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LAPPEENRANTA UNIVERSITY OF TECHNOLOGY

Faculty of Technology

Department of Industrial Management

MASTER'S THESIS

DECISION MAKING IN SALES AND OPERATIONS PLANNING PROCESS

Instructor: Prof. Petri Niemi

Supervisor: Mats Hollinggård

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ABSTRACT

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This research combines decision making and sales and operations planning (S&OP) theory to create a decision-making framework to solve complex situations when trying to match demand with supply. The research has been designed to solve problems in investment related decisions in a case company. The framework is built to help the case company to understand what kind of information is needed in the sales and operations planning process and what kind of KPI's the decision maker should follow before and after the decision has been made.

The research introduces a set of tools what a decision maker can use in different steps in the decision-making framework. Visualization is discussed to help understand trends and catch problem areas in the current supply chain. Decision making as a risk management tool is also covered and suggestions of question lists introduced. The framework is connected to calendar year so it's possible for the case company to make it visible on what information is needed and on what interval to support the decision-making process.

TIIVISTELMÄ

Opiskelija: Tero Kukkola

Työn nimi: Päätöksenteko myynnin ja tuotannon suunnitteluprosessissa

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Tämän tutkimuksen tarkoitus on luoda päätöksentekokehys ratkaisemaan monimutkaisia investointipäätöksiä jotka liittyvät kysynnän muutostilanteisiin. Kehys on rakennettu yhdistelemällä sales and operations planning (S&OP) ja päätöksenteon teoriaa. Kehys on rakennettu, jotta case yritys voisi ymmärtää paremmin minkälaista tietoa se tarvitsee S&OP prosessissa ja millaisia mittareita sen tulisi seurata ennen ja jälkeen päätöksenteon.

Tutkimus esittelee työkaluja joita päätöksentekijä voi tarpeen mukaan soveltaa kehysten eri vaiheissa. Tiedon visualisointia käsitellään päätöksenteon apuna, visualisointia voidaan mm. käyttää tunnistamaan trendejä tai ongelmakohtia nykyisessä toimitusketjussa. Riskienhallintaa päätöksenteon avulla käsitellään luomalla kysymyslistoja, joiden avulla päätökseen voidaan valmistautua ja tarvittavat vaihtoehdot käydä läpi. Lopuksi päätöksentekokehys kytketään kalenterivuoteen jolloin case yritys voi suunnitella erilaiset tiedon tarpeet etukäteen ja sopia miten ne päivitetään tukemaan päätöksentekoa.

PREFACE

Writing a master thesis has felt somewhat surreal. Until I was 25 years old any type of education did not interest me. Still I had pushed through high school and graduated from polytechnic university with a Bachelor's degree because that was the thing to do. Then something clicked in my brain and I understood that the only person deciding how I will live my life is myself. After that I have not seen a limit of the thirst of knowledge that I have. I strongly believe that people can learn almost anything and the things we can't is a matter of timing.

The past two years have been fun, hard and stimulating. I hope that the friendship and classroom spirit will live together with us for years to come. I am extremely thankful that I had the opportunity to learn together with such bright minds. Special thanks to my thesis instructor Petri Niemi who has the ability to transform complicated topics into more understandable format.

All this said I could not have done this without my wife Anni and my children Stella and Viola. Thank you for everything. Without you this would not mean anything.

“Read, Learn, Repeat”

-Unknown

In Kerava 30.12.2016

Tero Kukkola

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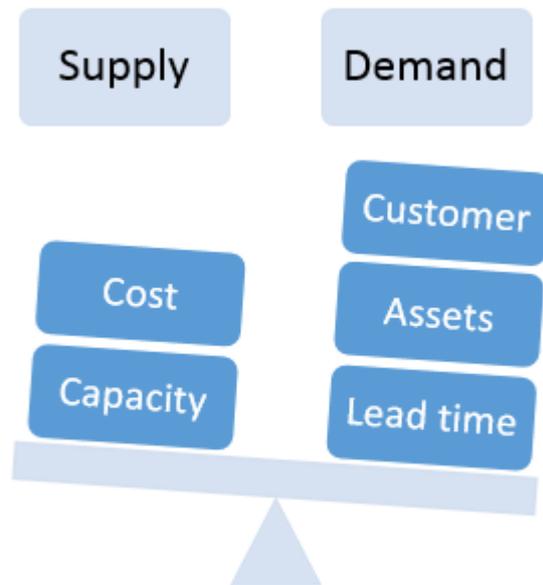
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1. INTRODUCTION

1.1. Background of the thesis

The case company is a Regional Business Unit (later RBU) in a Global Gas and Engineering company. The RBU is in Northern Europe and has operations in 8 countries. Customer Experience is a focus area for the case company and most of their customers want reliable and flexible deliveries (picture 1). At the same the case company is part of a global conglomerate and thus under rigorous analyze of profit and loss and needed investment money. In the case company for the past few years the ROI has reduced and from that development the general conclusion is that not all investments are generating enough profit. The operating profit has been declining as well which backs up the conclusions from the ROI (The Linde Group 2016). The company has faced heavy competition and the pricing structure of products and services has been under pressure. This is creating a catch 22 type of situation where money is needed to up keep and develop the business but at the same time the overall business is mature and growth is flat. It is hard to justify large investments into existing business if there is low additional gain for the company. On the other hand, the asset fleet is getting old and new investment just to up keep the assets are needed more and more. The company has started heavy cost reduction programs and this research tries to find the pain points in the Sales and Operations planning and give tools to do better investment decisions and allocation of existing assets.



Picture 1. Balancing Supply and Demand.

New kind of Investment appraisal methods are needed and all demand changes should be handle with more care and supported by good data. The usage of existing assets should be optimized better in country and Regional Business unit levels. More cooperation between sales and operations is needed to understand what kind of business possibilities the company have now and where are the areas for improvement. The company already has a sales and operations planning process on going but on some parts, it's not fully delivering the value it should. The process is a monthly process but investments are planned on quartile based so there's a contradiction and a possible confusion what are the possibilities to handle demand change situations. One of the core dimensions of cooperation with Sales and Operations is the company Strategy and short term goals. The wanted service level to customers and meeting other customer demands are important but equally important is to match these demands with the correct cost. If the cost to serve is too high the company will not make enough profit thus creating pressure to price increase or reduction of service level. The company Strategy needs to be present in the cooperation with Sales and Operations and ultimately in the decision making of the management team.

1.2. Objectives and limitations

The goal of the thesis is to find best practices from Supply Chain and Decision Making literature how to handle demand change situations and how to do better decisions in these situations. The result is a decision-making framework in Sales and Operations Planning Process. The scope of the thesis is decisions in Cylinder Supply Chain and especially decisions connected to demand changes causing pressure to invest into new fixed assets. The problem areas in the as is process is described and the biggest gaps identified. The journey from demand input to final decision is described and suggestions how help the decision maker to use existing tools or develop new to back up the decision with fact based information. Finally, a decision-making framework has been designed to full fill the gap in the as is process and enable knowledge based decision making.

The research question is:

How can the case company improve decision making in the Sales and Operations Planning process?

The sub-questions to help answer the research question are:

- How information should be structured to help the decision maker to do better decisions?
- What kind of KPI's the decision maker should follow to understand if a decision is needed?
- What kind of KPI's the decision maker should follow to understand if the decision made was a good one?

The creation of sales forecast is not in the scope of this study but as it is an integral part of demand plant the different forecast levels and groupings are discussed trough the research. When making business with renting fixed assets to customers it's important to understand that the rotation of the assets has a big part of how many Assets overall is needed to full fill the customer need. The sales forecast has bigger meaning than just to describe the needed delivery or production amount. The company needs to find a way to transform the sales and demand forecast into needed fixed assets.

1.3. Research process and methodology

The research has followed the qualitative study approach and the following methods have been used to collect the data from the case company processes: unstructured interviews, observations and discursive document analyze.

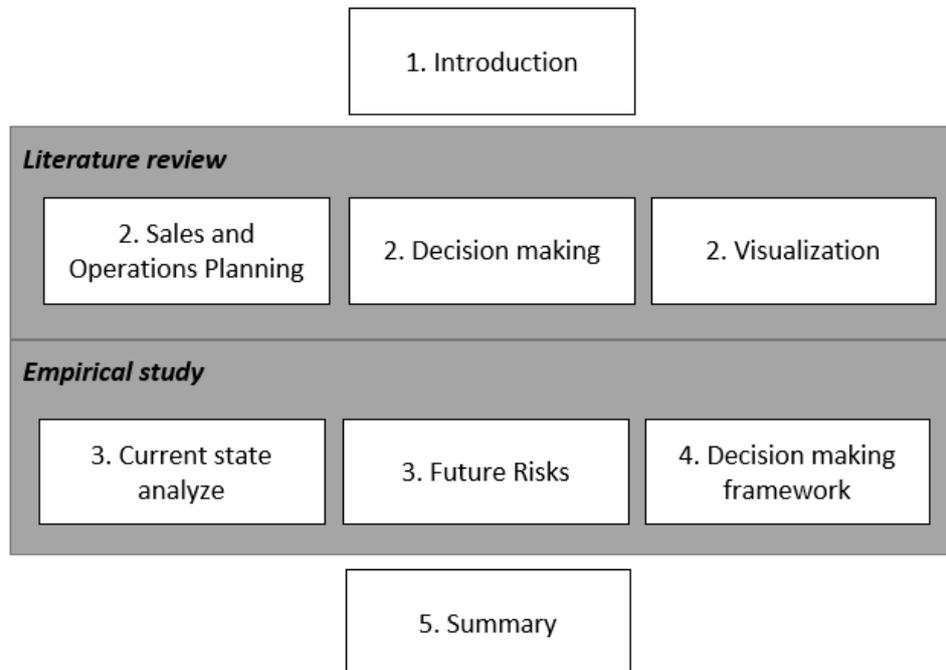
The researcher has made a holistic data gathering and the data is collected from real circumstances. The data is analyzed inductively so that the goal was to reveal unexpected findings. The findings have been treated as unique and the result of the research is most likely only applicable for the case company.

The data is gathered from conversations, interviews and observation. The people interviews and the literal sources have been picked to back up the original problem statement. Some preliminary research questions were set but the questions have lived together with the research and the researcher and have been changed when it has been clearer what is possible to achieve with the research.

1.4. Structure of the report

In the first chapter of the thesis the problem statement, the goal of the research and the final research questions are presented and the scope and limitations of the study discussed. In the second chapter the theory to help to solve the problem is presented and a synthesis of the theory created to create a decision-making framework to help the decision-making process. The key parts in the theory chapter are decision making and sales and operations planning literature reviews. In the third chapter the current state of the company and the problems is described in more detail. The future risks are discussed on the chapter three to understand what could happen if nothing is changed in the decision-making process. The maturity of the current S&OP process is analyzed in chapter three and some conclusion is drawn to support the analyze of what are the gaps in the as is S&OP process. In the chapter four the theory synthesis is used to help to create decision making framework that could be implemented into the company existing process. The framework is designed to visualize and improve the decisions made in the demand change situations. In chapter five the research is summarized and relevant answers to research questions provided. In chapter five there is also some

discussion what could be the implement steps for the decision-making framework and what are the topics that needs further investigation that was not covered in the research. The research structure is described in picture 2.



Picture 2. The structure of the thesis.

2. THEORY

In the case company's supply chain, it's not enough to just understand how large stock of cylinders you need to have. One must understand that cylinders are at the same time fixed and variable asset. Company can have enough capacity to full fill the gas need of a customer but not enough cylinders to carry the gas for the customer. In this chapter is described how to understand and handle demand change effects in supply chain and make decisions how secure the best service level possible. The case company needs more structured way of doing decisions and in this theory chapter is defined some key concepts how to analyze current Supply Chain and possible demand changes. The goal is to create a theoretical framework which could act as a toolbox for the decision-maker. The framework would also have time dimension to standardize the decision-making interval so there's clear deadline for e.g. data updates that are needed for the decision-making process.

2.1. Safety stock

One of the basic problems for companies to solve in inventory management is to find a balance between cost and service. Safety stock can be considered as a buffer against unstable demand. Defining safety stock to a material will help answer the question how much stock should a company keep in order to serve the customer with agreed service level. Adding average replenishment time demand and safety stock will tell the company the reorder point when the stock needs to be replenished. Safety stock can be calculated with the following components (2003, Hopp).

Safety factor z is based on the wanted service level. If the company wants to have a service level of 95% and the demand is normally distributed, then the safety factor is 1.645. The values can be computed or looked from a ready table.

Standard deviation σ is calculated from the normally distributed demand set of the material. The formula for defining safety stock is then:

$$s = z\sigma$$

2.2. Financial measurements

DuPont model is one way to visually illustrate what are the building blocks of ROI. In picture 3 is one way of drawing a DuPont model. The main give away of this model is ROI, Profit Margin % and Asset turnover. In this paragraph these measurements are defined.

Operating Income	626 603	Earnings Before tax and interest	144 119	Profit Margin %	23,00 %
-			/		
Operating Expenses	482 484	Operating Income	626 603	X	Return on Investment, ROI/ROCE
Fixed Assets	500 000	Operating Income	626 603	Asset turnover	0,59
+					
Current Assets	570 000	Assets	1 070 000		
			/		

Picture 3. DuPont model of ROI with generic numbers

ROI

Return on investment is an accounting term to define how well company's assets generate profit. ROI is one of the most common measurement of financial performance. ROI considers: revenues, costs and investment. ROI is a single percentage and as such can be compared between different business units in the company. As seen on picture 3 there's three ways to improve ROI (Horngren 2002):

- Decrease assets
- Increase revenues
- Decrease cost

Profit Margin %

Profit margin % is a measurement how much operating income a company makes compared to total revenue. The operating income is usually defined as the total revenue of operations minus cost of goods sold and operating cost. Interest expenses and taxes are excluded. (Horngren 2002)

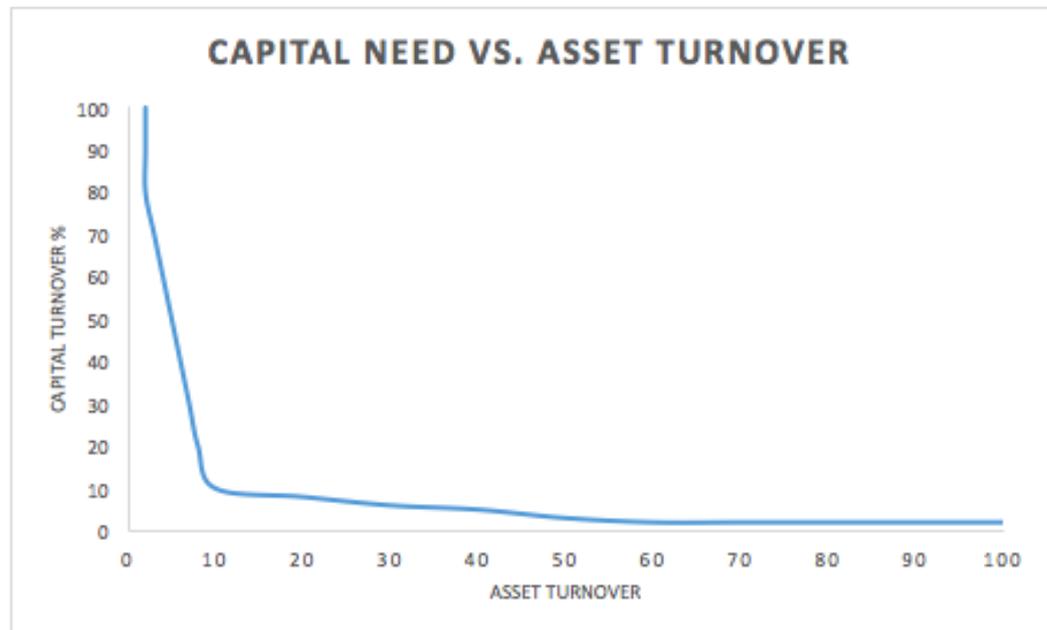
Asset Turnover

Assets can be divided into three groups: Current Assets, Long-Term Productive Asset and Intangible Assets. Current Assets are cash or assets that will be turned into cash with in less than one year. These assets usually include cash, accounts receivable and inventory. Long-Term Productive Assets are kept more than one year and used to produce goods and services for customers. These assets include buildings, machinery, computers and information infrastructure. Intangible assets are e.g. patents and trademarks. (Horngren 2002)

Asset turnover can be calculated with the following formula. Depending of the industry a suitable Asset group can be chosen or use all Assets groups. (Horngren 2002)

$$\text{Asset Turnover} = \text{Yearly Revenue} / \text{Assets}$$

High turnover speed is as good sign of how well the company's assets are generating revenue so when the Asset turnover increases the need of capital decreases (picture 4). (Karrus 1998)



Picture 4. Capital turnover in relationship with Asset Turnover (Karrus 1998)

2.3. Sales and operations planning

Sales and operations planning process (later S&OP) is meant for balancing customer demand, production and logistic requirements and to communicate know limitations. S&OP in a nutshell is:

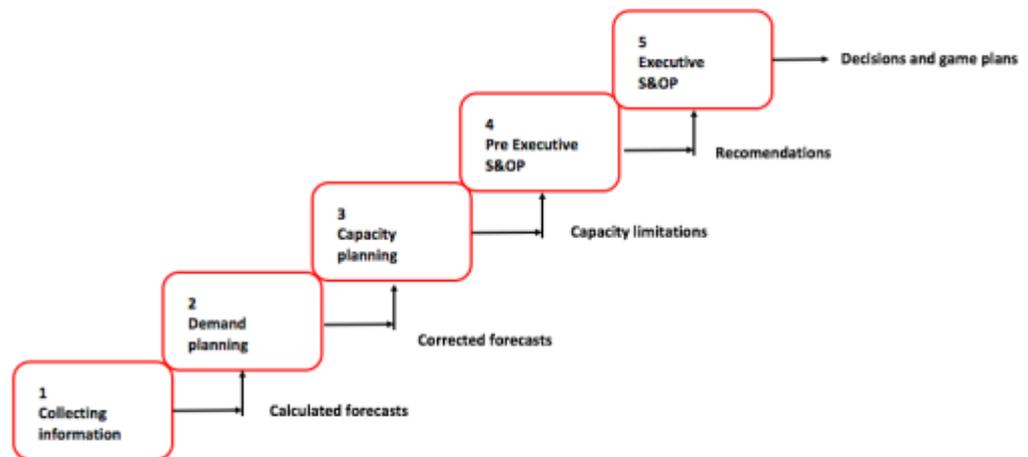
- Cross functional tactical planning process
- Combines company's different plans into one
- Time horizon is from under 3 months up to over 18 months
- Connects company's strategy into operational actions

(Thomé et al. 2001)

Five step monthly S&OP process in companies includes: (picture 5)

1. Collect and review delivery data from the past and analyze forecasts to the future
2. Review demand plan for the future
3. Review delivery plan based on demand plan
4. Prepare for Executive S&OP meeting. Make decisions and prepare initiatives for management decisions.

5. Executive S&OP meeting by end of the month



Picture 5. Monthly S&OP process (Falck 2013).

2.4. Sales and Operations Planning coordination

Coordination plays a key part in S&OP process by aligning business strategy and operational planning and aligning the business functions and supply chain partners. Coordination can be thought as a pattern of decision making and communication between stakeholders reaching for common goals. In supply chains the coordination target is met when stakeholders do decisions that are efficient for the whole chain. The result of S&OP coordination should be a clearly communicated one integrated set of numbers. Coordination framework is presented in picture 6. (Tuomikoski 2014)

S&OP organization

In the S&OP organization it should be clearly defined who should be involved in the process from which organization and functions. The key elements of the formal S&OP organization are the decision-making mandate, what decision are centralized/decentralized and the description or roles and responsibilities. (Tuomikoski 2014)

S&OP process

In S&OP process is defined how different sales and operations sub-plans are created and communicated in the S&OP process. Formal planning activities, decision making process and how to co-operate between functions are all important part of S&OP process. The hard core of S&OP process is the collaborative decision making and dynamic planning in a cross functional set up. (Tuomikoski 2014)

S&OP tools and data

Accurate data and fit for purpose tools are essential to succeed on effective decision making in S&OP process. In a basic level S&OP process effective IT-tools are not in that big focus instead the focus should be on accurate data. The data used for decision making should be commonly used data sets which are validated and trusted in all functions. When company wants to step into more real time data and using data from multiple sources effective IT-systems starts to play more essential role. (Tuomikoski 2014)

Performance management

S&OP process should be measured in order to follow up how the targets are full filled and corrective actions can be taken if not. Performance that could be measured are e.g. financial performance, operations performance or process performance. Important KPI's to follow up in order to monitor financial performance are e.g. profit, revenue or cost to serve. Operational KPI's could be fill-rate, on time deliveries, forecast accuracy and quality measures. (Tuomikoski 2014)

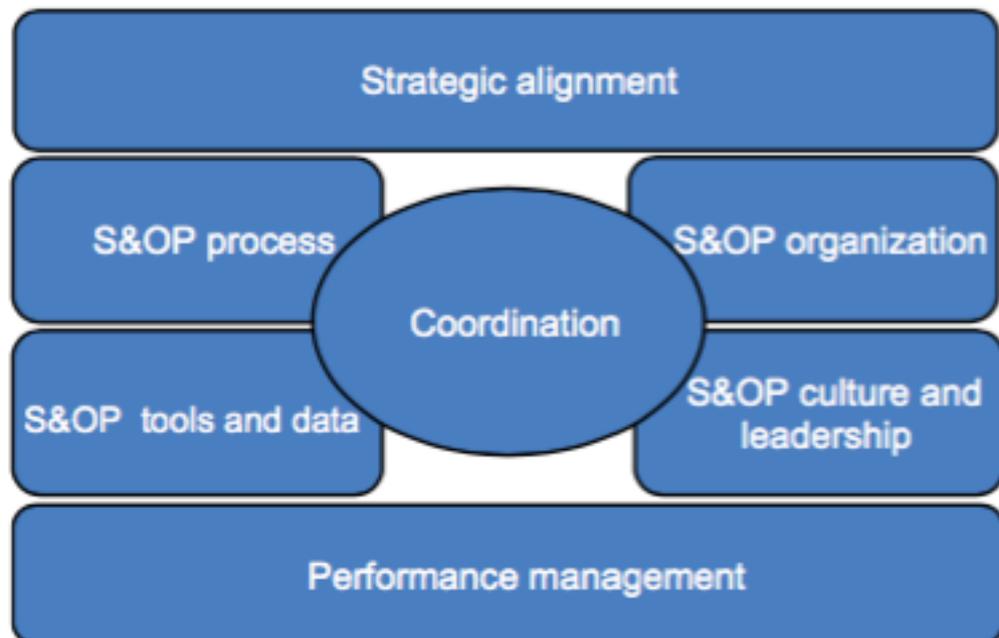
Strategic alignment

One of the key purpose of S&OP is to create a vertical link between short term operational plans and the company's long term strategic targets and plans. The alignment has two-fold purpose. Firstly, it makes sure that the operational tactical plans are aligned with the vision and strategy of the company. Secondly the S&OP process will create a possibility to promote sales and find gaps between strategic business plans and S&OP plans. Many times companies use S&OP

process just to reach operational improvement but S&OP can have an impact of stimulating sales activities and effect the demand e.g. campaigns or discount activities. (Tuomikoski 2014)

S&OP culture and leadership

S&OP culture and leadership supports and makes sure that from top management down to floor level all organizational levels commit to the S&OP process. Management shows example and set's targets and incentives to achieve the business targets. Management will also set the mandate for the S&OP organization so that actual decisions can be made in the process. (Tuomikoski 2014)



Picture 6. S&OP Coordination Framework (Tuomikoski 2014)

2.5. Sales and Operations planning maturity model

The maturity of companies Sales and Operations Planning process can be assessed with a matrix where is five different dimensions and the equivalent level of each dimension on a scale of 1 -5. The model emphasizes that the nature of the S&OP process is to optimize profit through S&OP plan integration so it's important to understand that the dimensions are means to that end (J. Grimson 2007). The dimensions are:

- Meetings and Collaboration
- Organization
- Measurements
- Information Technology
- S&OP Plan Integration

The maturity of the process can be defined by analyzing where the company is in the different stages. The matrix will then give an overview what are the biggest gaps in the sales and operations planning process. The stage 1 represent a company that don't have S&OP process in place and the stage 5 a leading company which has a proactive and collaborative S&OP process. The dimensions and requirements for different stages are presented in table 1. There is no absolute truth on which stage the company is but with an honest analyze it should be possible to grade all the different dimensions. The company can be in several different stages depending on the dimension e.g. the company can have a good IT-system in place but is lacking meeting and organization structure to get the benefit out from the planning system. (J. Grimson 2007).

Table 1. S&OP maturity model (J. Grimson 2007)

	Stage 1 No S&OP Processes	Stage 2 Reactive	Stage 3 Standard	Stage 4 Advanced	Stage 5 Proactive
Meetings & Collaboration	<ul style="list-style-type: none"> • Silo Culture • No meetings • No collaboration 	<ul style="list-style-type: none"> • Discussed at top level management meetings • Focus on financial goals 	<ul style="list-style-type: none"> • Staff Pre-Meetings • Executive S&OP Meetings • Some supplier / customer data 	<ul style="list-style-type: none"> • Supplier & customer data incorporated • Suppliers & customers participate in parts of meetings 	<ul style="list-style-type: none"> • Event driven meetings supersede scheduled meetings • Real-time access to external data
Organization	<ul style="list-style-type: none"> • No S&OP organization 	<ul style="list-style-type: none"> • No formal S&OP function • Components of S&OP are in other positions 	<ul style="list-style-type: none"> • S&OP function is part of other position: Product Manager, Supply Chain Manager 	<ul style="list-style-type: none"> • Formal S&OP team • Executive participation 	<ul style="list-style-type: none"> • Throughout the organization, S&OP is understood as a tool for optimizing company profit.
Measurements	<ul style="list-style-type: none"> • No measurements 	<ul style="list-style-type: none"> • Measure how well Operations meets the sales plan 	<ul style="list-style-type: none"> • Stage 2 plus: Sales measured on forecast accuracy 	<ul style="list-style-type: none"> • Stage3 plus: New Product Introduction • S&OP effectiveness 	<ul style="list-style-type: none"> • Stage 4 plus: Company profitability
Information Technology	<ul style="list-style-type: none"> • Individual managers keep own spreadsheets • No consolidation of information 	<ul style="list-style-type: none"> • Many spreadsheets • Some consolidation, but done manually 	<ul style="list-style-type: none"> • Centralized information • Revenue or operations planning software 	<ul style="list-style-type: none"> • Batch process • Revenue & operations optimization software – link to ERP but not jointly optimized • S&OP workbench 	<ul style="list-style-type: none"> • Integrated S&OP optimization software • Full interface with ERP, accounting, forecasting • Real-time solver
S&OP Plan Integration	<ul style="list-style-type: none"> • No formal planning • Operations attempts to meet incoming orders 	<ul style="list-style-type: none"> • Sales plan drives Operations • Top-down process • Capacity utilization dynamics ignored 	<ul style="list-style-type: none"> • Some plan integration • Sequential process in one direction only • Bottom up plans - tempered by business goals 	<ul style="list-style-type: none"> • Plans highly integrated • Concurrent & collaborative process • Constraints applied in both directions 	<ul style="list-style-type: none"> • Seamless integration of plans • Process focuses on profit optimization for whole company

2.6. Decision making cycle

Decision making is seen as process in which a problem is defined and the decision can be solved by comparing the problem into one or more pre-defined objectives (picture 8). To reach these objectives a set of alternative actions should be generated. The alternatives are compared against certain criteria and finally a decision is made. The decision needs to be implemented and followed up and if the results are not satisfactory a new cycle should be started. (Harrison 1995)

Searching for alternatives

When doing decisions there's many times limitations with time and money and the value of additional information tends to decline and the cost rise. (Harrison 1995). Already from setting the managerial objectives the decision maker has had to choose different kind of paths to walk and these paths determine what kind decisions should be taken. (Gorgulho et al. 2015)

Comparing and evaluating alternatives

There should usually be three to five alternatives to make intelligent decision. If one has only one option that is basically doing nothing. Alternatives should be evaluated based on the managerial objectives e.g. highest profit. Also the

evaluation should include the forecasted outcome and possible limitations of each outcome. (Harrison 1995)

The act of choice

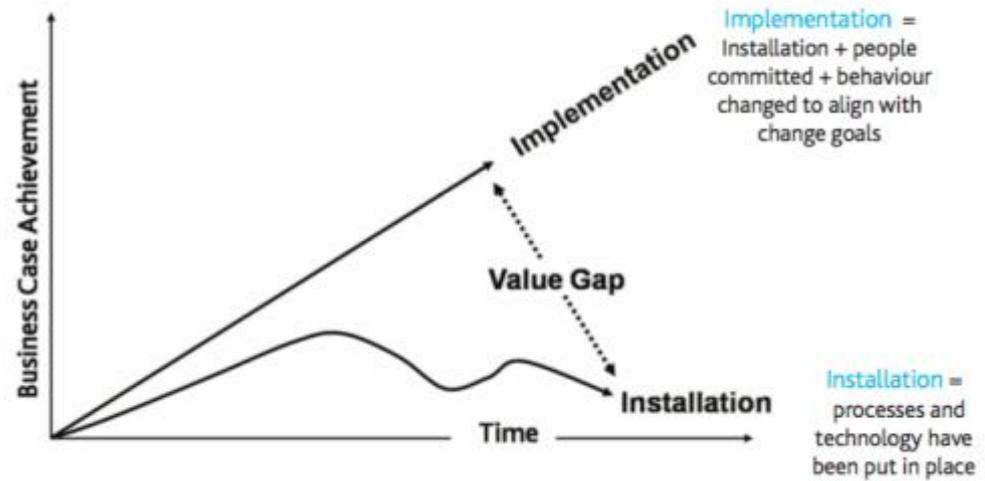
The choice or the actual decision is the culmination of the decision cycle but only a part of it. The decision maker needs to make effort for the decision in order to choose between options. The best alternative is not always apparent. (Harrison 1995). The decision maker should use simple tools to support the decision making because merely relying on one's gut feeling in many cases is not enough.

Implementing decision

When implementing decision, the success of the decision is basically based on the quality of decision and how and when the decision is implemented. If the decision is not made on time or the risk/reward relationships is overlooked there's a higher possibility that the implementation will not be a success. Optimum amount of information, low rate of conflict of interest and influence of decision maker will make increase the success of implementation. (Harrison 1995)

In the picture 7 is presented a visualization of what is the difference between installation and implementation. When one installs something one is merely handing over process and technology to people to start to use. When one implements a process or a tool people who should work in the process and with the tools have been committed and behavior changed to align with the new process goals. (Change First 2011)

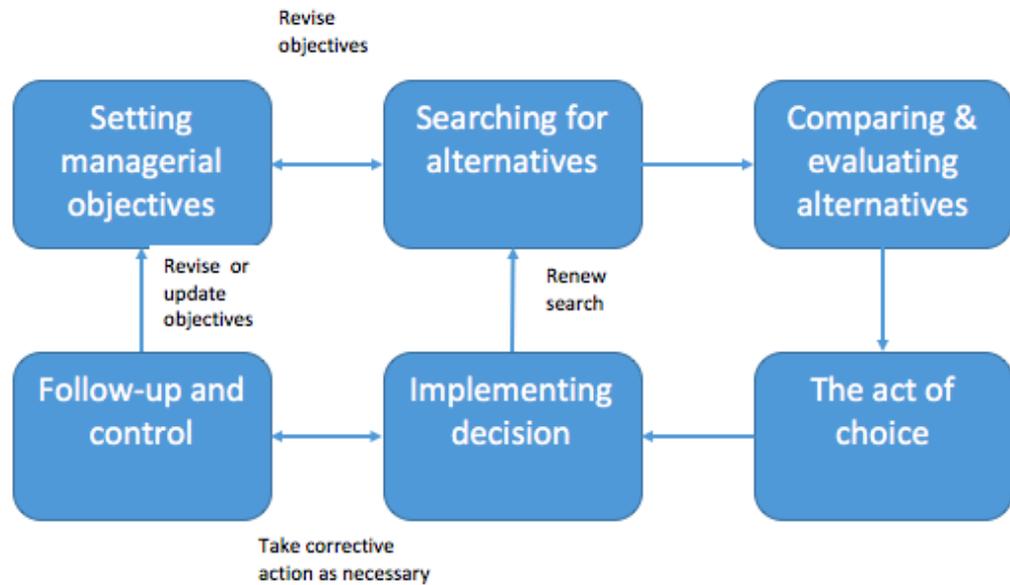
Implementation versus installation



Picture 7. Implementation versus Installation (Change First 2011)

Follow-up and control

Follow-up and control is needed to make sure that implemented decision has been rolled out in the organization. If deviations are observed they should be attacked right away. Performance should be measured based on the original managerial objective. Follow-up and control observations can and should launch a new decision making cycle. (Harrison 1995)



Picture 8. Decision making cycle (Harrison 1995)

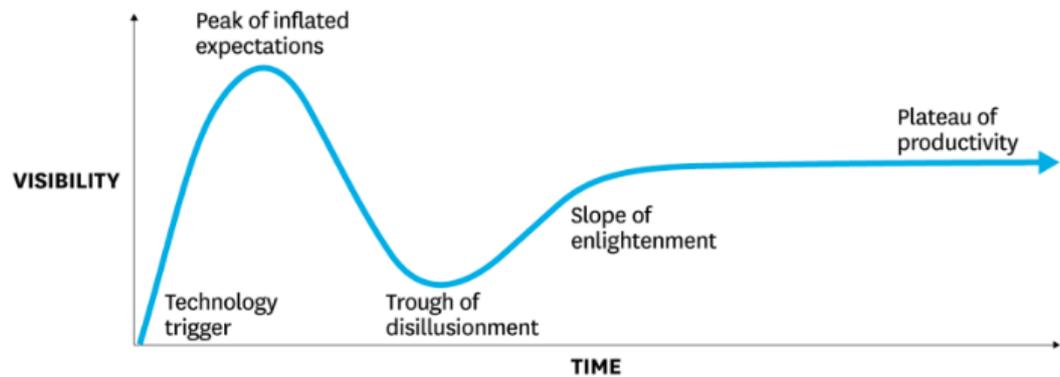
2.7. Visualization

Data visualization boils down to two questions:

1. Is the information conceptual or data-driven?
2. Is the purpose to declare or explore something?

The first question is usually the simpler one. You either want to present a concept through visualization or you present actual data in visual way. In picture 9 there's a classic example of visualization that is conceptual so the graph itself is not based on any actual data. The goal of the visualization is to show a certain pattern. Many times, these types of visualizations are data-driven so one can see actual values on the y- and x-axis. (Berinato 2016)

Hype Cycle for Emerging Technologies



Picture 9. Declarative Visualization (Berinato 2016).

The second question will then answer what are you doing with the information. Are you communicating information (declarative) or are you trying to investigate something (exploratory). When you are using declarative visualizations you are making a point with the data (Berinato 2016) e.g. how is our actual sales compared to budget. This information is generally used for larger crowds such as team meetings or management meetings.

Exploratory visualizations are two types: Testing a hypothesis or Analysis when you don't know what you are looking for. Hypothesis testing happens basically when you have a question that needs to be answered e.g. why sales team performance has been lagging lately. The other type of exploratory visualization is when you know that you have an issue but no idea what you should be looking for so you are missing the hypothesis. So then one needs to mine through the data finding anomalies, trends and patterns. These types of analyses are many times big strategic questions such as why the revenue is falling. Usually the crowd for these for these analyses are oneself or a small team. (Berinato 2016)

2.8. Risk management by decision making

Many managers focus on the performance targets that are set to them from their managers. There is a risk then that the managers then behave differently when making decision in these areas compared to the not measured areas. When managers are over or behind their targets that might cause them to avoid or take

more risks than in a neutral situation. Many performance rewarding systems tend to reward “good outcomes” not “good decisions” (Tang 2006). Many companies do not even have a system in place to measure and improve decision making over time (Larson 2016). In this paragraph is described some methods that could help managers and employees to make good decisions that leads to good outcomes.

Question lists

When a decision maker is set into a situation that a decision needs to be made there's some set of questions and playlists that the person can go through to do better decisions. The set of questions is meant to widen your perspective, reality test your assumptions, take distance to the decision and prepare to be wrong. Especially the questions try to stop decision maker not to end up in to a “whether or not” decision making situation. Usually one has more than one option. The questions worth going through in a decision-making situation are:

1. Imagine that the option you're currently leaning towards simply vanishes as a feasible alternative. What else could you do?
2. Imagine that the alternative you are currently considering will actually turn out to be a terrible decision. Where could you go looking for the proof of that right now?
3. How can I test this decision without implementing it full speed?
4. If you would be replaced, what would your successor do about your dilemma?
5. Six months from now, what evidence would make me retreat from this decision? What would make me double-down?

(Heath et al. 2013)

Implement the question lists

After the decision maker, has asked a lot of questions and got a better understanding of the decision-making situation. There are some tools what to use during and after the decision-making process.

1. Write down five preexisting company goals of priorities that will be impacted by the decision.

2. Write down at least three realistic alternatives.
 3. Write down the most important piece of information you are missing.
 4. Write down the impact of your decision will have one year in the future.
 5. Involve a small team (2 – 6 people). Getting more perspective reduces bias and increase buy in.
 6. Write down what was decided, as well as why and how much the team supports the decision.
 7. Schedule a decision follow-up in one or two months. This will create a possibility to learn from past decisions and take corrective actions.
- (Larsson 2016)

2.9. Framework for decision making in Sales and Operations Planning

As a synthesis from the theory can be created a six-step model when and how to make decisions in Sales and Operations planning process. The model is described in picture 10. The model is planned to run as a cycle once a month. The core inputs to the process are: long and short term demand plan from Sales and Marketing and capacity plan from Operations. In the next paragraphs the model and supporting data will be explained in more detail.

Step 1

In the first step of the model all the information of demand changes and marketing campaigns, capacity status, open investments and purchases are put together. As an outcome of this step is a sales forecast for agreed period typically, 12 -24 months.

Step 2 & 3

In the second step and third step of the model all the information is put together as a demand plan which is converted into capacity need and thus capacity plan. Already in these steps the S&OP team should try to seek alternative ways to handle the demand e.g. balancing inventory between stock locations. As an outcome of this step is a ready analyze what are the effects to the asset needs.

Step 4

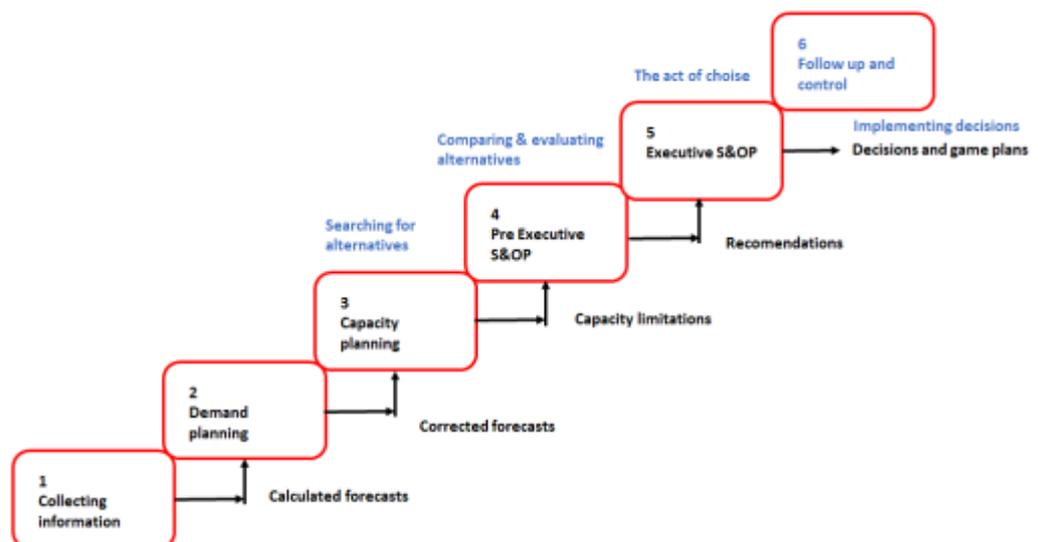
In step four all the possible limitations and alternatives how to handle the demand should be presented. In this step the S&OP team should compare and evaluate the different options and capacity limitations. As an outcome of this step there should be clear recommendations to the management team to make a decision.

Step 5

In step five the decision should be made. As an outcome of this step should be a clear communication what are the game plans and how to implement the decision. The decision maker should use data, data visualizations and questions lists to support the act of choice.

Step 6

In step 6 the S&OP team and the case company should follow up and make sure that the decisions have been implemented and the effect in agreed KPI's are shown. Actions should be taken immediately if deviations from original decision can be seen.



Picture 10. Six step model for decision making in S&OP process.

2.10. How to support decision making in the model?

In table 2 are shown different data needs for the steps in the model. Also in the table are suggestions what kind of KPI's should be used to follow-up the success of the decision-making process. How to produce a demand forecast is out scoped from this thesis so the concentration is on how to analyze and decide actions from an existing demand forecast. That said it's important still to keep in mind that e.g. demand forecast accuracy plays an important role how the company will succeed in handling the demand changes.

Table 2. Data and KPI needs for steps in the model.

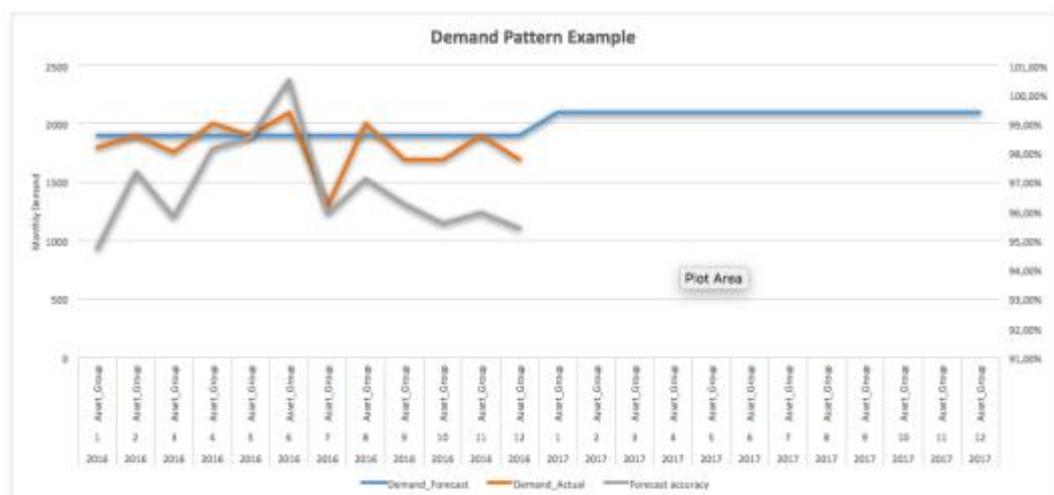
Step	Data	KPI
1	Demand input	
2	Demand forecast	Forecast accuracy
3	Capacity review	Delivery precision, Capacity analyse
4	Capacity need	Days of Stock
5	Alternatives	
6	Followup dashboard	ROCE, Operational profit

Demand and capacity visualization

When analyzing the demand changes and current capacity and that the goal is to present something to the management. The visualizations are data driven and the S&OP team should use visualization methods to:

1. Explore
2. Explain

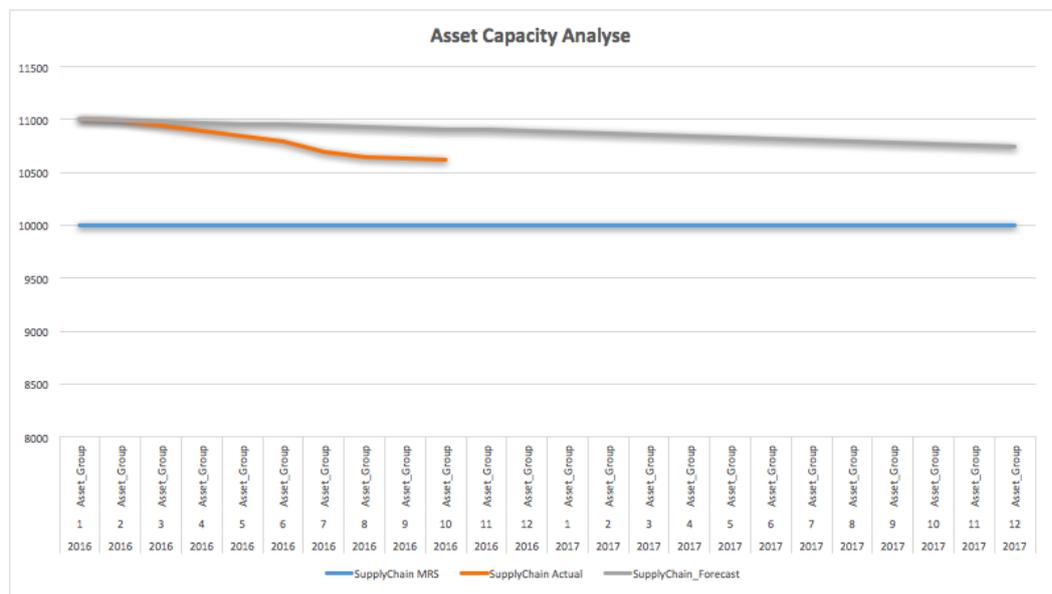
The demand patterns could be analyzed and explored with e.g. line graphs (picture 11) where you can see the actual demand and forecast demand. On the right axis you have demand info and on the left axis forecast accuracy percent. The reliability of the forecast can be measured and presented with forecast accuracy. The example graph would show us that January 2017 there will be a demand increase in that asset group. This finding would get the team forward with the analyze loop telling them that this is an asset group they need to do further investigations. This kind of graphs and summaries the team could use to explore the demand data.



Picture 11. Demand Pattern analyze example.

Similarly, the as is asset capacity can be analyzed and possible limitations found. On picture 12 is an example of exploratory way of analyzing Asset capacity. Other capacities that the team should analyze is transport and production. In the picture 12 is presented the number of assets in the supply chain. The blue line is the target

level based on customer balance and the MRS levels set on the stock positions. The Orange line is the actual supply chain situation and the grey line the forecast. The changes are based on how many cylinders is being scrapped i.s taken away from rotation and how many cylinders will be committed into customer balance due customer demand changes. In the example graph on picture 12 the team could see that asset have been taken away from rotation more than forecasted so the forecast should be adjusted. The pattern seems stable for the coming 6 – 12 months so no immediate actions is needed.



Picture 12. Analyzing Asset capacity

Capacity need Calculation

The team could then add the demand increase forecasted into the capacity analyze and see what effect that could have onto the supply chain balance. To be able to know how many assets is needed to full fill certain demand increase the team needs to use rotation speed to convert demand into asset need in rough level. Simple model is shown in table 3.

Table 3. Capacity need calculation.

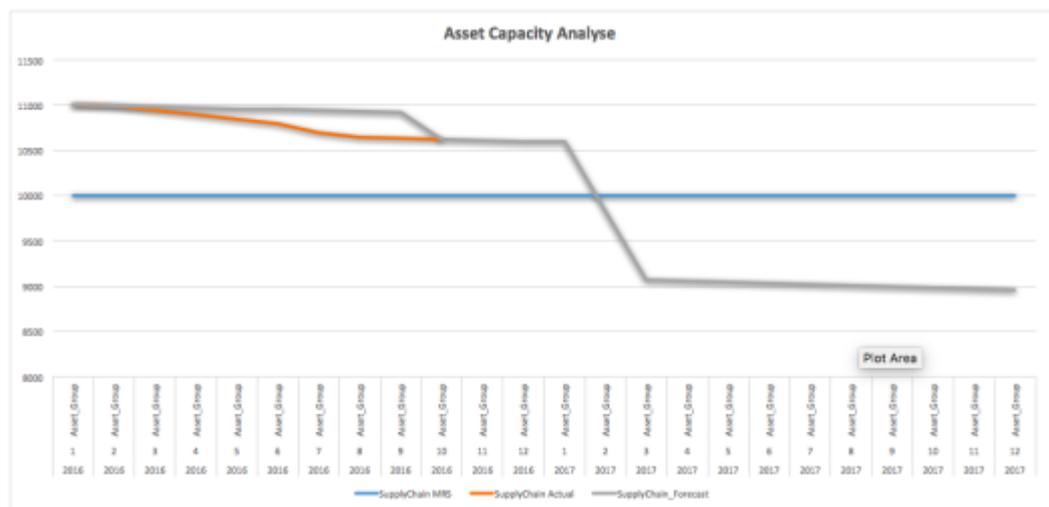
Asset Group	SupplyChain MRS	SupplyChain Actual	DemandHistory	DemandNew	RotationHistory	Asset Increase
100696	10000	11000	21760	25200	2,176	1581

With the rotation speed calculation, we can analyze that with in the yearly demand there will be an increase of 3440 units sold. This means that with the historical rotation speed there's a need to increase the assets in the supply chain by 1581 units.

Assumptions to simplify the calculation

- Demand increase happens in similar customers so rotation speed keeps the same
- Calculation does not consider in what sales channel the increase will happen: direct or trough re-seller
- Asset are material carries so the selling company owns the assets and customer just uses the material inside the carrier

After the demand conversion to needed assets the S&OP team can combine the asset need into the capacity forecast to see what effect the demand increase will have on the supply chain capacity. In picture 13 is adjusted Capacity forecast with and addition for the forecasted demand increase.



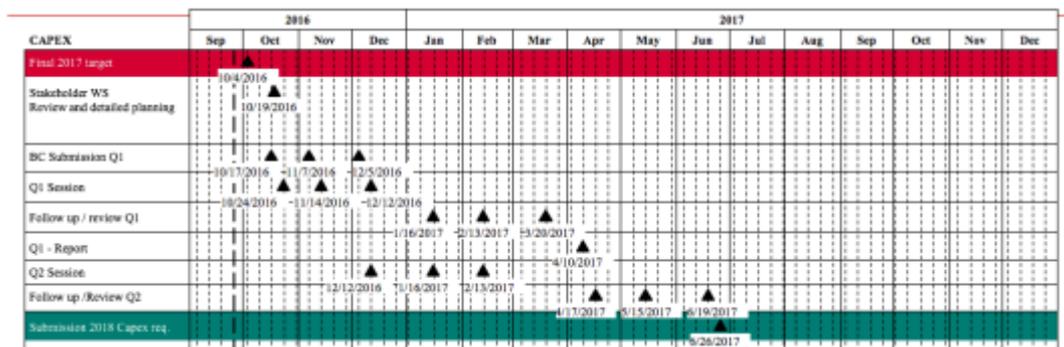
Picture 13. Adjusted Asset Capacity Analyze.

3. DEMAND PLANNING PROCESS IN THE CASE COMPANY

3.1. Intro of Capex

Capital Expenditure in case company can be divided into two minor or major spending. Cylinders are in the minor category. Yearly minor Capex portfolio is several million and split into over 100 different projects. The General Distribution Equipment Capex (later GDE) is executed as quarterly process (picture 14) where certain steps are taken during the year:

1. Collect yearly Capex portfolio of different investment projects
2. Analyze and Balance Asset needs before finalizing the Capex submission
3. Once a quartile release money and execute purchases and communicate
4. Once a quartile analyzes business case material to back up the investment
 - a. Investment Appraisal (IRR, Payback) in Volume Growth Investments
 - b. Service level effects in Replacement Investments
5. Once a month follow up purchase order situation and communicate



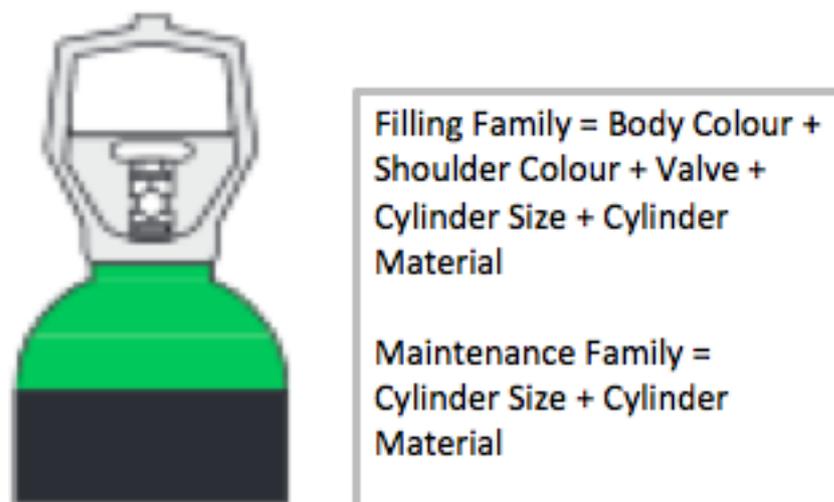
Picture 14. Capex Yearly Calendar.

3.2. Asset management in the case company

In this paragraph is described only the relevant Asset Management processes for this thesis. Almost everything in the Supply Chain steering starts from MRS (Maximum Recommended Stock) set up. MRS for all agreed stocking positions in

the supply chain is calculated 4 times per year. Stocking positions are re-sellers with case company stock, case company production sites and maintenance sites. The reality is that the demand patterns for materials are not changing in rapid speed and 4 times per year has been enough. Case company has not seen a great positive value or effect if static steering values would be calculated more often.

The main Asset in the case company Supply Chain is the gas cylinder. The MRS is calculated based on the consumption of the Gas + Cylinder combination. Customers usually want's certain amount of gas of certain molecule or molecule mixes. The gas is delivered to the customer in a container preferred to the customer. Most popular containers are the 20L and 50L cylinders (water capacity). In the use of the cylinders there is certain amount of modularity possible e.g. different types of products that use 50L cylinders can be re-labelled to another product. These groups are called Filling Families and the change of service can be made in the production site. More general grouping is the Maintenance Family (Picture 15) this means that a cylinder can be changed between Filling Family groups if the cylinders are subject to certain technical inspection process in the maintenance site. Using these groups in planning and Asset Management creates flexibility to use Asset where they are most needed.



Picture 15. Gas cylinder modularity

The gas cylinders are under ADR and TPED regulations. The biggest effect from Asset Management perspective is that every gas cylinder needs to go under maintenance test every 10 years. In the case company this is ca. 150 000 cylinders inspected every year. This means that roughly 10 % of Assets are unusable for customer deliveries all the time. The maintenance for the cylinders is forecasted yearly to book estimated amount of capacity from the maintenance sites. Actual orders are placed on a bi-weekly rhythm in an Asset Balancing Process. Order is based on actual stock per cylinder grouping vs. MRS value. For every group that the stock is under the MRS there is a need to have more cylinders (table 4.).

Table 4. Maintenance order logic.

FillingFamily	Material	Stock	MRS	OrderSuggestion	
X	A		50	60	10
X	B		50	40	-10
X	C		70	100	30
X			170	200	30

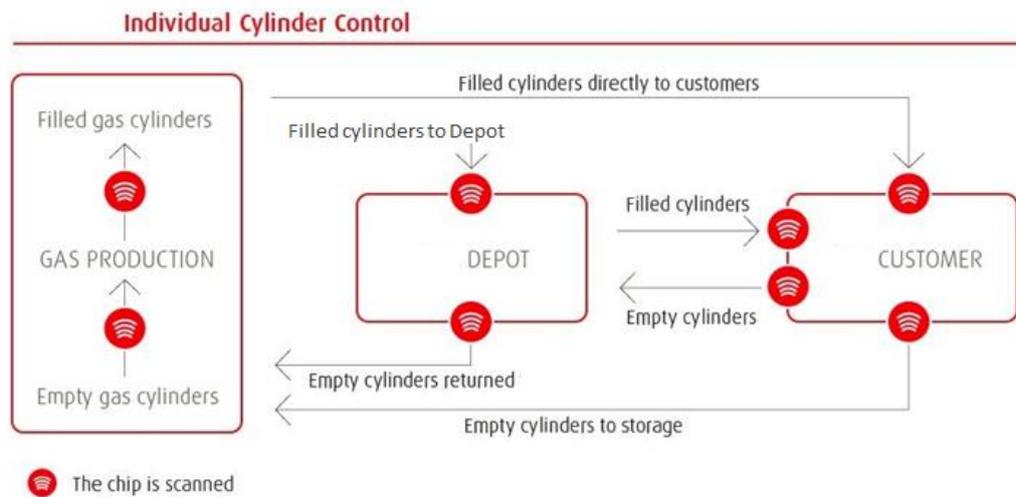
There's also a possibility to change the material within a group. This means that then there is no need to order cylinders from maintenance but use existing assets in the Supply Chain (table 5). All possible maintenance needs can be also handled by transferring usable cylinders between production sites or recalling surplus cylinders from the re-seller network (Agent/Depo).

Table 6. Change of service logic in the maintenance planning.

FillingFamily	Material	Stock	MRS	OrderSuggestion	
X	A		50	60	10
X	B		50	40	-10
X	C		100	100	0
X			200	200	0

In picture 16 is described the Asset movements in the Supply Chain. The basic logic is that when an existing customer gets one cylinder it returns one cylinder back so in most customer cases they are using some simple stock management principles that when cylinder is empty they order new one. The MRS set up in the case company will cover also the known seasonal variations during a calendar

year. Possible issues will happen when a new customer will start to order as in the first deliveries the customer does not give any cylinders back. This of course means that the stock in the case company Supply Chain will be reduced. If this has not been planned, there's a risk of service level issues for material at question to all customers.



Picture 16. Case Company Individual Cylinder Control.

3.3. Integrated Business Planning in the case company

The case company has a described integrated business planning process in the Regional Business Unit (picture 17). The process has six steps. First step is Product Review in which the product portfolio is analyzed and potential new product launches and phase outs decided. The second step is Demand Review where market planners in each country will update and maintain a rolling 24-month demand forecast. In the third step supply will analyze the demand forecast and makes decisions what areas they should react and create plans to handle the demand. Fourth step is Project Review where all open demand or supply related projects are reviewed and the consequences to business are described. Fifth step is Reconciliation where all the inputs, plans and limitations are put together and an agenda for the management review is formed. The sixth and final step is the Management Business Review where management will be informed about ongoing cases and decisions of game plans are made. The purpose of the

Management Review is also to keep the company strategy and the operational work aligned so that the company will reach its targets.



Picture 17. IBP process in the case company.

3.4. Maturity analyze of S&OP in the case company

The maturity of the S&OP process was analyzed during the research process with help of the maturity matrix introduced in the theory section (Table 6). The grading is based on researchers own interpretation and interviews on key Operations personnel. The Meeting & Collaboration is set on the Stage 2. This means that no official meetings around S&OP's topics is active. In fall 2016 the company has started to implement Local S&OP meetings in the country organizations. So maybe it would be fair to grade meetings and collaboration into between 2 and 3 but further proof is still missing how the Local meetings are working. The S&OP organization roles are mainly part of some other roles e.g. Logistics manager so there's no formal S&OP team assigned. The components are scattered throughout the Sales and Operations organization silos. Measurements is graded into stage 2 mainly because there's measurements for different capacity utilizations and service levels but they are not connected into the Demand plans. Also in the sales forecast tool, there's a field for forecast accuracy but that KPI is not steering any activities. Information technology is graded also into stage 2. There's a lot of databases and spreadsheets that can answer majority of the questions that the

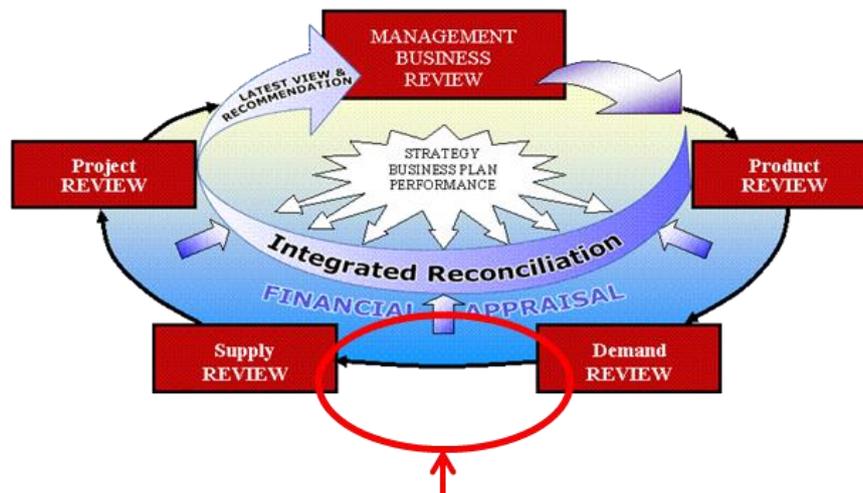
analyze of the demand plan could rise but the demand plan is not connected to any tool or data set. The cost, revenue and profit analyzes in different scenarios is not possible to do with the IT-systems in use today. No official S&OP system or module is in use at the case company. The S&OP Plan Integration basically does not exist today. The demand plan is not actively steering anything and the analyze of the demand plan is ad hoc bases at best and the Operations plans activities based on history information. The demand plan is not connected to needed Assets and is not connected to investment or budget planning processes.

Table 6. S&OP process maturity in case company.

	Stage 1 No S&OP process	Stage 2 Reactive	Stage 3 Standard	Stage 4 Advance	Stage 5 Proactive
Meetings & Collaboration		X			
Organization			X		
Measurements		X			
Information Technology		X			
S&OP Plan Integration	X				

3.5. Risks and problems in the as is process

In picture 18 is described the biggest problem areas per interviews with key persons and the output from the maturity model. The sales organization now can produce a product level 24 month rolling forecast. This demand forecast is analyzed in Operations but it's not transformed into needed assets. The forecast accuracy is not measured in a visible way so that every stakeholder would understand the reliability of the forecast. This lack of visibility is causing distrust towards the forecast. The decision-making chain is disturbed because investment decisions are not presented to management on time. There's in many cases already a hurry to make an investment thus creating less opportunities to analyze the priority of the different investment needs. The demand plan and capacity plans are not created as joint venture together with sales and operations. Both organizations are working in their own silos demanding that the other party will do their part.



Picture 18. Problem area in the as is IBP process.

As a consequence of the distrust and problems to see demand changes in advance is that the assets are not allocated into the correct place at correct time. Natural is that this will cause delivery issues and a lot of extra work to handle both existing customer demand and the unplanned new demand. Majority of the problems caused by the unplanned demand changes is in timing of the change. In table 7 we can see the basic type of lead times what it takes to add assets into the supply chain.

Table 7. Lead times to match demand in case company.

Demand schedule	Demand starts	Lead time to match demand	
		Surplus Stock in Country	Surplus Assets in Company No surplus - need to invest
Contract signed	Now - 3 months	1 - 3 days	4 - 5 weeks
RFQ answered	1 - 3 months	1 - 3 days	4 - 6 months
Budgeted demand increase	1 - 24 months	1 - 3 days	4 - 6 months

From the table 7 we can see that clear issues will happen if assets do not exist at all or the assets are allocated into the wrong part of the supply chain. The case company can add asset to the supply chain in three different ways.

1. Investing into new assets
2. Refurbishing old second hand assets
3. Using modularity of the assets to change the material group

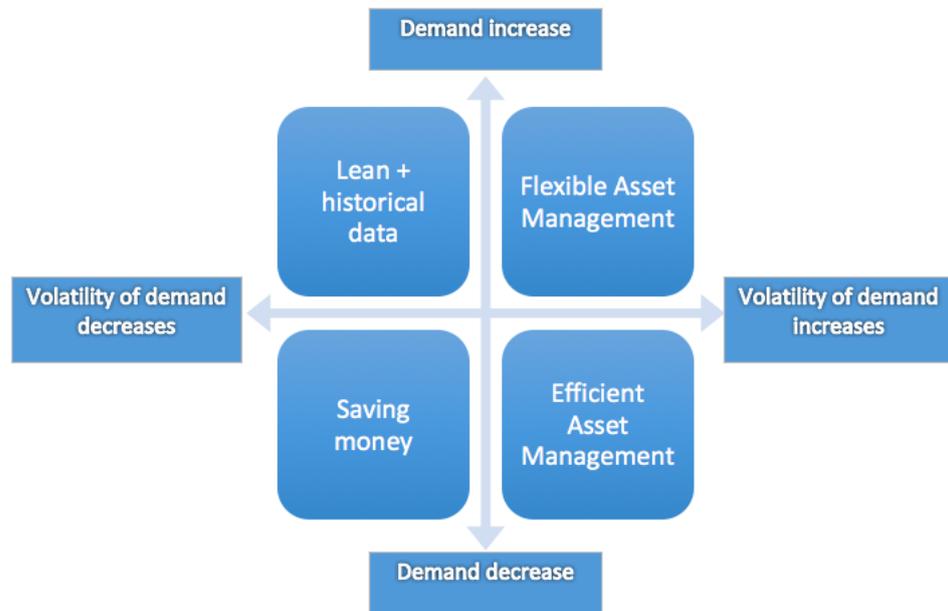
The investment lead time in many cases is 4 -6 months. So it's obvious that a long term demand plan needs to be in place. In worst case scenario, the company will take a new customer with a demand increase starting now but can match fully the demand only after 6 months. The demand changes itself does not tell if there's a

need to add assets into the Supply Chain or not. There should be a robust monthly analyze of what is the effect of demand change in the need of assets in the Supply Chain.

3.6. Future risks in the process

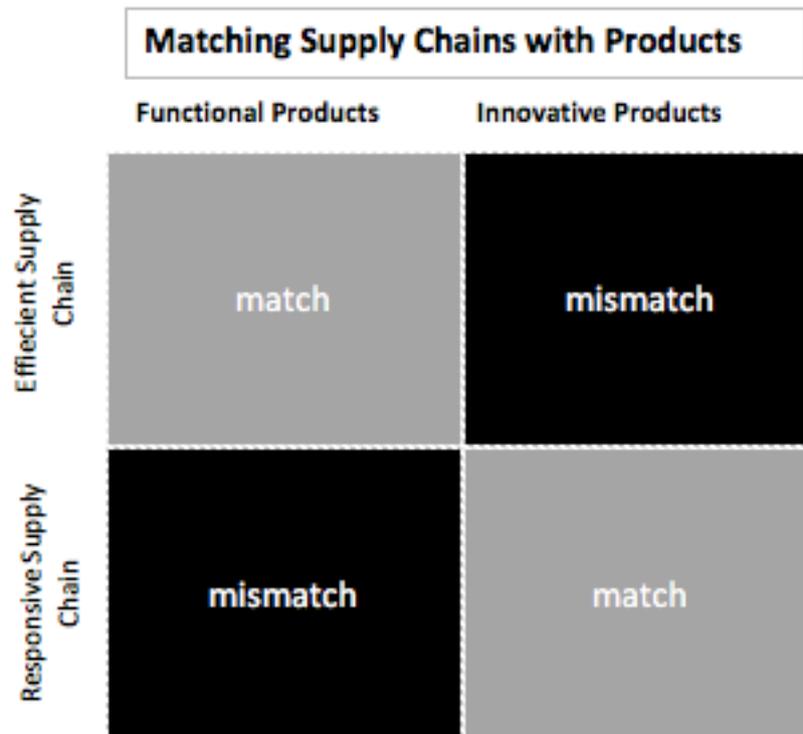
The Asset Management in the case company is largely based on stable or gradually declining demand. The executive board of the company has set target to increase sales and ROI but admits that at same time the company will face a lot of uncertainty and competition. On picture 19 is described with the help of deep sea quadrant the different actions how to react into different kind of demand change scenarios in the company level. If the prediction and strategy of the board is correct the case company has stepped into a new era also in Asset Management. In an environment where demand increases and at the same time the volatility of the demand increases some sort of flexibility or buffer is needed. The three most common buffers in supply chain management are: (Fisher 2003)

1. Time
 - a. Lead time from suppliers
 - b. Order to delivery time
2. Production Capacity
3. Inventory



Picture 19. Deep Sea Quadrant of Demand development in case company.

The company should understand that if and when they want to operate in a physically efficient and market-responsive supply chain they need different strategies for different product groups (Fisher 2003). In picture 20 is a simple matrix describing how the supply chain set up match the product type. Fisher has divided product types into Innovative and Functional products. Companies can have different types of products and one product can transform from Functional to Innovative or vice versa during time (Fisher 2003). It's important for any company to analyze their product portfolio and challenge the current logistic models of the products.



Picture 20. Matching Supply Chains with Products (Fisher 2003).

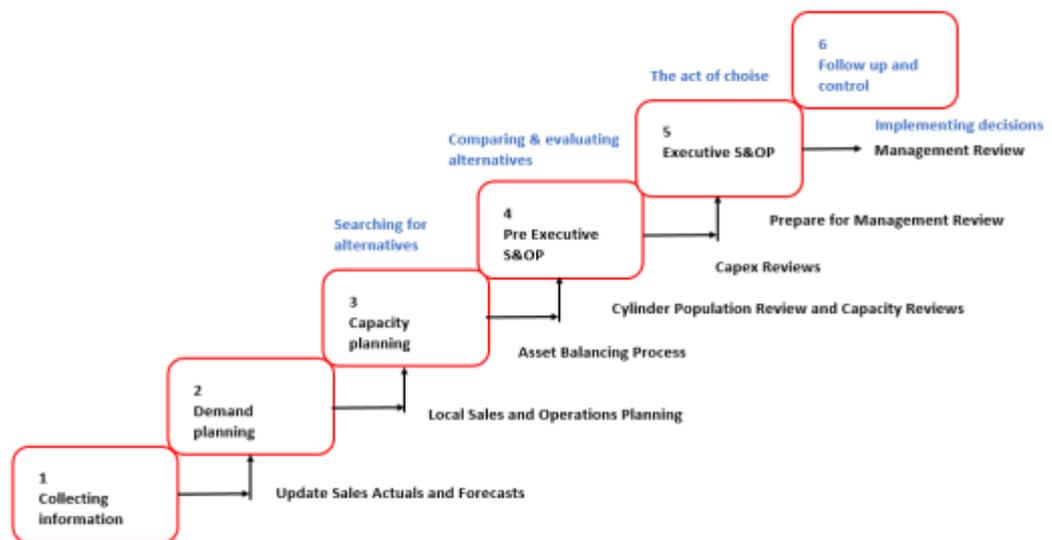
The characteristics of the two different product types are described in table 8. Although the company has mostly functional products it is still bringing new products into the market. Part of the portfolio reaches end of life time both product sales point of view and Asset life time e.g. certain type of cylinders cannot be used anymore and new variant needs to be implemented. Clearly the company needs to handle new product launch situation differently than the bread and butter products that have not that big variances. The market growth is flat in the North Europe area so there's a high risk of cannibalism on the portfolio when introducing new products and this analyze needs to be done when creating sales and demand forecast. It's important to understand what are the effects on the investment need portfolio when investing into new products. It can be that the new investment lowers the need to e.g. refurbish some other asset type as the demand for products connected to that group will go down.

Table 8. Functional vs. Innovative products.

Variants	Functional	Innovative
Demand type	Predictable Demand	Unpredictable Demand
Product life cycle	More than 2 years	3 months to 1 year
Product variety	low (10 -20 variants per category)	high (often millions of variants per category)
Average error in forecast	10 %	40% to 100%
Average stockout rate	1% to 2%	10% to 40%
Lead time required for made-to-order products	6 months to 1 year	1 day to 2 weeks

4. DECISION MAKING FRAMEWORK IN THE CASE COMPANY

In this chapter is presented the decision-making framework for the case company. The suggested framework is a synthesis from the theory presented in this study (Picture 21) and existing case company process. The framework aims to describe the processes where decision making should happen, on what interval and which kind of data should support those decisions. The six-step model has been modified to match as much as possible the company existing processes to make it simple to implement the steps.



Picture 21. Six step model for decision making in S&OP process.

4.1. Decision making framework overview

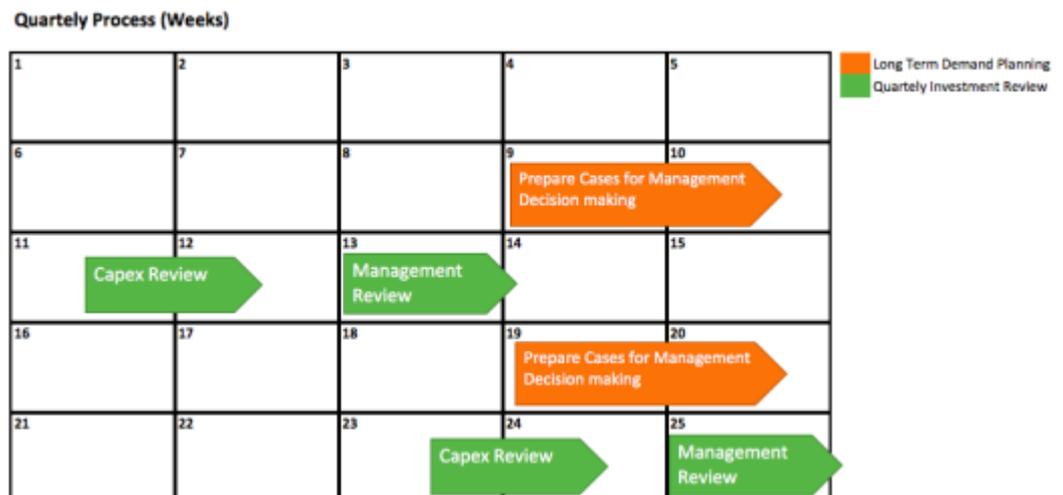
The decision-making framework will support decision making in two different time axels the steps have been transformed into a daily or weekly calendar. On a monthly level (picture 22) the company is running Local Sales and Operations planning meetings, updating demand forecast and analyzing capacity to full fill the needs. The decision mandate limits to use of the existing supply chain and capacity. This process can only feed information from Investment needs to the Investment process and in the end to the quarterly process. No additional

investment decisions that would increase the overall investment budget can be made in this process.



Picture 22. Suggested Monthly Demand Planning Process.

On a quarterly basis (picture 23) the company will analyze the investment portfolio (CAPEX) and adjust if necessary. This process is run 4 times per year so once in every quarter. In this process the long-term limitations and new business opportunities should be presented to the company management. At least 3 different options should be presented to the management for decision making. The cases should not only describe the problem but also the suggested solutions and the cost of each solution.



Picture 23. Suggested Quarterly Investment Review.

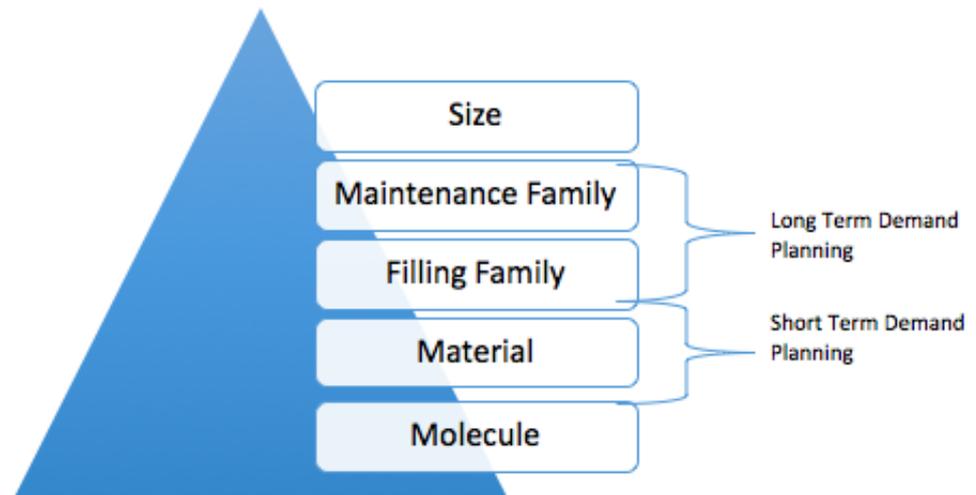
4.2. Update Sales Actuals and Forecast

As the focus in this thesis is not to analyze or improve the forecast process itself the creation of the forecast is not covered. The needed format is presented in table 9. The existing demand forecasting output is enough that the demand data can be connected to the Asset situation in the Supply Chain.

Table 9. Needed Format of Demand Forecast.

Year	Month	Material	MaintenanceFamily	FillingFamily	Demand_Forecast	Demand_Actual
2016	1	Material_Code	IG_50L_ST	GREEN	1900	1800
2016	2	Material_Code	IG_50L_ST	GREEN	1900	1900
2016	3	Material_Code	IG_50L_ST	GREEN	1900	1760
2016	4	Material_Code	IG_50L_ST	GREEN	1900	2000
2016	5	Material_Code	IG_50L_ST	GREEN	1900	1900
2016	6	Material_Code	IG_50L_ST	GREEN	1900	2100
2016	7	Material_Code	IG_50L_ST	GREEN	1900	1300
2016	8	Material_Code	IG_50L_ST	GREEN	1900	2000
2016	9	Material_Code	IG_50L_ST	GREEN	1900	1700
2016	10	Material_Code	IG_50L_ST	GREEN	1900	1700
2016	11	Material_Code	IG_50L_ST	GREEN	1900	
2016	12	Material_Code	IG_50L_ST	GREEN	1900	

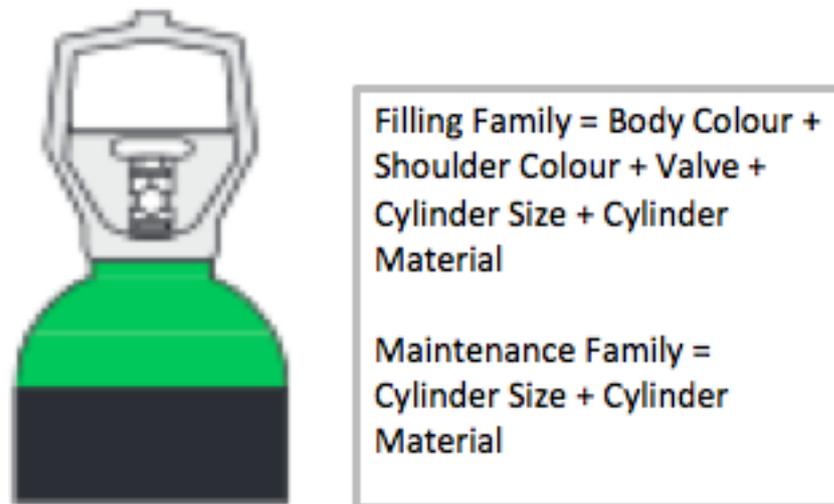
The forecast levels or groupings are presented in picture 24. In history, the demand has been forecasted in many levels. It has been also clear that if the company wants the sales forecast to be used to determine needed assets it's need to be in a level that can be used by all functions in the company. So clearly molecule i.s. the gas in the cylinders is too broad forecasting level because in real life the customer wants a certain kind of cylinder or container to carry the gas. Cylinder size then is too detailed forecast level as it's not telling what is the molecule.



Picture 24. Forecast Levels in Different process.

The optimal level for long term demand planning (6 - 24 months) is either maintenance family or filling family (picture 25). Due the nature of a gas cylinder there's a certain degree of modularity that should be used in advantage when creating demand forecasts. This means that one cylinder size and type can be used for several materials and the material type can be changed during the refurbishment process. These materials are grouped into the same Maintenance Family. The Filling Family grouping is a narrower and it means that certain materials can use the same cylinder, valve and painting combo so to balance the assets there's only a need to change the product label and register the material into the ERP system.

In the short-term demand planning (0 - 6 months) the demand need input needs to be in a material or filling family level. One of the key points for the short-term demand planning is to solve where to allocate the company's existing assets. If the information is in too broad level, there's a risk that wrong type of assets is allocated or that extra work needs to be done to increase the number of assets in the supply chain.



Picture 25. Gas cylinder modularity.

4.3. Local Sales and Operations Meeting

Local Sales and Operations planning meeting is a forum where Local Operations and Local Sales within one country comes together to analyze short term demand changes. The meeting is run by sales and the meeting revolves around a pipeline of new or lost customers. In the meeting the participants open and close demand cases and discuss about possibilities and communicate limitations. The forum tries to solve the allocation issue of current assets.

Analyze

Large part of the analyze in this process happens when the capacity inquiry reaches local operations. Sales needs to provide monthly consumption and assets committed to customer stock with the capacity inquiry. Deliver and Production will analyze capacity need to full fill the demand and communicate the possibilities latest on the Local S&OP meeting. If the demand need cannot be handled with the current assets, production or transport capacity the case will be escalated to Operations Planning team which will first analyze the Regional possibilities and after escalate the case to investment planning.

Decisions

In this process step is important to analyze and answer as soon as possible to sales what demand is possible to handle and on what timetable. Clear communication is needed to make sure the field sales do not over promise anything to the customers.

Key decisions in the step are:

- What demand cases can be handled and on what timetable
- What cases should be escalated to Regional Process to evaluate possibilities
- Update the status of demand pipeline cases (Done, Waiting for info, Close)

Data to support decision making

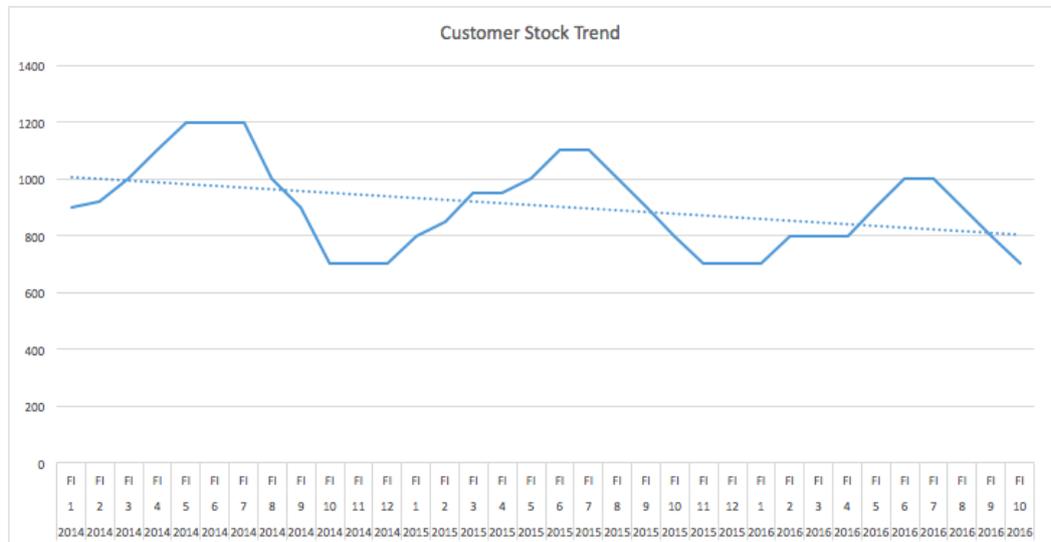
The main document supporting the Local Sales and Operations forum is the Demand Pipeline list. In the Demand Pipeline list is covered all the key information to support Asset availability decisions. The list also makes it easy to communicate and escalate the different demand cases forward in the organization. In the list the following fields needs to be filled in order to create efficient communication and avoid e-mail ping pong around the different cases. The demand and timetable are clearly shown so it makes easy to start to analyze the different possibilities to match the demand e.g. Asset increase or Transport interval increase.

- Case_number
- Case Status
- Country
- Plant
- Customer Info
- Material
- Description
- Customer_balance_units

- Monthly_demand_units
- Starting_Timetable
- Ending_Timetable
- Customer_responsible
- Comments

The decision making in the local operations can be supported by producing a regular Cylinder Population Review on the country level. In the Population Review (picture 26) one could analyze the Asset situation in the whole Supply Chain thus concluding what is the availability of Assets for the Demand increase. A simple visualization of customer stock development could help in some cases to define if the material has seasonal nature and on what time of year that happens.

Country	Plant Type	Material	Stock	MRS	Diff	DailyDemand	Days of Stock	MRS Days of Stock
FI	Agent	Material X	100	150	-50	5	20	30
FI	FillPlant	Material X	600	550	50	10	60	55
FI	Customer	Material X	700	0	0			
Total			1400	700	0			



Picture 26. Cylinder Population review and Customer Stock trend analyze.

After analyzing the as is situation of the Asset fleet local operations have the possibility to use Cylinder Availability tool (table 10) to analyze what does the demand change means in terms of needed assets. The simple tool connects the current demand into the needed inventory and then uses the new demand to estimate the increase or decrease of assets in the Supply Chain considering changes in the customer stock. There's a possibility to play with the thought that

if Operations do not increase the number of assets what kind of service level effect it could have. Assumptions to simplify tool are the following:

- Demand variation does not change when demand change
- Service level effect is calculated simply by presuming that the Service Level will fall linear together with the days of stock e.g. if target Days of Stock is 10 on a service level 98 % then Days of stock of 9 will give you service level of 88 %.

Table 10. Cylinder Availability tool.

Cylinder Availability Analyse				Daily				Daily			
Material	M_family	Stock	MRS	Demand	Days of stock	MRS Days of stock	Demand increase	Customer balance need	Days of stock after demand increase	Cylinder need	Service level effect
107593		2500	1969	271	9	7	16	868		473	80 %
107561		190	167	13	15	13	14	793	-43	910	-330 %

Follow up

The key KPI's to follow-up in the Local Sales and Operations forum are Delivery Precision and Compliance to maintenance orders. The Delivery Precision (table 11) will tell the forum how well the Supply Chain is performing. The KPI can be monitored even on daily level so it creates future possibilities to create trend analyze and notice frequent or recurring materials that pop up in the shortage list.

Table 11. Delivery precision report per fill plant.

DPUWeek	CylCountry	Plant	PlantName	ShortageQty	OrderQty	DPU_ %
201650	DK	3501	Plant 1	708	27728	97,45 %
	DK Total			708	27728	97,45 %
	LV	8508	Plant 2	14	20250	99,93 %
	LV Total			14	20250	99,93 %
	NO	2001	Plant 3	74	32034	99,77 %
	NO Total			74	32034	99,77 %
	SE	4509	Plant 4	484	5914	91,82 %
		4523	Plant 5	1132	14102	91,97 %
		4525	Plant 6	916	14958	93,88 %
		4531	Plant 7	634	17962	96,47 %
		4580	Plant 8	294	15714	98,13 %
	SE Total			3460	68650	94,96 %
201650 Total				4256	148662	97,14 %
Grand Total				4256	148662	97,14 %

The Compliance to maintenance orders (table 12) will tell the forum how well Assets are put back on rotation and how well the maintenance plant is performing. In the contracts with the maintenance plants is set fixed capacity and lead times for asset maintenance. The compliance to maintenance orders measures the agreed

production time in to the actual production time thus creating the possibility to contract management and Source function to measure the performance of the maintenance plant.

Table 12. Compliance to maintenance orders.

Month	Plant	Order_quantity	Produced_In_Time	Sum of MLT_ %
10	Maintenance site 1	2166	1348	62 %
10	Maintenance site 2	4908	4558	93 %
10	Maintenance site 3	15012	6915	46 %
10	Maintenance site 4	4814	4287	89 %
10	Grand Total	26900	17108	64 %

4.4. Asset Balancing Process

The Asset Balancing Process is a North Europe level process of analyzing bi-weekly the needed Assets in each country. The outcome of this analyze is Asset maintenance plan and Asset transfer plan. Assets that need refurbishment will be ordered from maintenance sites and gaps in Asset Supply Chain will be full filled by balancing stocks between production sites and countries. The work is done in Operations Planning function together with Local Operations. Individual countries are not allowed to place any maintenance orders so the order process is centralized into a Regional team.

Analyze

The main Analyze done on the Asset Balancing Process is to analyze what assets should be in the fill sites and what is the actual inventory in the whole Region level. The analyze is done on Filling Plant and Filling Family level so that every material is aggregated into group and then the maintenance need will appear to the biggest material in that group (picture 27). The Stock Controller performing the analyze is comparing the total needs into available capacity and surplus in other stock locations. The Stock Controller will after this analyze create a maintenance order for next two weeks and a transfer order plan for next two weeks to balance stocks between stock locations.

Plant	Material	Filingfamily/Description	Version	Full		Empty		TOTAL		MRS	Act. TOTL	Diff	Compliance To MRS [%]	Confirmed Order	Compliance To MRS with Order [%]		Suggestion Order
				Req. Full	Act. Full	Req. Empty	Act. Empty	MRS	Act. TOTL						MRS	Act. TOTL	
2001	599999	INDUSTRIAL, SOL ST LIGHT GREEN, Valve, Ac/N2 2SE DF PL-0	Version 1	275	393	317	60	592	453	539	77%						
2001	100969	MISON# 1E 50 L	Version 1	192	209	177	24	370	233	537	63%	180	49%				
2001	100572	CORCON 25 50 L	Version 1	27	60	33	0	60	60	8	100%						
2001	100974	MISON# 2 50 L	Version 1	22	35	35	12	57	47	10	63%						
2001	100730	MISON# 25 50 L	Version 1	16	33	24	12	40	45	5	113%						
2001	100975	MISON# 8 50 L	Version 1	17	56	48	12	65	68	3	105%						

Picture 27. Snapshot of maintenance planning tool.

Decisions

The key decision in this process step is what type and what number of assets should be ordered from maintenance plants and what assets should be transferred between different stock locations in the Supply Chain. The Stock controller should give early warnings if the capacity of maintenance plants or capacity of available assets start to decrease below trigger lines. The Stock Controller is then responsible of contacting the sourcing organization and start planning to increase capacity on short or long term. The Stock Controller needs to also prioritize the orders as many times the Bi-weekly capacity is not enough to full fill the whole need. The key player to help with this prioritization is the Local Operations which should have the local knowledge of asset situation. The input they can give is ongoing customer projects that could have an effect to the assets situation.

Data to support decision making

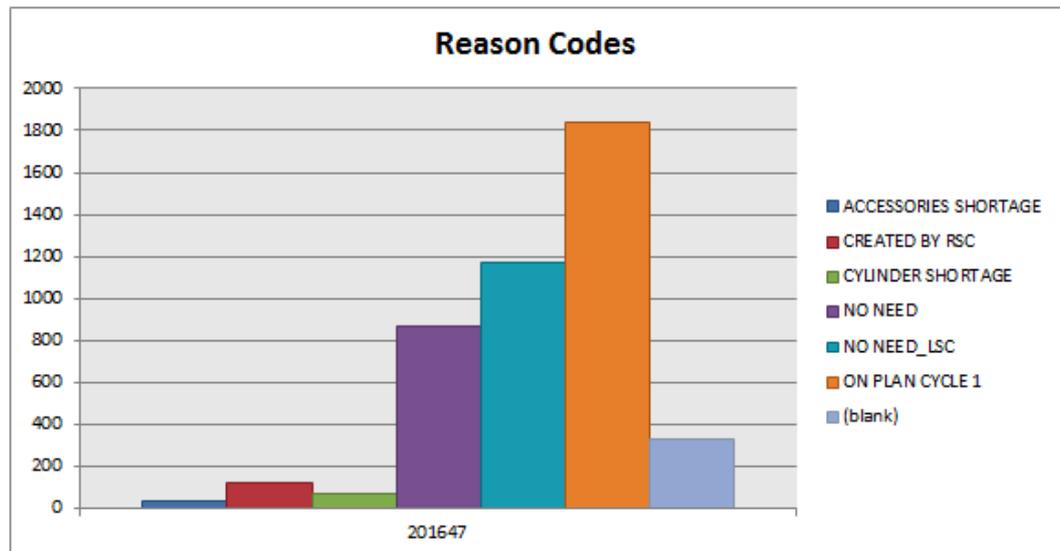
The key data to support the decision making in the process is the inventory data from the whole Region. The Local Sales and Operations forum should also feed information of short term demand changes into the process. The data to output from the process is the maintenance order to the maintenance plants, transfer plan to and from all stock locations and a report to communicate what decision has been made in the process. In the communication report, Local Operations can see the time table of assets coming and the status of Production capacity in the maintenance plant and the Asset capacity in their country and plant.

Follow up

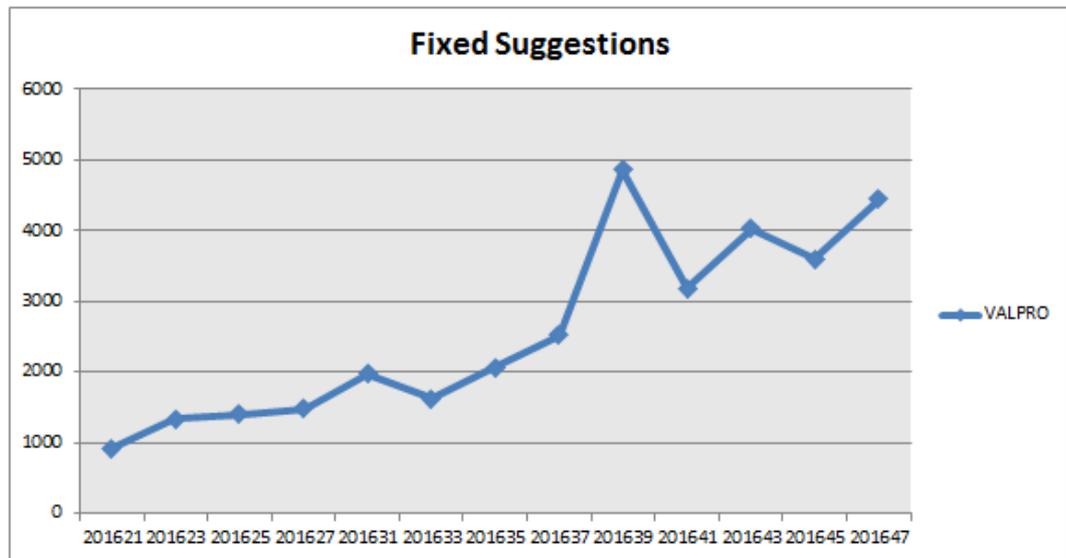
The Asset Balancing processes key follow-ups are the already mentioned Compliance to Maintenance orders % and Asset Balance Review report. The Asset Balance Review Report includes the following information:

- Open maintenance orders
- Open transfer orders
- Suggestion orders trend (Picture 28)
- Causes for cancelling suggestion orders (Picture 29)

With the report, it's easy to follow-up the maintenance and asset capacity trends and open orders. Then the Local Operations are always informed of status of the process and Source can take actions if current capacity is not enough. The Asset Balance Review can be also used to inform the Local Sales and Operations planning forum of Asset capacity status.



Picture 28. Cancelled Order Causes summary.



Picture 29. Maintenance Suggestion Order trend.

4.5. Cylinder Population Review

On most part a structured Cylinder Population Review do not exists now. This is part of the gap in current S&OP process in case company. The meaning for the review is to connect the development of the assets in supply chain to the changes happening in the demand. The overall purpose is to transform the demand change into needed or released assets. The analyze should be a monthly process but the findings from the process should be closely connected into the Capex review and the quarterly nature of investment decisions. Depending of the urgency of the demand cases the company should try to collect the future investment portfolio up to 24 months ahead to make sure that spending money into new assets would be kept minimal and that needed analyzes can be conducted on time to support the decision-making process.

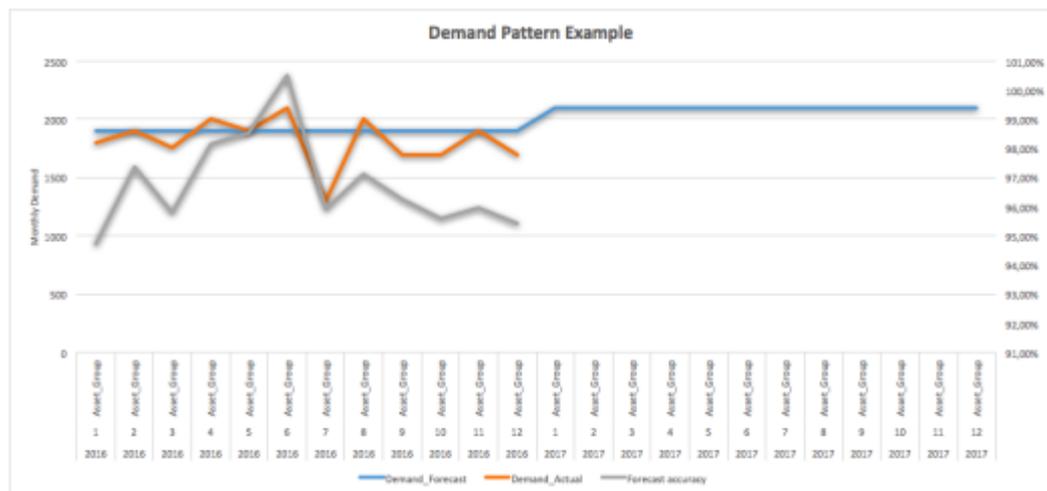
Analyze

The key analyzes in this process step is to transform the sales forecast into a demand plan and then connect that demand plan into the as is situation of the Supply Chain. When the case company knows the Demand trend and the Supply Chain trend they can start to analyze what kind of effects these parameters have into the Service level and overall performance of the Supply Chain. There is

several trend analyzes and capacity analyzes possible to perform from this kind of data set. The most interesting in the beginning would be to understand if investment should be done to match the current or future demand.

The challenging part of starting the analyze will be to find the material groups where more analyze effort should be spent. That means that what are the triggers that help the analyst to determine what is a possible issue in area in the supply chain. To help with this investigation the analyst could use some visualizations to help get forward.

The demand pattern (picture 30) can be analyzed on different levels e.g. material or material group. Let's presume that the company target for forecast accuracy is 95 % so then the analyst could observe that in the demand pattern example it seems that forecast accuracy is in a decent level but the trend is going down. The analyst could observe that there's a forecasted increase in the demand beginning of 2017 so these would be clear triggers to dig deeper and analyze the Supply Chain situation as well.

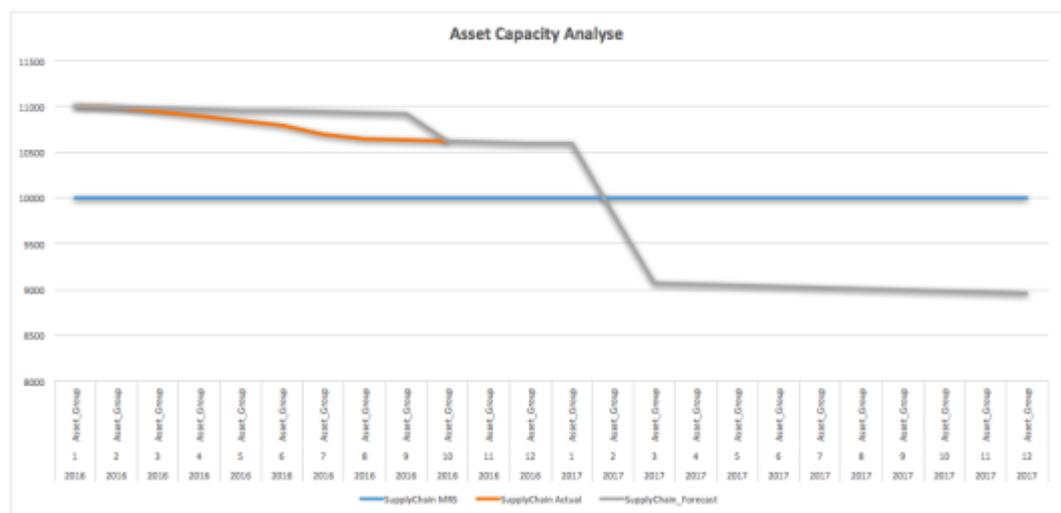


Picture 30. Demand pattern example.

After the demand pattern analyze the analyst could connect the demand plan into the Supply Chains forecast (picture 31). There the analyst could see that already in the Supply Chain forecast there's some trend showing that the Asset capacity is

going down maybe due some scrapping of outdated assets or similar. Then the analyst can see that if the forecasted demand will happen in beginning of 2017 it will have and dramatic effect to the Supply Chains asset capacity. After the analysis, there would be a clear case to create different options to the Capex or management review. Options in this case could be:

- Invest 100% into new assets to full fill the future gap in Supply Chain
- No investments and take short term risk on service level because other forecast shows the overall asset need is going down thus releasing assets for this demand later in 2017 / 2018.
- Transfer surplus assets inside the RBU and invest into the maintenance of those assets



Picture 31. Asset Capacity Analyze example.

The analysis should of course be done both ways so that the supply chain is analyzed pro-actively as well. The triggers for Supply Chain forecast could be e.g. that if the actual asset capacity seems to go under or close to under the needed asset amount (MRS). Scrap rate as an individual KPI should be followed up. The effect into one year may not be that big but during 2 -3 years the scrapping of assets might start to have an effect into the service level of the Supply Chain. As mentioned also in the Local Sales and Operations analyses the customer stock analyze is really import it tells the analyst the amount of released assets from the

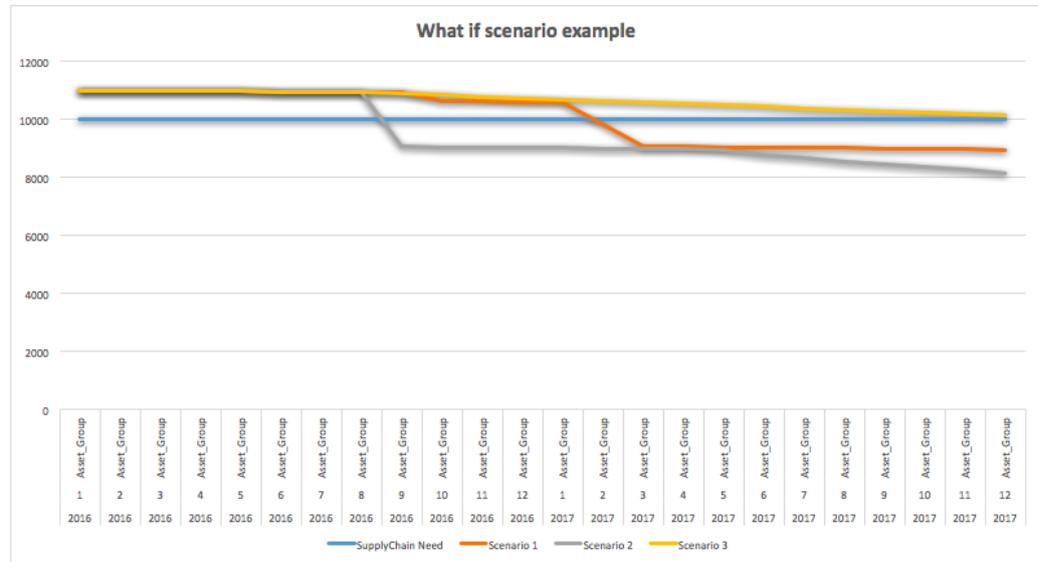
customer stocks but it will give an indication will there be issues in terms of physical space in the different stock locations.

Decisions

The key decision in Cylinder Population review would be that what demand change cases in the mid and long term needs actions. Then when that is clear the cases needs to be analyzed and the needed actions clearly described. The information with suggested options should be escalated into the Capex and management review. Some sense of urgency should be presented e.g. if the demand increase is forecasted to start 18 months from now it might be that that case needs to be added into some future investment portfolio list what is then reviewed and validated into later stage. If the demand change comes from the Local Sales and Operations planning loop it might be that faster actions and decisions is need to secure the service level.

Data to support decision making

The key data to support decision making in this step is the full inventory data, scrap rate and demand plan created from the sales forecast. In short term the inventory data is already in a tool called Cylinder Population Review. The population review tool has all stock locations and stock steering values from the whole Region. The scrap rate should be collected from the cylinder maintenance process to indicate how many % cylinders are scrapped per year. Combining these datasets, it is possible to form a proactive forecast for the Asset fleet development. In the beginning when starting this kind of analyze the company could use these as separate tables or data sources but quite soon these data sets could be handled inside the same tool. This would create the possibility to do e.g. what if analysis of Asset fleet development in different scenarios (picture 32).



Picture 32. What if scenario example.

Follow up

The key KPI's in the Asset Capacity Review to follow-up are Days of Stock and MRS Compliance % to follow-up how much under or over stocked the Supply Chain is and Scrap rate to follow-up how many assets is lost every year from the Supply Chain.

Days of stock and MRS Compliance % (table 13) are simple KPI's to follow-up if the Supply Chain is over or under stocking materials and how much. Depending on the audience the KPI's are presented the analyst can choose either of them. The pros in the Days of Stock measurement is that it will give a clear indication how long the stock location has inventory to sell. It also has a familiar reference point which most people will naturally understand. On some people in the other hand the more generic % will tell more about the magnitude of the problem e.g. it might be clearer that we have 200 % stock vs. what we should instead of 15 days over stock. The specific nature of the inventory consisting of *fixed asset (cylinder)* + *variable asset (gas)* make's it sometimes hard to understand that it's difficult to dispose surplus inventory as it possible in other industries keeping inventory of e.g. brown or white goods.

Table 13. Days of Stock and MRSC% in some material in several stock locations.

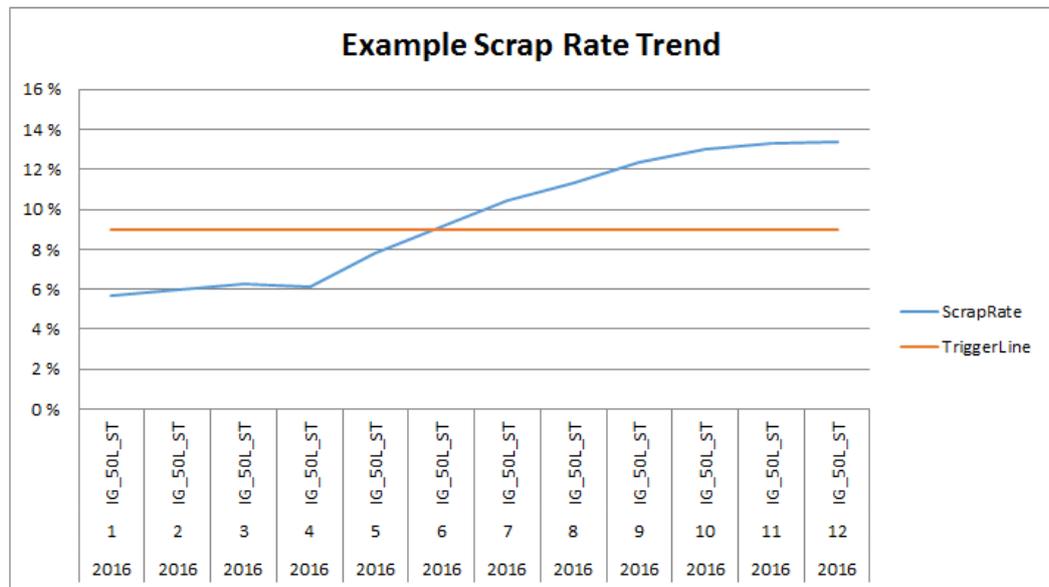
	Stock_units	MRS_units	Customer_balance_	Total_fleet_units	Fleet_balance_cyl	MRSC_%	Days of Stock	Calc. Days Of Stock
FI	1491	974	4 027	5 518	792	153%	27	17
Agent	522	394	0	522	150	132%	57	43
Customer	0	0	4027	4027	0	0%	0	0
F_Plant	969	580	0	969	642	167%	21	12
Grand Total	1491	974	4 027	5 518	792	153%	27	17

The scrap rate works best when used together with demand or inventory forecast but it can work as a standalone KPI as well (table 14). The main purpose would be to detect some outliers or increasing material or material groups. First, it is important to define the baseline for every material so that the increase or decrease can be detected. This could be achieved by simply agreeing a monitoring period such as 6 months and then based on the results setting the trigger line to different materials or group (picture 31).

Table 14. Cumulative Scrap rate.

Row Labels	Maintenance Amount	Scrap Amount	Scrap Rate
IG_50L_ST	8400	695	7,64 %
Material 1	1000	100	9,09 %
Material 2	500	5	0,99 %
Material 3	900	80	8,16 %
Material 4	1000	500	33,33 %
Material 5	5000	10	0,20 %
Grand Total	8400	695	7,64 %

After the baseline is set the scrap rate should be followed at least 4 times per year to detect if there's some increases from the baseline (picture 33). Individual months of course can vary so the scrap rate should be calculated as a cumulative sum during agreed period e.g. 1 -2 years. The scrap rate trend should be one of the KPI's that the analyst needs to consider proactively and might work as a trigger to more investigation work. On material groups where there's a lot of surplus stock in the Supply Chain it might not have that big effect in the short term if the scrap rate goes up but for sure at some point it will have an effect to the service level if not handled properly.



Picture 33. Scrap rate trend.

4.6. Capacity Review

Capacity Review is not fully in place either as a regular process. The goal for this review would be to connect the Demand plan and Asset Population Review into needed Production and Transport capacity. Not in all demand change the effect is on the Assets. It might be that demand is project based so there's no point of doing heavy investments into Assets but instead increase in short term the production or transport capacity to increase the Asset turnover. Even though the transport and production capacity review are not in the scope of this thesis it's worth mentioning the effect of those functions to the overall Supply Chain capacity.

Analyze

The key analyze in this step is will the demand change have an effect for production or transports capacities? The demand plan should be connected to the existing production and transport network. In the optimal situation, the demand changes in the supply chain should be analyzed trough the capacity of the available assets and the capacity of the production and transport network. First,

the analyst should be able to define if there will be some bottlenecks in the supply chain that will be a show stopper. Second the analyst should understand the time axel of the demand and try to figure out if the demand increase can be handled by increasing asset turnover. The asset turnover can be achieved by filling products more often i.s. increasing production capacity or by increasing the transport interval to wanted geographic area.

The sales commitment is essential to achieve this. The customers are relative conservative and many e.g. international companies are used to order majority of the projects gas need all at once. Which will lead into situation that assets are committed into the customer stock without any use. This will cause extra rental cost for the customer and pressure for the case company to invest into assets that might generate profit for relatively short time. In the end this can increase the prices and causes problems when competing in the market place. It's therefore important to understand the customer need, support the customer with different logistic models and train them for project inventory management.

Decisions

The key decisions are should the company source more transport capacity or production capacity. Some simple analyzes should be done monthly to understand the as is situation of the supply chain and what kind of effects the demand changes will have in the supply chain. Majority of the analyze should happen on the local level where the best short term information is available. The production and logistics managers with their teams should produce follow-ups and reviews to understand what are the pain points in the supply chain. On the long term the whole network should be analyzed few times per year and key findings escalated into management review with suggested actions.

Data to support decision making

The data to use in the capacity analyze and the decision making is the demand plan and as is transport and production network. From the different network analyzes the result should be a straight forward summary of effects in the supply

chain in different demand scenarios (table 15). Optimal would be that all Asset, Production and Transport capacity review results could be presented to the management at once. This would give them a clearer overall picture than if the reviews are presented separately. The summary should then be backed up with some options how the production or transport capacity increase could be handled. Possible options could be:

- Source more production capacity inside the RBU
- Source more production capacity outside the RBU
- Source more transport capacity from existing contractors
- Source more transport capacity from new contractors

Table 15. Example of production capacity analyze.

Asset Group	Max Production Capacity	Demand Now	Demand Increase	Production capacity needed
Asset Group 1	1000	800	100	900
Asset Group 2	500	450	100	550

Follow up

The key KPI's to follow-up to understand better the capacity situation and future possibilities are:

- Load and time utilization
- Production capacity utilization
- Compliance to full stock

The load utilization (table 16) will tell the analyst if the transport capacity is used in an optimal way and are there some geographic areas where more capacity is needed or is there some room for combining transport routes or schedules. The production capacity utilization will tell the analyst how the theoretical production capacity is in use in network and where is the room for improvement. The compliance to full stock will tell if the production sites are using the cylinder assets in the optimal way if the they over produce some product it will could mean that there will not be enough assets to full fill the need of some other product or that the flexibility is ruined to match ad hoc needs.

Table 16. Load utilization example per truck.

Geographic area	Truck	Monday	Tuesday	Wednesday	Thursday	Friday
Geographic area 1	Truck 1	90 %	110 %	80 %	70 %	50 %
Geographic area 1	Truck 2	120 %	50 %	50 %	80 %	90 %
Geographic area 1	Truck 3	70 %	70 %	70 %	50 %	50 %

4.7. CAPEX Review

Yearly Capex portfolio is reviewed 4 times per year to release money allocated to each quartile. The overall deadline of yearly CAPEX is end of Q3 for the next year. When the money is released for each quartile there's already a purchase plan ready. So to add investment related purchases during a quartile is almost impossible. Therefore, the Capex review and Capex planning are crucial steps to manage demand changes in the Supply Chain.

Analyze

The main analyze that should be performed to the Capex portfolio during a Capex year is that are the open investment cases still valid. Some of the inputs could have been added in to the list one year back so it's needed to sanity check the need before purchasing the items. Before every money release the Capex portfolio cases for the upcoming quartile should be reviewed. The request to sanity check the Capex portfolio cases can be feedback to Asset Capacity analyst who can make sure that the need is still valid. The Capex controller will create the official investment request with business case information and makes sure the purchase department gets the needed input to place the purchase orders.

The different demand inputs towards creating investment needs should be also considered and the Capex controller needs to keep together a Capex portfolio also for one year ahead. So that he or she always have's an active portfolio for current year and a draft for the next where the non-urgent cases can be put so that they can be reviewed later. There should not be that much questioning the Capex need for the next years Capex but the controller should ask a clear compact business case to support the investment. In the long-term planning that can be very high

level just to describe the case and why the need is there. This info is important so that in later stage it's easier to go back and analyze if the case and need is still valid.

Decisions

The key decisions in this process are to balance the need between different investment cases, communicate decision and follow up purchases. The Capex controller need to analyze the urgency of investment needs popping up during the year and allocate some of the non-urgent cases into next year's investment portfolio. To help make these decisions a simple question lists could be implemented. A suggested question list for prioritizing investment in the active portfolio could look like this:

- What if purchasing new assets is no longer a possibility? Are there some other options to full fill the need?
- What data could prove that the investment is a terrible decision now?
- What data could prove that the investment is a terrible decision six months from now?
- Is it possible to do a partial investment to test the assumptions in the business case?

The important part is to try to create and agree the question lists beforehand so that when the decision should be done the tool is ready to be used. It's important to create the questions in a neutral environment and that there's some mental distance to the Capex portfolio so that decision maker's own beliefs and insights do not bias the questions into one way or another. The questions should be linked to the company goals and the business case behind the investment should be followed up regularly to understand the quality of the decision.

Data to support decision making

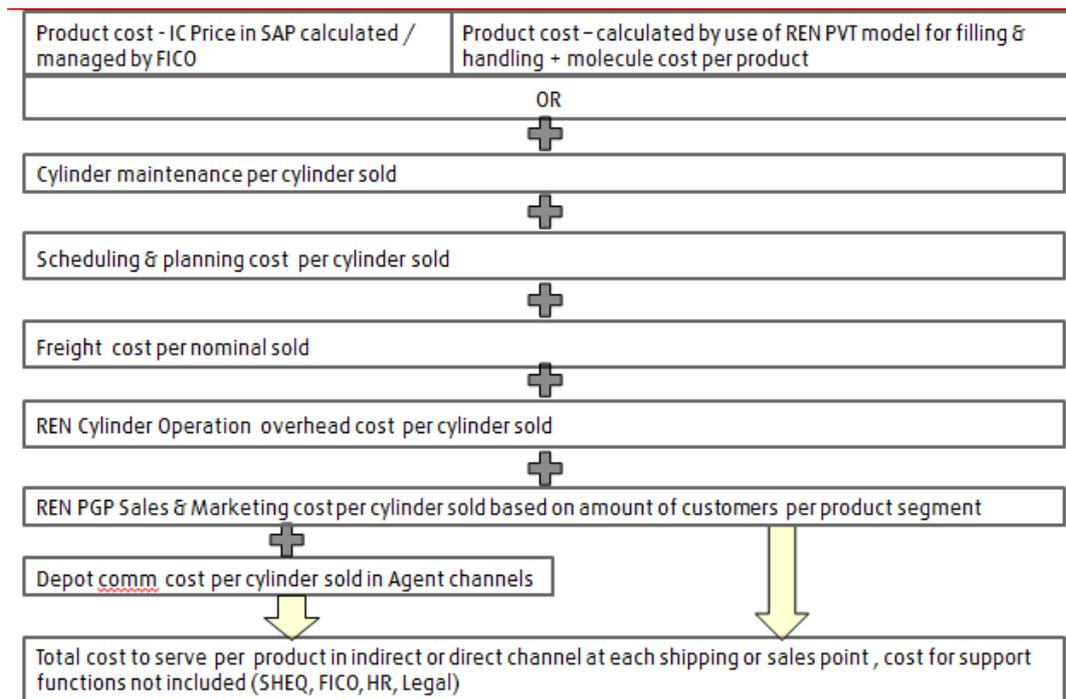
The key data to support the decision making in this step is the input from Asset Review and escalated cases from the Local Sales and Operations planning meeting. Some input for long term investment needs can come from the product

portfolio work e.g. new product launches. Typically, there will be two main types of cases coming from the Asset review:

- Replacement need
- Volume growth need

The data can be used to build up the long-term investment portfolio or to validate the need in the existing portfolio for current year. The input from the Local Sales and Operations forum come faster pace and thus many times the investment is needed to start 0 – 6 months' interval. The Capex controller needs to have strong understanding of how to transform demand need inputs into needed assets and there should be a close connection with the analyze of Asset Capacity.

To prioritize the investment needs the Capex controller will also need to connect the replacement need and the volume growth into investment appraisal. It's essential to understand that the new investments need to be backed up by a solid business case describing the estimated Investment Return Rate, Operating Profit and Payback time. Many times, these key figures are only delivered with the volume growth cases but it's equally important to understand is the replacement investment money allocated into profitable business. This problem can be solved by analyzing the profitability of the existing business for the material in question. The case company uses a Cost to serve model (picture 34) to determine what kind of cost, revenue and profit structure the material or material group has. By connecting the as is situation into simple investment appraisal tools its relatively straight forward to see if it makes sense to continue the business by replacement investments.



Picture 34. Structure of the Cost the serve model.

Follow up

The key KPI's the Capex controller needs to follow-up is Actual vs. Planned Capex € and Actual vs. Planned Capex projects. Even though the Capex budget is split into different projects in the end it's still a pot of money. Therefore, it's important to analyze how the investment money is spent and if there start to be cases that do not happen it's natural that money will be released to other use inside the Capex year. The cylinder maintenance is treated as investment as the money spent for maintenance work and hardware is capitalized. The cylinder maintenance investment money is then a variable that needs a separate follow-up because changes during the year can increase or decrease the maintenance need thus effecting the total investment portfolio. The maintenance investment is ca. 60 % of the total investment portfolio so it needs to be under strong control otherwise there's a risk that the lack of money in that part effect the possibilities to invest into e.g. Assets to cover volume growth.

4.8. Prepare Cases for Management Review

This step in theory is in place but the process to make suggestion to management is unclear. The cases now are prepared mostly on ad hoc basis and no clear structure to handle long term proactive investment needs exists. In this step the critical part would be to collect together the cases that cannot be solved with existing capacity or investment budget. The goal is to present real options so a decision can be made. Naturally the management team has a big scope and the demand related topics is only a part of it. So it's vital to create clear cases with options to present to the management decision making.

Analyze

In this step the analyst should combine the input from Asset Review, Capacity Review and Capex review. The cases escalated from those analyzes should already clearly define the problem and possible solutions to handle the problem. The forum where this analyze could be done is e.g. Supply Review where all function heads and key specialist are present. The analyze is more to sanity check if all needed info to do a decision has been catch.

Decisions

Basically the key decision in this step is what cases to escalate into management review? The analysts in the different reviews might not have always the current information from all activities on going in the Supply Chain area. So it might be possible that they flag cases that will be handled in a separate process or a consequence from some other activities. These cases should be closed in the forum and proper communication package should be created to inform all stakeholders.

Data to support decision making

The key data in this step is the analyses from Asset, Capacity and Capex review. A ready template (picture 35) for each should be used to carry the information and clarify the problem and the options to solve it. Also analyzes from the Cost to

serve tool and Capex investment appraisal documents should be presented and attached to back up the decision making.

Business background:	
Here is described the business background. Key figures: IRR, Operational Profit, Gross Margin Key goals are presented At least 3 different options described	
Burning platform:	Goals:
By December 2016: <ul style="list-style-type: none"> — Here the analyst should describe the limitations and problems in the as is situation — Here should be also described the needed investment € — Also consequences of not investing should be described 	By February 2017: <ul style="list-style-type: none"> — Here the analyst should describe the short and long term goals of the investment case

Picture 35. One pager of investment need.

Follow up

This forum should follow up the decision made in management review and analyze and communicate the consequences to relevant stakeholders. There's no clear KPI's what could be followed up in this forum. The cases that was not brought into the management decision making forum should be revised if some new info will arise. This will be clear if the actions presumed to handle the problem are not working or that the effect has not been significant enough. The forum should try to learn from cases that the management has thought easy to make decision on. The cases that has come back with the note that more information is needed should be review and key learnings caught.

4.9. Management Review

Management review is active forum now but a clear input from the Sales and Operations planning process is missing. The management team has a meeting at least once a month but the outputs from the different reviews probably should be handled 4 times per year. The management review should be connected to the

timetable when the Capex money is released into the different quartiles. This way the management decision can be implemented with a short time table.

Analyze

Compared to the other steps in the process in the Management review there's not that much analyze to be done. The focus is on decision making and the pre-work has been already done. The key analyze in this step is to define that is the case justified enough to use money on or is there some key data missing to do a good decision.

Decisions

There has been a lot of decision before this step and only the topics that need management decision making should be presented. Therefore, it's essential that employees have enough power to do decisions. This kind of process step therefore can help management team to understand the un-clarities hindering decision making in their organization. The key decisions for management team are linked to the usage of investment money. Either there's need to add money to the investment portfolio or management decision is needed to priorities the usage of money in existing Capex portfolio.

Data to support decision making

There's a lot of data that the management team should expect to support the decision making. There most likely is no need to feed detailed data into management review instead the analyst persons in the previous process steps should concentrate to produce high quality presentations with enough options. Management team could consider that a key person who has been part of the case could physically present the case for the management team. This would create the possibility to the management team to ask some questions to clarify unclear points and would create the possibility for the presenter to interact with the management team. The key document is the One pager for the investment need (picture 36).

Business background:	
Here is described the business background. Key figures: IRR, Operational Profit, Gross Margin Key goals are presented At least 3 different options described	
Burning platform:	Goals:
By December 2016: <ul style="list-style-type: none"> — Here the analyst should describe the limitations and problems in the as is situation — Here should be also described the needed investment € — Also consequences of not investing should be described 	By February 2017: <ul style="list-style-type: none"> — Here the analyst should describe the short and long term goals of the investment case

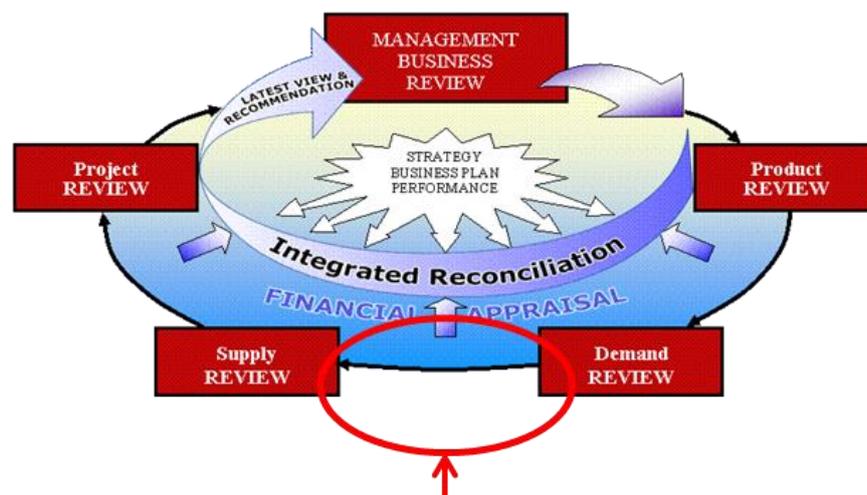
Picture 36. One pager of investment need.

Follow up

According to the focus areas that the management team has communicated with in the company the key KPI's are Operating profit % and Revenue on Capital Employed. These key figures will tell the management team what is the relationship between revenue and profit and how the investments are generating profit. These are figures that the management team will of course follow-up on company level but it would be worth considering if they should follow-up the biggest individual investment cases as well. In the creation of the business case there's some assumptions done and it would be important to follow-up how well those assumptions have come true. In all the steps in the sales and operations planning learning from done decisions should be a key driver of the analyze as well. If some decisions turns out to be really bad the follow-up would guarantee that those cases are re-analyzed and the direction corrected.

5. SUMMARY

The goal for this research was to create a decision-making framework to support decision making in demand change situations. The platform for doing the decision is an existing S&OP process which has not been fully implemented into the Cylinder Supply Chain area. From the framework, the company can see and analyze what type of data and tools are needed to support decision making. The framework was built by analyzing theoretical models from the literature and hunting down best practices from the case company's existing processes. The gaps in the as is process was defined (picture 37) and the framework designed to full fill those gaps. The result is a decision-making framework for improving decisions in Sales and Operations planning process.



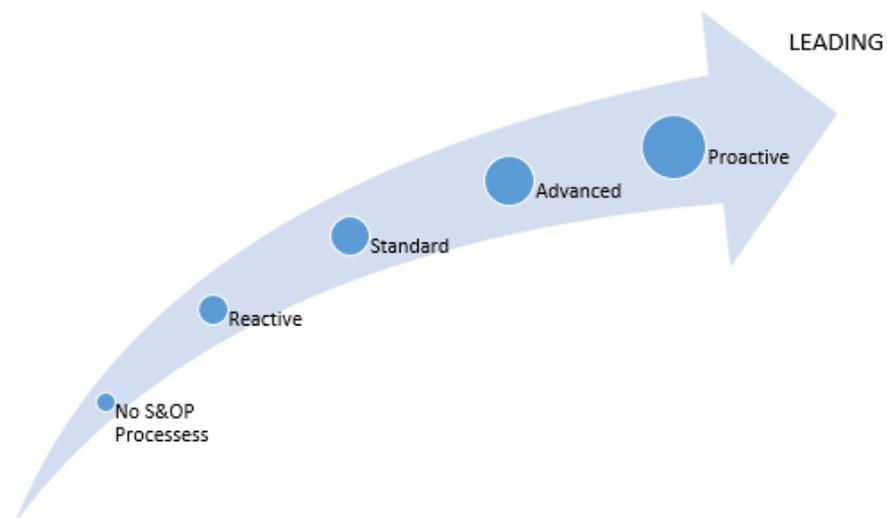
Picture 37. Problem area in the as is process.

Some of the analyze reports and graphs are still on concept level but based on real available data. The approach in the empirical part was to create a framework that could be implemented with the as is tools and data available. In the case company, there's a lot of learning to do in terms of analytics and consequence analyzes so the implementation of simple MS Excel and Access based tools should be taken a learning experience and a pre-work to build more complex systems.

During the research, it has been clear that many people have a tool-centric view of the process but at the same time the process itself is lacking even the basic structure. The company should therefore consider the possibilities to invest into

better or more appropriate IT-systems but only after the process structure is decided and management support gained. Strong indications from research and S&OP literature shows that S&OP process can be rather unique in every company so it's unlikely that a tool will solve the issues in communication, process and change management.

The framework presented in this research could raise the company into Standard stage in S&OP maturity (Grimson 2007) and in some areas even to Advanced stage (picture 38). To be able to reach the highest level the company should fully integrate the S&OP into their operations and e.g. involve the biggest suppliers into the structure. All processes should be focused to optimize profit with the highest customer experience possible. The biggest problem to increase over the standard level now is the lack of S&OP's plan integration.



Picture 38. Maturity Stages of S&OP process.

The framework will help to define the needed investment cases related to Cylinder Supply Chain up keeping and the demand change situations. It will also provide more tools to analyze and prioritize the different investment needs as it is not always possible to full fill all needs. The framework will also make it visible what kind of Key Performance Indicators needs to be implemented to follow up the quality of decisions and what kind of data is missing to build these follow-ups. In appendix 1 all the steps are defined in a matrix table.

5.1. Future proposals

The company needs to decide in which organization the decision mandate is in different steps and this could be achieved with the help of simple RACI-matrix where the responsible, accountable, consulted and informed people are defined. The company should consider of appointing a S&OP champion from the management team to support the implementation and continuity of S&OP process. The organization should be a cross functional matrix where all functions are represented with suitable persons (picture 39). The implementation should concentrate to build the process and framework around the decision making. The company could start from simple analyzes and simple reports build with Excel. The product range could be limited at first to keep the process simple and manageable. Gradually the product range included in the S&OP should be increased and finally every product group should be included in the process scope.



Picture 39. Suggestion of Sales and Operations planning organization.

The company should try to promote the success stories from demand increase cases that have been handled well. The trust for process should be backed up with showing to people that with good cooperation complex goals can be achieved. The company should also promote the decision-making tools and train people for analytical mind set and consequence analyzes. There's relatively few people that needs a deeper understanding of the Supply Chain dynamics but by investing some training to those people the company would have relatively short payback time.

There's three big dimensions that needs further investigation: Sales forecasting, Production Capacity analyze and Transport capacity analyze. In this research these big areas have not been handled in detail but to get the full benefit from Sales and Operations Planning process these areas needs to be in order and supporting the service level promise to customers.

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APPENDIX 1: DECISION MAKING MATRIX

Decision Step	Analyze	Decisions	Data to support	Follow-Up
Update Sales Actuals and Forecast	Sales history and sales forecast from country sales	Is the calculated forecast real/label or is manual adjustment needed	Sales history, forecast accuracy and sales actions e.g. campaigns or new product launches	Forecast accuracy
Local S&OP	What actions a demand change will require from the Local Operations	What demand cases can be handled and on what timetable. What cases should be escalated to Regional Process to evaluate possibilities.	Cylinder Population Review. Demand pipeline list from Sales.	Delivery Precision. Compliance to maintenance orders.
Asset Balancing Process	Supply Chain Asset Balance. Stock vs. MRS.	Create BI - weekly maintenance and transfer orders.	Inventory data	Compliance to maintenance orders. Asset Balancing Report (Open maintenance orders, open transfer orders, Suggestion and cancelled orders trend)
Cylinder Population Review	Transform Demand plan into needed Assets. Correct demand plan into Supply Chain as is Asset situation.	What demand type of demand changes needs further actions e.g. investments or sourcing capacity	Inventory data, scrap rate per asset type and demand plan	Days of Stock. MRS compliance % and Scrap rate trend.
Capacity Review	Demand Plan effect to transport and production capacity	What demand type of demand changes needs further actions e.g. investments or sourcing capacity	Demand Plan. Current Transport and Production capacity in the as is network	Load and time utilization. Production capacity utilization and compliance to full stock
Capex Review	Are the open investment cases still valid and on which timetable a purchase order should be made. Analyze new inputs during the Capex year.	Balance the money need between different investment cases and followup purchases done	Input from Local S&OP and Cylinder Population Review. Input from product portfolio work. Output from Cost to Serve model.	Actual vs. Planned Capex € and Actual vs. Planned investment projects
Prepare for Management Review	Combine the different output from previous steps and make sure all needed info is in place to make a decision	What cases to escalate to management review	Output from previous steps. Investment appraisal documents and business case template	N/A
Management Review	Different inputs from the previous steps	Make a decision based on the outputs and the problem statements from the previous steps	Outputs from previous steps. One pager summarizing the problem	Operating profit % and ROCE