FACULTY OF TECHNOLOGY

SALES & OPERATIONS PLANNING IN COMPLEX BUSINESS-TO-BUSINESS PLANNING ENVIRONMENTS

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ABSTRACT
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Abstract

Sales & operations planning (S&OP) is a tactical planning process to balance company's demand and supply. Increasing demand volatility has made S&OP very topical. Business-to-business (B2B) manufacturing with high product variation sets high requirements for S&OP processes and tools. Digitalization has created lots of hype around integrated business planning, which might have raised unjustified benefit expectations for S&OP deployment. In order to deploy S&OP process, it is important to recognize its core purpose and its plausible benefits, to avoid deployment failures caused by the lack of knowledge. This thesis aims to provide S&OP knowledge for complex business to business manufacturing. The qualitative research conducts literature review, and investigates tactical planning processes of three case companies, and current S&OP tool offering of five vendors through semi-structured interviews. From the aim of this thesis, three research questions were conducted:

RQ1: What are the desired outcomes of S&OP?
RQ2: What aspects of business are expected to be improved by S&OP process and tool deployment according to case companies?
RQ3: How do the identified S&OP process models and tools compare with the case companies' expectations?

Following answers to research questions were found:

RQ1:S&OP can be defined as a systematic tactical planning process to enhance collaborative target setting, vertical and horizontal integration, visibility creation, and performance management. By combining the different outcomes in different situations, the ultimate desired outcome seems to be the ability to consider all necessary factors in tactical planning. Answer to this research question is derived from the literature review, and it reflects to other research questions.

RQ2: Visibility creation, demand forecasting, supply planning, financial planning, scenario planning, internal collaboration, external collaboration, product portfolio management and after sales services were high level requirements derived from the case companies' specific expectations in the empirical study.

RQ3: Identified S&OP process and tools support the major parts of case company expectations, although when having a closer look of some of the case companies' specific external collaboration, and supply planning aspects, case companies have some unplausible expectations for S&OP tools.

Managerial implications: In the early phases of S&OP deployment, companies should mainly focus on designing the process, rather than tool consideration. Only after the suitable process is established, companies should utilize advanced planning tools. The tactical planning tool vendors might emphasize high customizability or high optimization capabilities. These aspects might be trade-offs which companies should be aware. Platform flexibility allows non-standard process designs, and industry specific S&OP practices enables optimization to maximize results by S&OP specific tools.

Scientific implications: This study investigates companies operating in B2B business that are utilizing make-to-order production strategy's variants. Study provides insights of companies planning environments requirements and their desired outcomes of S&OP deployments. Study pointed out the conflicts between S&OP methods and quick response make-to-order strategies in high product variety environments, which indicates that besides evaluating S&OP's design for planning environments at deployment, evaluation of S&OP methods' suitability to company specific strategies should be highly considered.

Additional Information

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Tiivistelmä

Sales & operations planning (S&OP) on taktisen suunnittelun prosessi yrityksen kysynnän ja tarjonnan tasapainottamiseksi. Kasvanut kysynnän vaihtelu on tehnyt S&OP:sta erittäin ajankohtaisen. Vaatimukset S&OP prosesseille ja työkaluille ovat korkeat, kun yritys valmistaa useita erilaisia tuotteita yritysmyyntiin. Digitalisaatio on kasvattanut kiinnostusta integroitua liiketoimintasuunnittelua kohtaan, minkä vuoksi S&OP:ta kohtaan on voinut syntyä katteettomia hyötyodotuksia. S&OP-prosessin käyttöönotossa on tärkeää tunnistaa sen päätarkoitus ja mahdolliset hyödyt, jottei implementointi epäonnistuisi tiedonpuutteen vuoksi. Tämän työn tarkoitus on tuoda tietoa S&OP:sta vaativissa yritykseltä-yritykselle-markkinan valmistusympäristöissä. Tässä kvalitatiivisessa tutkimuksessa koostetaan kirjallisuuskatsaus, tutkitaan kolmen case-yrityksen taktista suunnittelutoimintaa, sekä tutkitaan nykyistä S&OP-työkalutarjoamaa viiden järjestelmätoimittajan avulla. Case-yritykset ja järjestelmätoimittajat haastatellaan puolistrukturoiduilla haastatteluilla. Tutkimuksen tueksi on koostettu kolme tutkimuskysymystä:

TK1: Mitä ovat S&OP-prosessin odotetut hyödyt?
TK2: Mitä osa-alueita case-yritykset odottavat S&OP-prosessin ja työkalujen parantavan?
TK3: Kuinka tunnistetut S&OP-mallit ja työkalut tukevat case-yritysten parannusodotuksia?

Tutkimuskysymyksiin löydettiin seuraavat vastaukset:

TK1: S&OP voidaan määritellä systemaattiseksi taktisen suunnittelun prosessiksi, joka vahvistaa yhteistä tavoitteiden asettamista, vertikaalista ja horisontaalista integraatiota, näkyvyyden luomista ja suorituskyvynjohtamista. Yhdistämällä erilaisia mahdollisia hyötyjä erilaisissa tilanteissa, suurin tavoiteltava hyöty olisi kyky ottaa huomioon kaikki tärkeimmät lopputulokseen vaikuttavat osatekijät taktisessa suunnittelussa.

TK2: Näkyvyyden luominen, kysynnän ennustaminen, tuotannon- ja hankinnansuunnittelu, finanssisuunnittelu, skenaariosuunnittelu, sisäinen yhteistyö, ulkoinen yhteistyö, tuoteportfolion hallinta ja jälkimarkkinointi – palvelut ovat tunnistettuja ylätason osa-alueita, joita yritykset odottavat S&OP-prosessin ja työkalujen parantavan.

TK3: S&OP prosessit ja työkalut tukevat pääosin yritysten odotuksia, mutta yrityksillä on eräitä spesifisiä ulkoisen yhteistyön ja toimitusketjun suunnittelutoiminnan odotuksia, joita ne eivät tue.

Käytännön implikaatiot: S&OP-prosessien käyttöönottovaiheessa yritysten kannattaa ennemmin keskittyä prosessin suunnittelun, kuin työkalujen hankkimiseen. Vasta kun yrityksellä on vakiintunut S&OP-prosessi, yrityksen kannattaa pohtia kehittyneempien suunnittelujärjestelmien hankkimista. Suunnittelutyökalujen järjestelmäntoimittajat saattavat korostaa tuotteidensa räätälöityvyyttä tai optimointikyvykkyyttä. Välttämättä näiden molempien ominaisuuksien tuomia hyötyjä ei voida saavuttaa samassa järjestelmässä. Järjestelmän joustavuus sallii joustavamman rakenteen taktiseen suunnitteluprosessiin, kun taas optimointikyvykkäät järjestelmät nojautuvat toimialan suositeltuihin S&OP-prosessimalleihin.

Tieteelliset implikaatiot: Tutkimus esittelee kompleksisissa ympäristöissä toimivien yritysten tarpeita S&OP-prosessille. Tutkimuksessa todettiin ristiriita nopean asiakasvasteen strategian, ja S&OP-metodien välillä, kun yrityksen tuotetarjoama on erittäin suuri, ja kaikki valmistettavat tuotteet ovat asiakasspesifisiä. Tämä viittaisi siihen, että toimivaan S&OP-prosessin rakenteeseen ei vaikuta voimakkaasti vain suunnitteluympäristö, vaan myös yrityksen strategia.

Muita tietoja

PREFACE

This thesis was conducted between October 2020-March 2021 for Reboot IoT Factory research project, and it is an one outcome of collaboration between universities and industrial companies. From University of Oulu, I would like to express my gratitude to my supervisors; D.Sc. Osmo Kauppila and D.Sc. Jukka Majava, who gave their support to me to conduct this research. Insightful discussions with you always gave me confidence to coordinate this research in a right way. Great thanks for all of the company representatives, your solid industrial experience drived this research to focus on correct issues and discussions with you emphasized the universality of the need for internal collaboration.

This thesis is final part of my Master's studies, and I would also like to thank everyone who supported me during my studies, you know who you are. Special thanks to Eve. Last, but definitely not the least - mom, dad, and Ville, thank you.

In Oulu, 21.4.2021 Jussi Keränen

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LIST OF ABBREVIATIONS

AI	Artificial intelligence
APS	Advanced planning system
BI	Business intelligence
BOM	Bill of materials
B2B	Business-to-Business
CTO	Configure-to-order
DPT	Demand planning tools
ERP	Enterprise resource planning
ETO	Engineer-to-order
IT	Information technology
IS	Information systems
KPI	Key performance indicator
MPS	Master production schedule
MTS	Make-to-stock
MTO	Make-to-order
NPI	New product introduction
SIT	Sales input tools
S&OP	Sales and operations planning

1 INTRODUCTION

1.1 Background

Sales and operations planning (S&OP) is a process to develop and refine production and sales targets (Grimson & Pyke 2007). The S&OP process combines sales, marketing, development, manufacturing, sourcing, purchasing and financial plans into one integrated set of plans. In other words, it is the definite statement of the company`s plans for the near to intermediate term. Executed properly, the S&OP process links the strategic plans for the business with its execution, and measures business performance for continuous improvement. (Pittman and Atwater 2019).

Information technology (IT) is considered as an enabler of advanced S&OP processes (Grimson & Pyke 2007, Damese et al. 2018, Wagner et al. 2014) and a coordination mechanism to control and support the S&OP process (Tuomikangas and Kaipia 2014, Goh & Eldrige 2019, Kristensen & Jonsson 2017). Milliken (2008) argues that most of enterprise resource planning systems (ERP) do not support S&OP planning, and companies are using spreadsheet-tools for their S&OP planning. Grimson and Pyke (2007) visioned that highly advanced IT-tools are required in the fully integrated stage of S&OP. 14 years ago, suitable tools were not available (Grimson & Pyke 2007). Today, advanced digitalization has made S&OP a very hot topic.

This research is conducted for Reboot IoT Factory project, which consists of Finland's top industrial companies and research organizations. The ultimate goal of Reboot IoT factory is to create totally new types of smart products, factories and supply networks to Finland, in which the possibilities offered by IoT are not only taken into account in the manufactured products but also in the production and supply network processes.

1.2 Research problem, objectives and scope

Increasing volatility in demand has made S&OP very topical. Business-to-business (B2B) manufacturing with high product variation sets high requirements for S&OP processes.

Digitalization has created lots of hype around integrated business planning, which might have raised unjustified benefit expectations for S&OP deployment. S&OP practices are always case specific (Kristensen & Jonsson 2017), but a lack of understanding of S&OP's purposes and methods tends to lead to implementation failures (Milliken 2008). In order to deploy a S&OP process, it is important to recognize its core purpose and its plausible benefits, to avoid deployment failures caused by the lack of knowledge. Three Reboot IoT Factory case companies participated in this study to gain knowledge for improving their tactical planning capabilities. This thesis aims to provide S&OP knowledge for B2B companies operating in complex production environments in which variants of make-to-order (MTO) production strategies are used. From aim of the thesis, three research questions were presented:

RQ1: What are the desired outcomes of S&OP?

Literature review is conducted to answer this research question. The target is to identify a S&OP process model and diverse aspects that are pursued in S&OP planning.

RQ2: What aspects of business the case companies expect to be improved by S&OP process and tool deployment?

Answer to this research question is based on case company interviews in empirical part of this thesis. Target is to understand what kind of needs companies planning environment creates for planning and how the case companies fathom the S&OP.

RQ3: How do the identified S&OP process models and tools compare with the case companies' expectations?

RQ3 aims to analyze whether the companies' expectations could be fulfilled by the identified S&OP processes and tools. Further data regarding this research question was collected through interviewing five S&OP tool vendors.

1.3 Research methods and approach

According to Bryman & Bell (2007, p. 62) the basic case study "entails the detailed and intensive analysis of a single case". Multiple-case study designs are extension of basic case study designs, and are common in business and management research since they allow researchers to compare and contrast the findings deriving from multiple cases. Multiple-case study enables recognition of unique aspects and common aspects across cases. (Bryman & Bell 2003, p.64). At S&OP research, it needs to be understood that benchmarked processes cannot be taken at face value as best for all companies, since each S&OP implementation is unique and based on a company's business environment coupled with its intended strategies, operating model and operational performance objectives (Lapide 2005). The inductive research approach emphasizes collection of qualitative data, concerning the contexts of events taking place (Saunders et al. 2009, p. 126-127, 590).

This inductive research conducts multiple-case study to examine planning processes of three different companies and S&OP tool offering of five different vendors. Data for process analyses is gathered from semi-structural individual interviews, focus group interviews and by utilizing the case companies' process descriptions from the thesis by Kallio (2020). Data for S&OP tool analyses is gathered for semi-structured individual vendor interviews.

Structure of the thesis is presented in Figure 1. The introduction chapter provides background information of topic, defines research problem, and sets research questions. The literature review provides a theoretical background for inspecting S&OP processes and provides information to answer RQ1. Empirical study presents the case companies current states and desired states, identified S&OP tool vendors, and their technologies. Empirical study's benchmark provides information to answer RQ2. The discussion part presents the S&OP tool analyses and discusses case companies S&OP improvement possibilities, and thus provides information related to RQ3. Also, the scientific and managerial implications of this study are presented, and study is critically evaluated in discussion chapter. The final part presents the key results by providing compressed answers to research questions and presents recommendations for further studies.

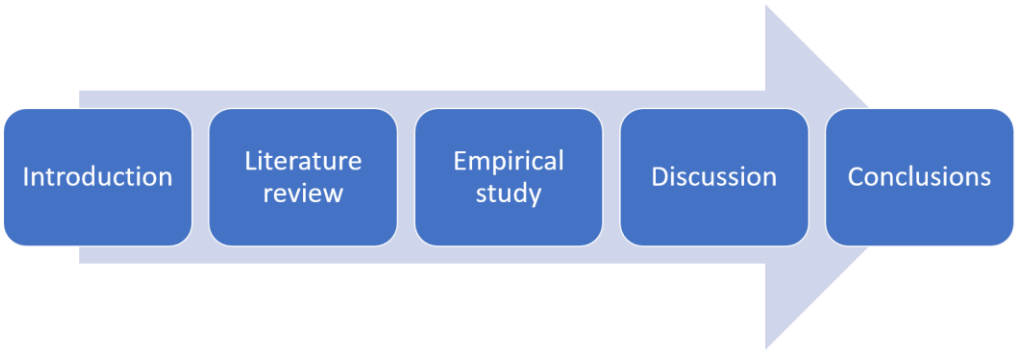

Figure 1: Thesis structure

2 LITERATURE REVIEW

2.1 Planning and S&OP

Planning can be inspected in strategic level, tactical level, and operational level. Each planning level covers a certain length of time, called planning horizon. Strategic planning level has the longest planning horizon, and it sets the frames and constraints to tactical planning level. Constraining factors could be manufacturing processes or production facilities' capacities. Tactical planning adjusts the production, inventory, and sales levels within the constraints, and operational level planning aims to make the best use of the available capacity and resources. (Bozarth & Handfield 2019 p. 320-321) Companies' business plans have roughly the same planning horizon as tactical planning. A business plan is a projected statement of income, costs and profits and it reflects plans for market penetration, new product introduction (NPI) and capital investments (Krajewski & Ritzman 1999 p. 599). S&OP is a tactical planning method to bridge business and strategic plans into operations (Thome et al. 2012). S&OP aims to balance demand and supply and provide early warning signals when they are becoming unbalanced (Vollman et al. 2005 p. 61)

S&OP is a process to develop tactical plans to strategically direct business by bringing together sales, marketing, development, manufacturing, sourcing and financial plans into one integrated set of plans (Pittman & Atwater 2019). S&OP plans are mainly constrained by finance and operations capacity (Thome et al. 2012). Sales & Operations planning is sometimes called demand management (Crum & Palmatier 2003, p. 2, p. 49) or aggregate planning (Bozarth & Handfield 2019 p. 320). Term aggregate planning is used especially in older literature (Krajewski et al. 2013 p. 529, Krajewski & Ritzman 1999 p. 597). Aggregate plans focus on a general course of action which is directed by strategic goals and objectives. Aggregation is done in product families, production rates, work-force levels, inventories, and capacities. In the context of S&OP and forecasting, product families consist of products that have similar demand requirements and similar material, labor, and processing requirements. Aggregation in tactical planning level is recommended because it is considered more economical than detailed planning.

(Krajewski & Ritzman 1999 p. 597). The aggregation is done in order to allow sales and operations departments to share their information in needed accuracy. Ability to define correct aggregation levels could have great direct impact on S&OP performance. When confronting high volumes and diversity, aggregation relieves planning. If the aggregation is too abstract, the aggregated information has no reference of product mix or lower-level items, and large portion of supply constraints are hidden, which leads to unfeasible plans. (Ghrab & Sali 2019).

2.2 Cross-functionality in S&OP

In the S&OP, tactical planning is done cross-functionally. Traditionally these functional areas specialize in different planning activities which can result conflicts in expectations for the use of organizations resources (Harrison et al. 2014 p. 270). According to Krajewski & Ritzman (1999), planning goals that typically could be conflicting against each other are:

- Minimize costs
- Maximize profits
- Maximize customer service
- Minimize inventory investments
- Minimize changes in production rates
- Minimize changes in work force levels
- Maximize asset utilization

S&OP processes are designed for collaborative decision making for seeking the balance between the conflicting goals to produce tangible plans (Krajewski et al. 2013 p. 534, Krajewski & Ritzman 1999 p. 601, Bozarth & Handfeld 2019 p. 321). Balancing the objectives requires consideration of various alternatives by both sides, demand, and supply. The basic types of balancing actions can be classified to reactive and aggressive alternatives. Reactive alternatives are supply sides attempts to adjust to given demand and aggressive alternatives are demand side's attempt to adjust demand more suitable for supply side. (Krajewski & Ritzman 1999 p. 601)

S&OP planning typically includes top-down and bottom-up information flows. Information flows top-down, when strategy and business plans set the frames and goals for aggregate planning, and aggregate planning sets targets for master production scheduling (MPS). If the feasible master production schedule cannot be developed, the information flows bottom-up for requesting aggregate plan adjustments. Also, if the aggregated plans cannot meet the goals of business plans, the business plans adjustments are requested. (Krajewski & Ritzman 1999 p. 600). If the manufacturing requirements between different products are very similar, bottom-up information flow is minor because constraints could be checked quite accurately at aggregate level. If the manufacturing requirements between the products differs a lot, bottom-up information flow is emphasized in constraint checking (Bozath & Handfield 2019, p.322-329).

S&OP produces plans for cross functional departments. Wagner et al. (2014) classified outputs of S&OP in supply side plans, financial plans and demand-side plans. Supply-side plans include sourcing plans, manufacturing plans and inventory plans. Financial plans included budgeting, investment plans and cash flow plans. Demand-side plans include sales forecast, marketing plans and product life cycle plans. (Wagner et al. 2014). By considering top-down and bottom-up information flows, and cross functional planning, S&OP process emphasizes vertical and horizontal integration (Figure 2).

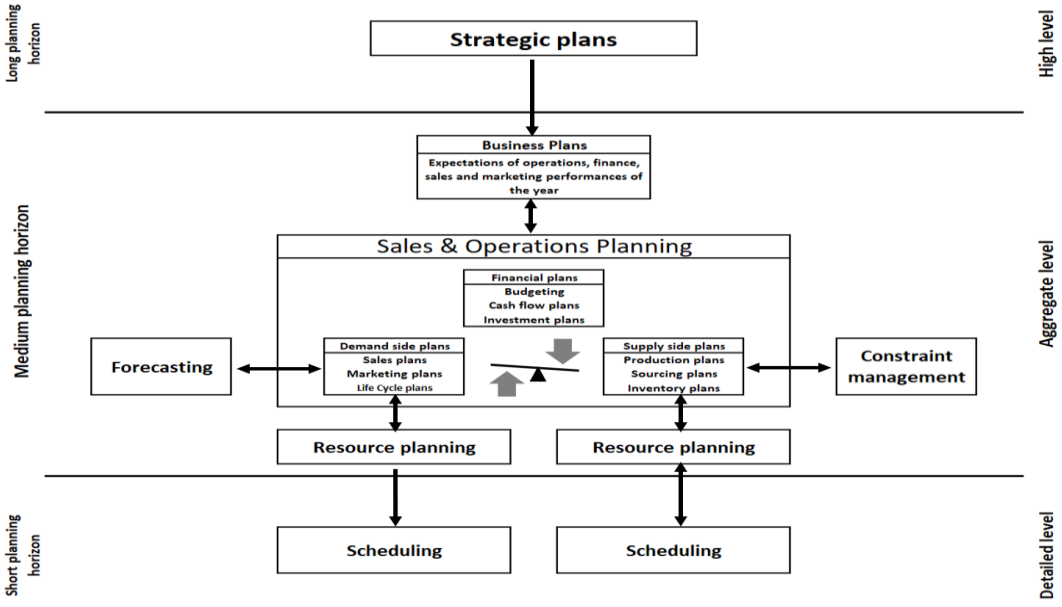

Figure 2: Vertical and horizontal integration in S&OP process (Adapted from Krajewski et. al. 2013, p. 530).

2.3 S&OP process and its sub-processes

S&OP process is typically performed in monthly frequency for 12- 18 months rolling planning horizon to develop integrated set of plans that are aligned with strategic and business plans (Grimson & Pyke 2007). Although the perception of the process steps slightly varies in literature, it can be interpreted that demand forecasting, supply planning, and the S&OP meetings are main process steps in S&OP (Figure 3). In this process, activities such as data gathering, performance reviews and meetings are performed. (Lapide 2004; Grimson & Pyke; 2007; Kjellsdotter Ivert & Jonsson 2010; Wagner et al. 2014; Hulthen et al. 2016).

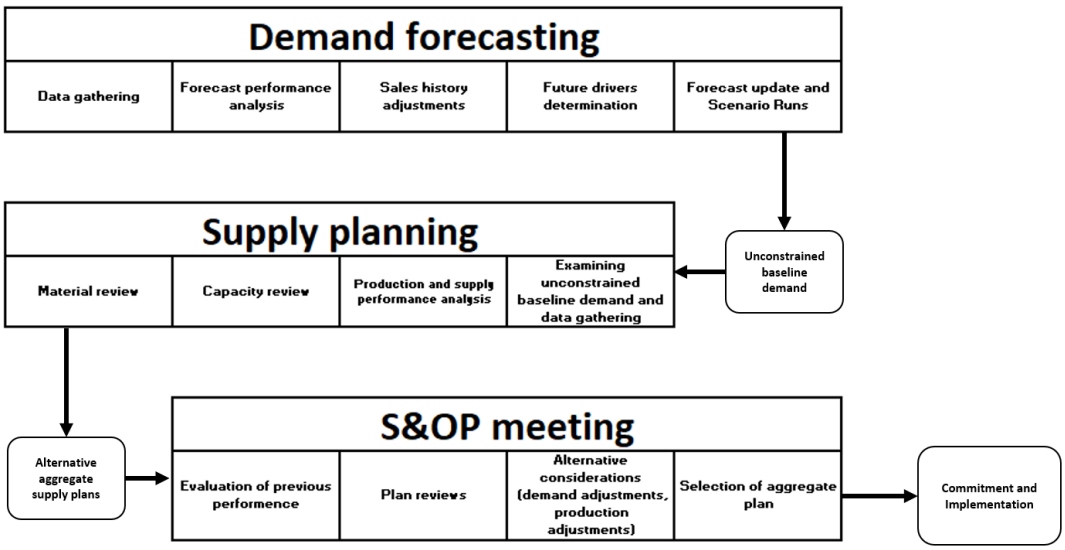

Figure 3: S&OP process (Adapted from Harrison et al. 2014 p. 272)

Hulthen et al. (2016) emphasized the importance of the monitoring data quality and comprehensiveness. They argue that data quality, which can be inspected by characteristics such as reliability, timeliness and availability and standardization of the measures, is vital for well performing S&OP. Study of Ambrose & Rutherford (2016) indicates that poor information quality disturbs S&OP effectiveness and also decreases S&OP teams' ability to achieve genuine collaboration. According to Grimson & Pyke

(2007) performance measurement is essential for S&OP process monitoring and continuous improvement. Various different performance measures could be created for production, NPI, sales and finance. Suitable S&OP measures vary by industry, manufacturing processes, and product lines (Grimson & Pyke 2007). Data gathering and performance reviews can be found in every sub-processes of suggested process models by Wagner et al. (2014), Hulthen et al. (2016) and Grimson & Pyke (2007).

2.3.1 Demand forecasting

First sub-process of the S&OP is demand forecasting or demand planning, which is performed by sales and marketing teams. The goal of the demand planning is to produce consensus-based unconstrained baseline demand forecast which considers firm orders and forecasts (Lapide 2004; Grimson & Pyke 2007; Wagner et al. 2014; Hulthen et al 2016). Grimson & Pyke (2007) emphasizes that good demand plan captures what could be sold to customers, not what it could produce. It is important to consolidate all known factors that influences demand, for example promotions, advertising, NPIs and product obsolescence, in baseline demand (Lapide 2004; Grimson & Pyke 2007; Wagner et al. 2014, Hulthen et al.2016), because baseline demand forms a working-draft from which final supply and demand plans are developed (Lapide 2004).

Forecasting methods (Figure 4) can be segmented to quantitative methods and judgmental methods (Krajewski et al. 2013, p. 490-492). Understanding the characteristics and nature of the demand is vital for forecasting (Grimson & Pyke 2007; Croxton et al. 2002). This knowledge enables product segmentation and correct forecasting method selection (Croxton et al. 2002). For example, Kathrein-Werke KG antenna systems manufacturing company segmented their products by volume and by the volatility of demand. Company conducts forecasting technics to high volume products, safety stocks to medium volume products and set up make-to-order process to slow volume products for which forecasting technics would be ineffective. This helped the company to balance production, identifying different delivery times to different categories, and utilizing the possible surplus time to safety stock products production. (Lindert 2019) Demand characteristics could be recognized by observing patterns in demand data. According to Krajewski et al. (2013 p. 485) five basic patterns in demand data are:

- horizontal – fluctuation of data around a constant mean
- trend – systematic increase or decrease in the mean of the demand data
- seasonal – repeatable pattern of increases or decreases in demand data, depending on the day, week, month, or season
- cyclical – less predictable gradual increases or decreases in demand over longer periods of time
- random – unforecastable variation in demand data

Demand time series could comprise any combination of these five patterns. Krajewski & Ritzman (1999) claim that the ability to make reasonable long-term forecasts depends on accurate estimates of cyclical patterns. Cyclical demand patterns may rose arise from economic cycles. Economic cycles are hard to forecast because they are affected by national or international events. They are also external factors that are beyond management's control. Cyclical demand patterns can also arise from product or service life cycle. Internal factor affecting the demand patterns could be decisions about product or service design, price and advertising promotions, salesperson quotas or incentives, and expansion or contraction of geographic market targets. (Krajewski & Ritzman 1999 p. 493-495).

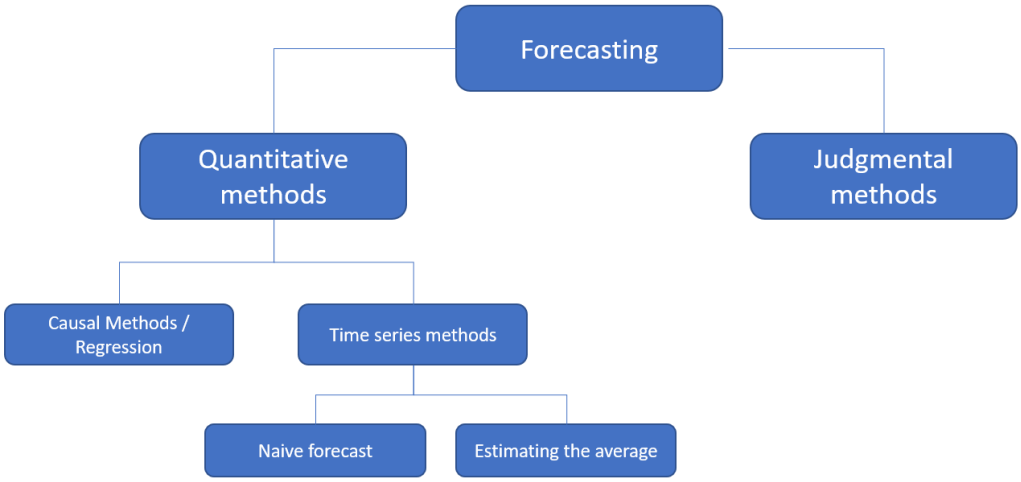

Figure 4: Segmentation of forecasting methods

Many authors emphasize the importance of tracking and analyzing the forecast error (Croxton et al. 2002; Wagner et al. 2014; Hulthen et al 2016). Tracking the error provides possibility to fine-tune the forecasting methods and improve future forecasts through root-cause analysis. Root-cause analysis is performed by tracing the source of the unexpected demand or shortage of demand. Root cause could be for example particular customer, product group or region. When the source is identified it is vital to determine how long the change in demand will last (Croxton 2002).

2.3.2 Supply planning

Next S&OP sub-process is supply planning (Grimson & Pyke 2007; Wagner et al. 2014; Hulthen et al. 2016).). Supply teams gather information about inventory strategy, supply chain capacity and operations capacity, and use baseline demand forecast to develop new supply plans considering backlogs, inventories, capacities, and desired load profiles. (Grimson & Pyke 2007; Wagner et al. 2014, Dilworth 1996 p. 426-428). Since the S&OP provides targets to mid-term supply chain planning activities, which according to Fleischmann et al. (2015) are considering aspects of: distribution, production, personnel, and materials, should the tangible S&OP supply planning reveal, is any of these aspects restricting the fulfillment of the baseline demand forecasts (Bagni & Marcola 2019). Output of the supply planning phase is the rough-cut capacity plan to meet the baseline sales forecast (Lapide 2004; Grimson & Pyke 2007; Wagner et al. 2014; Hulthen et al. 2016). Development of tangible S&OP plan requires bottom-up information flow which requires using shorter-term planning methods and tools in certain accuracy (Figure 5). For example, bill of materials (BOM) is fundamental building block in long-term planning as well as short-term operations scheduling (Wacker & Miller 2000).

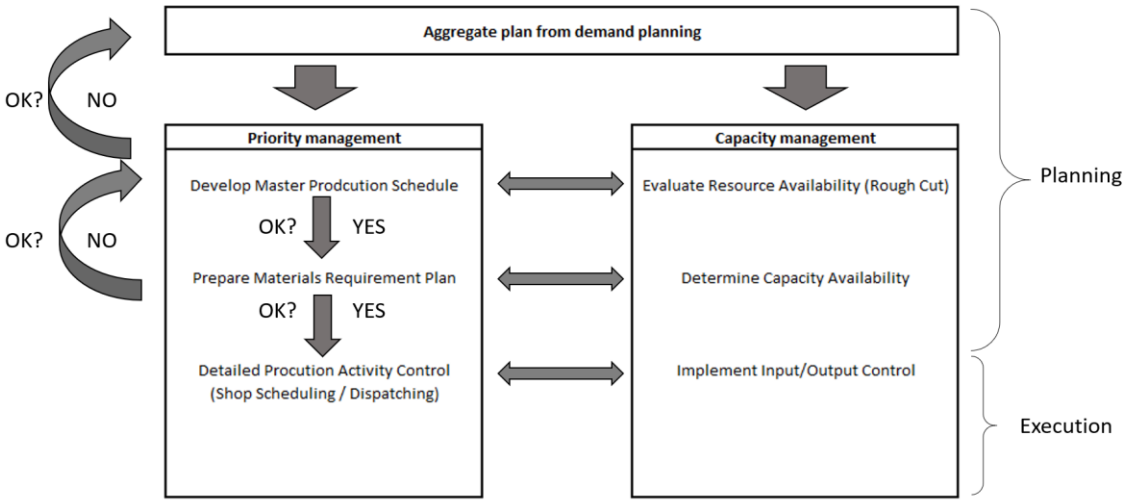

Figure 5: Information flows in supply planning (Adapted from Wacker & Miller 2000)

In CTO environments, companies must plan their operations before BOM's are completely specified. CTO companies utilize planning BOM's that are changed constantly. Although each CTO product is substantially different, product families share some common material and labor requirements. Key thing in CTO planning process is to identify product family configurations' long lead time items, medium lead time items, and short lead time items in order to design suitable time periods for product configuration confirmation stages. (Wacker & Miller 2000) In CTO environment, significant revenue and serviceability improvements can be achieved by correctly accounting BOM's configuration uncertainty in planning. (Chen-Ritzo et al. 2010).

2.3.3 S&OP meeting

Final phase of S&OP process is S&OP meetings, in which different balanced planning scenarios are evaluated. Typically, it is suggested to have pre-meeting for scenario creations and executive review meeting for gaining the top managements acceptance. S&OP meeting leads to common agreement and commitment to upcoming plans. Cross functional participation of finance, operations and sales representatives in scenario creation is emphasized in the literature (Lapide 2004; Grimson & Pyke 2007; Wagner et al. 2014; Hulthen et al. 2016.). The financial reconciliation is seen as an important part of S&OP meetings (Lapide 2004; Grimson & Pyke 2007; Wagner et al. 2014; Hulthen e al.

2016). Hahn & Kuhn (2011) and Croxton et al. (2006) suggested to evaluate financial outcomes of different scenarios by using decision trees (Figure 6). Hahn & Kuhn (2011) emphasized especially inspection of plans' effects on operating profit margin, asset utilization and operational cash flow by examining sales and production volumes, inventory and transportation quantities, overtime needs, and total amount of cash, accounts payable and accounts receivables.

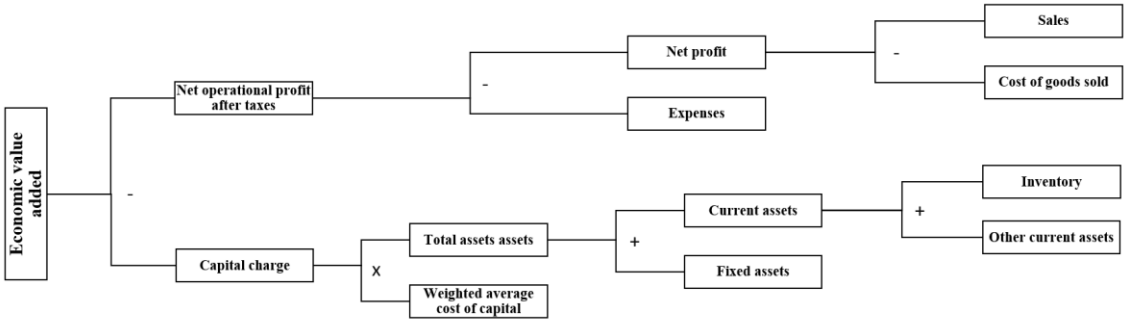

Figure 6: Decision tree (Adapted from Hahn & Kuhn 2017, and Croxton et al. 2006)

Even though the balance between sales and operations is the core aspect in S&OP, it has been noted that sales forecasts are often assumed as fixed uncontrollable inputs that are rarely requested to be adjusted (Croxton 2006; Lapide 2004) and operations are put on a burden to meet the demand (Grimson & Pyke 2007) Tuomikangas & Kaipia (2014) suggests to monitor the balance of the plans, because of the conflicting functional goals. However, Hulthen et al. (2016) argue that literature has the lack of example indicators for this monitoring purpose and the companies face difficulties on defining proper measures. Abrose et al. (2016) suggested to seek balance by tying a portions of sales managers' financial incentives to inventory management goals and operations managers financial incentives to fill rates and customer satisfaction goals.

2.3.4 Balancing actions

Scenarios for balancing the supply and demand, involves consideration of various alternative actions. Alternative actions can be classified as supply side's reactive actions and demand side's aggressive alternatives. Supply side's options to respond the uneven demand could be work-force adjustments, undertime and overtime, vacation schedules, subcontractors, outsourcing, backlogs, and anticipation inventories. Workforce adjustments can often produce ethical issues and costs especially if company uses lots of temporary or overtime workforce. Anticipation inventories and subassemblies can stabilize work-force level or output rates, but this approach can be expensive. Backlog is an accumulation of customer orders promised to deliver at future. Backlogs reduce production uncertainty, and it could be a mechanism to level production requirements. If backlogs increase a lot, they become competitive disadvantage because of long delivery times. Backorders are customer order delays and stockouts are refused customer orders which generally are to be avoided. Sometimes planned backorders or stockouts could be used if the cost of using reactive and aggressive alternatives is greater than expected customer goodwill and revenue losses. (Krajewski & Ritzman 1999 p. 602-603)

Aggressive alternatives are sales departments actions for demand leveling (Krajewski & Ritzman 1999 p. 603). Croxton (2006) argues, that companies focus often on dealing with the consequences of demand variability, and usually aggressive alternatives of demand planning are not considered. Demand management focuses on influencing the timing and volume of demand. Timing of demand could be extremely important factor for efficient resource and production capacity utilization. Demand management mechanisms could consider price incentives, advertising promotions and the delivery schedule adjustments (Krajewski & Ritzman 1999, p. 495). Croxton (2006) recognized that credit terms, minimum order quantities and long distribution channels could affect in timing and volume of demand. He mentions that supply flexibility increases companies' ability to confront demand variability, but supply flexibility increasement is often expensive. It is important that the level of flexibility developed is consistent with the needs of supply chain (Croxton 2006). In well performing S&OP, various combinations of reactive and aggressive actions are utilized in order to produce optimal final operating plan (Krajewski & Ritzman 1999 p. 605)

2.4 S&OP coordination

Organizations can only sustain performance outcomes by effectually coordinating internal processes to consistently fulfil customer needs (Swaim et al. 2016). Tuomikangas & Kaipia (2014) conducted a S&OP coordination framework model of tools and practices for connecting different functional areas and planning levels. They identified six coordination mechanisms:

- S&OP organization
- S&OP process
- S&OP tools
- Performance management
- Strategic alignment
- S&OP culture & leadership.

Culture of commitment, trust, empowerment, collaboration and leading by example improves the coordination of S&OP. S&OP tools are introduced as coordination mechanisms by capturing, sharing, storing, and refining data for decision making Performance management is a S&OP coordination mechanism to ensure reaching the business targets. Strategic alignment is S&OP coordination mechanism to ensure reaching strategic targets. Authors suggest establishing a formal organization structure and standardized process to set up decision making authorities and decision-making practices (Tuomikangas & Kaipia 2014)

Goh & Eldridge (2019) studied effects of coordination mechanisms presented by Tuomikangas & Kaipia on supply chain performance. They perceived “Supply chain performance” as a variable indicated by fill rate, inventory levels, lead time and flexibility. In their large survey (N=568) they concluded that strategic alignment had the strongest positive effect on supply chain performance. Tools, S&OP organization and culture also had significant positive effects on supply chain performance. Study revealed also that tools bring more value when product variety is large. Surprisingly, the strict standard S&OP procedures and schedules have negative relationship with supply chain performance. Because of that Goh & Eldridge suggested that organizations ability to re-

organize routines and reordering, could be the coordination mechanism that replaces strict processes. (Goh & Eldridge 2019) Grimson & Pyke (2007) and Danese et al. (2018) visioned that in highly mature S&OP processes event driven meetings would supersede standard processes, but to achieve this stage, standard processes have to be established first.

2.5 Integration and optimization

Top down -planning scenario, where sales planning process is carried out centrally, and supply chain activities to meet the demand are planned separately, is called decoupled planning approach (Feng et al. 2008; Nemati et al. 2016). Decoupled approach in S&OP planning reduces complexity in decision making (Feng et al. 2008), but as the case studies of Feng et al. (2008) and Nemati et al. (2016) indicates, decoupled approach can often result in sub-optimal decisions, and especially in multi-site production environments approach often do not yield the best economic return. (Feng et al. 2008; Nemati et al. 2016) According to Feng et al. (2008) companies are moving from decoupled planning towards more coordinated and integrated supply planning to reduce total costs, improve performance and increase service levels.

Feng et al. (2008) and Nemati et al. (2016) compared results of decoupled approach to more integrated planning approaches in their multi-site operations research studies. Feng et al. (2008) applied models to MTO company in oriented strand board business and Nemati et al. (2016) applied models to company dairy company. Both companies had multiple factories, multiple distribution centers and they are serving multiple customers. Both companies offered contracted sales that needs to be fulfilled and non-contract sales that can be cancelled. Feng et al. (2008) and Nemati et al. (2016) created three types of optimization models. First is decoupled model which had separated sales, production, distribution, and procurement planning. Second model balanced sales and production jointly, and distribution and purchasing costs where optimized locally in each factory. Feng et al. (2008) called their model Sales-production planning -based S&OP and Nemati et al. (2016) called similar model Partially Integrated S&OP model. Third model seeks overall total optimization of sales, production, distribution, and procurement. Feng et al. (2008) called this model Supply-chain-based S&OP and Nemati et al. (2016) called the

model Fully Integrated S&OP. The models were tested in sensitivity analysis to inspect what happens if demand, production costs, purchasing costs, transportation costs or inventory costs changed. The overall benefits in sensitivity analyses compared profit, revenue and total cost of production, distribution, and procurement. In both studies, decoupled approaches had lowest profit. Fully integrated model by Nemati et al. (2016) gained 7,3% higher profit than decoupled model, and 1% higher profit than partially integrated model. Supply-chain-based S&OP model by Feng et al. (2008) gained 1,9 % higher profit than decoupled model, and 0,9 % higher profit than Sales-production planning-based S&OP. In sensitivity analyses, highest benefits of integrated systems compared to decoupled systems were gained when the marked price dropped down or demand increased. (Feng et al. 2008; Nemati et al. 2016).

Study by Alfonso & Rutherford (2016) indicates that centralization and moving away from autonomous decision making could impact S&OP effectiveness primarily through the collaboration it fosters. It has been suggested, that in more advanced S&OP processes not only internal operations are integrated in the decision making but the main suppliers and customers should participate in parts of planning (Grimson & Pyke 2007; Danese et al. 2008). Nakano (2009) examined the impact of internal and external collaborative forecasting and planning on logistics and production by structural equation modeling of 65 survey answers from Japanese companies. Study indicates that internal collaborative forecasting and planning is experienced improving logistics and production performance. Research did not find any evidence that collaborative forecasting and planning with customers or suppliers would have been felt influencing companies' production or logistics performance. (Nakano 2009).

2.6 Planning Environment

S&OP processes has been established in various industries (Swaim et al. 2016). Still, there are no "one size fits all" S&OP practices (Goh & Eldridge 2019). Kjellsdotter Iverts et al. (2015) stated that S&OP process needs to be adapted to the unique planning environment of each company. Planning environment embodies the characteristics of products, manufacturing processes, supply network and demand in which planning methods are applied (Jonsson & Matsson 2009; Kjelssdotter Ivert et al. 2015a;

Kjelssdotter Ivert et al. 2015b). Planning environments are forcing businesses to utilize different production planning strategies, such as level production, chase production and mixed production strategies. The goal of level production strategy is to maintain constant production rate by using inventories to absorb differences between supply and demand. A level approach is typical when changing the production rate is either extremely expensive, or very difficult to perform. compared to the possibility to hold inventory. At chase production approach, production is adjusted in each time to match forecasted demand. Typically chase planning approach is used when holding inventory is more expensive than adjusting the production levels. Some environments force the companies to use chase planning approach, for example service business environments. Mixed planning approach is mixture of chase and level plans. (Krajewski & Ritzman 1999, p. 605, Bozarth & Handfield 2019, p. 325)

Especially planning environments that have high NPI frequency, high demand uncertainty, high service levels, high supply uncertainty and high product site complexities creates a need for S&OP. Suitable S&OP setup and S&OP process parameters depends on planning environment. S&OP setup considers planning object (stock keeping units or product group), planning frequency and planning horizon. S&OP process parameters follows typical classification of inputs, activities and outcomes. Supply and demand uncertainty affects planning frequency and inputs of S&OP process. Supply uncertainty, which includes material supply uncertainty and production uncertainty affects also planning horizon and S&OP activities. Production network complexity does not affect the S&OP setup, but it affects the inputs and outcomes of S&OP process by making deliveries, data collection and plan distribution more complex. Product launches can affect on S&OP setup by changing planning objective from product family level to SKU level. (Kjelssdotter Ivert et al. 2015a; Kjelssdotter Ivert et al. 2015b) Dynamic complexity, which is the entirety of supply and demand uncertainty, increases the need for vertical and horizontal coordination and requires scenario planning and risk management practices in S&OP. Detail complexity, in terms of multiple sales units and production process steps, can generate need for extra sub-processes. Sometimes, there are more than one S&OP processes that are parsed together because of high detail complexity. Companies that have high detail complexity experience higher operational benefits from successful S&OP deployment. (Kristensen & Jonsson 2017).

2.7 S&OP maturity

Maturity models presents a simple but effective way to measure the quality of processes. First maturity model concepts were developed for software development and software engineering, but the field of maturity models has widened, and nowadays there are very broad and general applicability of the maturity concept in process analysis. Many maturity models lack sufficient validation and practitioners should fall back on well validated models. (Wendler 2012)

Lots of models have been created for evaluating S&OP processes maturity. (Lapide 2005, Grimson & Pyke 2007, Wagner & Uhlrich 2014, Danese et al. 2017, Bagni & Marcola 2019) The Grimson & Pyke model has been considered a point of reference on S&OP maturity models (Denese et al. 2019). Grimson & Pyke (2007) composed a 5-stage model based on research literature and interviews of wide array of companies (Table 1) Model by Grimson & Pyke (2007) emphasizes vertical and horizontal integration to achieve higher profitability. Grimson & Pyke (2007) emphasize a top management participation in S&OP meetings. Ambrose (2018) argued that executive managements function in S&OP is to monitor commitment level in S&OP teams and hold teams accountable for using correct information sources and procedures.

Table 1: S&OP maturity model (Adapted from Grimson & Pyke 2007)

	Stage 1 - No S&OP	Stage 2 - Reactive S&OP	Stage 3 - Standard S&OP	Stage 4 - Advanced S&OP	Stage 5 - Proactive S&OP
Meeting & collaboration	Silo culture No meetings or collaboration	Discussed at top level management meetings Focus on financial goals	Demand review, supply review and executive S&OP meetings Some supplier and customer data	Supplier & customer data incorporated Key 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	S&OP is part of other position (product manager, supply chain manager)	Formal S&OP team Executive participation	In entire orgaization, S&OP is understood as core business process
Measurements	No measurements	Measures on-time-deliveries	Stage 2 plus: Sales forecast accuracy measured	Stage 3 plus: New product introduction related measures S&OP effectiveness measures	Stage 4 plus: Company profitability
Information technology	Individual managers keep own spreadsheets No consolidation of information	Many spreadsheets Consolidation done manually	Centralized information Revenue or operations planning software	Revenue & operations optimization software S&OP workbench	Integrated S&OP software, full interface with ERP, accounting, and 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

Damese et al (2018) conducted their maturity model (Table 2), for the research of evolutionary paths between S&OP maturity stages. Damese et al. (2018) used Grimson & Pykes (2007) as a basis of their model and thus a lot of similarities can be found

between the models. Damese et al. (2018) model positions some performance metrics to standard stage that have been positioned in 11 year earlier represented Grimson & Pyke model (2007) as a advanced metrics. Also, IT tools requirements are more clarified in the newer version. Damese et al. (2018) model and Grimson & Pyke (2007) model emphasizes the participation of partner companies in certain parts of planning, but research of collaborative planning indicates that have not experienced their external joint planning actions improving production and logistics performance (Nakano 2009)

Table 2: S&OP maturity model (Adapted from Damese et al. 2018)

	Stage 1 - No S&OP	Stage 2 - Reactive S&OP	Stage 3 - Standard S&OP	Stage 4 - Advanced S&OP	Stage 5 - Proactive S&OP
People and organization	Lack of sponsorship from business executives No S&OP team Silo Culture	Some collaboration between sales and operations No definition of responsibilities	New planning culture with non-dedicated S&OP team Clear roles and responsibilities Excellent commitment	Form S&OP team with executive participation Collaboration with main customers and/or suppliers Personnel skill development	S&OP process owner coordinates entire network Participation of top management of all partnering companies
Process and methodologies	No formal S&OP process Frequent re-planning and revenue focus	Emerging but still inconsistent process No financial integration	Formalised and structured process with regular meetings Financial integration	Process balanced with the external network partners Demand and supply plans jointly aligned	Dynamic process Event-driven meetings
Information technology	Individual managers keep own spreadsheets No consolidation of information	Many spreadsheets or functional solutions Some consolidation, but done manually	Integrated demand and supply planning platform Improved data rationalisation and integration capability	Technology to access external partner data and capability to share information with them	Innovative technology to support decision making (e.g. risk management and scenario analysis for profitable trade-offs) using information dispersed in the supply network and beyond
Performance management	Basic measurements	Functionally specific measures Measures on-time-deliveries	Integrated supply chain metrics to manage trade-offs	External supply chain metrics to support decision making at the supply network level New product introduction metrics Metrics for S&OP effectiveness	Assessment of the impact on company profitability Measurement of the impact on the ecosystem (e.g. social impact, global environmental impact, etc.)

The final stages of maturity models are ideal stages that company should purse, but there is absence of real-world examples and pilot projects (Grimson & Pyke 2007; Damese et al. 2019). Grimson & Pyke (2007) argue that companies should first organize the organizational and process aspects of S&OP and after that provide the IT-tools to support the teams. Study of Damese et al. (2018) indicates that actions to develop organizational structure tends to precede process and methodology improvements which are later consolidated with IT-tools and performance indicators. Study also reveals that evolvement between maturity stages is not serial, and when the process is evolving towards more mature dimensions, evolvement becomes more difficult, and dimensions become more connected to each other which requires managing the multidimensional aspects in combination. According to industry interviews, companies executed changes in tools, process, and performance management relatively quick, but the evolvement of people and organizational aspects required lot of time. (Damese et al 2018)

2.8 Information systems

IT tools are often recognized as enablers of advanced S&OP processes (Grimson & Pyke, Danese et. al 2019). According to Laudon & Laudon (2015), IT for business perspective can be described as "all of the hardware and software that are needed to achieve business objectives". Information systems (IS) can be described as a "set of interrelated components that collect, process, store, and distribute information to support decision making, coordination and control in an organization". IS consist of IT, people, and organizational parts. In order to utilize IS properly, the organizational learning and process aspects should be highly focused. (Laudon & Laudon 2015, p.39, 72, 353-354) Sometimes companies' processes must be re-engineered to gain the benefits of an integrated IS (Krajewski et al. 2013). Advanced planning systems (APS) are often viewed as an extension of enterprise resource planning (ERP) systems (Jonsson et al. 2017). Usually, APS vendors integrate APS modules to ERP and Customer relationship management (CRM) systems to create applications for supply chain planning tasks. Typical modules of APS are presented in figure 7. Advanced planning systems' S&OP modules operating logic is based on planning information exchange between the Demand planning and Master Planning modules, (Meyr et al. 2015), which is utilized scenario simulations. (Musselmat et al. 2002)

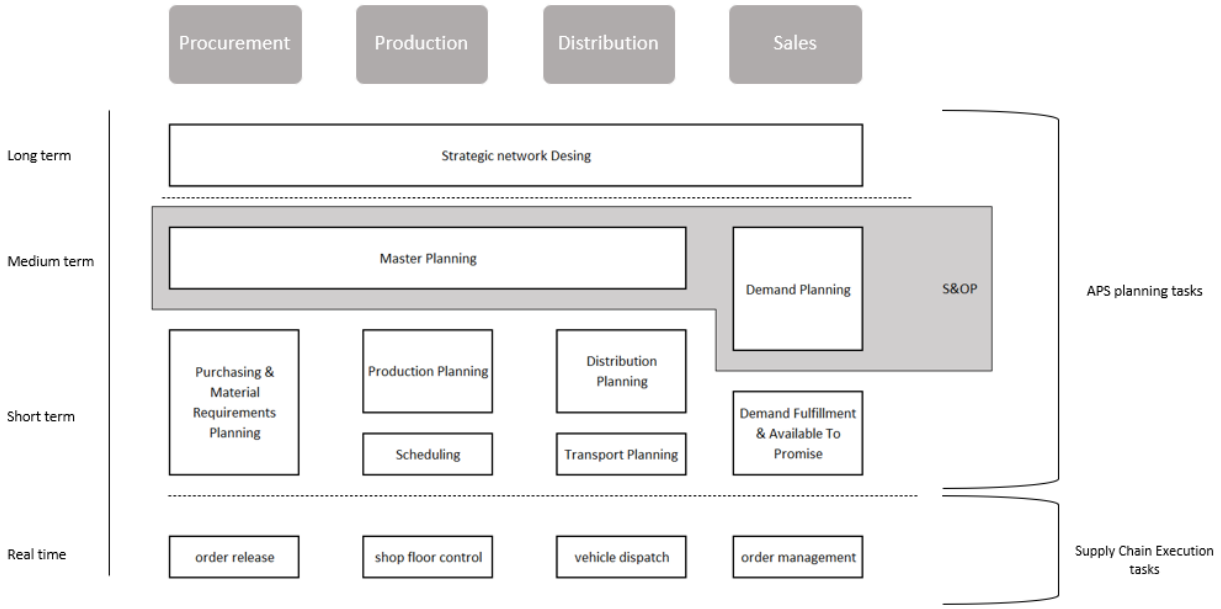

Figure 7: Module structure of an advanced planning system (adapted from Meyr et al. 2015)

2.9 Integrated business planning

Term “Integrated Business Planning” (IBP) is used increasingly for processes to develop integrated set of sales, operations, and financial plans (Chart 1). According to Lindert (2019) consulting company Oliver Wight was the organization that first used term IBP. IBP is described as: “the business planning process that extends the principles of S&OP throughout the supply chain, product and customer portfolios, customer demand and strategic planning, to deliver one seamless management process” on the Oliver Wight website (What is integrated business planning? 2021). Kristensen and Jonsson (2017) interpreted Integrated Business planning (IBP) as a mature S&OP process with a finance integration. Frank Vorrath, the Executive Partner Supply Chain at Partner consulting company, has interpret IBP as the most mature stage of S&OP which considers monetary value rather than production or delivery volumes alone (Lindert 2019). According to Toor & Dir (2011) IBP “refers to the technologies, applications and processes which connect the planning function across the enterprise and improve organizational alignment and financial performance” and “IBP is about planning (not just budgeting) across an

entire business (not just one department, business unit or function) in an integrated fashion". IBP utilizes advanced planning methods such as driver-based planning, rapid planning cycles and rolling-quarters time frames (Toor & Dir 2011).

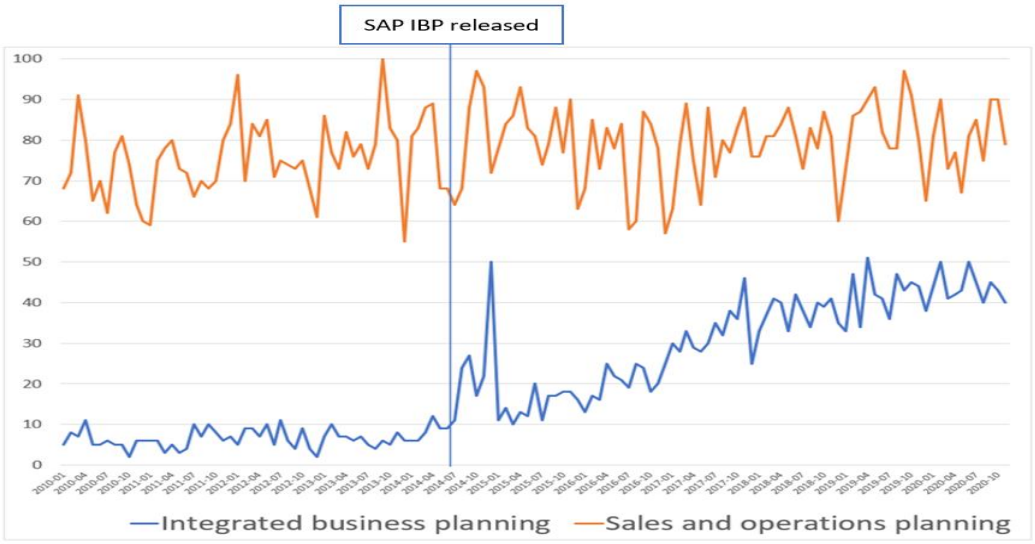

Figure 8: Relative Google search volumes of topics "Integrated Business planning" and "Sales and Operations planning" in 2010-2020 (Google Trends 2020, SAP News Center 2014)

Term also creates some counter reactions, for example Bower (2012) claims that IBP is just a restatement of characteristics of mature S&OP process and the describing IBP as a new management tool is just a marketing trick that offers nothing new. Lapidus (2017), argues that "The concept of integrated business planning – closing gaps in an organization's various planning functions and aligning operations and strategy with its financial performance – has existed in various forms for decades. What has changed is creation of planning platforms that can handle the fluidity of data to erase silos and enterprise borders where once there were multiple geographies, departments, time zones, languages and currencies." "IBP shares characteristics from S&OP to match demand projections to supply chain capabilities." "It also has characteristics of enterprise or corporate performance management in that these technology tools are essential for creating connections across the enterprise with a focus on analysis, modelling and reporting" (Lapidus 2017)

3 EMPIRICAL STUDY

This chapter introduces the three case companies' current and desired processes and commercial offering of S&OP tools. In this study, all company names are anonymized. Also, all of the quotations are referred as company representatives, in order to anonymize the individual opinions.

During October and November of 2020, information of three case companies were gathered by interviews. At first, case company were examined individually to gain information of their current planning processes and their desired processes by semi-structured interviews. From case company A, representatives who took part in company interview were associated with supply chain management and sales management. From case company B, representatives were associated with value chain management and supply chain management. From case company C, interviewed representative was associated to company's S&OP coordination. After the individual company interviews, focus group that included interviewed representatives from all of the case companies was conducted. Focus group enabled the information sharing between the case companies, and it refined the information of their current and desired processes.

In January 2021, five S&OP tool vendors were interviewed about their offering. Suitable vendors were searched on Google, and their offerings suitability for case companies' needs was evaluated based on their solution descriptions from their websites. Only vendors that operated in Finland were included in the study. Vendors were contacted by email and telephone, where the nature of the study and the basic needs of the companies were promptly introduced. Consultants from vendor companies that accepted the interviews were interviewed individually. Interviews were semi-structured interviews, in which their solutions capabilities to fulfil case companies S&OP planning needs were examined. Also, the basic information about their technologies were gathered from these interviews. Case company representatives were allowed to follow the vendor interviews.

3.1 The case companies

Three case companies were examined in this thesis (Table 3). Even though companies are operating in different industries, all of the case companies are using make-to-order (MTO)- production strategy variants in B2B markets. Product and process complexities are present at all planning environments and companies face demand and supply uncertainty. These factors conduct very complex planning environments.

Table 3. Planning Environments of case companies

		Company A	Company B	Company C
Industry		Heavy machinery	Electronics	Heavy machinery
Manufacturing strategy		CTO	MTO and ETO	CTO
S&OP process established		No	No	Yes
Product / process complexity	Products	30 (at least)	800-1200 different products (includes variants)	15 product groups
	Product complexity	high	high	high
	Production process complexity	high	high	high
	NPI's per year	Not every year, but couple of larger variant introductions that requires changes in production	Hundreds	Dozens
Production network complexity	number of production sites	1	10	4 factories that conducts S&OP
	Production site interdependencies		Subassemblies from factory to factory	Subassemblies from factory to factory Design work from location to location
Demand Uncertainity	Demand variation	High weekly variations (Covid-19 affects the demand)	Sales revenue quite stable, but output volume varies a lot	Large volume groups quite stable- small volume groups quite high in percentages (quantities still small)
	Cyclicality or Seasonality	Vacation times have lower demand, demand differences between sales regions smoothens the variation	Lower demand in summer times	Seasonality in some product groups
Supply Uncertainity	Material supply variation (quality, quantity, lead times)	Not an major issue	Different challenges in different materials	Variation recognized (quality of some molded components can have high impact)
	Production uncertainity	Production output quantities are stable	Production is flexible to upscale and can produce when material is in hand (Covid-19 have affected a little)	Production operates quite stable

3.2 Company A

Company A is a heavy machinery producer. Company is using configure-to-order production strategy, which means that every delivered product is configured for specific customer. Company has one factory from which it distributes products globally. Company A executes annual business planning. At annual business planning, the sales plans and forecasts are evaluated and balanced against production and supply chain volume and capacity reviews. Budgets for upcoming year are made at annual planning and planning leads to agreement of annual production and sales volumes and schedules.

Updates and modifications in schedules will be made when the needs occur but company A does not have systematical process to update sales, production, and financial plans.

Company A experiences that current planning processes advantages are easiness and that activities do not require constant efforts. Company has large order backlog which enables longer-term production planning and component requirement inspection. Backlog has also provided opportunity to share their demand information to major suppliers. Company A recognizes planning processes' vulnerability if the order backlog decreases. Company A wants to develop processes to gain midterm visibility and improve response time for changing demand. Company A's production processes are based on modular production, and process lead times for different modules are up to date.

Company A is considering establishing S&OP process to shorten response time. Company A has started and CRM process improvement project for standardizing the sales pipeline information updates. The goal of this CRM process is to be able to forecasts and monitor sales prospects' evolvement in sales pipeline. Company A is participating in this study for gaining S&OP knowledge and pre-studying S&OP tools capabilities to support:

- CRM data analyzing
- demand planning
- supply planning
- information sharing and planning between sales and production
- rolling forecast sharing for vendors
- product portfolio management
- new product introduction processes
- after sales services
- budgeting

3.3 Company B

Company B operates in electronics industry. It does not have own products and company B's products are produced against customer-specific specifications. Serving multiple customers for their specific needs companies production strategies are engineer-to-order and make-to-order production strategies. It has 10 factories that delivers products globally. Company B's manufacturing coordination is based on customers' forecasts,

some of which have quite poor accuracy. Customers deliver their purchasing forecasts to Company B, and Company B promises short delivery times to its customers. Company B delivers volatile customers' forecasts to its suppliers, which rises incredulity in supply chain. "*It is always a special process if customer places unexpected orders for forecasted products. 40 % of orders in some sites are orders that does not match for customers forecasts."* "*Oscillation of customer forecasts reflects to our vendors. Challenge is who believes who." "It leads to large amount of reschedule actions and cancellations of purchase orders." (Company B representative)*

Company B's business model allows customers to place and change orders almost unlimitedly. In order to adapt demand oscillation, Company B have created very large production capacity: *"Let's say that we have so large capacity, that there will never be capacity issues that could limit our supply, excluding the Covid-situation but in this case the shipments are just postponed." (Company B representative)* Company B monitors on-time-delivery accuracy, but because of large capacity Company B has not had to monitor their process lead times or capacity constraints and process related data is outdated. "*I think by having a good S&OP, we could achieve more suitable costs, because it helps us to understand what our maximum capacity level is, and we would plan our production against to that." (Company B)*

In Company B's MTO business environment, the acceptance of order modifications will lead to very short production scheduling window and company is not able to make tangible longer-term production plans. Company B has created Sales & Operations Execution process to inspect 4 months demand horizon on supply side point of view, but this process does not create tangible production commitments. The lack of longer-term planning might sometimes affect on ability to achieve on-time deliveries. *"Some factories create plans for next day, some for next week, but of course in this case, the little fine tuning is needed. Some sites have SOE process where the material availability and capacity requirements are checked for 3 months, but the checking is done only in generic way and the plans are not locked." "We do not have any frozen periods, and because of that, sometimes we might accept the orders which manufacturing should have started two weeks ago to achieve the promised delivery dates." (Company B representative)*

Company B is pursuing to integrate their Rolling 12 -financial planning process with their Sales & Execution planning review to practice integrated planning. *"When talking about S&OP, we practice it in local business units, and we do not use the S&OP term because it has bad reputation in our company, we call it Sales & Operations Execution and we are inspecting shorter time. "Let's say that Rolling 12 and SOE are Company B's S&OP" "We are taking first steps to build that process." (Company B representative)*

Rolling 12 process is developed to create 12 months rolling financial forecasts based on the demand forecasts. Process is monitored by tracking the accuracy of financial figures, but process does not monitor volume accuracies which could present a biased view on company's ability to create vision on upcoming demand. Rolling 12 process does not take account supply chains capability to fulfill demand which had occasionally led to unplanned expenses or delivery problems in goal fulfilment.

Company B considers S&OP- processes for two goals:

- *"We want to stabilize the demand for 3-month-planning-window, which would increase cost efficiency and capacity utilization efficiency."*
- *"Also, those sites that do not have SOE, have very fragmented operations. Every department in the site have their own numbers and they drive their operations in their own direction. Departments do not work together." "We want to develop one-set-of-numbers that every department follows in their actions."*

Company B is looking for tools to improve customers' forecast accuracies to tame the bullwhip effect: *"We should have tool to collaborate with our customer. We should be able to demonstrate orders' time-series evolvement and show to our customers how well their forecasting performs." "With the correct tool, we could challenge our customers for reliability of their forecasts. Sometimes we could tell them that we do not want to input your forecasts to our systems because we do not believe those."" We should have a system that provides customer specific forecast suggestions based on sales history." (Company B representative)*

3.4 Company C

Company C produces industrial pumps. Every delivered product is configured to match customer specifications. Four factories of its global factory network conduct S&OP process. Company C executes monthly S&OP process in rolling 24 months planning horizon. Planning is done in aggregate product family level. Company C's process follows the typical S&OP cycle (Figure 9). Company C's demand forecasts are allocated to factories that are practicing S&OP process. Before demand review phase, the factories' unconstrained sales forecast is generated by sales managers from sales forecasts and order book. The sales departments are committed to obey agreed delivery times, and demand plans are not biased by too short-term updates. At demand planning phase, S&OP coordinator composes factory specific product category level demand plan based on sales forecasts, historical time forecasts and sales departments comments. At supply review phase, the factories are reviewing material availability and their supply and manufacturing capacity to fulfill demand. At consensus meeting, the balanced sales and production volume plans are chosen for 3-12 months planning horizon. Typically plans are chosen at consensus meeting and executive meetings main function is reviewing plans to business units' managers. At current Covid-19 situation, plans are modified more than usual at executive meetings. Company C has S&OP coordinator for coordinating S&OP process and executing planning activities. Company C's ambition is to develop S&OP process in a way that planning activities are done increasingly in part taking departments, since the current state is that planning work is done mostly by S&OP coordinator.

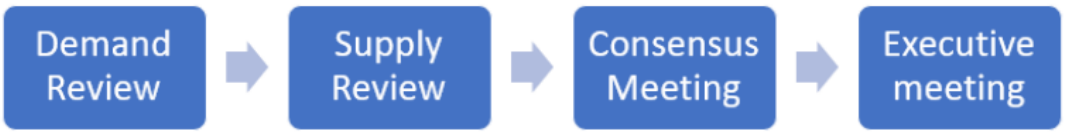

Figure 9: Company C's S&OP cycle.

Company C consider the standardized process as their strength. Company C's process has successfully established efficient way for gathering product category level sales forecasts

and delivering those forecasts from global sales organization to S&OP factories. Sometimes aggregate forecasts shared with selected suppliers. When the forecasts are shared with suppliers, Company C's contact personnel will review the category forecasts for suppliers. Suppliers have given positive feedback from this information sharing.

At current state, Company C is using mostly heavy Excel-based tools for S&OP planning. SAP ERP system is used mainly as a data warehouse for order and stock data, and Company C considers that ERP system does not support comprehensive S&OP planning and has created Excel-based tools for that purpose. Company C's main Excel-based tools for S&OP are Sales Input Tool (SIT), Demand Planning Tool (DPT) and Planning BOM's. Company C is increasingly utilizing SQL servers for their tools.

SIT operates on SQL server and it has Excel based front-end. Sales department managers and sales region manager creates demand forecasts in SIT. SIT enables demand allocation to S&OP factories and system combines demand information into single dataset. S&OP coordinator transfers order history information and open orders from ERP systems and product category budgets from a file received from budget responsible personnel to SIT to support sales forecasting. Historical data is used for statistical forecasting. Sales personnel can leave comments about their judgmental forecasts and statistical forecast in this system. Overestimations and underestimations of forecasts are monitored but informing forecast accuracies to different sales departments is challenging because importing shipment date data from ERP system is unambiguous.

S&OP coordinator uses DPT for developing category level demand plans from sales personnel's judgmental forecasts, statistical forecasts and sales personnel's comments. Planned demand includes forecasts and confirmed orders. DPT composes of many Excel-spreadsheets to which sales forecasts are downloaded from SIT. DPT has capabilities to create visualizations and reports to be presented in S&OP meetings.

At Supply review chase, production and supply chain plans are made mainly by Excel spreadsheets. Spreadsheets are made for inspecting material lead times and capacity availability. Planning BOM – Excel-files are used for disaggregating demand to component needs to evaluate supply capabilities for fulfilling the demand plan. Planning

BOM files are used for planning purposes, because final order BOM configuration might be uncertain in forecasting phase. Customer has possibility afterwards to modify concrete orders' BOMs for extra costs.

Executing the component purchases is done by SAP ERP system, but ERP system itself does not support comprehensive S&OP planning. Some components are managed by linking them to SAP's Forecast based planning feature. Information about forecasted components are shared to supplier web -portal, where vendors can inspect the upcoming component needs. Still, major part of components is managed individually or by stock level management features. Current ERP system's stock level management features does not take account forecasted demand.

Company C is researching possibilities to substitute heavy Excel -based tools by smoother S&OP platform. At current state, Company C sees component forecasting as their biggest challenge, the production capacity is not considered to be an issue. Company C is inspecting tools to improve their process to transform aggregate demand plans to component forecast, which would improve their ability to perform scenario planning. System features that Company C considers highly important are:

- easy master data modification for planning BOM's and supply network
- integration capabilities
- capability to inspect forecast accuracies and adjust forecasts on different planning levels
- automatic and dynamic Key performance indicator (KPI) reporting and parameter modification
- component requirement's reliability inspection and pinpointing reaction needs

3.5 Vendor and technology overview

3.5.1 Vendors

Five vendors were chosen to be interviewed about their S&OP tool solutions (Table 4). Three of them were SME's, that are developing S&OP tools on IBM and Jedox platforms. IBM and Jedox platforms are referred as "open platforms" in this study because these are platforms not specifically made for S&OP planning, but because of their flexibility, lots

of S&OP tools are developed by these platforms. Two of the interviewed vendors are configuring and implementing platforms specifically made for S&OP planning. These platforms are referred as direct S&OP tools in this study. Open platform overviews are conducted from vendor interviews, demo presentations and from "BARC Score Integrated Planning & Analytics - Portfolios for planning, reporting and analysis "report by Fuchs et al. (2020). Direct platform overviews rely mostly on vendor interviews, since report by Fuchs et al. (2020) does not mention inspected direct S&OP tools, and demos were not presented.

Table 4: Vendors

Interviewed Vendor	Offered Technology	Amount of Personnel	Revenue
IBP Vendor	SAP IBP	330 000	47,6 billion USD
Quintiq Vendor	Delmia Quintiq	20 000	4,45 billion euros
Jedox Vendor	Jedox	54	6,6 million euros
IBM Vendor A	IBM	23	2,7 million euros
IBM Vendor B	IBM	8	1,0 million euros

3.5.2 IBM Planning Analytics

IBM is one of the world's largest vendors of IT hardware, software and services and their core offering for planning and analytics consists of IBM Planning Analytics, IBM Cognos Analytics, IBM Watson Studio, and IBM SPSS. The IBM Planning analytics is a development environment targeted at power users who create planning, analytics, and strategy management solutions. Therefore, it has no dominant focus on particular topics and it has limited amount of predefined business content (Fuchs et al. 2020). Both IBM vendors are offering IBM Planning Analytics as their primary solution for developing customer specific S&OP tools. *When the IBM Planning Analytics environment is purchased, there is nothing premade. All dimensions, cubes, data inputs and data input interfaces are created for customer needs"* (representative of IBM Vendor B), *"Customer's process conducts the developed S&OP solution, IT system should not force the customers to change their processes*" (representative of IBM Vendor A)

IBM Planning Analytics can be deployed by cloud service or on-premises versions and it has web- and Excel-interfaces. Modification of interfaces seemed very flexible, since

IBM Vendor B demonstrated possibilities to modify parameters, add different KPI figures and visualizations directly in web-interface. The cloud service uses pay-per-licence pricing mechanisms. According to IBM Vendor B, the selection between cloud or on-premises deployment methods depends mostly on customers IT strategy: *"Some companies have IT strategy that aims to outsource IT-infrastructure to cloud environment, so they do not need to maintain it. If there are problems at IBM cloud environments, IBM is responsible to solve those problems. Service level target agreements are made, and if IBM could not reach the targets, they will compensate it"* (Representative of IBM Vendor B) Fuchs et al. (2020) argues that cloud versions of IBM Planning Analytics offer alternatives for cost savings and faster deployment times.

IBM has wide portfolio of products that could support the planning (Table 5). According to interviewed IBM vendors, those products could be integrated to Planning Analytics, for further improvement of certain fields of planning. IBM ecosystem is considered as a strength for IBM. However, Fuchs et al. (2020) argue that integration between Planning Analytics, Cognos Analytics and Watson Studio products is incomplete, but integration of Planning Analytics and Cognos Analytics has improved in recent versions. However, vendors have public references of their IBM ecosystem integrations.

Table 5: Supporting IBM products

IBM Product	Description
Cognos Analytics	BI solution for dashboard creation; cleaning and connecting data
CPLEX optimizer	Optimization platform
SPSS	Software fo advanced statistical analysis. Machine learning and text analysis capabilities
Watson Studio	Data science platform; building, running and managing AI models

According to interviews Cognos analytics seems to be a business intelligence (BI) solution that vendors possession mainly for reporting purposes. Watson Studio is a data science tool for advanced analytics. Watson Studio also provides possibility to further improve forecasting by using SPSS modeler. According to vendor interviews, CPLEX optimizer is optimization engine for solving very complex business problems There are contradiction about the price for CPLEX – implementations: *"I think it is too expensive because the license prices are tens of thousands of euros"* (representative of Jedox

Vendor), *"There are different kinds of pricing models, license prices could be generated for example as price per transactions or price for unlimited use. At the cheapest, cost is very minimal"*. (representative of IBM Vendor A)

3.5.3 JEDOX

"Jedox hit the sweet spot in markets, when big corporations who already used SAP products, Microsoft product and Oracle products, did not want to add IBM products as a one more big player in their IT portfolio. " (representative of Jedox Vendor). According to Fuchs et al. (2020), Jedox products are often used in departmental or small and medium scenarios, but the implementation projects have been growing in terms of users and data volumes. (Fuchs et al. 2020).

Jedox is a flexible corporate performance management and analytics platform with planning, reporting and financial consolidation capabilities for business users. Although, Jedox's flexibility as a development environment could lead to complex handling when implementing or building applications. (Fuchs et al. 2020) "*Jedox's weakness might be that heavy-users cannot do lot of user-interface modification at the web-interface, the development have to be done throughout the modeling tool. "* (representative of Jedox Vendor)

Jedox user-interfaces are Excel add-in, Web-interface, or 3rd-Party user-interfaces. "*Most common user-interfaces are web-based interfaces which will be made suitable for end-user, but in some cases, customers prefer also to use Excel add-In with web-based interface and Jedox emphasize lots of that opportunity in its marketing. "*(representative of Jedox Vendor). According to Jedox Vendor, the partner technology network provides an opportunity for the cloud version to use Power BI to perform reporting from Jedox. "*We have provided solutions where actual computing is done in Jedox, but the customer user interface is Power BI". "This kind of planning activities could not be done by using only Power BI, because it does not support the data collection and certain kind of computational logic."* (representative of Jedox Vendor)

According to Fuchs et al. (2020) the AI (artificial intelligence) features are strategic initiative for Jedox. AI assisted planning leverages machine learning functionalities

supporting business-users in tasks such as predictive forecasting and pattern recognition. (Fuchs et al. 2020) *"Jedox supports forecasting with AI – module which have four predefined models". When the planning is done with discipline, people would also improve their ability to recognize patterns, but the AI-modules could help them to recognize patterns"* (representative of Jedox Vendor)

3.5.4 IBM VS JEDOX

IBM Vendor A and Jedox Vendor representatives are familiar with both IBM and Jedox technologies and they were asked why they would prefer one over other. All in all, they stated that IBM Planning Analytics and Jedox are very similar products. "*The basic logic of Jedox is pretty much copied from IBM Planning Analytics. Systems operate in same way and in fact there are not anything that other could do that other could not" "Systems also have similar pricing, both systems are using pay-per-licence method and they can be deployed on cloud or on-premises."* (representative of Jedox Vendor) "*If I say it in a politically corrective manner, I could say Jedox and IBM have a lot of similarities, but IBM have the supportive portfolio for other solutions that Jedox does not have. "*(representative of IBM Vendor A)

Vendors were asked why the other platform would be recommended over the other. Jedox vendor emphasized Jedox's integration capabilities and pre-made AI-features: *"If company uses SAP or Oracle ERP system, I might recommend Jedox over IBM. Jedox have very strong Microsoft contacts so for example it integrates very smoothly to Power BI." "When speaking purely about IBM Planning Analytics, there are not really an AI-assisted planning module, even if some might say there is." "R and Python have premade AI-functions that can be integrated to IBM Planning Analytics, but Jedox has those features built-in."* (representative of Jedox Vendor). All of the interviewed platform vendors assured that platforms could be integrated to all basic ERP systems, and integration capabilities should not be considered as an issue.

IBM vendor emphasized IBM's comprehensive portfolio, flexible user-interface, and computing power: "*If one would want to expand reporting or data science capabilities, IBM offers extension products that Jedox does not have" "IBM Planning analytics have*

*very highly developed self-service dashboard user-interfaces while Jedox users have to operate pretty much in Excel-based user-interfaces. ""User-interface of Jedox is lagging behind IBM, it is more static and clumsier." "We experienced challenges of system performance with Jedox, IBM just can process larger data-volumes. At least we experienced it that way". (*Representetative of IBM Vendor A*)* It have to be noted that Jedox Vendor have developed Microsoft Power BI -dashboard user-interfaces for Jedox. Representative of Jedox Vendor also assured that Jedox has enough computing power for basic S&OP implementations. When inspecting the computing power of IBM, their references are quite notable. *"IBM uses Ansestry DNA analytics company as a reference for computing capabilities. Ansestry has 18 quantillion cells in one data model." "Size of the cube is not an issue in computing" "There are no need to make compromises for example by executing planning in product level, because the system has not enough power to calculate component levels"* (representative of IBM Vendor B)

3.5.5 SAP IBP

SAP SE is large German IT-provider that might be best known from ERP systems such as R3 or 2015 released S4/HANA. SAP IBP is a product to support S&OP planning. *"SAP IBP is planning solution build on HANA cloud platform. "*(representative of IBP Vendor). It seems that SAP IBP, even though it operates on HANA platform, does not require latest version of SAP S4/HANA ERP system; *"In Finland there are IBP solutions configured for SAP R3. When SAP S4/HANA supersedes SAP R3, some features of SAP SCM, also known as APO, will be divided in a way that parts of the features will be available at SAP IBP and other parts at SAP S4/HANA. IBP is full suit solution to perform planning from tactical level to operative level. "SAP IBP integrates best to other SAP products, but in theory everything can be done. Integrations to other ERP systems have been built."*

SAP IBP has web-based Fiori user-interface and Excel based user-interface. SAP IBP consists of six modules: Demand, Inventory, Sales & Operations Planning, Demand Driven Replenishment, Response & Supply and SAP Supply Chain Control tower (Table 6). "*All modules operate in same data model, except Response & Supply, which is order level planning module" "Module division is actually just a pricing-based approach".*

"Pricing mechanisms for IBP is annual license, and price depends on amount of purchased modules and company's revenue" "IBP is very scalable product since its price does not depend on number of user-licenses and system can be implemented very widely across organization" "Some customers purchase individual modules, major part of customer purchase only S&OP module which will allow you to run basic S&OP processes." "There are also use-cases where customer have purchased only demand module" (representative of IBP Vendor).

Table 6: SAP IBP modules

Module	Use-cases
Sales & Operations planning	Running simple S&OP process; basic forecasting and supply requirement calculations
Demand	Advanced demand forecasting and demand sensing
Inventory	Inventory Optimizations
Demand Driven Replenishment	Planning based on theory-of-constraints
Response & Supply	Optimization of demand and supply
SAP Supply Chain Control Tower	End-to-end process monitoring

IBP Vendor explains their approach in SAP IBP implementation processes: *"One possibility is to use best practice S&OP process developed to be operated with SAP IBP". "System implementation depends on the customer preferences; do they want to re-engineer their processes for IT-systems or will the IT-system be modified to match customer processes and in what level the changes are needed. IBP is quite flexible, there might be need for little bit of configuration which comes with complexity. Many things can be done with SAP IBP, and we do not get locked with process frames". "SAP does some implementation processes by itself, but their implementations are pretty much template solutions. We have always business focused approach to fulfill the customer needs. We will always do enough customization, not too much and not too little, to provide reasonable configuration to support processes".* (representative of IBP Vendor)

3.5.6 Quintiq

Quintiq products, are made by Dassault Systèmes, a French software corporation. "*Quintiq is core software, which is used for different planning applications" "S&OP module is designed for longer-term strategical and tactical planning and when moving towards shorter term plans, Quintiq's MPS module is aimed for more detailed factory*

level operational planning and when there are need for minute-level scheduling Quintiq offers solutions for that also. Solutions are also available for production, logistics and workforce planning optimization, Quintiq's portfolio is very comprehensive to fulfil customer need for difficult planning tasks" (representative of Quintiq Vendor). Quintiq products can be deployed in cloud or on-premises installations. Pricing mechanism of the Quintiq product is based on number of user-licenses.

Dassault Systèmes have a large portfolio of design and planning applications and their vision is to build seamless digital connectivity between their products. For example, their portfolio includes Enovia PLM system and CATIA CAD software. "*Quintiq itself have wide offering of applications and software for business simulations, and Dassault ecosystem could provide exceptional value by simulating upcoming business before it is executed in real world, by digital twin approach" "Companies have traditional order-to-cash, or order-to-delivery process which can be seen as an ERP processes in the old world. Modern corporations also have product life cycle process which starts from product innovating activities, continued to engineering, production and the after sales activities. At some point, these processes cross each other and at that point there are some software applications. Dassault is aiming to develop digital connectivity. Data that is first produced in research and development activities can be utilized in PLM process and in order-to-delivery process. Processes would be united by using the same data and same data models. Dassault Systèmes' approach to solve those process problems is by using this process connectivity approach and utilizing different products of Dassault portfolio"* (representative of Quintiq Vendor)

Quintiq vendor emphasized lot of Quintiq's optimization possibilities, and they mention that Quintiq have made world records in optimization competitions. "*Quintiq's core approach is using optimization algorithms in customers planning puzzles".* (representative of Quintiq Vendor) Quintiq Vendor argues that optimization approach typically yields better results than judgmental approach: *"People might not be able react in fast occurring events, optimization parameters does not get affected by fast occurrence, algorithms calculate and recommend what should be done". "It has to be emphasized that planning personnel always make decisions, but these optimization systems could support them".*

At implementation, Quintiq products are configured to meet the customer needs. *"Amount of required configuration depends on customer cases complexity" "Our approach is, that 70 % of software consists of standard solutions, on top of that is industry specific layer and the final layer consists of modifications based on customer needs.""* *Every company has their own operating logics and value creation logics. Quintiq products adjusts to the companies' processes and activities, company do not need to adjust their operations" "Customer's puzzle will be modeled in needed accuracy in order to assure optimizations respond to reality"* (representative of Quintiq Vendor)

4 DISCUSSION

4.1 Platform inspection

This chapter examines the platforms capabilities to answer the needs that case companies highlighted in individual interviews and focus group interviews.

4.1.1 Demand forecasting

For demand planning purposes, S&OP platforms are integrated to ERP system in order to transform product data and historical shipment data for statistical and AI- forecasting. Product hierarchies and structures are modeled in planning systems and placing forecasts on different levels updates forecast information of all linked levels. Platforms have capabilities to flexible modify the product structure data. Different logics for product category level forecasts deviation to component level forecasts can also be flexible configured to systems. Utilizing CRM as a data source is possible by all inspected platforms, but vendors emphasized that CRM process must be standardized in order to provide quality data.

Statistical or AI-based forecasts are basis of demand forecasting. These methods provide baseline forecasts, but in order to provide good quality statistical forecasts, data volume have to be sufficient, and data must be unbiased. IBM Vendor A stated that 18 former data points is minimum to provide accurate forecasts. Jedox Vendor mentioned that for example the COVID-19 years' data might be so abnormal that time-series methods might provide kooky results. Systems provide possibility to make manual forecasts, and differences between baseline forecasts and judgmental forecasts can be inspected. Information can also be hidden from different users if the companies want to operate that way.

Quintiq and IBP vendors presented possibilities to analytically segment the products or market areas in order to choose correct forecasting methods to different types of demands. Quintiq and IBP vendors also emphasized the easiness of inspecting forecasting accuracies on different groups and market areas on dash-board views. Segmentation

features were not mentioned by all open platform providers, but features could be developed for open platform systems also. Customers might need to be more aware of suitable features when purchasing open platform systems compared to direct S&OP tools.

Vendors stated that forecasting accuracies can be calculated in every product hierarchy level, including component level, and forecasting KPI's would be dynamically updated. Still, Jedox Vendors' statements raised some concerns, which could also consider other platforms:

"Of course, if the forecasts are made in product levels you can utilize shipment information, but usually the forecasts are made in higher levels. The allocation of forecasts from product family to product level is based on data and developed logic. If the shipments have those connections, calculations can be made quite smoothly. If the forecasts and shipments are on same level the comparison can be made". "We have couple of times developed planning systems for customers, that utilize planning BOM's. In those cases, companies utilize planning BOM's because their customer might not be decided final configurations of their orders. In those cases, the planned products and manufactured products are different, so the ERP information is inequivalent. The forecasts and shipments could be equivalent in higher levels but when "dummy codes" are used in planning, the item shipment data seldom should be used in forecast accuracy calculations". (representative of Jedox Vendor)

IBP Vendor explained that system supports Planning BOM's updates, when orders are clarified and change them to order BOM's when sales are confirmed. This indicates the possibilities to inspect evolvement of forecasts and compare accuracies in detailed levels in CTO environment. Quintiq Vendor had their vision on digital connectivity, which in supply chain planning context stands for connectivity between engineering BOM's, manufacturing BOM's, planning BOM's and order BOM's. This indicates also the possibilities to calculate detail level forecast accuracies in CTO environments. It seems that some similar logic of connecting planning BOM's to orders have to be developed for open systems in order to calculate more detailed forecast accuracies in CTO environments. Also, comparing forecast accuracies between different levels is actually monitoring the correctness of deviation logic, which is set up by planners. Measuring this

would provide knowledge about how well the forecasters can estimate the demand deviation within the product category group, and it provides lots of information about forecasting abilities.

4.1.2 Supply planning

Basic logic of APS supply planning is to break down demand to component and manufacturing requirements by using BOM-structures and process requirements. This is done in order to check could the demand plans be fulfilled within the set production and supply chain constraint parameters. Production process constraints are based on production process owners' estimations and constraint parameters could be for example volume constraints, available working time, or available personnel. Case companies emphasized the importance of examining material availability over the manufacturing process capacity, since all companies had products, that require some components which have relatively lead times. The material availability could be examined by inspecting current stock information and purchasing lead time information. The material availability emphasis in planning generates a need for detailed bottom-up information flow. IBP Vendor confirmed that this emphasis is typical in companies that utilize MTO-strategies and its variants:

"S&OP practices are suitable for engineer-to-order (ETO) environments, although the challenge is different compared to make-to-stock (MTS) environments. At MTS environment, the focus is on the production capacity. For example, in paper and pulp industry the utilization of production assets is very critical, and companies usually want to use their assets as efficiently as possible. At ETO environments the focus is on material availability, the assembly capacity is not so critical issue. Focus is different but there are lot to be achieved, for example comparing purchasing options from different vendors with different lead times and prices. Also, the make-or-buy decisions are typical in ETO S&OP planning. When there are lot of complexity, there are lot of optimization potential. MTS environment might be easier to be managed and its S&OP tools might not need to be very advanced. ETO environment is more complex to manage." (Representative of IBP Vendor)

Open platforms could be configured to compare demand against manufacturing capacity and break-down demand to component requirements to inspect material availability issues. Actual stock information and supply lead times could be transferred from ERP systems, and updates of information could be timed. Data modification is made flexible, which allows to inspect results of different scenarios. In order to produce optimized scenarios, open platforms have to be integrated in optimization platforms which increases costs.

Even though the open platforms could be configured to support the CTO-needs, one open platform vendor suggested using planning systems concurrently with ERP systems for gaining suitable bottom-up information. *"Current stock information can be transferred to planning system, but in that case, the system operates very similarly than ERP systems. It has to be pondered, should that logic be configured in planning systems, since ERP systems gather the order and stock information constantly" "If there are delay in the updates, the planning systems material availability information might be very different than ERP systems information" "ERP systems are quite good today, of course if the ERP system does not have stock level alert features, these can be developed in planning systems"* (representative of Jedox Vendor). Company C has built their own Excel-based tools for supply planning since they experienced that ERP systems does not support planning of uncertain demand comprehensively. It seemed, that Vendor's approach in S&OP focuses on top-down constraint checking which is very suitable for companies that produces non-customer specific products which has very similar component requirements. In these situations, the stock levels are absorbing the demand movements. *"The stock limits and constraints are set in the planning system and the system points out if the demand is larger than the current stock and also the other way that if the stock levels increase too much"* "*Stocks are rolling costs, of course planning system calculates costs of goods sold and warehousing costs, usually these systems are utilized to provide this information to finance"* (representative of Jedox Vendor) This kind of system would not support the CTO or high product variant MTO environments supply planning comprehensively.

Direct S&OP tool vendors assured their product's to be suitable for CTO environments. SAP IBP calculates heuristically supply requirements. IBP utilizes actual ERP stock and

lead time data for supply planning and system supports manual scenario generation by planning parameter modifications. SAP IBP could also be configured to utilize demand and supply optimizations, inventory optimizations and end-to-end process monitoring by module purchases. Quintiq's supply planning features are always based on optimization. System calculates the base scenario and alerts if the demand cannot be fulfilled. Base case optimization is starting point of supply planning, and supply planners could inspect how changes in supply network would affect the results. Quintiq utilizes the actual stock information from ERP system, but Quintiq representatives emphasized that S&OP module is not meant to be used as a daily management tool, and stock levels should be considered as starting figures at medium term planning.

4.2 Case analyses

4.2.1 Company A

Company A is planning to deploy S&OP process. Company A has experience of cross functional planning from annual planning process and Company A's capacity and process information is up-to-date. These aspects could be a good basis for deploying S&OP process. It is recommended that S&OP process has top management's support, and especially in project ramp-up phase, top management's process ownership could enhance the different department's collaboration by authority. Company A's example proved that process could be ramped up by using spreadsheets, and Company C's process could be suitable benchmark process for pilot process. Designing a tool before or concurrently as designing a process might direct process in a disadvantageous way or might lead to unnecessary tool modification. Company A is pre-studying S&OP tools capabilities to support following features:

- CRM data analyzing
- Demand planning
- Supply planning
- Providing rolling forecasts to suppliers
- Product portfolio management
- New product introduction processes
- After sales processes
- Budgeting

All of the examined planning platforms could be integrated to CRM systems. According to vendors, well-structured CRM process could be very effective method of sales data gathering for S&OP planning and sales pipeline stages could be used for evaluating probabilities of upcoming demand. Basic steps of S&OP process for supply and demand planning are supported by inspected platforms. Structured process with the suitable tools could enhance internal operations information sharing. Providing rolling forecast to suppliers could be done by extracting supplier specific reports from demand by S&OP platforms and share those by email. This method was recommended by all interviewed platform vendors, and Company C used this method in their S&OP process. IBP Vendor also mentioned that SAP IBP system could be integrated to SAP ARIBA supplier collaboration platform to share supplier specific forecasts.

Current literature suggested that all aspects impacting to demand should be considered in S&OP planning and NPI metrics are suggested to be followed in S&OP processes. Cohen et al. (2000) identified time-to-market metrics, product performance target metrics and development cost metrics as most commonly used NPI KPI's. Even though Cohen et al. (2000) did not study S&OP processes, linkages between the S&OP planning stakeholders and NPI KPI's could be recognized; time-to-market target connects research and development (R&D) to production; product performance connects R&D to sales and marketing departments; and development costs connects R&D to financial department. Current literature did not identify processes to integrate NPI in S&OP planning. Reason might be, that NPI processes are always company specific processes and generalization of practices for NPI processes' S&OP implementation could be dubious. Maybe because of that, product portfolio management is discussed in S&OP literature mainly by examining profitability and volumes in demand planning and emphasizing companies to evaluate how product life cycle aspects, product launches and ramp-downs, would affect for total demand. S&OP tool vendors stated that platforms could be used for inspecting supply needs of ramp-ups and ramp-downs and to create different planning scenarios for NPI launches' similar products demand cannibalization aspects.

Basic structure of S&OP process could be utilized for service operations planning. (Krajewski et Ritzman, 2013 p. 539) Most of the current literature embodies S&OP as a manufacturing operations planning process and after sales processes are not perceived as

a part of manufacturing S&OP. IBP Vendor representative told that usually aftersales business is seen as an separate business, and after sales and manufacturing should not be planned jointly. Quintiq Vendor presented a vision of digital continuity in supply chain processes and product life cycle processes. This means that S&OP and aftersales processes would utilize same product master data. Still, planning and optimization of aftersales and manufacturing processes was presented to be done by separate tools. Interviews and literature studies indicates that S&OP processes and aftersales processes should not be unified as a single planning process, but there is a possibility to create separate S&OP processes for manufacturing and after sales services.

4.2.2 Company B

Company B is pursuing to achieve “one-set-of-numbers” and stabilized planning horizon for 3 months by combining Rolling 12 process and SOE process. Because Rolling 12 process does not force departments commit to plans, the process can be seen as data gathering process rather than planning process on supply chains side. Uncommitted estimates of upcoming demand provide only a little support to supply planning. This perception indicates that Rolling 12 process is mainly a sales target setting process. Company B is using reactive scheduling to fulfill the demand, and Company B does not have standardized longer term production planning functions (Figure 10).

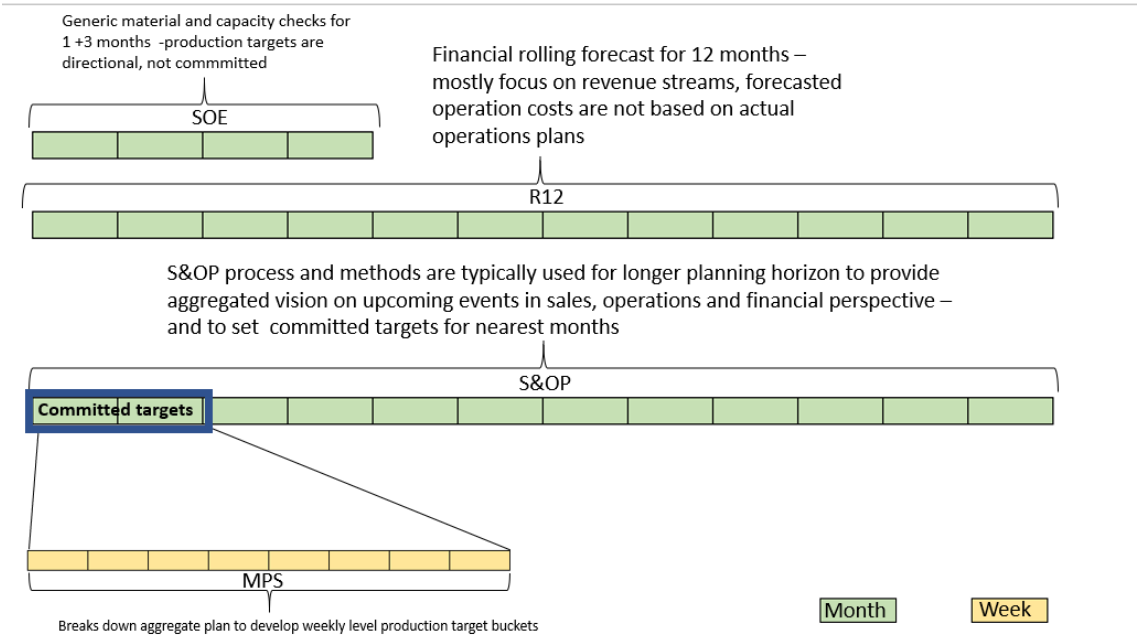

Figure 10: Company B's processes compared to S&OP and MPS

S&OP processes are methods to pursue mid-term visibility on sales, supply and financial point of view. Process utilizes long rolling planning horizon to adjust aggregate level sales forecasts and to set production targets in nearest months by common agreement. Well established S&OP process consider the supply and production constraints on target stetting. If Company B is pursuing the one-set-of-numbers in their production sites, the S&OP process could support achieving this goal. It has to be noted that S&OP process focuses on methods to agree and communicate reliable targets to lower planning levels, tighter schedules are not a part of the S&OP process.

Production stabilization is goal of production planning which is pursued by setting committed production plans. S&OP process sets targets to production planning which creates production plans to fulfill those targets. Typically, Master Production Schedules (MPS) are created from S&OP targets. MPS sets weekly production level targets, and production scheduling creates weekly or daily schedules based on prioritization of available resources.

Company B have built their supply for boundless capacity, and company's drivers for S&OP deployment are stability, collaboration and cost-efficiency. Practicing S&OP

would mean that customers could not modify their orders in short time frame and capacity constraint would have to be analyzed closer. If Company B's strategic customer promise is that customer could modify their orders arbitrarily, and Company B have created their supply capacity based on that decision, possible cost-inefficiency is aspect that might have to be accepted. Also, practicing S&OP would mean that Company B should define roughly good estimates of different process lead times. S&OP processes are not projects or tools for determining the process lead times and capacity constraints, but S&OP process and tools produce plans based on those planning factors. Usually, the adequately accurate factor values are demanded from responsible process owners for S&OP planning.

According to Lapide (2005) "Successful supply chain practices need to tie to a company's competitive strategy, operating model and performance objectives and the practices themselves must fit together by being consistent and reinforcing in order to yield performance that is more than the sum of the parts". It seems that S&OP methods are conflicting against Company B's competitive strategy and operating model. S&OP process and production planning methods could fulfill stabilization and one-set-of-numbers goals, but Company B should consider very carefully does those processes suit for their situation. S&OP processes are processes for co-creating committed production targets, which could stabilize the planning horizon and drive departments to collaborate. If the industry typically allows very high order flexibility, there is very high risk that customers could switch their supplier. Also, if the customers are used to this flexibility, even if it is not standard practice of industry, the changes might harm Company B's reputation. Even though in IBP-visions, S&OP process could have occasionally very short updating frequencies, comprehensive and tangible S&OP process could be too heavy for very short updating frequency and stabilization goals are ignored in frequent short-term updates. High frequency plan generation in S&OP process might turn a tactical planning process to very bureaucratic way to execute production scheduling. There are not any S&OP tools, which would provide the one set of numbers without commitment to plans, and there are no systems that would constantly update departments figures without unified planning processes. "*Of course, it would be ideal to have only one forecast and one-set-of-numbers, but I do not know that such a system could have been built"* (representative of Jedox Vendor)

Company B searches a platform to improve its customers' forecast accuracies. S&OP platform vendors were asked what their suggested practice would be for importing customer forecasts, and could their platforms be used for supporting customers to improve their forecast accuracies. For this case, it seems that challenge really is about designing a process, and platforms are very flexible to suit for the needs: "*Jedox or IBM does not constraint what could be done, the question is more about how customer wants to manage this process*" (representative of Jedox Vendor). *"Techcnically SAP IBP could be opened for users outside of the organization very quickly. In most cases the challenge is on process design."* (IBP Vendor)

Platform vendors suggested two ways of importing customer forecasts:

- Ask customers to provide their forecast in formal files, that would be inserted to systems manually.
- Open platforms for customers to provide forecast supporting information.

In the first scenario, Company B's personnel would use the systems forecasting capabilities to compare customer forecasts to statistical or AI-based forecasts. In this scenario, the platforms would improve Company B's forecasting capabilities, but system would not directly improve customers' forecasting, or support collaborative forecasting, since commenting and suggesting adjustments would be done by contacting individual customers.

In the second scenario, customers would insert their forecasts to Company B's system and utilize statistical or AI-forecasts to improve their forecast accuracy. Even though the customers could have access to systems to support their forecasting, it is not guaranteed that customers would want to improve their forecasts. Interviewed vendors have not build this kind of systems before. Opening the planning systems for customers would also increase license costs in most systems.

On both ways, there are no guarantee that customer would be interested improving their forecast accuracy, there are not any forcing or attractive features in tool approach. In order to get customers to improve their forecasts, forecast improvement should benefit them

somehow. Supplier collaboration mechanisms should be researched for this purpose, but it is outside of this thesis scope.

It is probably not the best case to modify S&OP platform to improve customers' forecasting practices, since the S&OP is not designed for that purpose. Collaboration improvement projects and its specific tools and practices should be benchmarked for process design.

4.2.3 Company C

Company C has established standard S&OP process, and they are looking for more suitable S&OP planning tools. Company C was especially interested in tools' capability to produce component level forecasts. Vendor interviews indicates that all of the technologies could be capable to support Company C's processes, but as the feature inspection chapter presented, CTO environment requirements might not be clear for all platform providers. Company C should ponder, does the open platform approach or direct S&OP tool approach suit them better.

If the Company C is aiming to replace current fractured Excel-tools by smoother platform with same operating logic, open platforms approach might suit that need. *"Projects for replacing Excel – tools are ideal cases for customer satisfaction. In those cases, customers have already ramped up the process and they recognize the features they need. Replacing Excel-tools are easy wins, but usually the customer desires more advanced features when they notice that those features could be developed." "Excel tools works well as proof of concept for S&OP tools"* (representative of IBM Vendor A). Jedox and IBM Planning Analytics are very similar platforms. IBM user-interface modification capabilities could be experienced as a more flexible way to adjust and create KPI's than Jedox's development tool approach. For handling larger data-masses, IBM has stronger references of its computing power. If the Company C is choosing to utilize open platform approach, choosing correct developer is vital. Company C should carefully evaluate vendors ability to understand Company C's specific needs. Vendors' earlier projects might direct the development suggestions in adverse way.

All of the platforms inspected platforms will be integrated to ERP systems, but SAP IBP is specifically aimed to be used with SAP S4/HANA ERP. If Company C is using or planning to use the SAP S4/HANA ERP system, SAP IBP should be considered with extra attention. SAP IBP's full suit integration with ERP system might improve material availability inspection capabilities. Costs of SAP IBP depends of the purchased modules. If Company C is planning to use SAP IBP, feature evaluation should be done properly in order to avoid costs of unnecessary features.

Quintiqs core features are based on optimization engine. Basic S&OP process can be supported with all of the inspected systems, but Quintiq is especially aimed for companies who are pursuing delivery efficiency or cost savings by making optimized decisions in complex supply networks. If the Company C is looking for a tool to run its established process in individual factories, the powerful optimization engine might be overkill. IBM Planning analytics integrates with IBM CPLEX optimization engine, and SAP IBP has its own optimization modules, but those systems could be purchased without optimization possibilities, if the optimization is not pursued.

Operating costs of platforms are always case sensitive, and thus comparison between the platform prices could not be made in this research. IBM Planning Analytics and Jedox are often perceived cheaper options compared to direct S&OP platforms, but any data to valid that perception was not obtained. SAP IBP's operating cost reduction could be pursued by feature mapping. Other platforms operative cost could be reduced by designing the process in a way that minimum number of personnel is using S&OP platform.

4.3 Scientific implications

Firstly, S&OP is defined in many ways in current literature. At conclusion part of this thesis, alternative simple definition of S&OP proposed. Lots of previous research suggests that S&OP process should be modified to match company specific planning environments. This thesis investigates companies operating in B2B business that are utilizing make-to-order production strategy's variants. The empirical study provides insights of companies planning environments requirements and their desired outcomes of

S&OP deployments. Study pointed out the conflicts between S&OP methods and quick response MTO strategies in high product variety environments, which indicates that besides evaluating S&OP's design for planning environments at deployment, evaluation of S&OP methods' suitability to company specific strategies should be considered. Thesis also presented current S&OP tool offering, and it seems that similar systems that Grimson & Pyke (2007) visioned in their article of "Sales and operations planning: an exploratory study and framework" are nowadays available. Integrated business planning is not academically defined. The review of this study indicates that integrated business planning is mostly seen as a maturity aspect for traditional S&OP.

4.4 Managerial implications

Especially today, when there are lots of hype around Integrated Business Planning, companies should pursue to gain knowledge of S&OP processes, to avoid unplausible expectations of tools and processes. In the early phases of S&OP deployment, companies should mainly focus on designing the process, and spreadsheets could be used for supportive tools in pilot projects. Process structure, team structures and responsibilities and directive measurements should be emphasized in process designing. Obtaining the high-level authority to process owner, might ease the development of cross functional collaboration. Only after the suitable process design is achieved, companies should utilize advanced planning tools. The tactical planning tool vendors might emphasize high customizability or high optimization capabilities. These aspects might be trade-offs which companies should be aware (Figure 11). Platform flexibility allows non-standard process design, and industry specific S&OP practices enables optimization to maximize the results by S&OP specific tools.

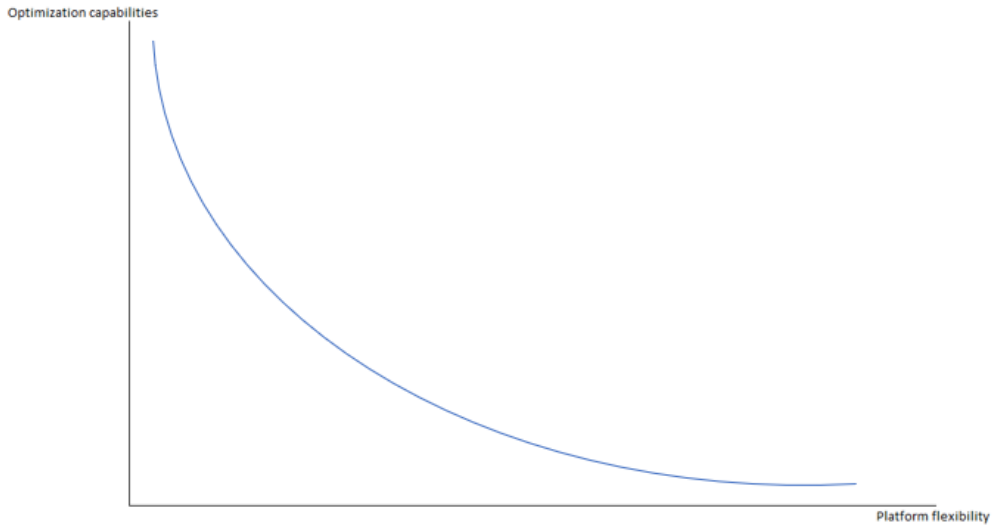

Figure 11: Illustration of trade-offs between platforms flexibility and optimization capabilities

4.5 Critical evaluation of the study

To evaluate research credibility, the validity and reliability aspects should be considered. Reliability refers to extent to which data collection techniques or analysis procedures will yield consistent findings and validity is concerned with whether the findings are really about what they appear be about (Saunders et al. 2009, p. 156-157). According to Saunders et al. (2009), Robson (2002) asserted that subject biases and errors and observer biases and errors threat reliability of qualitative studies. Subject errors and biases consider interviewees providing misinformation and observer biases and errors consider misinterpretations of interviewees answers. (Saunders et al. 2009, p. 156-157). This study has high potential of subject errors, since it is very unlikely that vendors would provide any negative information about their products. For open platforms, requesting direct competitors to evaluate other platforms, and utilizing the report by Fuchs et al. (2020) could mitigate the subject error a little. Risks of observer biases and errors were attempted to be mitigated by transcribing the interviews and asking multiple questions about the same topics from interviewees.

To increase case study's validity – "whether the findings are really what they appear" (Saunders et al. 2009, p. 156-157), triangulation –"the use of multiple data collection techniques within one study in order to ensure that the data are telling what you think they are telling you" (Saunders et al. 2009, p. 146) is utilized. At the empirical part of this study, case company data were gathered from individual interviews, from focus group interview and from thesis by Kallio (2019). For platform analyses, information was gathered from vendor interviews, and from report by Fuchs et al. (2020). The case company findings have larger validity than platform comparison findings, since suitable critical reports were not available for all inspected tools, and there is a high risk of subject biases and errors by examining product capabilities by vendor interviews. Triangulation was utilized in literature review also, and its main data source is peer-reviewed journal articles which increases its validity. Reflecting the conducted literature to case company analyses, the similarities can be spotted. According to Saunders et al. (2009, p.592) external validity extents the domain to which findings can be generalized. Literature review is conducted in a way that it avoids presenting detailed S&OP deployment methods or results, since S&OP processes are unique in every company, to maintain generalizability. By multiple-case-study, any generalizations about S&OP processes or planning methods cannot be done, since case only one case company had deployed S&OP process. Even though platform feature capabilities could not be validated, basic operating mechanism of S&OP tool could be generalized, since five different vendors presented very similar operating mechanisms and one case company had developed their own S&OP tool which operates in similar way.

5 CONCLUSION

This thesis was aimed to provide S&OP knowledge for B2B companies operating in complex manufacturing environments. Main focus of this study is S&OP process, and aspects such as forecasting methods and production planning methods are inspected just superficially.

5.1 Key results

This section provides answers to each addressed research questions.

RQ1: What are the desired outcomes of S&OP deployment?

Based on the literature review, four different aspects of S&OP could be identified:

- **Vertical integration and horizontal integration:** S&OP is a process to link company's strategy and business plans to departmental operations, and thus drive departments to work for common goal.
- **Visibility creation: S**&OP is a process to gain mid-term visibility by utilizing rolling planning horizon.
- **Collaborative target setting:** S&OP is a structured target setting process to produce and share tangible departmental targets by considering supply chain's capability to fulfill forecasted demand.
- **Performance management**: S&OP is a structural process to monitor and improve the performance of demand planning and supply planning, and overall performance of S&OP planning.

Based on these aspects, S&OP can be defined as a systematic tactical planning process to enhance vertical and horizontal integration, visibility creation, collaborative target setting and performance management. Defined process could be established for various specific outcomes. At ETO environments, desired outcome could be customer satisfaction by confirming supply capability in long-term projects. At MTS environment desired outcome could be cost-effective capacity utilization by avoiding downtime. Outcomes

depends on current strategy; sometimes it is reasonable to maximize the sales for example at market penetration situations, sometimes company needs to operate at lowest cost as possible. By combining the examples of different outcomes in different situations, the ultimate desired outcome seems to be the ability to consider all necessary factors in tactical planning.

RQ2: What aspects of business are expected to be improved by S&OP deployment according to case companies?

Three case companies were interviewed about their current planning processes and desired S&OP processes. Improvement expectations for nine different aspects were identified in multiple-case-study.

- **Visibility creation:** Different horizons of visibility creation were expected by case companies. One company was desiring to gain visibility for 24 months planning horizon, one was desiring to gain visibility within the annual planning periods, and one company was desiring for gaining visibility for 4 months.
- **Demand forecasting:** Case companies expected S&OP to improve their demand forecasting. S&OP tools were expected to improve forecast accuracies in product family level, product level and component level by utilizing judgmental and statistical forecasting methods and monitoring capabilities.
- **Supply Planning:** Case companies expected S&OP process and S&OP tools to improve supply planning by considering purchasing lead times and production capacities of their mid-term planning. CTO companies enhanced material availability and requirements examination over production capacity examination. One case company expected S&OP process to help them to understand better their manufacturing process capacities.
- **Financial planning** Case companies expected S&OP process and tools to improve financial planning by budgeting and evaluating financial results of different scenarios.
- **Scenario planning:** Case companies expected S&OP process and tools to improve comprehensive operations planning by scenario planning.

- **Internal collaboration** Case companies expected S&OP process to improve internal collaboration by forcing sales, operations and financial departments to share information and jointly deciding committed plans.
- **External collaboration:** Case companies expected S&OP process to improve collaboration with the suppliers by enabling the sharing of supplier specific plan information. One case company was expecting to S&OP to improve customers' forecast accuracies by collaboration.
- **Product portfolio management** Case companies expected S&OP process to improve product portfolio management and NPI-processes.
- **After sales operations:** One case company was expecting to S&OP to improve its aftersales operations.

RQ3: How do the identified S&OP process models and tools compare with the case companies' expectations?

Answer to this question is based on the reflections of literatures proposed S&OP models and vendors comments about their platforms' capabilities.

Visibility creation: S&OP is a recognized as a process to gain tactical level visibility by utilizing rolling forecasts. Literature indicates that different planning environments affects to optimal length of planning horizons, but typical planning horizon is considered to be at least 12 months. In rolling horizon planning, long-term vision is more uncertain, and vision iteratively clarifies in closer horizon, Reasoning for rolling horizons is that long-term vision is the preparation for shorter-term planning and strategic coordination requires long-term and short-term visibility.

Demand forecasting: S&OP processes and tools support the demand forecasting expectations. S&OP platforms' demand planning module's basic operating mechanism is integrating planning platform to company's information systems to gather historical data for statistical and AI-forecasting. S&OP platform provide capabilities to compare judgmental and statistical forecasts and generate adjusted forecast based on both forecasting methods. CTO environments set some challenges in component level forecast accuracy calculations, but it is reasonable to presume that systems could be configured to

fulfil the needs. Process and tools also suggest manufacturing allocation optimization, but the case companies did not consider these features important to their desired process.

Supply planning: Case company expectations are supported by the process and tools by inspecting the supply sides capability to fulfill the demand by the assumed planning factors. Manufacturing capacity constraint estimates are utilized for production capability evaluation. Tools will generate material requirement calculations based on BOM's and tools support flexible modification of the BOM structures. In adequate S&OP tools for CTO environments, component lead time information and current stock information are utilized to evaluate material availability. Still, all of the open platform providers did not consider CTO-specific bottom-up material availability information needs in their suggested systems. One case company expected S&OP process to help them to understand better their maximum manufacturing capacity. Manufacturing process capacity estimations are prerequisites for comprehensive S&OP. From the performance management aspect, if the production never reaches its targets, biased parameters could be noticed. Still S&OP is not a project to determine those parameters. Following process and quality management principles is more tangible effort to determine capacity than utilizing cross functional tactical planning process or its specific tools.

Financial planning: S&OP process supports the expectations by emphasizing the financial evaluation of upcoming plans. S&OP tools support this by budgeting functions and providing ability to compare financial results of different scenarios.

Scenario planning: S&OP process emphasizes the scenario planning aspects, which is enabled by S&OP tools. More advanced planning platforms utilize optimization methods to generate scenario suggestions according to set parameters.

Internal collaboration: Case companies expected S&OP to support collaboration between the sales, operations and financial departments. S&OP is a cross functional process aiming for common agreement of upcoming plans. S&OP' meetings enhance horizontal collaboration between departments. Also, if the company strategic objectives are taken into account in plan generation, and plans are reviewed by the executives, process would enhance vertical collaboration. S&OP tools support the collaboration by

providing possibilities to utilize same datasets in different departments' planning practices.

External collaboration: Case companies expected S&OP process to improve their ability to provide visibility for upcoming orders to their suppliers. Creation of supply plans enables to extract supplier specific supply plans. Supplier specific forecast reports could be created by inspected S&OP tools. Suggested practice is to share reports by email. Some S&OP tools could be integrated to supplier collaboration platforms. One case company expects S&OP tool to improve their customers' forecasting accuracies. As discussion part concluded, S&OP tools are not preferable solutions for improving customers' forecast accuracies. Studied maturity models visioned that in advanced S&OP processes, main suppliers and customers could participate in parts of S&OP meetings, but there are no indications that external participation would enhance operational performance.

Product portfolio management Case companies expected S&OP process to improve product portfolio management and NPI-processes. Current literature suggested that all aspects impacting to demand should be considered in S&OP planning and NPI metrics are suggested to be followed in S&OP processes. Time-to-market metrics, product performance target metrics and development cost metrics are most commonly used KPI's in NPI processes. Linkages between NPI KPI's and the S&OP planning stakeholders could be recognized; time-to-market target connects R&D to production; product performance connects R&D to sales and marketing departments; and development costs connects R&D to financial department. Current literature did not identify practices to integrate NPI process in S&OP planning. Reason might be, that NPI processes are always company specific processes and generalization of practices for NPI processes' S&OP implementations could be dubious. Maybe because of that, product portfolio management is discussed in S&OP literature mainly by examining profitability and volumes in demand planning and emphasizing companies to evaluate how product life cycle - product ramp-ups and ramp-downs, would affect for total demand. S&OP tool vendors stated that platforms could be used for calculating product profitability, inspecting supply needs of ramp-ups and ramp-downs and model scenarios to evaluate NPI launches' cannibalization of demand.

After sales operations: One case company was expecting to S&OP to improve its aftersales operations. Most of the current literature embodies S&OP as a manufacturing operations planning process and after sales processes are not perceived as a part of manufacturing S&OP. Some authors present that basic structure of S&OP could be utilized for service operations planning. Aftersales business is usually considered as an separate business function, and results of this study indicates that S&OP processes and aftersales processes should not be unified as a single planning process, but there is a possibility to create separate S&OP processes for manufacturing and after sales services.

5.2 Recommendations for further research

This study identified modern S&OP tools and examined them by interviewing platform vendors. Research should be conducted to examine these tools in practice, in order to find out whether they operate in a way that they are marketed. I would recommend for further research to identify companies that are utilizing modern S&OP tools identified in this study, and examine how the marketed features perform in practice. Identified S&OP tools' features are classified as the most advanced S&OP stages. tool features by S&OP maturity models. It should be researched, if companies, that are utilizing such tools, have managed to evolve other maturity aspects for the most advanced stage also.

This study also pointed out the conflicts between S&OP methods and quick response MTO strategies in high product variety environments, which indicates that besides S&OP's design for planning environments, S&OP's suitability to company specific strategies should be evaluated greatly in S&OP deployment. Research should be conducted to find out what combinations of competitive strategies and operational models S&OP methods support best.

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