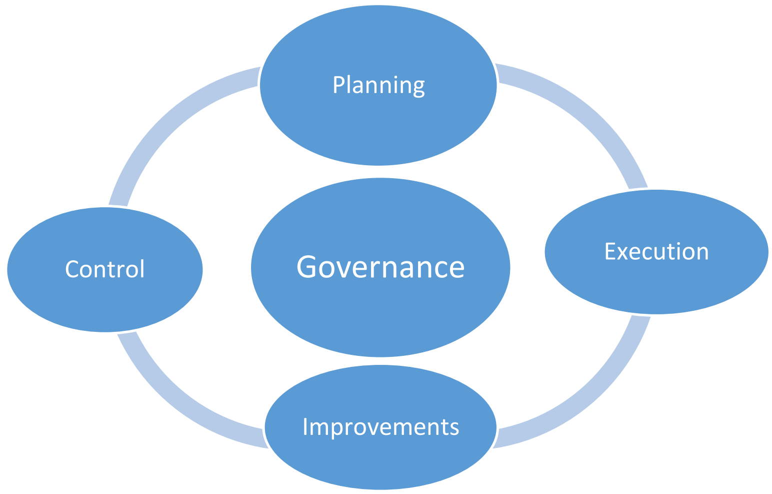

Figure 11. Process governance (Charantan & Sandeep 2013, p. 13)

Process should be documented so that people can be trained and process-understanding monitored, all key process activities should be documented (Boyer 2009, p. 9). Well documented, clearly defined and followed process policy and procedure leads to a better formalization of the process. Also, clear implementation guiding at the beginning of the process has been found to be exceedingly important. S&OP process must lead to improved team work, which goes in conjunction with the developing and operating a single company plan for a company. Which requires eliminating the maximization of local or functional targets and objectives, herewith foster monolithic targets and objectives to the company as a whole. Process should spend less effort on finger pointing. (Dougherty & Gray 2006, p. 50.)

Information

Information should be accurate but it does not have to be precise, perfect 100 percent accuracy is not required but generally 95 percent accuracy is recommended on inventory, production and capacity data. Forecasting accuracy can vary between companies, so acceptable deviation must be defined so that future demand volatility can be modulated to S&OP plans. Information should be in a usable and focused format, which means getting the right data in a timely manner. This highlights the challenges and fosters a rapid and persuasive decision-making – tabular displays of quantitative data, graphical representations and aggregations for example product family. (Dougherty and Gray 2006, p. 50–52.)

Lapide (2014, p. 15) states rough-cut and scarce plans should be applied. Charantan and Sandeep (2013, p. 14–15) highlights the effectiveness of right metrics ensuring that information gets recorded at the right time and way. Healthy organizational behaviour is driven by the right metrics. Processes should have purposeful and meaningful metrics. Smith et al. (2012, p. 13) states that 63 percent of 16 case companies suggested that timely information is crucial, for example early results from the process steps so that wider cross-functional buy-in can be executed. Lapide (2014, p. 15) states that unconstrained forecast should start the process with all demand impacts included. According to Singh (2010, p. 27) balancing supply and demand tacit knowledge should be manage through documented playbooks, which stores the decisions information in the right way.

Top Managements Alignment

Someone in top management, who has the authority to commit resources, must get involved into the S&OP process. Someone who can design, finance, tie input, advocate and lead it, as well inspire and teach the usage of the process to the top management. Activity may become optional and endure lack of resources for example IT support, if this kind of key player is absent. (Boyer 2009, p. 4–6) Dougherty and Gray (2006, p. 49) states that leadership and support from top management is crucial for the process and clear definitions of roles, responsibilities and ownership should be indicated in the process. Executives lead the process by setting an example. As well as, Smith et al. (2010, p. 12) present that 81 percent of its case companies emphasized executive commitment as prerequisite to S&OP process. Participants need to be empowered by the executives to make decisions based on the input data, their interactions with other members during the meetings. Collaborative process leading to consensus and accountability – managers need to engage on executing the plans and be responsible for the delivery of plans. (Lapide 2014, p. 15–16.)

Analytics, Linkage to ERP and IT

Analytics helps S&OP process to become more effective and cognizant of scenarios. Analytic-based reports inform the leadership what is the S&OP balancing. Actions needs to be executed and managed through tactical and operational S&OP. Results and trends can be seen from previous decisions and what corrective control actions needs to be done. (Charantan & Sandeep 2013, p. 15–16.)

The ERP system must be driven by the outputs of S&OP, so that detailed day-to-day decisions are synchronized with the aggregate decisions made in S&OP process (Boyer 2009, p. 9–10). Process design is experienced as a key to success, though software tools are not highlighted in thirteen case companies, actually none of the case companies utilized commercial S&OP software. Instead they developed own S&OP analytics using Excel with support of programs with access to ERP and systems, usually utilizing custom data bases (Access) and retrieval programs. (Dougherty and Gray 2006, p. 54.) Though, technology has developed enormously in past ten years, and so statement of utilizing merely own Excel sheets should be questioned, and hereinafter commercial analytics tools should be considered. From 16 case companies 88 percent experienced shared data and linked IT as keys to success – these two elements were most frequently cited success factors (Smith et al. 2010, p. 12).

Continuous Improvement

In the first half a year of implementing S&OP process, meeting mechanisms, formats, data accuracy, reports, and learning are consuming lots of time and these requires typically lots of improvements (Boyer 2009, p. 9). Charantan and Sandeep (2013, p. 16–17) continuous improvement is crucial because development ideas will come from the participants of the process, minor improvement does not generally require major capital investments, improvement ideas comes from employees. Once individual's influence is noticed, employees usually continually think ways to improve their own performance. The opportunity of influence motivates and encourages employees to take ownership from their inputs to the process. See figure 12. loop of continuous improvement.

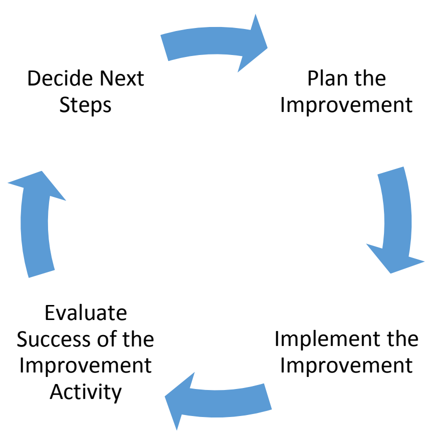

Figure 12. Loop of continuous improvement (Charantan & Sandeep 2013, p. 16–17)

From 16 case companies 88 percent emphasized continuous process redesign as an important requirement (Smith et al. 2010, p. 12). Hold the first S&OP meeting iteration usually six months after the designing process gets started. It takes usually six iterations for people to get a good understanding what is going on and all the issues are being fixed (Boyer 2009, p. 9). Dougherty and Gray (2006, p. 57–58) S&OP process can be streamlined as continuous improvement, lean manufacturing and total quality management or 6 Sigma. Improvement targets and monitoring check-list of improvement should be viewed at least annually.

Commitment

According to Boyer (2009, p. 6) attendance is one of the most important keys to success and as well is monitoring the tasks allocated in the meetings. It is essential that everyone knows the S&OP process dates and what duties and inputs is expected from one another. Lapide (2014, p.15) highlights the preparation and arrangement in the pre-meeting to support the executive meeting inputs – so that rough plans are arranged, synthesized and translated into visual form. S&OP needs to be a responsible, disciplined, repeatable process, which runs on timely basis and according to schedule. Moderating person is most likely a senior mid-manager. Facilitator’s goal is to drive towards consensus, not dominate the meeting by requiring approval to his or her point of views. S&OP should not lack clearly defined roles at the meetings. Each participant should contribute to the process by leveraging their functional expertise.

Allocate Effort to Designing

Here three prerequisites are presented, when effort is allocated to designing. Define *data format* – i.e. the capacity, sales, inventory, production data formats. Determine *data hierarchy* by each department, for example sales department is looking data from different point of view than production – sales looks currencies and product categories on the contrary production looks amounts and pipelines. Third designing pre-requirement is *performance measurements*. (Boyer 2009, p. 7) Process design is experienced as a key to success and initial design should be developed in two to four months, though time consuming to reach the perfect state is questioned, because managers will request changes to the initial design (Dougherty & Gray 2006, p. 54–56).

Time-horizon

Charantan and Sandeep (2013, p. 12) present progressive time-horizons as a success factor. Distinguishing strategic, tactical and operational time-periods from one anther is considered to be important. Looking at the big picture, linking strategic goals with day-to-day operations and reaching the consensus between demand, supply, and profitability are highlighted in the first S&OP building element. Timing is crucial – all the case companies, what Dougherty and Gray (2006, p. 52–53) presented, had one month S&OP cycle, companies experienced that marketplace, supply and demand source dynamics may vary substantially in a month time-period. It does not mean they do, and even that the plans do, but it means that S&OP data has the right to be reviewed once in a month. A comprehensive planning horizon, which extends at least twelve months forward – in many cases eighteen to twenty-four month time frame is necessary to indicate the implications of demand and supply to top managers.

Segmentation

Supply Chain should be segmented according to used resources, such as market and customer segmentation are well-known concepts. Potential benefits from segmentation in S&OP are effective time and resource usage to concentrate on exception-based decision making, accurate forecast reduces working capital and inventory, enhanced customer experience, and revenues from improved availability of goods and fill-rates. Segmentation is on-going improvement activity to examine whether any product is shifted across segments, for example a SKU which is pull-based replenishment could move to push-based replenishment. (Charantan and Sandeep 2013, p. 16.)

3 DEFINING THE S&OP STRUCTURE OF THE CASE COMPANY

3.1 Case Company

Case Company, Ekokem, is an environmental management company, which operates in the Scandinavia. Company provides waste treatment solutions including waste disposal, environmental and landfill construction, recycling and waste-based energy production. Its headquarter is located in Finland and it operates many constructions, landfills and waste centers across Finland. Case Company group operates also in Sweden and Denmark, where a waste-to-energy treatment plant and high-temperature incineration plants are located. (Ekokem 2015b.)

Case Company group focuses on economic cycle business – inventing new ways to utilize and accelerate raw material and resource reuse in economic cycle. Business focuses on the foreclosure of the economic cycle. Company increases recycling and recovery of materials, as well as contributes the understanding of how materials will be returned back to the society, for example to customer's raw material. Materials, which are not profitable to be recycled or are wanted outside from the cycle due to their toxic features, are directed into waste-to-energy plants. Thus, adequate supply of incineration-waste is ensured to treatment plants. Case Company's mission and values have a strong linkage to environmental-friendly attitude. Company values and mission are presented below in the figure 13. (Ekokem 2015d.)

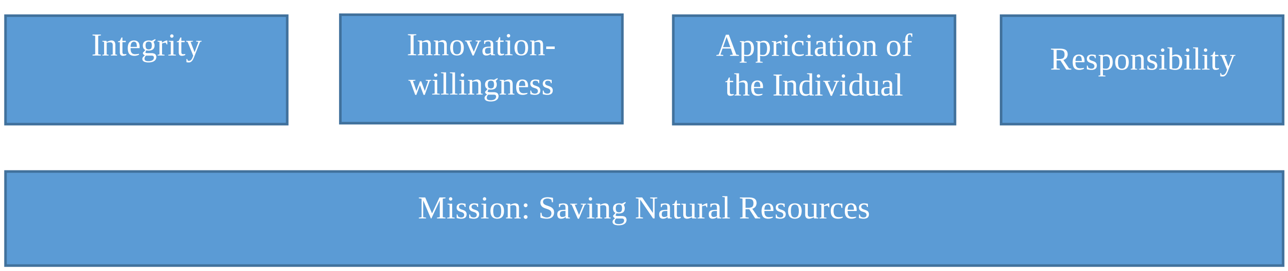

Figure 13. Case Company's values and mission

Case Company Group is currently under organizational change. Business units are recycle & energy and environmental construction, see table 5, the circles and square in the table are explained later. Recycle and energy consists of business areas recycle materials, hazardous waste treated in high-incineration plan, processed in physical chemical treatment and evaporator. As well as, municipal, commerce and industry waste treated in grate incineration plants are concluded in the recycle & energy business. The energy content of waste inflow is utilized for energy production in aforementioned centralized heating and electricity production plants, or in energy production by customers of Case Company. Environmental construction business unit consist of the following business areas: landfill construction projects, remediation of contaminated areas – soil, groundwater and industrial waste waters and reutilization of materials from energy production and industry. (Ekokem 2015a.)

Table 5. Business areas of Case Company (Ekokem 2015c)

Recycle and Energy	Environmental construction
- Recycle materials - Energy solutions - Hazardous waste - Municipal waste - Commerce and industrial waste - Plastic recycling - Oils and support fuels	- Water processing - Construction - Treatment centers - Demolition operations - Soil remediation services - Customer solutions

3.2 Product Planning Groups

S&OP context is illustrated in the business unit table 5. where business areas sections inside square and circle describes S&OP process environment. Circulated business areas are planned in product family and subfamily level and unit sections inside of the square are linked to S&OP process, as they provide spot deals and storage capacity for the recycle and energy business units. Environmental construction area is delimited aside from treatment centers, soil remediation and demolition operations. From recycle and energy area hazardous, municipal, commerce and industrial waste as well oils and support fuels are studied in the thesis.

Product families from recycle and energy are dealt in four separate groups A, B, C and D, illustrated in figure 14. Families A and D are dealt based on the treatment lines and group B and C based on the importance of waste types for the process. Thus C and D families are treated in the same treatment pipeline than group B products. A group is for controversial waste, B and D families for hazardous waste and C family for support fuel and oils. To gain more efficient end result and thou manage same time vital waste flows for the processes, development was reduced to few groups and subgroups. Product families are presented in the figure 14. where Case Company's S&OP families and subfamilies are defined before restructuring.

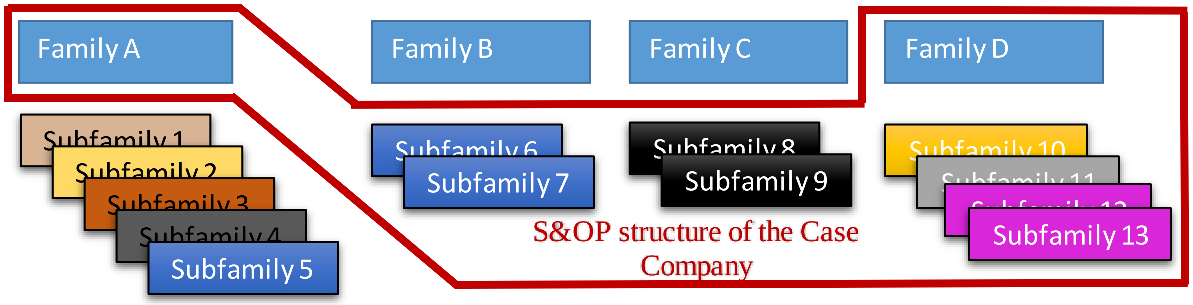

Figure 14. Case Company S&OP product families

Product family A consists of grate treated waste. The product family is divided into five different subfamilies. These five subfamilies are dealt further into separate waste fractions, though S&OP process does not take these into account, because these fractions would be too detail specific for the process. The S&OP process did not took subfamilies into account. Subfamilies were dealt as one big volume in the S&OP process as presented in the figure 14.

Family B consists of waters, which are dealt to high temperature incinerated and evaporator treated waste waters. Like in A subfamilies these are dealt into more detail-specific fraction in operation planning. S&OP process were managing these 6–9 subfamilies as separate volumes, not consolidating them into one bigger flows. Family C is separated into two subfamilies – high temperature incineration support fuels and evaporation oils. These subfamilies are separated into more detail-specific fractions in operative S&OP and production planning. S&OP process were managing these as separate subfamilies, not consolidating them into holistic flow, as they were treated in different processes.

Family D consists of other high temperature incineration fractions, these fractions have connections to evaporation like product group C and B have, and as well to other resources. Product group D is dealt to four subfamilies, from which subfamily 10 has connections to evaporation treatment and subfamily 11 to both evaporator and physical chemical treatment. Subfamilies 10–13 were managed as one consolidated volume, as well subfamilies 10, 11 and 12 were managed separately by customer deliveries and treatment pipelines. Subfamily 13 stands for other minor volume waste fractions together, subfamily 13 was managed as part of the consolidated volume, no allocations were made towards resources, because of the low volumes and heterogeneous fraction type.

Resources allocated vs un-allocated

To understand the classification more deeply, in figure 15. are presented the relations between waste fractions and resources. These resources are high temperature incineration, physical-chemical treatment, evaporator, external treatment, and waste-to-energy treatment. The overall dependencies are multidimensional, though two separate waste fractions can be identified as inflow specific waste fractions, these are subfamilies 7 and 9. These fractions have similar features, as the waste fractions, which are treated in high temperature incineration, but these are treated in evaporation pipeline. Therefore subfamilies 9 and 7 are dealt as waste-fraction point of view in family B and C with the subfamilies 6 and 7, see figure 15. Others major flows to waste-to-energy treatment plants and to high incineration treatment are separated to treatment pipeline based product family classification.

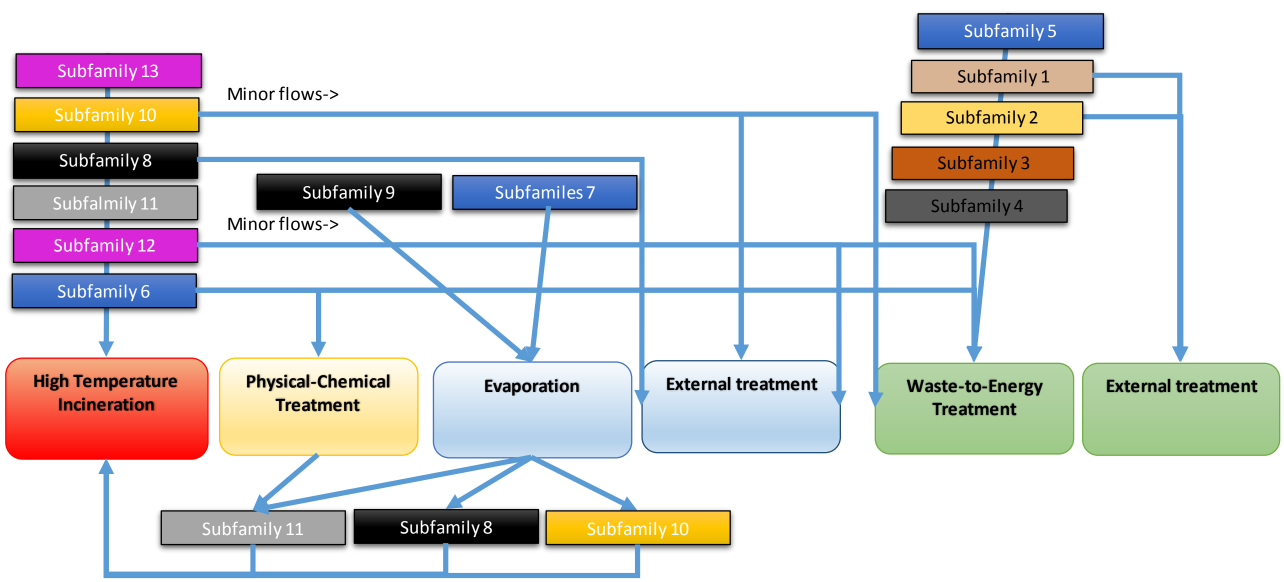

Figure 15. Dependencies of subfamilies and resources

Generation of production grades can be identified from evaporation treatment, where subfamily 8 from family C and subfamily 10 and 11 from family D are producing inflows to high temperature incineration processes. Physical-chemical treatment is generating production grade as well to high temperature incineration process, see subfamily 11. In addition there are many other phenomenon and actions for example storage transfers, waste converting, and internal transfers, which generates and consumes waste fractions, though S&OP balancing process does not take these into consideration, because they are not at aggregated level, as S&OP process‘ one of the main mission is to enable a holistic and aggregated view from material flows.

The classification of product families to treatment pipeline and product family oriented S&OP is illustrated in the figure16. Resources and subfamilies inside a family are described. Even though subfamily 12 is as well processed in the waste-to-energy treatment pipeline they are not included in the family A group nor is the treatment pipeline in the family group D. This is because the minor flows are irrelevant for the process, as seen in figure 15. Like aforementioned family B and C were not consolidated with the family D, even though they have all the same treatment pipelines. This is due to the relevancy of subfamilies 6–9 for the evaporation and high temperature incineration process. The evaporation and physical chemical treatment creates feeds to family D and C. These are not described here as they do not consume the subfamilies.

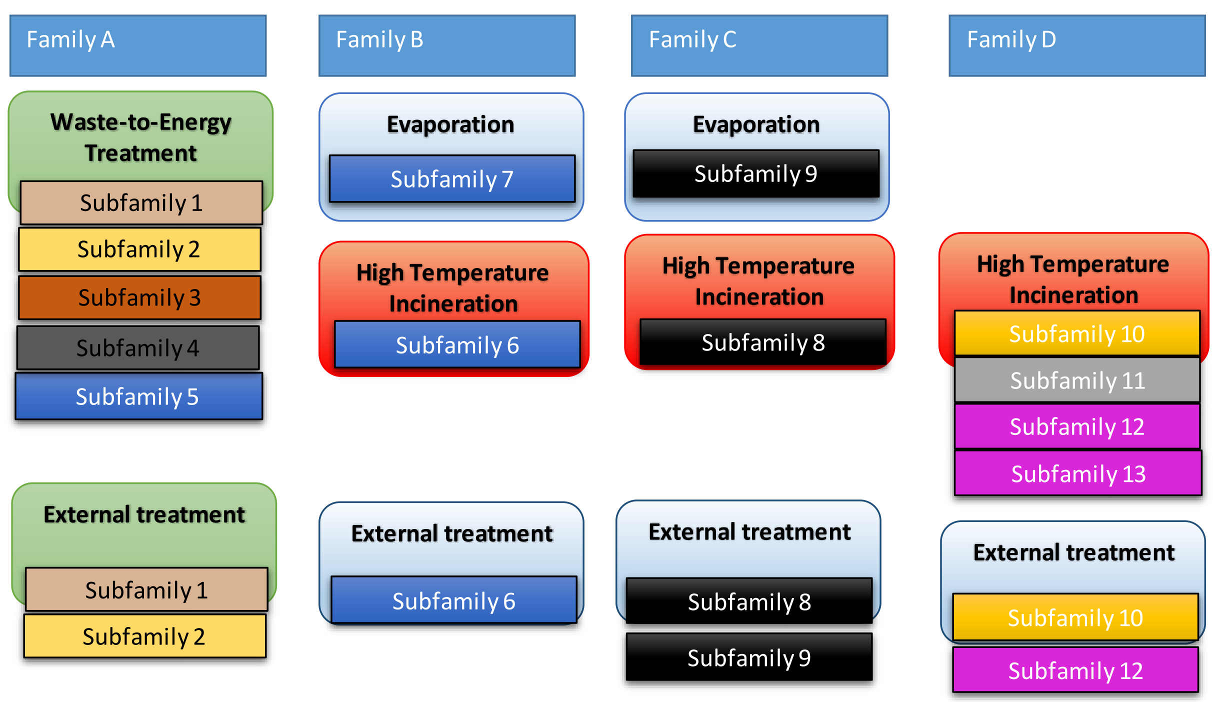

Figure 16. Mixture of treatment pipeline and product based classification

3.3 Demand planning

Demand was planned by yearly updated sales forecast. Towards the end of the year forecast was constrained and judgmentally adjusted by the S&OP manager. Demand planning has been the biggest challenge in the S&OP process, because the whole demand planning function lacked a formalized process. Demand plan was updated once a year by sales department and linked to S&OP, judgmental adjustments were made when new information occurred in the S&OP process. All though, the key point is to get the information outside into the S&OP process. The demand planning phase of S&OP process was executed formally once per year without an unconstrained forecast.

The sales department and customer service of the Case Company does inflow steering decisions from customers to the plant site. S&OP process should be the cross-functional information deliver between departments. Based on the interview 3. sales department experienced that S&OP process has not succeed in transferring information. Sales experienced a lack in transparency to exceptional steering decisions and reception locations. (See customer service and logistic section).

Sales department forecasts mostly currencies without ton based volumes. Volume based forecasting were done in indefinable way and the volume based linkage to S&OP demand plan was suffering from lack of sales information. Demand planning input lacked the volume based forecast information and output from S&OP lacked steering decisions and reception capacities.

Case Company's forecasting parameters are described in table 6. Sales department generated statistical forecast once a year from the last year's actual data. Forecast was generated at subfamily level, as the demand is independent. Contracts were gone through after the generation. Specific season fluctuation and spot deals were adjusted, bankrupt estates were removed, and so seasonal fluctuation was corrected. Biggest customers were as well contacted and their delivery volumes verified, the big volume customers are forecasted as sell-through method and low volume customers as sell-to method. Forecast for aggregate group level are created with bottom-up technic. Both currency and volume based forecast are created separately.

Table 6. Forecasting at the Case Company

Demand type	Independent demand
Forecasting frequency	Rolling yearly, informal adjustment in S&OP forecasts
Forecasting types	Constrained
	Statistical adjusted afterwards (once a year) / S&OP forecast adjusted manually when new information occurred in the S&OP process
	Sell-Through and Sell-To
	Bottom-Up

3.4 Supply planning

"It is much easier to deal with the mix issue, if volume is managed effectively. On the other hand, mix complication become immediately more unmanageable, if the volume is not planned well." (Wallance & Stahl 2008, p. 7)

Manufacturing department does a manufacturing budget once a year and it is adjusted rarely depending on the shortfalls or surpluses of inflows, though the key point was to run at full capacity and find external capacity when needed. S&OP was looking mainly actual processing amounts and forecasts were not in such an important role.

Daily challenges in waste-flow were identified, supply challenges were mostly due to uncontrolled inflow, and supply side desired a better signal from operative issues to sales department. Manufacturing department experienced that resource allocations were difficult to manage due to unknown fact of daily waste inflow volumes. Deficiencies in waste foreknowledge was identified and contact surface was viewed as unclear. (Interview 4.) This is partly due to a fact that customers do not know the properties of the waste when they are ordering a service. S&OP function were not experienced as a function for communication between sales and production departments. Manufacturing department hoped for a forecast and task list tracking, as well cause-and-effect relationship analysis. (Interview 5; Interview 6.)

Customer Service and logistics

Customer service communicates with the customer, if any exceptional steering decisions have been made. Smaller customers with own deliveries to plant are communicated through customer service. When steering decisions were changed, customer service experienced challenges in information flow. The information flow is passed from tactical to operative S&OP process, which executes the actions and informs customer service. Customer service imports the orders to ERP, on which the logistics plans transportation. If the orders are correctly imported to ERP, logistic does not require anything from S&OP process. (Interview 7.)

Customer service experienced interest on tactical S&OP output from main guidelines but felt more as a challenge the information flow from operational S&OP. Customer service requires information if any changes occur in the control actions and desired a report from exceptional actions. The information should include frame conditions of the ongoing case. The most important information is what kind of service the customer needs. Most challenging cases are when customers’ magnitude were small and they do not affect the total balances at any level but causes extra work. The mass logistic was working properly but the smaller individual transportation creates biggest challenges. (Interview 7.)

3.5 Structure of the S&OP process before refining

Waste volumes have increased almost by half from 2010. S&OP process was functioning and managing information at the lower waste volumes, though as volumes increased more resources to S&OP process were needed. S&OP participant gathered once per month for executive meeting and other S&OP related work was done informally. S&OP process was mainly once a month meeting where attendance percent was varying. Lack of S&OP linkage to operational level and especially to sales steering was identified and the challenges were noticed at the plant site as well. One of the new missions was to create a whole picture from tacit knowledge and control the material flows. The S&OP process lacked a visualized big picture, which could be easily interpret among the S&OP meeting participants, and which could be distributed to the externals, who were not participating in the meetings. Without the big picture S&OP was doing control decisions, but the decisions were not made by the best possible information based on the consolidated opinions, rather on the few deep talents’ information and opinions. (Interview 2.)

The current situation in the S&OP meetings is that participants are re-defining boundary conditions and the control actions are performed in the absence of accuracy and transparency. One of the key missions was to guide the process from event based philosophy to more advance planned process, where the number of events declines. In an event based philosophy S&OP process is discovering solutions to newly occurred event. Though, this is one of the most important missions of the S&OP process, but the key point is to prevent as much of the events than possible, by constant and effectual planning, rather than managing the events as they emerge. In the other hand, the planning cannot consume too much resources.

3.6 Process structure, planning parameters, and maturity

Process structure - Executive Meeting

S&OP participant gathered once per month for executive meeting, other S&OP related work was done informally. S&OP process was mainly once a month meeting, where attendance percent was varying.

Typically two sales chiefs, sales manager, two production managers from both hazardous and controversial wastes, logistic chief, SCM manager, chief operative manager of environmental construction and chief operative officer of treatment centers of environmental construction, group business director, operative officer of BU recycle and energy, chief operative officer oils and support fuels were participating into the meetings. Meeting did not lack of attendances, all the necessary expertise were in use of S&OP process. Information was not as ready as possible at the meetings, because the process did not have formalized preparing meetings. Especially managers felt that S&OP lacked easily interpret tables and visualized graphs, which are describing the upcoming trends.

Meeting agenda consisted tasks from previous S&OP, storage arrangements, product family related issues, and environmental construction activities. The Excel figures were revised in the meetings and environmental construction activities were managed with project list. In the table 7. is described the process structure.

Table 7. S&OP process structure

Data Gathering Phase	Demand Phase	Supply Phase	Consensus Phase	After the Consensus Phase
			1) Data gathered and updated 2) Forecast consolidation (unfomral) 3) S&OP executive meeting preparation 4) Executive meeting	5) Task list 6) Updated S&OP tools 7) Discussion with external pipelines 9) Investment opinions 9) Steering actions and storage plan 10) Linkage to operational S&OP

Planning parameters

Planning parameters of the Case Company are presented in the table 8. Demand planning horizon was 12 months for all product families, except three years for product family A. For A family, like for other product families, first 12 months were planned in monthly-level and updated year-by-year in the fourth quarter of the fiscal year. The other two years for family A were generated from the contract information at yearly-level. The forecasts were adjusted informally and irregularly as new information occurred to the interface of S&OP. For supply planning treatment, forecasts were made once a year and they were adjusted depending on the shortfalls and surpluses on the balance, though adjustments were extremely rare. Planning frequency depended on the adjustments and rough forecasts but standard planning frequency was yearly. Like aforementioned, planning groups varied depending on the pipelines and consequential waste inflows for the treatment pipelines. Planning objects depended on the planning group – objects were treatment pipeline, product family or subfamily. Resources were unaligned and the product families were developed according to these alignments.

Table 8. Case Company planning parameters before restructuring

Planning horizon	12 months, new year forecast updated towards end of the year, adjustments when needed, three year rough planning scope (yearly figures)
	Same as the lead time for capacity changes
Planning frequency	Rolling 12 months, adjusted when necessary
	Constrained, Statistical & Judgmental methods,
Planning objects	Treatment pipeline, Product Family level and product subfamily level, depending on planning groups
Planning Groups	Treatment pipeline based planning and Product Family based planning
Resources	Unaligned resources, complex correlations among resources

Maturity

The maturity of the S&OP process is illustrated by the Grimson & Pyke (2007) maturity model, see table 9. Current state is illustrated by the green square and to-be state illustrated with green arrow. The evaluated sections are divided to meeting and collaboration, organizational, measurements information technology, and S&OP plan integration. From all categories S&OP gets 2,6 out of 5, where stage five is proactive stage.

The S&OP process of the Case Company meeting are on stage three as one formalized meeting is organized once per month, though no pre-meetings existed. Organization is as well on the stage three because S&OP is recognized as a function and S&OP coordinator manages the S&OP information and materials. Resource allocated to S&OP process was varying and the S&OP lacked the continuous improvement part as the coordinator managed other task well. It was notified that S&OP function needs to be separated and requires more resources. Measurements are on the stage 3, though as the requirements of measurement stage are not demanding, measurements and KPIs need more development than the maturity model indicates. Information technology is on the stage two, because S&OP process uses ERP and spreadsheets as tools. S&OP plan integration is on the stage two, challenges in plan integration between different business areas were identified.

Table 9. Maturity level of the Case Company

	Stage 1 No S&OP Processes	Stage 2 Reactive	Stage 3 Standard	Stage 4 Advanced	Stage 5 Proactive
Meetings & Collaboration	• Silo Culture • No meetings • No collaboration	• Discussed at top level management meetings • Focus on financial goals	• Staff Pre-Meetings • Executive S&OP Meetings • Some supplier / customer data	• Supplier & customer data incorporated • Suppliers & customers participate in parts of meetings	• Event driven meetings supersede scheduled meetings • Real-time access to external data
Organization	• No S&OP organization	• No formal S&OP function • Components of S&OP are in other positions	• S&OP function is part of other position: Product Manager, Supply Chain Manager	• Formal S&OP team • Executive participation	• Throughout the organization, S&OP is understood as a tool for optimizing company profit.
Measurements	• No measurements	• Measure how well Operations meets the sales plan	• Stage 2 plus: • Sales measured on forecast accuracy	• Stage3 plus: • New Product Introduction • S&OP effectiveness	• Stage 4 plus: • Company profitability
Information Technology	• Individual managers keep own spreadsheets • No consolidation of information	• Many spreadsheets • Some consolidation, but done manually	• Centralized information • Revenue or operations planning software	• Batch process • Revenue & operations optimization software – link to ERP but not jointly optimized • S&OP workbench	• Integrated S&OP optimization software • Full interface with ERP, accounting, forecasting • Real-time solver
S&OP Plan Integration	• No formal planning • Operations attempts to meet incoming orders	• Sales plan drives Operations • Top-down process • Capacity utilization dynamics ignored	• Some plan integration • Sequential process in one direction only • Bottom up plans - tempered by business goals	• Plans highly integrated • Concurrent & collaborative process • Constraints applied in both directions	• Seamless integration of plans • Process focuses on profit optimization for whole company

S&OP process clearly needs improvements on the area of plan integration, information technology and measurement, where challenges were identified. Strength of the process is on the meetings & collaboration and organization. The green arrows describes the desired to-be state of the S&OP process. The leap of gaining two stages can be noticed on the information technology and measurement side. The gain of one step can be identified at organization and plan integration categories. Meeting and collaboration is considered as the biggest strength, so resources should not be allocated to this category in the near future. Like aforementioned this maturity level table is for illustrative purposes only and therefore two stage developing objectives were defined. Maturity models' stage requirements varies depending on when they were developed, so if the comparison would be applied to Cecere et al. (2009) model Case Company would get most likely an average stage between one and two.

3.7 Data, tools, and performance measuring

S&OP process was managed with Excel sheets and task lists. Four different Excel sheets existed and they were based on the planning groups. In the product family based sheets, waste inflow were managed in three different tables: demand table, table including supply according to resources, storage and warehouse development, and last table including generation of production grades.

An example of family D's demand, customers received & budgeted volumes, is illustrated in table 10. The actual deliveries of biggest customers per ton are compared monthly to the budgeted deliveries. Customers are not separated in the table by the subfamily deliveries, they are specified in the production grade table. Customer based and total delivery based balance is calculated to measure mean absolute error and relative error metric, as seen in table 10. Forecast for the deliveries at year end is generated based on the relative error metrics, which describes the actual inflow trend.

Table 10. Excel demand table (figures are random and they do not reflect the real situation)

	received & budgeted deliveries																
	1	2	3	4	5	6	7	8	9	10	11	12	Total	Balance	Average		
Customer	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	tn	€/tn		
Customer 1	247	927	424	666	707	354	183	900	510	99	805	512	6,334	848			
	484	728	37	676	736	657	481	15	256	141	564	612	5,387	21%			
Customer 2	886	828	962	469	988	900	443	724	967	189	475	138	7,969	1,718			
	142	732	994	931	310	768	215	831	526	677	56	1	6,183	32%			
Customer 3	269	228	700	545	900	687	923	873	407	509	229	391	6,661	405			
	469	474	718	812	945	260	989	66	394	169	442	863	6,601	8%			
Customer 4	76	269	69	293	901	240	797	699	702	1	192	289	4,528	-1,057			
	383	239	848	149	440	974	484	625	961	322	518	38	5,981	-21%			
Customer Deliveries, total	6,753	7,714	7,528	6,147	7,067	6,730	7,895	6,868	8,568	5,199	8,136	6,788	85,393	Forecast at year end		Balance (tn)	Balance (%)
Budgeted deliveries	*8,832*	*9,712*	*6,221*	*6,498*	*9,160*	*11,805*	*5,168*	*5,638*	*6,256*	*7,853*	*3,801*	*8,108*	89,052	83,885		4,020	-5.8 %

Second table of the sheet is supply, see table 11. Here treated waste according to subfamilies and resources are presented towards treatment budget. Four different subfamilies can be identified and three different resources, external treatment pipeline and two resources in the domestic area. Treatment forecasting is followed by mean absolute error and relative error metric, based on the relative error metric, a forecast for the end of the year is generated. In this table forecast for future storage level are displayed in the same row than actual storage level. Depending on the date, table creates a forecast based on the budgeted inflow and treatment. As this case example describes the past year, storage levels are actuals. Forecast-error metrics are not calculated from storage levels.

Table 11. Excel supply table (figures are random and they do not reflect the real situation)

Sub-family 1	2,313	2,326	2,253	2,166	2,248	2,216	2,422	2,312	2,320	2,168	2,186	2,214	27,144			
Treatment Estimate	2,094	2,164	2,345	2,348	2,380	2,413	2,157	2,453	2,343	2,182	2,202	2,231	27,312	27,144	168	-0.6 %
Sub-family 2	2,472	2,210	2,040	2,266	2,212	2,211	2,306	2,432	2,211	2,467	2,160	2,409	27,396			
Treatment Estimate	2,112	2,404	2,116	2,410	2,084	2,211	2,274	2,089	2,253	2,334	2,203	2,500	26,990	27,396	406	1.5 %
Sub-family 3	2,079	2,430	2,140	2,148	2,315	2,008	2,401	2,235	2,042	2,139	2,244	2,469	26,650			
Treatment Estimate	2,309	2,082	2,197	2,272	2,237	2,078	2,051	2,448	2,154	2,071	2,439	2,440	26,778	26,650	128	-0.5 %
Sub-family 4	2,132	2,333	2,411	2,089	2,235	2,180	2,024	2,015	2,431	2,012	2,239	2,494	26,595			
Treatment Estimate	2,116	2,122	2,075	2,207	2,058	2,324	2,399	2,191	2,426	2,360	2,438	2,244	26,960	26,595	365	-1.4 %
Resource 1	2,337	2,647	2,829	2,057	2,741	2,448	2,736	2,583	2,420	2,210	2,951	2,065	30,024			
Treatment estimate	2,405	2,765	2,702	2,817	2,938	2,346	2,784	2,436	2,747	2,812	2,819	2,251	31,822	30,024	1,798	-5.7 %
Resource 2	2,916	2,525	2,810	2,589	2,117	2,305	2,922	2,328	2,667	2,250	2,574	2,248	30,251			
Treatment estimate	2,617	2,046	2,235	2,870	2,007	2,676	2,589	2,553	2,580	2,170	2,842	2,726	29,911	30,251	340	1.1 %
external treatment	2,851	2,620	2,688	2,443	2,684	2,601	2,706	2,760	2,517	2,423	2,499	2,396	31,188			
Treatment estimate	2,686	2,483	2,414	2,179	2,873	2,601	2,202	2,216	2,401	2,952	2,249	2,890	30,146	31,188	1,042	3.5 %
Treated waste	8,104	7,792	8,327	7,089	7,542	7,354	8,364	7,671	7,604	6,883	8,024	6,709	91,463			
Treatment estimate	7,708	7,294	7,351	7,866	7,818	7,623	7,575	7,205	7,728	7,934	7,910	7,867	91,879	91,463	416	-0.5 %
Bunkers and storages, end of period	8,891	5,816	10,513	7,429	8,956	9,097	8,081	7,844	8,457	8,368	7,689	7,870				
Sub-family 1	1,880	1,161	2,430	2,393	1,252	1,909	1,700	2,168	2,439	2,149	2,822	1,230				
Sub-family 2	2,020	2,122	2,675	1,645	2,771	2,650	2,447	2,132	1,521	2,035	2,198	1,801				
Sub-family 3	2,176	1,280	2,462	2,004	2,332	1,890	1,688	2,404	2,471	1,502	1,364	2,024				
Sub-family 4	2,815	1,253	2,946	1,387	2,601	2,648	2,246	1,140	2,026	2,682	1,305	2,815				

To balance supply, generations of waste grades have to be taken into account. These are for example internal waste, conversion of waste fractions, waste refinery, internal and stock transfers. Customer specific deliveries by subfamily are as well described in the table. The generation of waste grades are dependent on the subfamily, see table 12. generation of production grades. Production grades are dealt based on the subfamily and internal waste is presented as a separate generation section. The balances of generation of production grades are measured with absolute error metric and relative error metric.

Table 12. Generation of production grade (figures are random and they do not reflect the real situation)

2.3.2015	Generation of production grades													
	1	2	3	4	5	6	7	8	9	10	11	12	Yhteensä	Balance
Customer	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	Tonnia	tn
Sub-family 1	2,236	2,774	2,578	2,303	2,061	2,458	2,173	2,563	2,611	2,286	2,685	2,520	29,248	-660
	2,139	2,424	2,730	2,159	2,142	2,941	2,497	2,090	2,328	2,874	2,838	2,746	29,908	-2%
Customer X	114	2	342	48	92	390	229	217	260	325	381	221	2,621	-949
	16	483	173	368	374	495	123	465	305	121	324	323	3,570	-27%
Customer Y	116	39	54	156	375	312	6	12	209	451	395	21	2,146	-1,684
	124	248	386	258	185	437	298	394	483	449	482	86	3,830	-44%
Customer Z	25	348	480	450	36	429	279	323	133	274	210	16	3,003	-149
	45	26	428	318	429	196	487	50	219	153	413	388	3,152	-5%
Sub-family 2	2,310	2,113	2,930	2,386	2,044	2,555	2,517	2,540	2,414	2,947	2,274	2,664	29,694	-469
	2,714	2,096	2,144	2,923	2,324	2,715	2,207	2,629	2,676	2,793	2,692	2,250	30,163	-2%
Sub-family 3	2,404	2,088	2,173	2,253	2,969	2,579	2,863	2,331	2,946	2,553	2,506	2,983	30,648	106
	2,427	2,438	2,997	2,235	2,312	2,131	2,791	2,748	2,575	2,631	2,746	2,511	30,542	0%
Internal Waste	298	463	178	483	209	116	76	166	418	137	184	143	2,871	975
	114	56	299	49	226	371	158	100	128	121	204	70	1,896	51%

Master data and measuring

Data of actuals to the sheets are inquired from databases with structured query language (SQL). Forecast data is in the same work book and have to be updated manually, if any adjustments occur. Manual updating has been one big challenge for the S&OP process. As well as, to transferring the sales departments forecast to the use of S&OP process.

During the process master data challenges were identified when consolidating the demand plan of the process. When consolidating the demand plan demand planner, S&OP manager, SCM manager and BU manager were compering own departments' forecasts together, it was identified that differences occurred in sales forecast and S&OP process demand plan. Differences were identified and further actions for consolidation were introduced.

Sales department do not have the same product planning subfamilies in product family B than S&OP have, so waste classification was varying frequently. Product family A, C, and D are categorized in demand planning to same subfamilies that S&OP utilizes. When order occurred product family B was allocated but no subfamilies were defined. Operations commented that on minor pre-clarification the reservation area, and waste steering to sufficient treatment line would be more effortless. Classification differences in master data was creating challenges for both S&OP process and operations.

Sales and operations planning process where mostly measured with balances and forecasting errors, by each customer, there were no exact link to financials. Like described earlier, for demand planning relative error metric and absolute error metrics were measuring customer based deliveries on the product family and subfamily level. For total deliveries by planning group, trend related estimations were generated. For supply planning phase the same metrics were applied, to treatment lines. As well as, treatment capacity estimations towards the year end were generated for overall planning group.

4 PROCESS DEVELOPMENT AND RECOMMENDATIONS INTO THE FUTURE

Processes were developed during the thesis project and used methods were mainly educations, interviews and workshop. In this chapter the actions done to each section of former sales and operations planning process are illustrated, as well future recommendations to achieve created target state is defined. Developing aspects are defined by each phase of S&OP process and further recommendations are presented.

4.1 Product planning groups

Product families were managed with two different levels (family level and subfamily level) depending on the family. It was noticed that lot of effort was spend to describing different levels of families and reporting these through S&OP process. The need for future development of product family planning groups were identified and future recommendations are presented as follows. First steps is to disaggregate product family level A – making a drop-down function of family A to subfamily level. Second step is to aggregate families B and C – making a bottom-up function from subfamilies to product families B, C. These subfamily and family levels should be observed simultaneously and seamlessly without separate effort on consolidating and disaggregation. Third step is to extend the observed families to other processes. In the figure 17. is presented the recommended product family and subfamily chart of S&OP point of view, red area describes the former process and the green area the future development. The to-be state is where every product family and subfamily are taken into account in S&OP process.

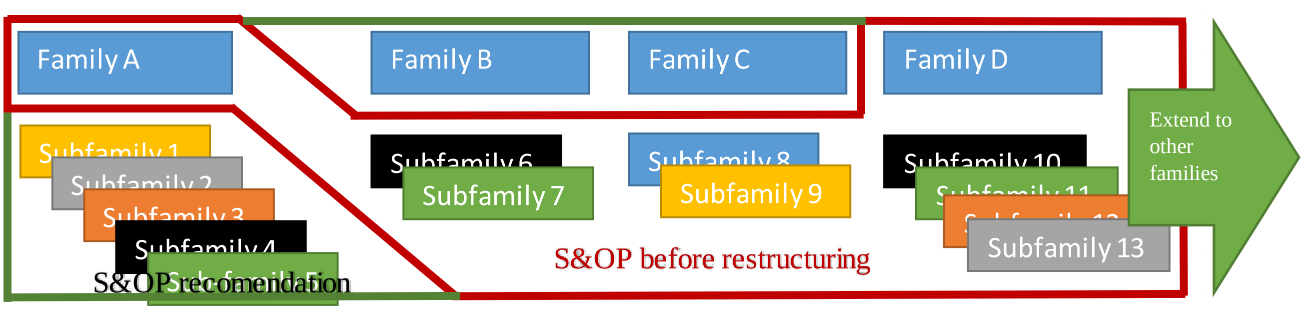

Figure 17. S&OP product family recommendation

Developing aspect of S&OP product planning pipelines where identified when S&OP process was planning at three different levels, product family level, subfamily level and treatment pipeline level, as described in chapter 3.2. Current state of the S&OP process is that it is planning depending on the families at three different scopes, product family (family A), subfamily (family B, C), treatment pipeline based (family A and D). These are the best planning levels for each family but in order to gain deeper knowledge of the balances between different subfamilies and families, modeling of planning groups needs to be done. In the figure 18. mixture of product based and treatment line based planning are described along with recommendations. Red color illustrates the former planning scope and the green color describes the development aspects so together the colors characterize the to-be state of the families.

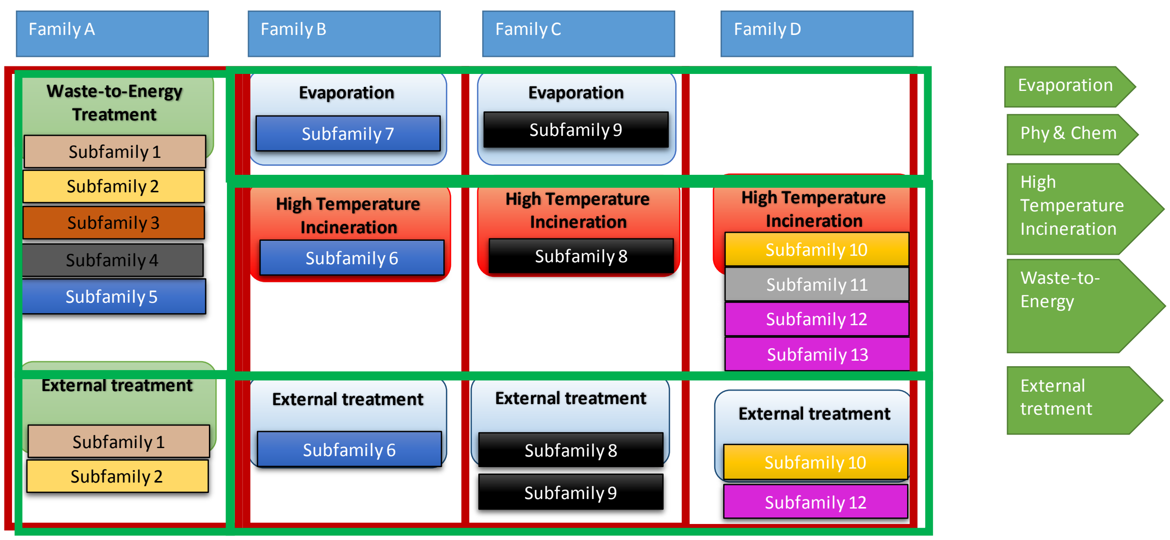

Figure 18. Mixture of product and treatment line based planning scope

To-be state was built for treatment line based point of view, evaporation, physical-chemical treatment, high temperature incineration, and external treatment are separated as individual planning groups. S&OP should be able to switch the planning scope depending on the case. It is vital to be able to observe the whole balance of particular treatment line. On the other hand, the same picture can be drawn from current planning scopes, but it would not be as time consuming and complex with the abovementioned to-be state. To gain better insight for different correlations between the resources and waste inflows, the possibility to switch the planning scope depending on the S&OP case, have to be developed. When the treatment line based planning is generated, it should be possible to disaggregate to family and subfamily level and select any subfamilies to be an observation target.

For example, when business areas and operations performance are observed the multi-scope planning parameters needs to be revised. Another example is that subfamilies may have similar properties and they can be stored in similar tanks resulting inventory planning efficiency at operational level. This would categorize planning scope to fluid wastes and there for reservation area planning would be easier. For example, fluid waste for high temperature incineration type of classification, would include subfamilies 6, 8 and 10. Operations chief officer stated that it would be desirable, if S&OP process would produce plant site planning forecasts more frequently. (Interview 5.)

4.2 Demand planning

"The entire business is based on a fact that demand must be profoundly understood" Group Business Director (Interview 1.)

Demand planning has been the weakest link in S&OP process. Forecasting customer demand has not been formal process and it is partly understood. In the thesis project S&OP function clarified forecasting methodologies and established a pre-meeting where customer forecasts were manually updated to spreadsheets. In the pre-meeting sales representatives were present and customers were contacted, if any lack of information occurred. As well as, investigation of the dependences between ERP actual deliveries and demand planning (DP) tool forecasts was started, to enable future linkage of DP forecast to S&OP tools. S&OP function did not manage the forecasts in DP, it had manually updated volume based forecast for each planning group. As the DP actuals did not depend on the delivery but on the billing date, the dependency clarification and adjustments to S&OP sheets were started.

CRM could be linked to S&OP process to provide more input to unconstrained forecasts in the long term. The input in sales funnel could be registered as they occur for KAM, so the linkage would enable the automatically updated prospect to S&OP tool. The time frame of sales funnel is recorded in CRM, this is longer than the forecasts in DP. Sales funnel would provide more input to long-term planning. Though, first the budget and forecasts created in DP have to be linked to S&OP process.

It is extremely vital to link the sales department on the demand planning process, because then sales department owns S&OP forecasts. As two different forecasts were identified the steps to synchronize were put into place. Sales department's deeper engagement to S&OP process, resulted better forecasting accuracy metrics in S&OP process.

Process should be planned with one set of numbers, which are based on the best possible information. As well as, forecast should be reflecting the most likely outcome, planned with best possible information available. Optimistic and pessimistic forecast, beside with baseline forecast, was experienced as valid input for the S&OP process. Forecasts have the right to be revised, and pre-meeting practice is a sufficient way to do it.

Recommendations

S&OP had its own unconstrained forecasts and these where revised at pre-meetings. Forecasting period should be extended to 24 months to gain more insight into the future. It is desirable to drive to the state that sales department would create the unconstrained forecast not the S&OP function. Sales department is establishing a forecasting process, where all KAMs are updating quarterly the biggest customers' forecasts in BP. To get deeper understanding in prospects the CRM data, should be linked to S&OP tool, and this should as well be validated in the demand planning meeting.

Correlation test to order intake and indicators could be applied. Order intake correlation to industry specific indicators and macro-economic indicators, such as Brent crude oil index for oil business. Europe's purchasing management index (PMI), OECD composite leading indicators and volume index of industrial output for all planning groups. These results could be utilized in statistical forecasting. Industrial output volume could be separated to three industries C manufacturing, D energy, E water supply and waste management, and so apply to specific planning groups depending on the customer industries. As future recommendation, the S&OP forecasting should be expanded to other families and environmental construction business unit. See table table 13, where recommendations are highlighted and compared to current state.

Table 13. Recommendations for demand management and forecasting methods roles

Demand type	independent demand
Forecasting frequency	**Rolling quarterly, 24 month time frame**
Forecasting types	Constrained and **unconstrained**
	Statistical rolling yearly, **adjustments if new information occurs at pre-meeting otherwise statistically forecast rolling quarterly and afterwards adjustments**
	Sell-Through and Sell-To
	Bottom-Up
Demand correlation test	**Compare demand actuals to example indexes to develop the statistical forecast generation**

4.2 Supply planning

"Operations are well evaluated and managed" Group Business Director (Interview 1.)

Objective of supply planning and management is to define the frame conditions for S&OP process. These are theoretical storage capacities with prospects, laws restricting supply planning. As well as, S&OP process ability to find external capacity for an event, which is defined by the frame conditions and costs of a specific customer. S&OP supply planning is more steering related as production is running at full capacity and S&OP is providing the material feed to process.

Frame conditions

According to interview 5, hazardous waste operations team desired that clear capacities and safety stock volumes for each subfamily, would be taken more fundamentally into account. Technical storage capacities were defined for all product families and subfamilies. As well as, a larger scope was defined from the whole national perspective, rather than continuing the previous S&OP factory of headquarter based perspective. Meaning that for subfamilies 6, 8 and 12 from product families B, C and D external storage capacities were defined, and for product family A inflows and treatment pipelines capacities were determined from national perspective. The following frame conditions are directing the S&OP process:

- Capacities, defined and clarified as visual reporting
- Storage rotation follow-up – manual follow-up and alarm level could be defined in the next steps.
- Aggregated S&OP perspective – Aggregated and disaggregate defined capacities
- Measurements – for example heat value, see chapter 4.5
- Expenses – Tracked and analyzed informally, in next step financials should be applied more deeply into to the process
- Law – Present in evaluating steering decisions

Balancing supply and demand

Supply inputs, treatment forecasts and actuals, are balanced towards demand inputs, actual and forecasted inflow, here customer deliveries. See figure 18. supply and demand actuals and forecasts. Forecast and actuals are described in the same chart, creating insight into the future and describing the forecasting efficiency. Here both forecasts are baseline forecasts generated based on the best possible information available. Gaps in planned demand and supply can be seen and future action can be presented to balance the gaps.

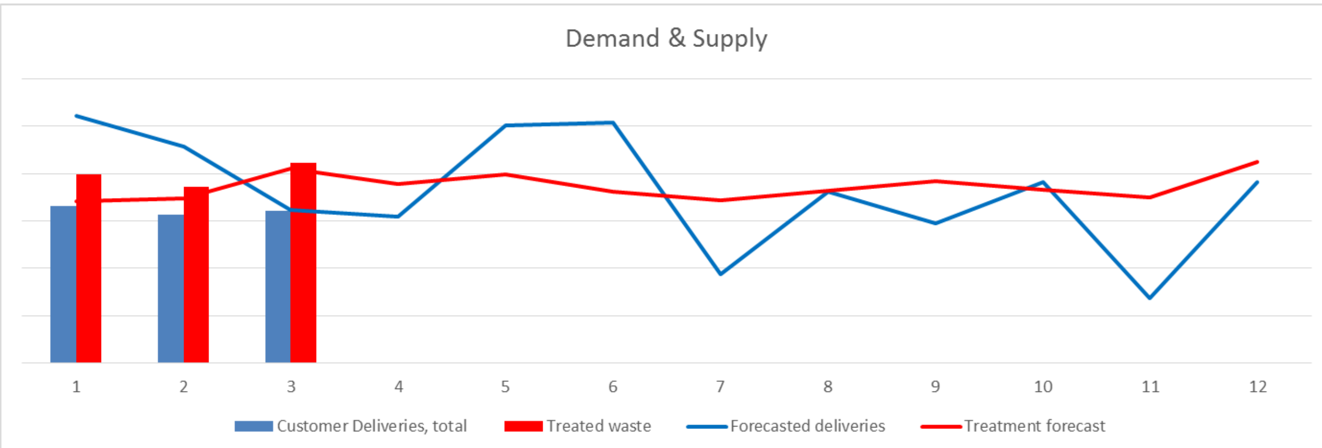

Figure 18. Supply and demand actuals and forecasts (Figures does not reflect the real situation)

The example situation would require clearance to deficit in actual customer deliveries compared to forecast and in gap between actual deliveries and actual treatment – decreasing actual balance. Deficit in actual deliveries, would require a statement from sales, it is important to understand the actual trend compared to what was initially planned. Balance gives a signal to operation when deliveries exceed the treatment capacity and vice versa, if the treatment exceeds the inflow. For example, balance differences can result the following outputs to operations and sales: stock growth, stock spending, steering to external treatment pipeline or outlining the possibilities of spot deals. Recommendation to future would be adding more scenarios, for example the optimistic, pessimistic, and trend forecast generation, as well volatility indexes and scenario possibilities could be applied.

Subfamily balances

Product subfamilies' yearly balances inside the factory were investigated to gain transparency of the processes. Operations and productions teams experienced that the formalized balance calculation is a vital process to gain transparency, accurate and validate the S&OP and operations processes, as well to maintain the master data reliability. The balance calculations were a structured and formalized process in the past. Operations team experienced that the balance calculations should be done quarterly as formalized process. Balance calculations were started from hazardous waste with operation and manufacturing team. When the balances of previous fiscal year for product subfamilies 10, 6 11, and 8 were calculated, S&OP tool balance and master data defects were identified. Required actions to correct the gaps were immediately put into place. Balances were calculated in disaggregate level observing storage transfers, internal transfers, internal waste, waste converting, inflow and consumption volumes. Relative error of five percent or lower was agreed to be the object of the balance calculation accuracy. Monthly S&OP process do not observe waste converting as it is on aggregate level. S&OP, operations, and production team experienced that it is necessary to continue and expand the balance calculations.

Inventory planning

Inventory planning was established as a new process in supply planning phase. Inventory forecasts were generated from balance forecasts. Balance forecasts were created from the demand forecast and treatment forecast scenarios. Depending on the scenarios multiple outcomes were created. In the figure 19. is illustrated three scenarios for possible stock balance of a subfamily for the rest of the three remaining quarters.

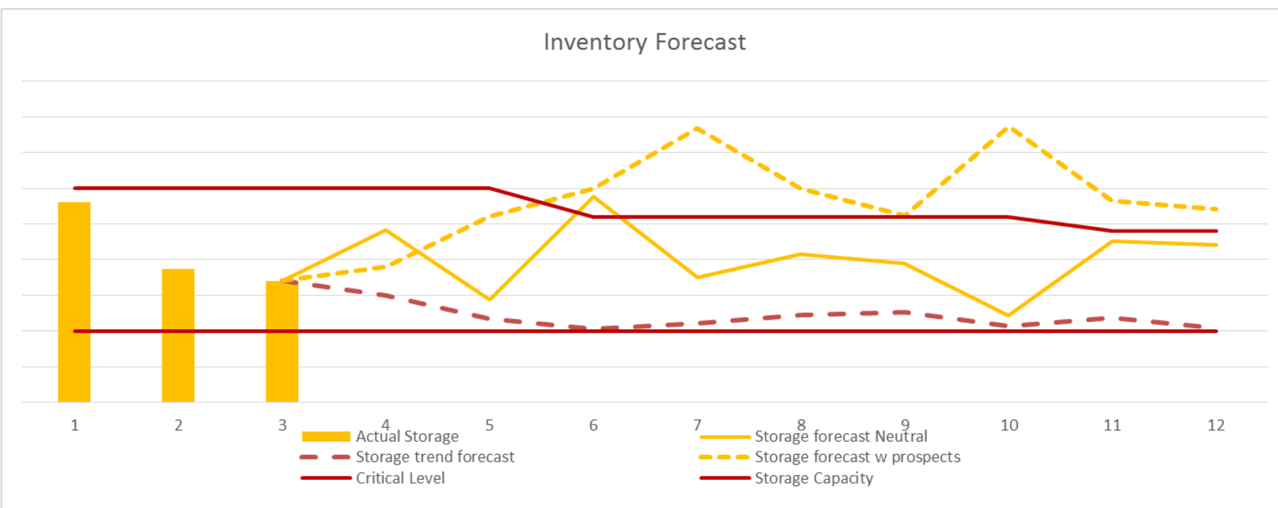

Figure 19. Inventory planning with scenarios (chart does not reflect the real situation)

The yellow pillars indicate actual stock, red lines present storage capacity and critical level. Storage capacity was determined and updated depending on the information from production department. Depending on the planning group and subfamilies critical level, was established to correspond a certain time period of maintaining the production. Red cutline illustrates the trend forecast generated from the actuals of the past months – here the sales actuals have been less than initially expected. Yellow line is the baseline forecast generated from best possible information, this is the most likely outcome for the storage balance. Yellow cutline describes the stock, if all prospects would be realized, for example this scenario's output would be stock capacity acquisition or increase of external treatment before May. Recommendation to future would be developing pessimistic forecasts and allocating volatility indicators and possibilities to each stock forecast scenario.

Recommendations

Palmatier & Crum (2003) *S&OP is not going to succeed without the proper linkage to the detailed planning. It is much easier to deal with the mix issue, if volume is managed effectively* (Stahl & Wallance 2008, p. 7).

In the table 14. is supply planning recommendations into the future. More scenarios could be added to supply and demand chart, for example the optimistic, pessimistic and trend forecast generation. As well as, volatility indexes and scenario possibilities could be applied to aggregate supply and demand chart. S&OP, operations, and production team experienced that it is necessary to continue and expand the subfamily based balance calculations inside the factory, as it validates the subfamily based balances in disaggregate level. Recommendation to future would be developing as well a pessimistic forecasts and allocating volatility indicators and possibilities to each stock forecast scenario.

Table 14. Supply planning recommendations into the future

Balancing supply and demand	Expand scenarios and apply volatility indexes
Balances inside factory area	Expand disaggregate balance calculation to all planning groups and subfamilies
Inventory planning	Estimated possibility percentages in different scenarios, volatility indicators, apply pessimistic scenario
Information flow	Develop a clear information flow practice to operations specially to logistic and customer service.

4.3 Structure of the process

"S&OP data has the right to be reviewed once in a month" (Dougherty & Gray 2006, p. 53)

Executive meetings were standard and formal practice in the Case Company. Formalized demand, supply or pre-meeting practices did not exist, to validate and refine the data presented in the executive meetings pre-meeting practice was put into place. In the table 15. is presented ideal S&OP process structure for the Case Company.

Table 15. To-be S&OP process structure

Data Gathering Phase	Demand Planning Phase	Supply Planning Phase	Consensus Phase	After the Consensus Phase
1) S&OP team gathers the information from past meeting. 2) Updating S&OP tool 3) No formal meeting	4) Consensus forecast 5) Demand plan is revised and possible forecast scenarios created 6) Sales meeting - formalize & refine	7) Treatment actuals and forecast revised 8) Inventory plan created possible 9) Supply planning meeting - formalize & refine	10) Executive meeting material created 11) No formal meeting, produced material revised by S&OP team before executive meeting 12) Formalized executive meeting	13) Task lists and updated materials distributed 14) Summary of game plan - develop & refine 15) Implementation of decisions and linkage to operational S&OP

Data Gathering and Demand Planning Phase

In data gathering phase actual inflow and treatment data is updated for pre-meetings. No formal process was established for the phase and the updating is done by S&OP team member. Demand planning meetings were established as new consolidation and validation meeting for S&OP process. Forecasts were adjusted manually based on the sales managers' information, if major customer inflow changes occurred, S&OP received information before the demand planning meeting. In the demand planning meeting all product family groups were revised. Meetings were seen as vital process step for S&OP, as lots of data was validated and forecast error was corrected. When moving towards sales department's forecasts practice subfamily group allocation defects were noticed in sales budget.

It is extremely vital to engage sales to S&OP process and align the ownership of sales forecasting to sales departments. Linking KAMs and sales managers more deeply into the demand planning process would increase the forecasting accuracy and enhance the understanding of demand. Forecasts have the right to be revised and pre-meeting practice is a sufficient way to do it. Pre-meeting participation percent was varying as it was still an informal meeting. It was felt that important data went side from S&OP, as the participation percent was varying significantly.

Supply Planning Phase

In supply planning meeting treatment actual and forecast were revised. As well as, generated balance and inventory plan was reviewed and afterwards recommendations to close the gaps were presented and an action plan was created. The meeting focused more on the data validity than on the action plan. This is a development aspect for the Case Company, to improve the data validity and tools' balance calculations, so that more attention can be drew to future game plans. Another developing aspect is to move to more planning oriented meetings, currently the meetings are looking more to what has happened than what is going to happen.

Supply planning was separated in controversial and hazardous waste treatment, though often both parties were present. Supply planning meeting is not standard and its agenda is informal. It was felt that important data went side from S&OP, as the meeting participation percent was varying significantly. For future recommendation agenda have to be streamlined, and the reason cause relationship of the meeting and the planning brought forward. As well as, the planning proportion of the meeting have to be emphasized.

Consolidation Phase

Conclusion report to executive meeting was created based on the validated forecasts in the demand and supply meeting. The meeting report was once revised before the executive meeting by the S&OP team. Agenda of the executive meeting was the following: going through tasks list, operational challenges, and revising the planning groups. Meeting structure was efficient and working properly. All the relevant stakeholders are represented at the meetings, and the meeting agenda is logical and the action points are in logical sequence.

After the meeting

Reports presented in the meeting were once again refined and corrected, if needed and task list updated. Report, task list, and Excel tools were distributed. It was felt that available reports support the decision making on an appropriate level (detailed content, summaries, graphs). Reports are robust and easy to grasp, although the game plan, decisions and exceptions made in sales and operational should be reported more clearly. Investment opportunities were evaluated based on these reports. As well as, measuring the process performance has to be refined, currently process measuring is tested and developed. For distribution, primary recipients should be sales department and operations team, so that the required operation targets and action to close the balance gaps can be reached. Although, sales team was infrequently asked to adjust sales plans. The required actions were put to operative level and international level after the executive meeting. Nonetheless, more information was desired considering the steering actions and exceptional steering decisions.

4.4 Data and tools

"The S&OP process needs to be supported by three types of software applications: 1) demand-side planning, 2) supply-side planning, and 3) an S&OP workbench." Lapide (2005, p. 19)

Development of Excel tools was started at the beginning of the thesis project. Development objects were identified during the clarification work as follows:

- Creating top-down and bottom-up function – creating a holistic tool from domestic aspect and separating headquarter as own reception location.
- Improvement of forecast generation
- Updating – adding external treatment pipelines and storage capacities
- Scenario management
- Optimization
- Storage planning function
- Visualization
- Report development

Like aforementioned, planning group recommendations were presented to make the aggregation and disaggregation between subfamilies and families. As well as, object of switching between treatment pipeline based locations was identified. A holistic picture was created from domestic location aspect for family A, and other aspect was created from the treatment pipeline based locations, headquarter location. At the gained maturity S&OP tool should be able to describe and switch the operation sites depending on the ongoing case. This should be done in BI system rather than heavily in Excel, as planning objectives could be easily changed depending on the ongoing case.

Forecast generation from past last year's trend and seasonality were generated. Seasonality trend was calculated based on the last year actuals and the sales forecast. Seasonality forecast created in the tool was replacing seasonality forecast from DP. Another trend based forecast was created based on past year actual fluctuation as presented in figure 19. Recommendation are that location based forecast should be developed in detailed level, currently S&OP and the sales do not have location based forecasts. Another improvement developing aspect is creating the linkage between the S&OP tool and the sales forecasts in DP with SQL and Ms Access. Afterwards the linkage to CRM system should be implemented, this would integrate the prospects and sales funnel more profoundly into the process.

Initially S&OP process did not have scenario management tool. Scenario conceptualization and reason cause relationships were tested and investigated with Excel. Scenarios were tested on the demand forecast differences – prospects, trend forecasts, customer specific, and baseline forecasts – and the correlations to storage planning were evaluated. Future step is to link the scenario planning to financials and to environmental construction products, so that the cost effect solutions can be evaluated. As well as, the products, which are shipped from long distance to different pipelines, should be evaluated in the supply planning tool with the feature of scenario management. Scenario management should be executed in the APS, as the optimization and calculation power is insufficient in Excel.

Future elements for supply chain management related scenario planning are storage creation or delimitation, demand change, treatment pipeline stoppages, financials relation – what is the price of the next contract and where should interim storages be created. The following outcomes are desired to be possible to achieve: financial effects, storage evolution, capacity situation, visualization of the plan, and easiness in operating the system.

Analytics of optimization was not tested, although, optimization of subfamilies and waste flows between treatment pipelines and interim storages was felt having a significant potential of operational cost savings. Supply planning management system should be able to optimize between different scenarios. This function should be integrated with scenario management aspect in APS.

Storage planning analytics were developed in Excel sheets. Storage forecast was generated automatically into the future when new monthly actuals were registered. Sales or treatment forecast variations were automatically taken into account. Storage planning is visualized in figure 19. and tactical level storage planning was applied to operations.

Demand and supply planning was visualized to graphs as seen in figures 18. and 19. It was experienced that decision could be made more easily and rapidly based on the visualized figures. Actual and forecast comparison with KPIs were easily understood. Storage planning was also visualized as mentioned. Visualization of the subfamilies and locations behind aggregated volumes has to be understood, otherwise wrong conclusion can easily be made. For example, comparing subfamilies theoretical storage capacity at national level, can create a situation, which is describing excessive total free capacity. Visualization was experienced vital for optimization and scenario planning, as well, when planning material flows between treatment pipelines.

Generally operational related information arouse interest and more transparency was required, thus the development of the standard reports were initiated. User should be able to generate the reports automatically from the S&OP tool, currently the reports are generated manually by the S&OP team. Reports are robust and easy to grasp, though the game plan, decisions and exceptions made in S&OP should be reported more clearly and refined. As well as, measuring the process performance reporting has to be refined, currently process measuring is tested and developed.

4.5 Performance Measurement

Process was measured with few KPIs and they were not observed systematically in monthly meeting. Absolute and relative forecasting error metrics were used for inflow and treatment, as seen in table 10 and 11. During the clarification work several possible KPIs were identified and the recommended metrics by department and responsible persons are presented in table 16.

Table 16. Recommendations of key performance indicators for the Case Company

Department	**Key performance indicator**	**Owner**
Sales	Inflow forecast error (Weighed, MAPE, relative and absolute)	Sales Manager
	Sales / Volume growth in euros	Sales Manager
		Sales Manager
	Mean absolute percentage error	Sales Manager
	Unfilled customer demand	Sales Manager
	Customer satisfaction	Sales Manager
	Standard deviation of deliveries compared to forecasts (product subfamilies)	Sales Manager
	Waste quality error statements from reception (Waste converting and harmful ingredients)	KAM
Customer Service	Service promise	Customer Service Manager
SCM	Inventory levels	Inventory manager
	Storage forecast accuracy rate	Inventory manager
S&OP team	Balance actual vs forecast	S&OP manager
	Executed tasks from to do list on time	S&OP manager
	Data reliability	Controller
Production	Bunker Storage	Plant manager
	Emission limit exceedances	Plant manager
	Calorific Value	
	Product mix	Plant manager / supply manager
	Safety	Safety Manager
	Balance (treatment efficiency)	Production Manager
	Treatment forecast error (relative and absolute)	Production Manager
	Plant stoppages	Production Manager
Finance	Cost per treated ton per product family - Absorption cost - Direct Manufacturing costs	Controller
	Revenue	Sales Manager
	EBIT	Operations Manager
	Operational costs	Operations Manager
	Inventory costs	SCM Manager
	Cash flow	

Sales' KPIs are mostly linked to forecasting accuracy. In the end of the chapter 2.6 is presented forecasting formulas, most of them are recommended for future KPIs. Forecasting error is calculated with relative, absolute, mean and weighed mean error metric. It is essential to measure the volumes with relative and absolute error metrics, because absolute error metrics describes the dimension relationships better to the operations. As well as, mean and weighed describes how well the overall forecasting efficiency. Volume growth, which is compared to budget, should be measured by customer specific and aggregate level. To gain better understanding from markets unfilled demand, comparison to unconstrained forecast is suggested as a KPI. Customer satisfaction is a key measure and its responsible person is the top manager from sales.

Standard deviation towards forecast describes the forecasting and delivery efficiency. Operations can be planned more effectively, if the deliveries are not fluctuating too much. Acceptable fluctuation was determined from amount of truck deliveries to the plant area. Last measure is error statements from reservation area, meaning that waste pre-knowledge has deficiencies. Waste type can be false, or harmful ingredients can be incorrectly reported in preliminary knowledge. In case of incorrect waste quality, production corrects the waste quality, and at worst, it could be steered to wrong process. Harmful ingredients are, for example iodine, chlorine and mercury. In both cases reception would do an error statement of foreknowledge.

Customer service is measured by service promise, which describes how the small collected deliveries are fulfilled. These are as well measured with standard deviation and forecast errors in the sales metrics but they are dealt as one group. Customer service manager is responsible for customer service metric.

SCM and S&OP team is measured with inventory levels, when the levels are high, it restricts the production as capacity cannot be utilized. On the other hand, sufficient safety stock must be uphold. The storage forecast accuracy rate is presented as second metric. Third metric is the monthly balance volume and its forecast error. Forth metric is the tasks executed on time from previous month’s task list, which obviously describes the S&OP process influence. Last metric is data reliability, which could be measured with correction to master data and how other stakeholders feel they can trust on S&OP reports and the numbers behind them.

Production is measured with bunker storage levels, when the storages are in sufficient level the proper product mix can be prepared and treatment is significantly greater. For example, if storage level decreases by 25 percentage to optimal storage level, production would increase by roughly 4 percentages in the waste-to-energy pipeline. Second metric is emission limit exceedances, which describes the processing manageability. The optimal calorific value allows grater treatment, if the calorific value decreases by one unit towards objective value, treatment would increase by 8,5 percentages in a waste-to-energy pipeline. It should be noted, that either bunker level nor calorific value can decrease under safety point. Right product mix enables more fluent treatment and it correlates with the calorific value. Safety is always considered and it is measured with near-miss situations and accidents. Treatment efficiency is compared to budget figures with volume and percentages, because volumes depending on the pipeline affects balances and percentages describes the line specific efficiency. Last measure is plant stoppages where aspects like unplanned compared to planned stoppages, duration, timing should be measured.

Finance metrics are the KPI table's last category, here cost per treated ton by product families and subfamilies should be described. First operating costs should be investigated with traditional costing method, where direct fixed and variable costs are allocated to families and subfamilies, and fixed and variable overhead costs are allocated roughly afterwards. More advanced method would be activity based costing, where overheads could be more accurately allocated to families and subfamilies. It is essential to describe first the direct manufacturing costs separately from overheads so that the cost structure would be understood. Basic financial business measures revenue and earnings before interest and taxes (EBIT) are recommended, to illustrate how large the business and effective it is. Finally operational cost and inventory costs should be tracked.

4.6 Evaluation of the process, and as-is and to-be state

Process section evaluation

Based on the theoretical success factors and important sections emerged from the empirical part of the thesis, ten evaluation areas were defined, see table 17. In this chapter, the results from workshop are illustrated. Workshop participators were from management, customer service and logistics, sales, production, and environmental construction BU. Ten evaluation sections of the process were defined as follows: *process integration, demand planning, supply planning, stakeholders, meeting effectiveness, performance improvement, decisions making, data accuracy, reporting, and technology support.*

The participations were asked to evaluate the areas from scale one to five. Supporting the rating participator were asked to justify the section's rating according to what does work and what does not. To evaluate the section significance towards stakeholder, the importance of the process' section was defined from scale one to five. The participators were also asked to propose concrete development ideas to those section, which was felt important but was rated low. The workshop was facilitated at the end of the thesis project, hence results describes the state of the process in the end of the thesis project. Whereupon the results are used as ground pillars when creating future development aspects.

Table 17. Classification of evaluation areas by sections

Section	Evaluation area
Demand planning	1. Demand planning
Supply planning	2. Supply planning
Structure of the process	3.1 Process integration
Structure of the process	3.2 Stakeholders
Structure of the process	3.3 Meeting effectiveness
Structure of the process	3.4. Decision making
Data and tools	4.1 Data accuracy
Data and tools	4.2 Reporting
Data and tools	4.3 Technology support
Performance measurement	5. Result tracking

Process integration: process optimizes decisions across business units, business areas and functions. There is a clear defined meeting structure for the S&OP process. The meeting timings are in a logical sequence so that information can flow through the process. *Demand planning (waste inflow)*: proper forecast accuracy enables accurate S&OP planning. Demand plans are reviewed at the appropriate BU, geography and family level. *Supply planning (Treatment capacity)*: right level of seniority and visibility over the production resources are granted to identify reliable supply planning. Demand planning represents an input to the supply planning, and gaps are actively identified. *Stakeholders*: all the relevant stakeholders are represented at the meetings. The attendees at the meeting have the right level of knowledge and seniority to meet the objectives of the meeting and take the necessary decisions.

Meeting effectiveness: time and effort are involved in the S&OP process results in value added results. Roles and responsibilities are clearly defined. Meeting is able to perform contingency and effect analysis for multiple scenarios. *Result tracking/performance improvement*: Actions agreed are tracked effectively and relevant KPIs are followed to confirm the progress. Process is linked to financials and actions agreed are partly based on cost awareness. *Decision making*: decision making is based on facts and decisions are implemented effectively. Decisions result in accurate business outcomes. *Data accuracy*: data is up-to-date and it bring value to decision making. Operations and other parts of the business trust the data produced by S&OP, for example forecasts. *Reporting*: available reports support the decision making on an appropriate level, for example detailed content, summaries, and graphs. Reports are robust and easy to grasp. *Technology support*: current systems or IT tools support the S&OP process, for example data gathering, data consolidation, and reporting.

Sales Department

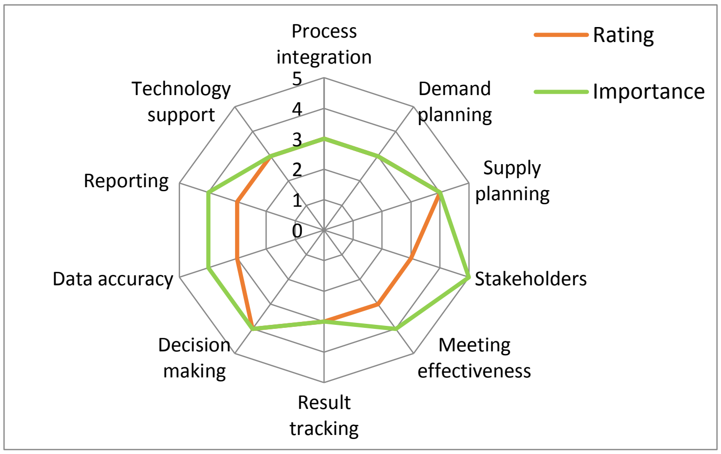

Figure 20. Sales department's section evaluation and importance

In figure 20 is presented sales departments evaluation of the process by rating and importance. Sales department felt that forecasting was significantly improved, as well, the decision-making in the S&OP meetings was experienced easier, because of the enhanced fact based calculations. S&OP process result tracking was experienced successful. Meeting efficiency was seen effective and meaningless. In general, S&OP process needs clarification to roles and relevancy of stakeholders. Universal understanding of different stages of the process is not yet at the sufficient level nor coherent. Cost information was not at adequate state to support decision-making. Information flow needs to be formalized with more uniform process. Clearer S&OP roles and responsibilities of the sales and linking the cost information more transparently to decision-making were suggested as improvement actions. As well as, control decisions should be exported to ITS in order to foster the systematic process and share the information more efficiently.

Production

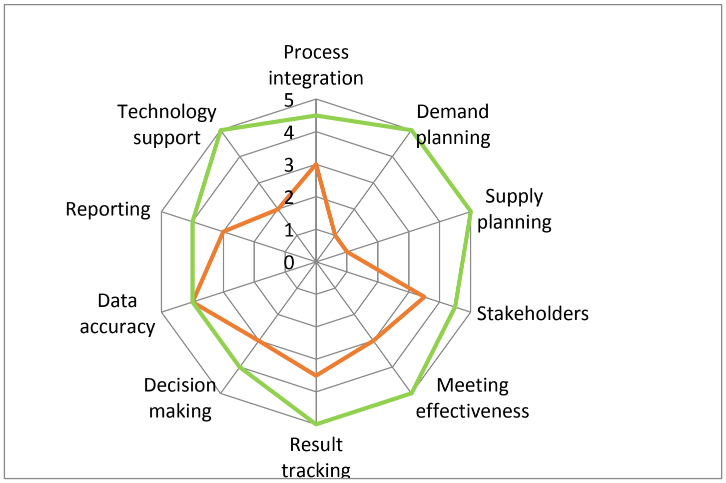

Figure 21. Production department's section evaluation and importance

Figure 21. describes the production's evaluation of the process in workshop. Production felt that S&OP process produces tactical information, which gives a holistic overview. Meetings have a clear and coherent agenda and produced analysis from the process is at good level. The process produces clear decisions and control activities are followed efficiently. Though, production experienced that process is lacking accurate and real time sales and production forecasts, as can be seen in demand and supply planning evaluation sections. Other shortcomings were that linkage to operational S&OP was insufficient, and there was no memo from control decisions. Production desired enhancement in monitoring of tasks' implementation. As well as, improvement in sales' understanding of the waste categories' contaminant concentrations. Production required enough mandate to take decision in the meetings.

Environmental construction business unit

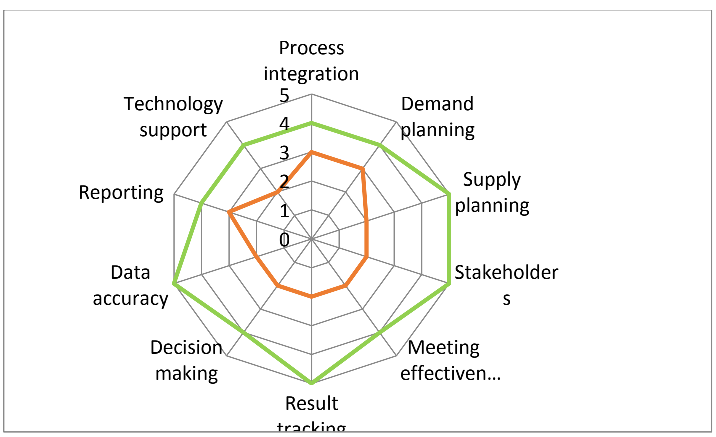

Figure 22. Business unit environmental construction evaluation and importance

Treatment center business area experienced that demand planning works for controversial waste, the process integration is in place, the meeting practice is well established, and meeting procedures and the efficiency was experienced having a great start. These can be seen from the figure 22. Last the data availability was experienced at good level and from its basis illustrative reports are created. On the other hand, business unit experienced that longer term capacity planning should be developed and that the utilization of cost information was at elementary stage. Improvement of information flow was as well desired. Business unit represented that information flow and communication practices should be first enhanced. Second, supply planning tool, where cost information and scenarios could be planned at detail level, was introduced as developing aspect to the current process state.

Management

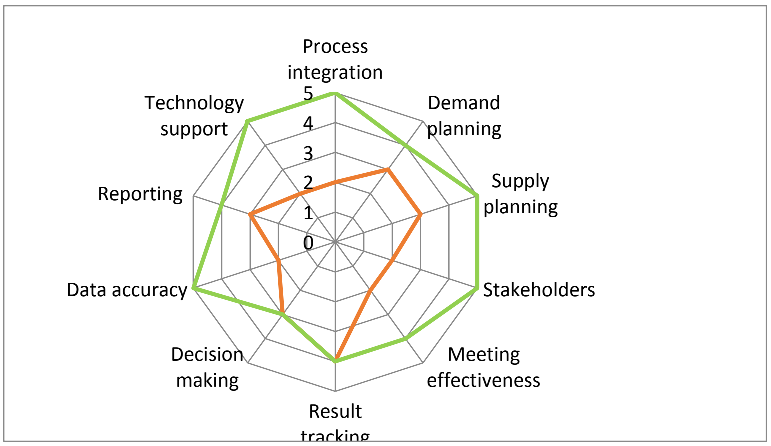

Figure 23. Management's section evaluation and importance

Management, represented by the controller and head of oil business, experienced that the people involved in the function scope are sufficient. Reporting graphs were felt robust, explicit, and easy to grasp. Which is a positive result, as lots of resources were aligned into reporting development during the thesis project. The responsibilities and roles were felt unclear. Also, the transparency to the waste streams, which are not followed by S&OP was experienced unclear, nonetheless these should be followed. Cost awareness should be applied to the process, and the ITS support, as well, reliability and timing of the data were experienced rather weak. Management proposed that the following improvement activities: improve data quality, in order to obtain the reliability of the decision-making. More controls to the systems and accounting practices were suggested. As well as, enhancement the data quality by implementing proper activities for all executed steering activities, these should be executed so that activities are registered into

ERP. Managers experienced that reporting systems should be developed and their usage increased. S&OP steering action should be also implemented to the knowledge of all business areas.

As-is and to-be state of the process

In the appendix 12. a chart is presented, which describes the objective state of process. In the upper x-axis is presented the process phases, and in the y-axis is the stakeholder departments. Lower x-axis presents the activity types performed by each department in each phase of the process, activities are evaluated with pros and cons. As well as, related ITS in each phase of the process are described and future recommendations are presented. Three types of activities are described in the chart, those which were executed already before the restructuring, those which were developed during the thesis project, and those which are the future recommended activities.

Process begins with S&OP function updating the data from previous S&OP. Afterwards the customer based budget is brought manually to validation meeting, where sales gives its comments from new prospects and cases. Here the cons are that changes in customer inflow are hard to detect, because of the manual updating, as well the new customer cases are cumbersome to update. The subfamily based forecasts are not validated often, so there are most probably distortions. Recommendation is to create a sales department wide rolling quarterly forecast practice and link it automatically to S&OP process. The tool used is Excel and everything is manually updated, future linkage to DP and CRM is recommended.

Validated and edited forecast from demand planning meeting functions as input for supply planning meeting. Treatment budget is standard and so future recommendation to create a treatment forecasts when treatment is not likely to meet the budget. Other inputs for the meeting are storage capacities of environmental construction business unit and storage levels from other sites. Storage levels and capacities are inputs for the supply planning meeting, where the cons are high storage levels, and that data from external storage locations is hard to receive. Future recommendation is to make a quarterly inventory, so that accurate data from external storage balances can be gained. Activity to plan storages based on scenarios was established.

For the production, high fluctuation in daily waste volume is a con. Production plans the deliveries with actual past data, as in process industry the volumes are standard so no further disaggregation of forecast is needed. Actual data is from ERP and it is automatically updated, which is a pros. In the supply meeting the created tools are validated and an initial plan created. Logistic is an operational function in S&OP process, where the big volumes are managed effectively, though visibility to external logistic is varying. As well as, interim storages and temporary storages utilization is in high level, this is considered as a con.

In consensus phase meeting are prepared and scenarios tested once again. The scenario logic is primitive and so a scenario management should be planned with more advanced tools. Planning could be supported with APS. Further on the meeting is facilitated with help of task list and slideshow. Before aforementioned suggestions, presented KPIs are recommended to be followed in the meeting and after the meeting.

After the consensus phase balance estimates are put forward to evaluate investments opinions and output to operative S&OP is given. Task list for next month is put into practice. Steering actions, use of external treatment and storage output are given, though a lack of information from exceptional steering actions was experienced by sales and customer service.

New activities should include report development, KPI follow-up and extension to other BU's and as well environmental construction areas family and subfamily follow-up, to gain better utilization of materials between different processes and projects. Creating a formalized information flow map to manage the inflow, product mix, storage levels and production is recommended.

Different ITS should be applied to S&OP process, currently process is heavy regarding to the manual updating. First, demand planning phase should be planned in DP and the data accuracy of forecast should be developed. Next step is to link sales funnel to S&OP with CRM. Information from supply planning process is efficiently imported from ERP. Optimization and scenario management requires more advanced logic, and further APS could support the decision making significantly. Last developing aspect is to link the BI tool to support the data mining and reporting the actuals and forecasts, as well creating different product planning aspects. As BI tool exist already, BI development is the first step after the DP linkage and forecasting practice implementation. Before APS tools are implemented to support the scenario management, it can be done temporarily in Excel.

4.7 State of S&OP in environmental management companies

Inquiry was sent to two Scandinavian environmental companies, see appendix 11. Key findings included that generally all elements were in the S&OP process of both companies A and B. It was noticed that company A had more detailed planning in the S&OP process viewing as well SKUs, on the other hand company B had more coherent process than Case Company and company A, as company B integrated finance more thoroughly with the process. (Inquiry)

Key findings from demand phase were that for company B sales department were not directly linked to S&OP, when in Case Company A it was. For company B sales forecasting process were more structured and inclusive, as they applied more frequent forecasting and included unconstrained forecasts. Company A planned demand based on more statistical forecast and past actual data, as well company B felt that sales is executing judgments to forecast effectively and S&OP process' focus more in past data. Although, both companies felt the same challenge in sales planning, it is a reactive process and for gaining better forecasting accuracy it should be more proactive. (Inquiry)

Supply planning was following the same procedure for both companies, based on sales forecast, treatment forecast was updated. Further, logistics are synchronized and modified around the updated sales as well as treatment forecast. Both companies felt that endeavors to balance demand and supply have been quite successful, and it has expanded the actual planning horizon substantially. (Inquiry)

Company B was measuring the process more deeply with financials than company A and Case Company. Both companies felt that their S&OP process is in low maturity and they included one formalized monthly meeting. Company A had BI tool for supporting the S&OP process, but it did not include input from sales and Company B supported S&OP with Excel. (Inquiry)

For conclusion demand planning is felt most challenging part in the S&OP process and supply planning can be managed quite well. Generally the process maturities were in low stage. To compare the Case Company, company B had more mature S&OP process, as well the S&OP process for both inquired companies was wider considering more BUs. It is notable that demand planning was felt as cumbersome in both companies, so it is the biggest challenge for all companies. More proactive the sales forecasting can be the more expanded the time horizon of operational planning will turn out.

5 CONCLUSION

In this chapter the objective of the research – to define the holistic state of the S&OP process in the Case Company – is answered through two research questions, in order to sum-up the conclusions of the thesis. These questions are answered based on the view point of six sections defined in the introduction chapter, which are *product planning groups*, *demand planning*, *supply planning*, *structure of the process*, *data and tools*, and *performance metrics*.

RQ1: What aspects are vital for S&OP process, which of these should be developed?

Generally S&OP process was experienced important, which can be seen from the conclusion chart, figure 23. On the other hand, some sections were experienced more important than others. The most important elements were as follows:

- Supply planning
- Structure of the process – stakeholders, meeting efficiency and process integration
- Data and tools – technology support, reporting and data accuracy
- Demand planning

Figure 24. Stakeholders' importance and performance analysis of S&OP sections

It can be seen that decision making, reporting and demand planning scored the lowest in importance evaluation, nevertheless they were still experienced important as none of them were rated beneath four except decision making. Decision making was the least important for the S&OP process, which is a positive result, taking into account that stakeholders understand that the S&OP process is not itself making the decisions, rather it gathers the functions together, which have the pre-eminent knowledge to make the decisions. Hereinafter the six sections are commented and their stage of relevancy and urge of improvement illustrated.

Product planning groups

Developing aspect of S&OP product planning pipelines were identified when S&OP process was planning at three different levels – product family level, subfamily level, and treatment pipeline level. Currently the S&OP process is planning, depending on the four families, at three different scopes. These are the best planning levels for each family, albeit in order to gain deeper knowledge of the balances between different subfamilies and families, modeling of planning groups needs to be done. It is essential to be able to define the desired planning scope, either product family, subfamily, or pipeline based scope, depending the ongoing case. For example, this can be applied on the more efficient storage planning of liquid wastes.

Demand planning

Demand planning has been a big challenge in the S&OP process, because the whole demand planning function lacked a formalized process. Although, demand planning was rated lowest with supply planning, data and tools, and process structure sections. A large gap in between the rating and importance of the process indicates the necessity of the demand planning phase development. Demand plan was updated once a year by sales department and linked to S&OP. Judgmental adjustments were made when new information occurred in the S&OP process. Nonetheless, the key point is to get the information outside into the S&OP process. A lack of ownership towards the sales forecasts in S&OP process was experienced to be imminent.

S&OP process should be the cross-functional information deliver between departments. Based on the interview 3. sales department experienced that S&OP process has not succeed in transferring information. Forecasting customer demand has not been formal process and it is partly understood. In the thesis project, S&OP function clarified forecasting methodologies and established a demand planning meeting, where customer forecasts were manually updated to spreadsheets. S&OP function did not manage the forecasts in DP, it had manually updated volume based forecast for each planning group.

Supply planning

Substantial gap between the rating and importance of supply planning was identified. The stakeholders expected that treatment budget should be updated more frequently. Manufacturing department does a manufacturing budget once a year and it is adjusted rarely depending on the rundowns, major shortfalls or surpluses of inflows. On the other hand, the key point was to run at full capacity and find external capacity when needed. S&OP was looking mainly actual processing amounts and forecasts were not in such an important role. This should be improved so that production would adjust forecast for the use of S&OP process.

Daily challenges in waste-flow were identified, supply challenges were mostly due to uncontrolled inflow, and supply side desired a better signal from operative issues to sales department. Manufacturing department experienced that resource allocations were difficult to manage due to unknown fact of daily waste inflow volumes. Deficiencies in waste foreknowledge were identified and contact surface was experienced unclear. S&OP function was not experienced as a function for communication between sales and production departments, and especially sales experienced lack in transparency to exceptional steering decisions and reception locations.

Structure of the process

S&OP process was functioning and managing information at the lower waste volumes, as volumes increased more resources to S&OP process were needed. S&OP participant gathered once per month for executive meeting, and other S&OP related work was done informally. Lack of S&OP linkage to operational level and especially to sales steering was identified and the challenges were noticed at the plant site as well.

Structure of the process – stakeholders, meeting efficiency, decision making and process integration – was evaluated high in importance, although lots of improvement aspect were presented towards the sections. The importance of the process structure was evaluated highest with the supply planning section. Gaps between the importance and rating in stakeholders, meeting efficiency and process integration evaluation areas can be noticed from the figure 23. Structure of the process is the cornerstone of the seamless information flow. It is a vital improvement area to be executed at the first step, as it does not require major effort compared to ITS, demand planning and supply planning. Decision making in the S&OP process was generally experienced working efficiently. Although, the linkage to operations and implementation had room for improvement. The practices how to record actions into ITS were unclear, resulting errors in master data. This is a process aspect as the practices have to be illustrated and distributed, to all stakeholder participating into the process either indirectly or directly, to secure that everyone knows what are the right steps to implement the actions.

More streamlined tasks executing and task monitoring was hoped from the S&OP process. This might been a miss evaluation as S&OP mission is not do the actual execution of the task, rather give the signals to stakeholders at operative level, what should be done. On the other hand, S&OP process did not fully understood how these actions should be implemented, which will support the analysis according to deficit in the authentic control.

Data and tools

Development of Excel tools was started at the beginning of the thesis project. This can be seen in the figure 23. as the reporting has been rated highest with result tracking and decision making. Visualization and development of the Excel tools gained results. Nonetheless, data accuracy did not correlate with the Excel tool development and this can be seen as gap between importance and rating. Reports were updated manually and so the process output was lacking a real time data. This can be noticed in data accuracy evaluation section. Sales and operations process needs improvements in overall data. In addition tools, which support demand and supply planning, have to be developed. S&OP workbench should be visualized and put forward with real time data. It was experienced that usage of Excel sheets is hard to gasp among the participators. The following improvement aspect arose during the thesis project.

- Improve data quality
- Create a top-down and bottom-up function
- Improvement of forecast generation and linkage
- Scenario management
- Optimization
- Storage planning function
- Visualization
- Report development

Performance measurement

Process was measured with few KPIs – absolute and relative forecasting error metrics were used for inflow and treatment. During the clarification work several stakeholder specific KPIs were identified. Overall S&OP was following forecasting errors and variances, stakeholders experienced that result tracking was in a good base, scoring almost the highest points. Stakeholders experienced that signals from S&OP were sufficient when balances were going to get imbalanced. For the conclusion S&OP process was following the metrics competently, on the other hand the metrics scale was not wide enough to track the every part of the process.

RQ2: What are the future recommendations for the Case Company?

Recommendations towards every section are presented while answering the *research question 2.* These recommendations are evaluated by the implementation benefit and resource requirement. The urgent and easily implemented improvement recommendations should be executed firstly. New project plan for the developing aspects to eight months were created based on the benefit, resource requirement and rating. Prioritization matrix is presented in the figure 24. The matrix was built with the S&OP team based on the stakeholders' importance and performance analysis of S&OP sections. There are four types of suggestions in the matrix.

1. Implement now – where resource requirement is low and the benefit high

2. Quick gain – resource requirement and achievable benefits are low

3. Question – which resource requirement is high and achievable benefit low, relevancy of the area should be challenged

4. Long-term – which implementation requires lots of effort and the possible gain is high

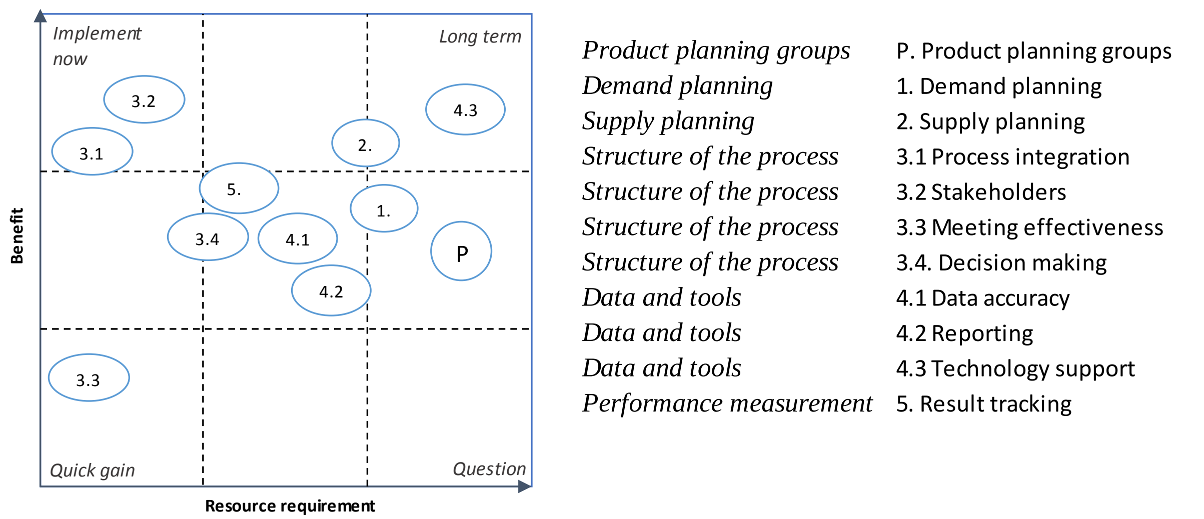

Figure 25. Prioritization matrix

The development areas, which do not require as much resources are implemented first and afterwards mostly ITS related development is put into place. It is important to prioritize the development according to potential and less effortless actions – implement now suggestion. Efficiency of the resource allocation to the next step of the developing process has to be profoundly considered.

Product planning groups

Product planning groups have to be developed, though it is not the first development aspect, as can be seen the benefit is medium and the resource requirement high. This development would go along with ITS implementation.

In the *product planning groups* first steps are to disaggregate the product family level A – making a drop-down function for family A to subfamily level. Second step is to aggregate families B and C – making a bottom-up function from subfamilies to product families B and C. These subfamilies and families should be observed simultaneously and seamlessly without separate effort on consolidating and disaggregation. As well as¨, possibility to choose desired planning scope depending on the ongoing case, for example two treatment pipelines together. Third step is to extend the observed families to other processes.

Connection enabling the observation of these dependencies on the treatment pipeline, should be applied afterwards. This classification goes hand in hand with the master data and tool development. Perspective of the *product planning group* should be evaluated in the process before the system development, so that participants truly understand the planning scope and levels of the process.

Demand planning

Demand planning is a long-term suggestion as lots of people have to be involved, and new process and ITS should be implemented to support the holistic integration to S&OP process. Suggestions are presented in the table 18. Investigation of the dependences between ERP actual deliveries and DP tool forecasts have to be initiated to enable future linkage of DP forecast to S&OP tools. Forecasting ownership should be shifted explicitly to sales department. Forecasting should be extended from 12 months to 24 months to gain more insight into the future. It is desirable to get to the state that sales department would create the unconstrained forecast, not the S&OP function. Sales department is establishing a forecasting process, where all KAMs are participating in quarterly updated forecasts in BP. To get deeper understanding in prospects the CRM data should be linked to S&OP tool, to work as a prospect input for the process. To sharpen the demand planning process, correlation tests, which compare the relationship between the order intake and macro economic indicators, could be applied.

Table 18. Recommendations for demand planning

Forecasting frequency	Rolling quarterly, 24 months time frame
Forecasting types	Constrained and unconstrained
	Statistical rolling yearly, adjustments if new information occurs at pre-meeting otherwise statistically forecast rolling quarterly and afterwards adjustments
Demand correlation test	Compare demand actuals to example indexes to develop the statistical forecast generation
Process	Explicit ownership to sales

Supply planning

Supply planning is a long-term activity, though the effort of implementation is not as high as ITS. Supply planning recommendations into the future are presented in table 19. Budgeting period should be more frequent than once a year. Production forecast adjustments should be done quarterly, to provide more accurate balance and inventory planning. More scenarios could be added to balance charts, for example the optimistic, pessimistic and trend forecast generation. As well as, scenario possibilities could be applied to aggregate balance chart. S&OP, operations, and production team experienced that it is necessary to continue and expand the subfamily based balance calculations inside the factory, as it validates the subfamily based balances in disaggregate level. Inventory planning should be enhanced especially external storage locations have been challenging to monitor, future recommendation is to establish a quararly inventory practice. As well as, scenarios should be applied to stock forecasts. Information flow challenges should be tackled in *supply planning* process, especially operative actions to logistic and customer service were unclear.

Table 19. Supply planning recommendations into the future

Budget	Start more frequent production forecasting (quarterly)
Balancing supply and demand	expand scenarios
Balances inside factory area	expand disaggregate balance calculation to all planning groups and subfamilies
Inventory planning	Enhance inventory planning External storages, quarterly inventories Estimated possibility percentages in different scenarios, volatility indicators, apply pessimistic scenario
Information flow	Develop a clear information flow practice to operations especially to logistic and customer service.

Structure of the process

Structure of the process development should be started firstly, as the implementation effort is not high and the potential benefits are significant. When the entire process is defined other section implementation can be executed, every participant has to understand the basic idea of the process. Future educations and promotion are recommended, so that generally S&OP process is well known function among in the Case Company. Stakeholder did not experience that the process was formalized, task changing was felt challenging as the boundaries between the information flow via stakeholders was indistinct. Stakeholders did not entirely know what are their roles in the S&OP process, and which phases of the process their input was required. Information was changed informally, so future recommendation is to define every part of the process clearly to stakeholder, how actions are put forward, and which information should be delivered to the process. Demand and supply planning meeting should be established, in which the stakeholders can give their specified input to the process.

Data and tools

Data and tools are long-term developing suggestion, as definition and implementation requires still a great amount of resources. Recommendation is to develop the DP platform for sales forecasting and further on change the Excel tool to BI software. After this a supply planning tool should be implemented to support the optimization and scenario creation in the supply planning phase.

- Manage forecast in demand planner tool
- Develop business intelligence tool to replace Excel
- Apply supply planning tool

At the gained maturity S&OP tool should be able to describe and switch the operation sites depending on the ongoing case. This should be done in BI system rather than heavily in Excel, as planning objectives could be easily changed depending on the ongoing case.

Forecast generation from past last year's trend and seasonality were generated. Seasonality trend was calculated based on the last year's seasonality trend and the sales forecast. Seasonality forecast created in the tool was replacing seasonality forecast from DP improvement developing aspect is creating the linkage between the S&OP tool and the sales forecasts in DP with SQL and Ms Access. Afterwards the linkage to CRM system to integrate the prospects and sales funnel more profoundly into the process.

Initially S&OP process did not have scenario management tool. Scenario conceptualization and reason cause relationships were tested and investigated with Excel. Scenarios were tested on the demand forecast differences – prospects, trend forecasts, customer specific and baseline forecasts – and the correlations to storage planning were tested. Future step is to link the scenario planning to financials and to environmental construction products, so that the cost effect solutions can be evaluated and logistic related products planned more effectively. Scenario management should be executed in the APS, as the optimization and calculation logic is insufficient in Excel.

Performance measurement

Suggested performance metrics are presented in the chapter 4.5 departments, which result monitoring should be developed are sales, production, SCM, customer service, S&OP function and finance. Performance measurement suggestion was evaluated in between implement now and long-term. It is more an implement now suggestion, as enormous potential benefits can be gained by linking financials into S&OP process. Every stakeholder participator in workshop felt that financials should be linked to the process immediately. This can be implemented in parallel with *process structure* developing.

6 SUMMARY

Objective of the thesis

Thesis objective was to explore extensively the S&OP process content of the Case Company. Objectives are categorized to seven different groups. *First*, process related planning groups are observed. *Second*, demand management's role in the S&OP process is clarified. *Third*, supply management role in the process is investigated. *Fourth*, process structure efficiency is evaluated. *Fifth*, objective is to clarify how the entire process should be monitored. *Sixth*, which information technology system (ITS) features the process requires. *Last*, Case Company's entire S&OP process is compared to theoretical success factors. Financial aspect of the S&OP process is not part of the thesis.

Literature review was done from the written material of the subject and the empirical part of the thesis was executed as qualitative research. Qualitative research methods used were active participant observation, qualitative interviews, enquiry, education and a workshop held in the end of the thesis project. Different interviews were conducted for management, sales, operation, customer service, and treatment centers business area. Interviews were held in the beginning of the thesis project. An inquiry was sent to two environmental management companies in Scandinavia. Questionnaire was answered by persons who are responsible for companies' S&OP process. Workshop was facilitated in the end of the thesis project, key stakeholders were participating to both interviews and workshop.

Theoretical findings

Design team will take care of all the process workings. Suggested a group of six people, which include roughly top management leader, a person from IT, demand planner, operation planner, a person from accounting, a person from sales. S&OP process is 60 percent change management, 30 percent process development and 10 percent technology. Senior executives often end up with a fallacy of change management, after they discover that S&OP is more getting right kind of information in exact time rather than a practice of change management.

Change management leads to renewed processes by taking small and tangible steps in the organization. Educating everyone involved does not mean that top tittle persons have a good S&OP knowledge, so everyone who affects the S&OP output should be educated. Successfully developed S&OP process cannot be long-lasting without proper process governance, which begins with planning, defining who will do what, when, where, how and why. It is important that different people are required to improve the process and the process is constantly evaluated. It is essential that everyone knows the S&OP process dates and what duties and inputs is expected from one another.

Information should be accurate but it does not need to be precise. Information should be in a usable and focused format, which means getting the right data in a timely manner. Unconstrained forecast should start the process with all demand impacts included. Someone in top management, who have the authority to commit resources, must get involved into the S&OP process. Someone who can design, finance, tie input, advocate and lead it, as well inspire and teach the usage of the process to the top management.

Analytics helps S&OP process to become more effective and cognizant of scenarios. Analytic-based reports inform the leadership what is the S&OP balancing. Actions needs to be executed and managed through tactical and operational S&OP. From previous decisions results and trends can be seen, as well as what corrective control actions needs to be done. The ERP system must be driven by the outputs of S&OP, so that detailed day-to-day decisions are synchronized with the aggregate decisions made in S&OP process. Process design is experienced as a key to success.

In the first half a year meeting mechanisms, formats, data accuracy, reports, and learning are consuming lots of time and these requires typically lots of improvements. Continuous improvement is crucial, because development ideas will come from the participants of the process, minor improvement does not generally require major capital investments. Attendance is one of the most important keys to success, as well as monitoring the tasks allocated in the meetings. Present progressive time-horizons is a success factor. Effective time and resource usage should be allocated to exception-based decision making. Also, accurate forecast reduces working capital and inventory, and enhances customer experience and revenues.

Initial state of the company

Waste volumes have increased almost by half from 2010. S&OP process was functioning and managing information at the lower waste volumes. Although, as volumes increased, more resources to S&OP process were needed. S&OP process was mainly once a month meeting, where attendance percent was varying. Lack of S&OP linkage to operational level and especially to sales steering was identified. The challenges were noticed as well at the plant site. The current situation in the S&OP meetings are that participants are re-defining boundary conditions and the control actions are performed in the absence of accuracy and transparency. One of the key missions was to guide the process from event based philosophy to more advance planned process, where the number of events declines.

Product planning groups scopes are subfamily, family and treatment pipeline, based on the business area. Demand was planned by yearly updated sales forecasts. Towards the end of the year forecasts were constrained and judgmentally adjusted, by the S&OP manager. Demand planning has been the biggest challenge in the S&OP process, because the whole demand planning function lacked a formalized process and sales department did not own the S&OP demand forecasts. Manufacturing department does a manufacturing budget once a year and it is adjusted rarely depending on the shortfalls or surpluses of inflows. S&OP was looking mainly actual processing amounts and forecast were not in such an important role. When steering decisions were changed, customer service experienced challenges in information flow. S&OP maturity is low as the formalized information flow in the process was not clarified. All relevant stakeholders did not know what their roles are in S&OP process. S&OP process was managed with Excel sheets and task lists. Manual updating have been one challenge for the S&OP process. Tools lacked a visual big picture and participators felt that adopting the tool was laborious, as well master data errors were identified through the thesis project.

Empirical findings

Empirical findings are presented in two different tables. First the research question “*What aspects are vital for S&OP process, which of these should be developed?”* is answered in the table 20. Second research question *“What are the future recommendations for the Case Company?”* is answered in the table 21. Research question are answered by the segmentation defined in the begging of the thesis – *product planning*, *groups*, *demand planning*, *supply planning structure of the process* and *performance measurement*

Table 20. Answer to research question one

RQ1: What aspects are vital for S&OP process, which of these should be developed?	
Product planning groups	- Development aspect of product planning groups - Efforts planning with different scopes - Hand in hand with ITS development
Demand planning	- Importance is high but it is not working at desired level - Sales does not own the S&OP forecast - Not frequent enough - Roles and process are unclear
Supply planning	- Importance is high but it is not working at desired level - Treatment budgets are not updated frequently enough - Roles and process are unclear - S&OP was looking mainly actual processing amounts and forecasts were not in such an important role - Stronger signal to operations - Lack in transparency to exceptional steering actions
Structure of the process	- Importance is high but it is not working at desired level - Lack in linkage to operational level - Information flow challenge
Data and tools	- Importance is high but tools are heavy - Endeavors done during the thesis project to visualization and reporting, can be seen in stakeholder increased satisfaction towards reporting section - Improve data quality - Create a top-down and bottom-up function - Improvement of forecast generation and linkage - Scenario management - Optimization - Storage planning function
Performance measurement	- More stakeholder specific KPIs - Ownership of KPIs - Stakeholders were satisfied to result tracking - KPI scale is not wide enough

Table 21. Answer to research question two

RQ2: What are the future recommendations for the Case Company?	
Product planning groups	- Benefit is medium and the resource requirement high - Disaggregate product family level A - Aggregate families B and C - Extend the observed families to other processes - Possibility to choose desired planning scope depending on the ongoing case (family, subfamily, pipeline)
Demand planning	- Long-term – achievable benefit is high and the resource requirement high - Rolling quarterly, 24 month time frame - Establish a link to S&OP tool - Adjustments automatically to S&OP process - Link the sales funnel and KAMs to the process with formalized practice (quarterly) - Demand correlation tests - Explicit ownership to sales
Supply planning	- Long-term –benefit is high and the resource requirement high - Start more frequent production forecasting (quarterly) - Expand scenarios - Expand disaggregate balance calculation to all planning groups and subfamilies - Enhance inventory planning - External storages, inventories - Clear information flow to operations especially to logistics and customer service
Structure of the process	- Implement now – resource requirement is low and the benefit is high - Promote the S&OP process and educate everyone involved - Formalize the process - Establish demand and supply planning meetings - Create information flow map
Data and tools	- Manage forecast in demand planner tool - Develop BI tool to replace Excel - Apply supply planning tool – manage scenarios in advanced planning system
Performance measurement	- Start measuring and commit ownership o Sales (relative and absolute error, unfilled demand, deviation, waste quality errors)

	○ Production (Bunker storage levels, emissions, calorific value, product mix, safety, balance, forecast error metrics) ○ S&OP team (Balance error metrics, executed tasks, meeting attendance) ○ SCM (inventory levels, storage forecast error) ○ Customer service (Service promise) ○ Other business areas - Apply financial metrics to enhance cost awareness ○ Cost per ton ○ Revenue ○ EBIT ○ Operational costs ○ Inventory costs ○ Cash flow

End words

In general, S&OP is a continuous improvement process, in which yearly updates and evaluations stakeholder from more structured analyze are vital for the process enhancement. The thesis project has improved reporting significantly, although there is lots of development areas in change management and process governance. Everyone whose work affects the S&OP process should be educated and clear roles defined. These have been one of the success factors in theoretical findings, which point out that the Case Company has to start developing more formalized S&OP process. Afterwards resources should be tied to demand and supply planning, and ITS development.

S&OP enables the connection from strategic to the operational planning. Master production schedule should be executed in a disaggregation form. Aggregate units, outputs of tactical S&OP, are used as inputs when modifying more detailed MPS. Case Company's S&OP outputs were not always used as inputs for detailed planning, as the supply and demand forecast were updated only once a year. This resulted as unsynchronized operation and sales. In practice this was seen as uncontrolled material flows to plant area. It is important that basics of the S&OP are working. During the thesis project aggregated S&OP volumes were updated as the disaggregated volumes were changed, although the input should first come from S&OP to detailed planning. S&OP is not going to succeed without the proper linkage to the detailed planning. It is much easier to deal with the mix issue, if volume is managed effectively. Mix complication becomes immediately more unmanageable, if the volume is not planned well.

To compare S&OP process in other environmental management companies in Scandinavia, demand planning was felt most challenging part in the S&OP process and, on the other hand supply planning can be managed quite well. Generally the process maturities were in a low stage. To compare the Case Company; company B had more mature S&OP process, as well as the S&OP process for both inquired companies was wider considering more BUs. It is notable that demand planning was felt cumbersome in both companies, so it is most probably a big challenge in environmental management companies. More proactive the sales forecasting can be, the more expanded the time horizon of operational planning will turn out. In the theory S&OP is at low maturity when it is reactive, meaning that supply chain is driving the process with a strong sales bias leading to imbalance, and when lack of clarify to the goal of S&OP is seen. This is one of the challenges what companies face, if they do not practice continuous improvement and change management. S&OP easily drifts to reactive state, if resources are not allocated, clearly defined team established, and participators' responsibilities clarified.

The ERP system must be driven by the outputs of S&OP, so that detailed day-to-day decisions are synchronized with the aggregate decisions made in S&OP process. Process design is experienced as a key to success. Generally, when manufacturing industries face rapid growth process governance and participators' roles can be set besides unintentionally. Main demand shaping tool for chemical industry is price management and it plans to sell excess capacity in lean times and profitably allocate capacity in high season. In the Case Company's S&OP process price management was not presented, although as the maturity develops more cost awareness can be gained.

In the theory surveyed companies are not seeing the benefits they expected from S&OP software, although they spent enormous amounts of money to S&OP software. This is because many did not change the process for fully leverage the enabling technology. The ERP system must be driven by the outputs of S&OP, so that detailed day-to-day decisions are synchronized with the aggregate decisions made in S&OP process. The Case Company has to be conscious when implementing new software to support S&OP process. Software are not by itself solving any challenges, after the process structure, roles and activities are working horizontally and vertically seamlessly, software implementation should be surveyed. This study proves that the theory applies for the Case Company as well, and other companies which have S&OP at the first maturity stages, should first focus on the development of the own process governance and information flow.

It would be interesting to study future investigation about the demand planning phase; how the waste fractions convert, and what are differences between sales and production cycle? These are the question, which should be pondered in the future study. Different correlation test and forecasting technic could be applied to the investigation. In addition, it would be fascinating to launch detailed supply planning investigation considering scenario managements opportunities compared to financial benefits. For example, the presented KPIs in the empirical part of the thesis, should be monitored during the implementation process. Hereby, the return on the investment from the acquired software could be studied.

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Interview 5. Operations Manufacturing Interview part 2, 7.11.2014, Logistic Chief/S&OP Manager, Operations Manufacturing Manager Finland/Hazardous waste

Interview 6. Treatment centers Interview, Logistic Chief/S&OP Manager, Chief Operative Officer BU Environmental Construction Treatment centers, Chief Operative Officer and Product Group Manager Officer BU Environmental Construction Treatment centers

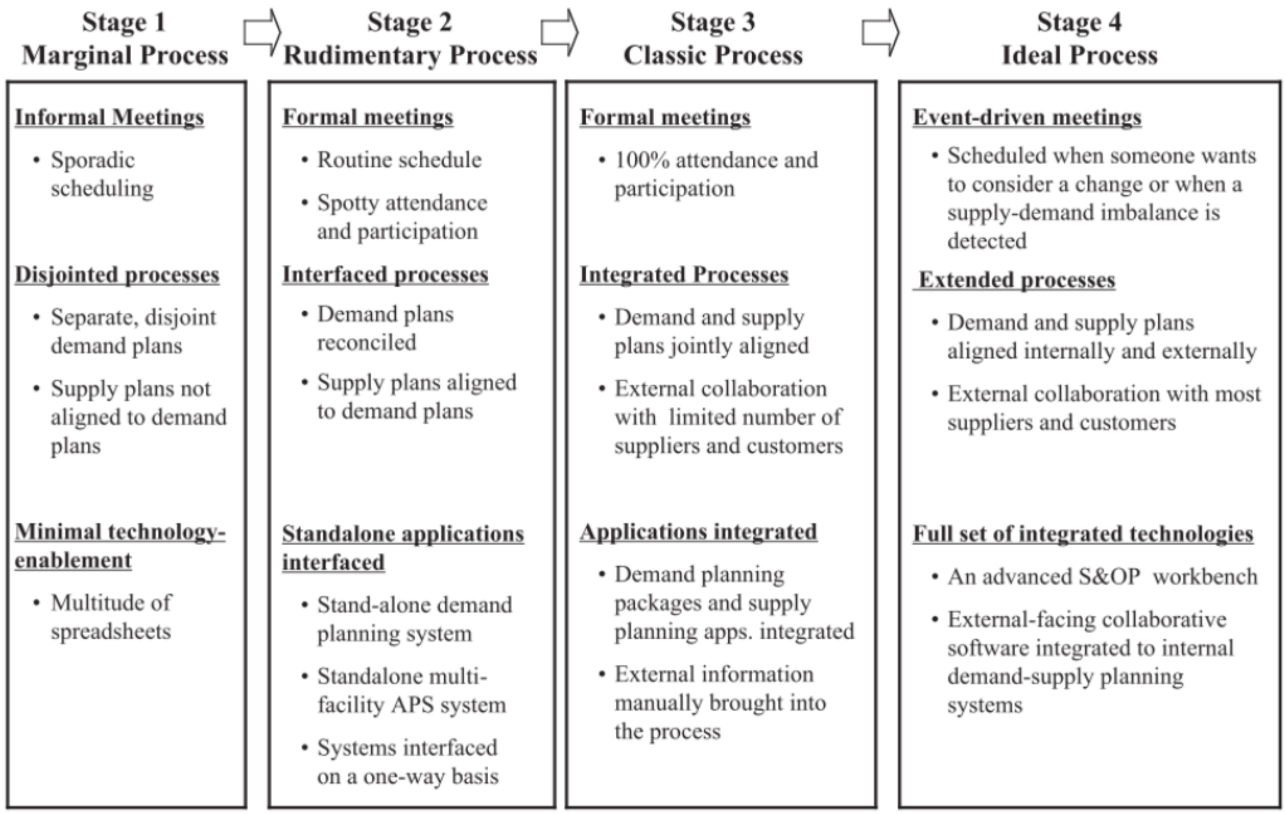
Interview 7. Customer Service Interview, 21.11.2014, Customer Service Manager, Category Chief, Back Office Manager

Inquiry. S&OP process in Scandinavian environmental management companies

Workshop meeting facilitated by a big four consultation company, 20.4.2015

APPENDICES

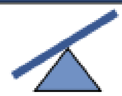
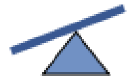
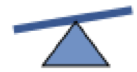
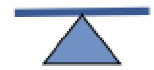
Appendix 1. Lapide (2005) Maturity Model



Appendix 2. Grimson and Pyke (2007) Maturity Model

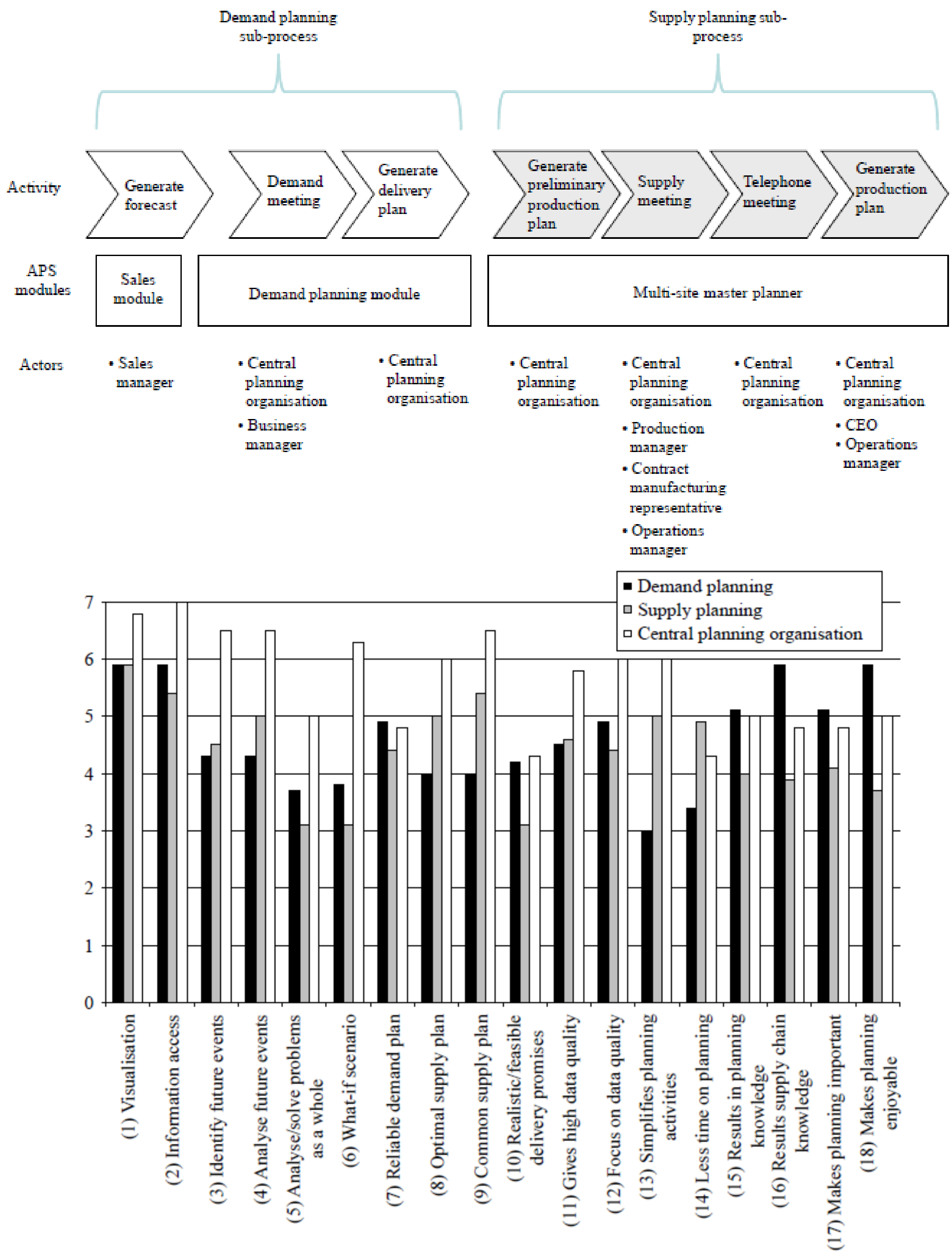
	Stage 1 No S&OP Processes	Stage 2 Reactive	Stage 3 Standard	Stage 4 Advanced	Stage 5 Proactive
Meetings & Collaboration	• Silo Culture • No meetings • No collaboration	• Discussed at top level management meetings • Focus on financial goals	• Staff Pre-Meetings • Executive S&OP Meetings • Some supplier / customer data	• Supplier & customer data incorporated • Suppliers & customers participate in parts of meetings	• Event driven meetings supersede scheduled meetings • Real-time access to external data
Organization	• No S&OP organization	• No formal S&OP function • Components of S&OP are in other positions	• S&OP function is part of other position: Product Manager, Supply Chain Manager	• Formal S&OP team • Executive participation	• Throughout the organization, S&OP is understood as a tool for optimizing company profit.
Measurements	• No measurements	• Measure how well Operations meets the sales plan	• Stage 2 plus: • Sales measured on forecast accuracy	• Stage3 plus: • New Product Introduction • S&OP effectiveness	• Stage 4 plus: • Company profitability
Information Technology	• Individual managers keep own spreadsheets • No consolidation of information	• Many spreadsheets • Some consolidation, but done manually	• Centralized information • Revenue or operations planning software	• Batch process • Revenue & operations optimization software – link to ERP but not jointly optimized • S&OP workbench	• Integrated S&OP optimization software • Full interface with ERP, accounting, forecasting • Real-time solver
S&OP Plan Integration	• No formal planning • Operations attempts to meet incoming orders	• Sales plan drives Operations • Top-down process • Capacity utilization dynamics ignored	• Some plan integration • Sequential process in one direction only • Bottom up plans - tempered by business goals	• Plans highly integrated • Concurrent & collaborative process • Constraints applied in both directions	• Seamless integration of plans • Process focuses on profit optimization for whole company

Appendix 3. Cecere et al. (2009) Maturity Model Adjusted with Gartner RAS Core Research

Strategy	Stage 1: Reacting	Stage 2: Anticipating	Stage 3: Collaborating	Stage 4: Orchestrating
Balance: S&OP				
Section 1: Goals	**Development of an operational plan**	**Demand and supply matching**	**Profitability**	**Demand sensing, and conscious trade-offs for demand shaping to drive an optimized demand response**
Section 2: Cross-Functional Alignment	Supply Chain driven process with a strong sales or operational bias leading to imbalance. Lack of clarity as to the goal of S&OP.	Supply Chain driven process for purposes of achieving optimum forecast and supply response to demand	Supply Chain becomes the S&OP orchestrator and business functions take ownership of input, output and results, looking at financial impact of decisions	Business ownership at multiple levels with strong participation from executives and finance. Collaboration extends beyond the enterprise to achieve end-to-end value.
Section 3: Process and Technology	Emerging process, inconsistent and marginally effective. Often more of a sales review meeting. Tools are mainly Excel and ERP.	Formal, structured process. One size fits all approach. Tools extend to include forecasting, SC planning and inventory optimization	Process tailored to business model and needs. Dialogue, and start of use of tools, around what-if analysis for demand shaping, financial reconciliation and cost to serve.	Process becomes balanced, dynamic and event-driven. Strong connection to strategic planning and execution. Tools also support risk-value trade-offs, price optimization and complex simulation.

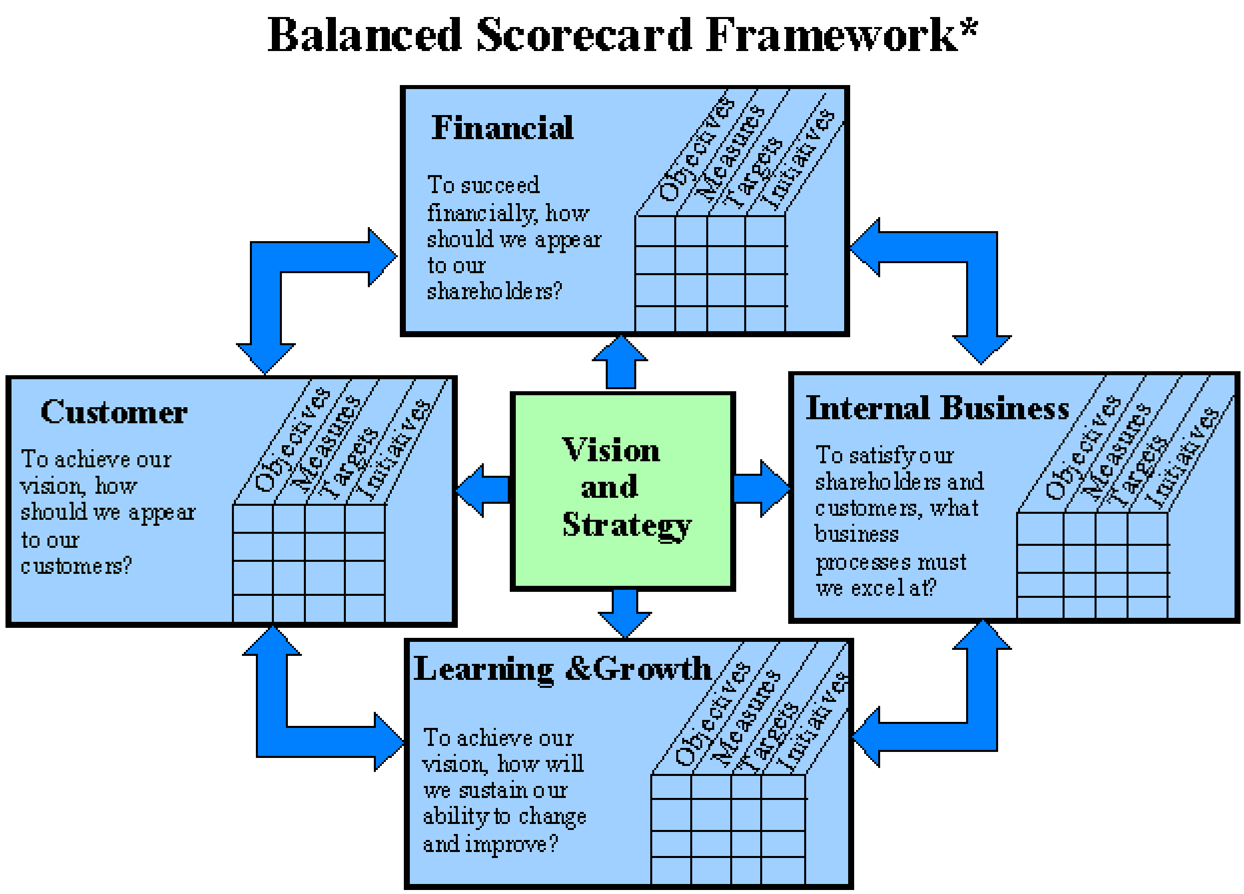
Increase in Organizational Balance

Appendix 4. Ivert & Jonsson (2010) APS systems benefits in S&OP process of a Case Company in chemical industry.



Notes: The y-axes represent the level of agreement that the respective benefit is received, is graded on a seven-point scale, where 1 = strongly disagree, and 7 = strongly agree. The 20 benefits are presented on the x-axes

Appendix 5. Balanced Scorecard Framework (Kaplan & Norton 1996)



* Adapted from Kaplan & Norton 1996. *The Balanced Scorecard*. Harvard Business School Press: 9. Original from HBR Jan/Feb 1996, p. 76.

Appendix 6. Common KPIs appearing in the literature

Demand	- Forecasting accuracy (product family) - Customer profitability - Volume / Sales growth - Gross margin - Order fill rates - Forecast accuracy (Revenue) - Order backlogs - Unfilled customer demand - Variance to baseline forecast and budget - Market share
Supply **Operations**	- Return on asset - Profitability - Revenue - Working capital - Inventory costs - Supply chain costs - Expected plant utilization - Production capacity shortages - Critical component shortages/surpluses - Line fill - Obsolete inventory - Inventory on hand - Expediting frequency - Stock-outs - Variance to standard costs - Quality utilization - Capacity utilization
Customer service	- Completed orders - Satisfaction
Finance	- Accuracy to monthly profit plan - Sales - Stock Price - Revenue - Profit - EPS - Inventory return - Market share - IRR - ROI - Cash-to-cash cycle - NPV - Gross margin

Appendix 7. Management Interview

Operational

What information management receives from operational S&OP?

What information management wants from operational S&OP?

Is the operational S&OP requirement for tactical S&OP?

For how long time-horizon operational S&OP produces information?

Tactical

What information management receives from tactical S&OP?

What information management wants from tactical S&OP?

For how long time-horizon tactical S&OP produces information?

For how long time-horizon should tactical S&OP produce information?

How often should tactical S&OP produce information?

Strategic

What information management receives from strategic S&OP?

What information management wants from strategic S&OP?

For how long time-horizon strategic S&OP produces information?

For how long time-horizon should strategic S&OP produce information?

How often should strategic S&OP generate information?

Finally

How do you see S&OP links business plan and strategic planning?

How well S&OP has filled this?

Appendix 8. Supply Interview

Information

How often other departments contacts storage in storage-related changes?

Who is responsible for operational, tactical and strategic storage planning?

What are the biggest information-related challenges that supply department faces?

What information should S&OP produce functionally from organization?

Resources

What are the realistic storage capacities?

What fractions can be monitored?

How often storage levels can be updated?

On what level inventory is done?

On what level could inventory be done?

Who could provide input data?

What are the boundary conditions?

What fractions are the most challenging?

What are the bottle necks of storage?

What is the time-horizon to storage planning?

How often storage planning takes place?

Where is the historical data available from storages?

Finally

What input data supply department provides for S&OP process?

What input data is supply department ready to provide?

What output does supply department wants from S&OP?

What challenges supply department has identified from S&OP?

What are the typical matters supply department brings forward to S&OP process?

Appendix 9. Production Interview

Information

How often other departments contacts plant?

Who are responsible for operational, tactical and strategic production planning?

What are the biggest information-related challenges which production department faces?

What information should S&OP produce functionally from organization?

Resources

What are the most challenging fractions?

On which level does production department have fraction-based capacity information?

Does production department measure utilized capacity?

What are the capacities of the storages of production department?

How often and on which time-horizon it is possible to forecast production planning?

What is the state of production planning and what it could be in the future?

Finally

How often and in what level production data is generated into ERP system?

What output does production department want from S&OP process?

What challenges production department has identified from S&OP?

What are the typical matters production department brings forward to S&OP process?

How decision should be monitored in S&OP process?

Appendix 10. Sales Interview

Information

How Sales contacts production department when orders change?

Who are responsible for operational, tactical and strategic sales forecasting?

What are the biggest information-related challenges which sales department faces?

What information should S&OP produce functionally from organization?

Forecasting

What are forecastable fractions?

How often sales forecasting takes place?

What is the forecasting time-horizon?

What is the forecasting level?

What are the forecasted customers?

Who does the forecasting?

How forecasting accuracy is monitored?

Does sales department apply both unconstrained and constrained forecasts?

Finally

How often and on what level does sales department generate information into CRM?

What output does sales department want from S&OP process?

What challenges sales department has identified from S&OP?

How monitoring should be arranged and improved in S&OP process?

What are the typical matters sales department brings forward into S&OP process?

Appendix 11. Enquiry of other environmental management factories

General:

How does your S&OP process link operational planning and strategy?

Which departments (Sales, Finance, R&D, SCM, Manufacturing, Marketing, etc.) in your company are linked to S&OP process?

What business units are participating into S&OP process?

What kind of challenges are delimited from S&OP process? (for example project business)

What is the lowest detail-level in your monthly S&OP planning (Product Family, Product Subfamily, Model/Type, Size, SKU)?

Demand:

How do you perform foreseeable predictions to S&OP?

Is sales department linked to S&OP, if yes how?

How do you manage Sales forecast?

How often does your S&OP update forecasts? (eg. Rolling monthly)

Does your company perform constrained, unconstrained or both forecasts?

What are statistical and judgmental forecasting roles in your S&OP process?

How well does sales forecasting reflects the actual income?

Supply:

How do you link treatment forecast to S&OP process?

How do you link logistics to S&OP process?

How do you manage inventory and inventory estimates?

How does your company link Resource Requirement Planning with S&OP process?

Financials:

How do you evaluate that your S&OP process reviews company’s performance and creates value?

What are measured in S&OP process?

Process:

Does your company have a structured S&OP process?

If yes, what is the structure of the process?

How do you prepare S&OP meeting information? Monthly preparing?

How many participators your Firm have in the monthly executive S&OP meeting? (final meeting)

From which departments are they?

What are the steps of the S&OP process structure in your company, please describe each step with few words?

IT:

What tools are used to manage S&OP process?

What tools are considered to be developed for the use of S&OP process?

Appendix 12. To-be state of S&OP process