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Supply Chain Management

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Demand Forecasting Process Design and Methods in Medium Sized Enterprise

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ABSTRACT

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Hakusanat: Kysyntä, Ennustaminen, Prosessi, Sales and Operations Planning, S&OP, Eksponentiaalinen Ennustaminen, VMI, Bullwhip Effect, Informaation jakaminen

The purpose of this thesis was to study the design of demand forecasting processes and management of demand. In literature review were different processes found and forecasting methods and techniques interviewed. Also role of bullwhip effect in supply chain was identified and how to manage it with information sharing operations.

In the empirical part of study is at first described current situation and challenges in case company. After that will new way to handle demand introduced with target budget creation and how information sharing with 5 products and a few customers would bring benefits to company. Also the new S&OP process created within this study and organization for it.

TIIVISTELMÄ

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Tutkimuksen tarkoituksena oli tarkastella kysynnän hallinnan ja ennustamisen prosesseja. Kirjallisuuskatsauksessa löydettiin kysynnän hallintaan soveltuvia prosesseja, kuin myös ennustamismenetelmiä ja -tekniikkoja. Samalla bullwhip efektin merkitys toimitusketjussa tunnistettiin ja kuinka sitä voidaan hallita informaation jakamisella.

Työn kokeellisessa osiossa kuvattiin aluksi nykyinen tilanne toimitusketjussa ja sen haasteet ennustamisen ja kysynnän hallinnan kannalta. Tämän jälkeen uusi kysynnän hallinnan menetelmä esitellään budjetoinnin kautta ja kuinka informaatiota jakamalla vain viiden tuotteen osalta voidaan saavuttaa kilpailukykyyn vaikuttavia tuloksia. Samalla uusi S&OP prosessi luotiin yritykselle ja tälle prosessille taustaorganisaatio.

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First of all I want to thank my supervisor Professor Timo Pirttilä for the opportunity to carry out this study under his supervision. His guidance and view about industry defined the scope of the study and let me focusing on the important themes.

In a case company I would first thank my managers for continued intellectual sparring throughout this project. Conversations through this working period have given assistance for this project and solutions both in working life and private life. Second thank goes to purchasing team for accepting new models presented this thesis.

Finally I would thank my partner for understanding all my long nights working with this thesis and for taking care of our children. Also a huge thanks goes to my parents who have support me all my time in studying and free time.

Iisalmi, September 2014

Joonas Vitri

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SYMBOLS AND ABBREVATIONS

α	Smoothing constant
β	Trend component in smoothing
γ	Seasonality component in smoothing
BOM	Build of materials
C	The cycle Length of the Seasonal Pattern (that is, the cycle length for 12-month pattern is C = 12)
CPR	Continuous Replenishment Programs
E_t	Forecast error
ERP	Enterprice resource planning
F_t	Forecast for Period t
F_{t+1}	Forecast for Period t+1
L	Level
ME	Mean error
N	Number of Period in the Moving Average
S_t	Sales for Period t
S_{t-1}	Sales for Period t-1
T	Trend
t	The time period in which the sales occurred
S&OP	Sales and operations planning
VMI	Vendor managed items

1 INTRODUCTION

Organizations face a lot of uncertainties when doing a business in changing environment: for example rapidly changing demand can effect negatively production capacity and in worst case company can't delivery sales as dealt. On the other hand companies prepare for these changes with inventory, which fasten capital and costs space and money.

Therefore managing future demand is necessary activity to handle business processes. Sometimes company knows exactly future demand and there's no uncertainty but in most cases the demand is not known. Then company has to manage demand with forecasting activities. Forecasting is a common tool to help organizations manage their operations. In practice, forecasting means estimating the future events that are controlled by the organization itself. (Kerkkänen, 2010)

1.1 Background of the research topic

There are a lot of needs for forecasting in industrial and economical contents. Banks and other economic organizations try to forecast inflation and economic growth while industry tries to forecast raw material price changes and market area changes. All that forecasting needs to be managed in some way for getting the best possible results. Forecasting offers several benefits when the forecast improves the quality of capacity plans, production plans and sourcing plans.

Moon et al. (2003) sees that literature in the field of forecasting mainly focuses on the development of forecasting methods. There are a large variety of methods to solve different problems by mathematic and some of these methods are presented also in this study.

Even though many sophisticated forecasting methods have been developed, surveys concerning the use of forecasting methods report that simple forecasting methods are preferred over complicated ones and qualitative forecasting methods have a

strong role. (Dalrympe, 1987) Although different forecasting techniques have not in general led to improved forecasting performance and it has been suggested that more focus should be put on the practical side of forecasting, especially on organizational issues. Forecasting methods are just a single component of a forecasting process. (Kerkkänen, 2010)

So although there are a huge selection of different mathematical forecasting models, the forecasting process and its management is the thing that produces maybe the most value to the organization. So for academic literature there is a need to look and study forecasting as a process.

1.2 Research scope and limitation

This study is focusing to forecast as a process. The mathematical methods are presented but the main interest is not in calculations but in forecasting processes and demand management processes. That forecasting and management is not thought as single process but it is linked to the organization other functions such as purchasing, production planning and sales and marketing development.

The meaning of this study is mainly concerned with designing demand management process and creating tools to manage demand. Process design involves creating the management process to handle all the information and functions that demand affects in organization. Although there are different kind of processes and it central to sees what kind of process is suitable for each case. So the first research question is:

> ***RQ1****: What kind of processes can be found from literature that are suitable in demand management in small and medium-sized businesses?*

So when these processes is found the next question is what kind of sub-processes is needed for example for forecasting practices and how this information is used in demand management processes. Although it needs to be clear which methods are

suitable for each management method. So within those needs the research question 2 is following:

> ***RQ2:*** *What kind of forecasting and managing practices can be found that fits to those processes and produces the most profitable output for management process?*

This study is made for answering RQ1 and RQ2. First there's found the answers for RQ1 from literature and analyzed those that are the most suitable for current situation. Then there's found answers from literature for RQ2 and analyzed the most suitable practices.

1.3 Research methods

In this master thesis the research method is case study research. That study was carried out as a two level process: the first level was theory material collecting where suitable methods were looked for answering research questions. In the second part these methods were put to use as a case company needed.

The author was employed in case company and the main objective were determine demand management process and methods to handle all the information that is available in company. The project were started in May 2014 and it were a part of a bigger operational development project. This master thesis were however the biggest work in demand management and all other projects included research for other sector.

1.4 The outline of the study

The study is shared in two parts: first in theory part where is theory background discussed for answering the research questions. Second there's description of case company operating model in current operational situation.

In the first chapter there's introduction that introduces background of the study, research questions and outline of the study. Second chapter handles different process solutions for demand management and forecasting in theory perspective.

Third chapter handles different kind of forecasting methods mostly in time series-contexts. Main focus is in exponential smoothing and variations from it. Finally there's theory about performance measurement in forecasting.

Fourth chapter handles real time information and how with it can bullwhip effect minimize. Also vendor managed items-system is handled in chapter four. Chapter five includes today analysis about case company situation and after that in chapter six is demand management framework for company created.

In chapter seven is future S&OP process design created. Chapter eight includes results rating and future improvement targets. Finally in chapter nine there's conclusions for this study. In table 1. is whole study structure descripted.

Table 1. Structure of thesis.

Information source	Chapter	Output
Background information, assignment of thesis	1. Introduction	Research scope, limitations and structure
Literature and research materials	2. Demand forecasting process management	Forecasting process models and S&OP framework
Literature	3. Demand forecasting methods	Different time series forecasting methods, forecasting performance management
Literature	4. Importance of real time information in the supply chain	Basics from bullwhip effect, meaning of information sharing and VMI
Interviews and company materials	5. Case company description	Process chart, ABCa-analysis and product roadmap
Interviews, ERP data, data from importers	6. Demand management in case company	Way to handle demand, calculation model
Literature review, interviews	7. S&OP Meeting	Year clock for S&OP process, issues to do in process
Study: theory and empirical	8. Results	Table about results and discussion
	10. Conclusions	Discussion about study and about future research issues
Literature	References	List of references

2 DEMAND FORECASTING PROCESS MANAGEMENT

Demand management is the supply chain management process that balances the customers' requirements with the capabilities of the supply chain. Management can match supply with demand proactively and execute the plan with minimal disruptions, with the right management process. (Croxton et al, 2002) Demand management is a part of the supply chain management and it's truly important part because demand from the final customer is the force that drives the activities in the supply chain. (Helms et al, 2000)

2.1 Forecasting process

The role of sales forecasting changes depending upon the position in the supply chain that a company occupies. Anyway in any supply chain has only one point of independent demand: the demand that comes from the end-use customer of the supply chain. Often that is consumer customer that buys products from retailer. (Mentzer & Moon 2005)

Winklhofer et al, (1996) have created a framework for organizational forecasting practice as literature review. In figure 1. there's description about his framework.

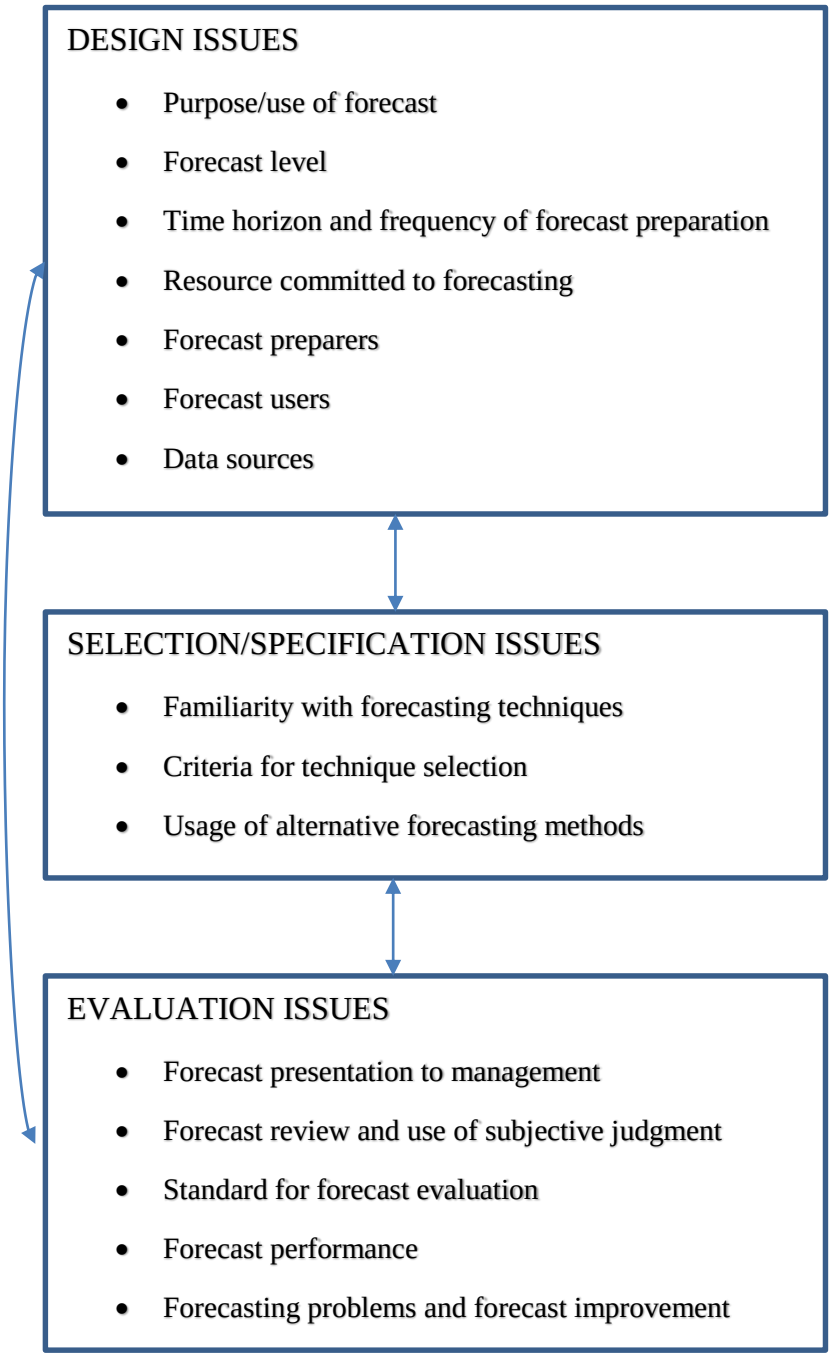

Figure 1. A framework for organizational forecasting practice. (Winklhofer et al., 1996)

Framework presented in figure 1. provides a logical and orderly representation of organizational forecasting practice and establishes a clear overview of the latter. It should be noted that arrows in figure means that every part of figure are linked to each other, so every different decision affect others. (Winklhofer et al., 1996)

Design issues

Main question has to be "why the forecast is made and who uses the forecast". Typically is that smaller firms uses sales forecast's more often for personnel planning while larger firms for example purchasing planning. (Winklhofer et al., 1996) Rothe (1978) keeps production planning and budgeting as important decisions areas than personnel planning and purchasing planning.

It is important to manage the level for which forecasts are prepared. So company have to decide for which products forecasts is made and for which market area and for which customers. Also time horizon have to be decided: is forecast updated monthly or weekly and for which time horizon it is made. (Winklhofer et al., 1996)

Selection/specification issues

A large body of literature focuses on companies' forecasting techniques. Literature focuses mainly to examine different types of techniques and comparing them. Although it seems that the fact is that companies seems to be more familiar with judgmental than with quantitative forecasting methods. (Winklhofer et al., 1996)

Wheelwright and Clarke (1976) have identified four factors that are really important selecting forecast method:

- Cost
- User's technical ability
- Problem specific characteristics
- Desired forecasting method characteristics

Evaluation issues

Within Winklhofer (1996) it is quite important that managers understand how the techniques produce their forecast. For organizations it is quite important that meetings are interdepartmental so every part of organization knows what is current forecast for demand and if it is possible, to use human judgment after forecasting.

2.2 Sales and operations planning

Sales and operations planning (S&OP) is the key business process to balance customer demand with supply capabilities. General objective for S&OP is simple: matching demand and supply in the medium term, by providing an instrument for the vertical alignment of business strategy and operational planning. (Feng et al., 2013)

In many companies sales forecasting is an integral part of a critical process for matching demand and supply and that process is called S&OP. (Mentzer & Moon, 2005) In figure 2. there are one view how the S&OP should work in companies.

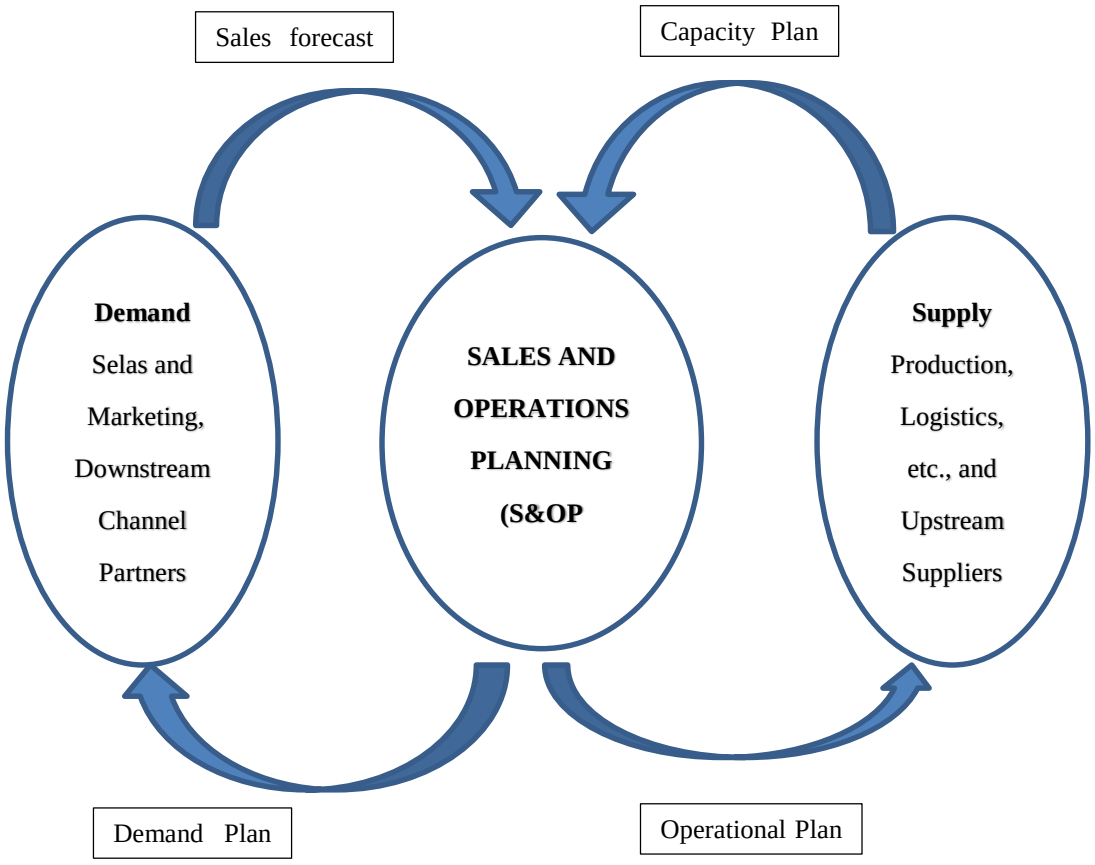

Figure 2. S&OP: The Junction Box. (Mentzer & Moon., 2005 pp. 11)

As shown in figure 2., critical input to the S&OP process is the sales forecast. It is projection into the future of expected demand. Within Mentzer & Moon (2005, pp. 11) they see that demand forecast should be made by marketing and sales department cause of their connection to the customers. The second important input for S&OP process is the capacity plan. It is really important to understand limits of own production and also limits of whole supply chain before manufacturing.

Out of the S&OP process come two critical plans: the operational plan and the demand plan. Operational plan includes following plans:

- Manufacturing plan
- Procurement plan
- Distribution plan

- Human resource plan

These plans can be short-term planning actions, such as monthly production schedule. Also, it is useful think plans in long-term perspective especially for example extended contracts for raw materials. (Mentzer & Moon 2005, pp. 11)

Demand plan is the other critical plan that emerges from the S&OP process, which involves sales and marketing making plans what should be sold and marketed given supply capabilities of the firm. Demand plan can give advices for example shifting demand from low-margin products to high-margin items. (Mentzer & Moon 2005, pp.11)

Tuomikangas & Kaipia (2014) have created a framework as synthesis from presenting literature for coordination S&OP process. In attachment 1 there's their descriptions for each mechanism and in figure 3. there's their view about S&OP framework.

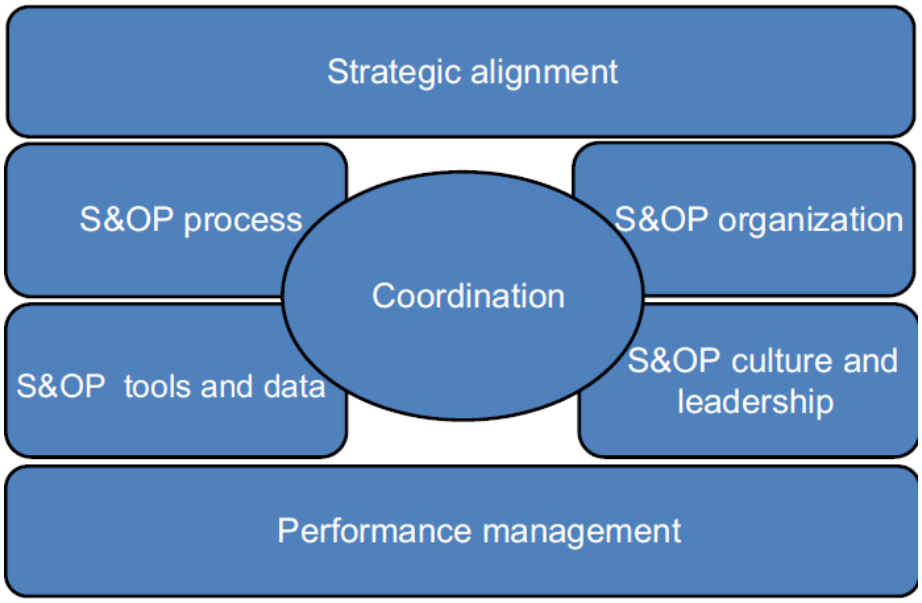

Figure 3. S&OP coordination framework formed as synthesis of concept analyses. (Tuomikangas & Kaipia, 2014)

Specific descriptions can be read from attachment 1. But main thing in figure 3. is that every part of S&OP is integrated together and depend on each other. Performance management builds the foundation for all activities and strategic alignment is the "roof of the house" and is the main piece in vertical coordination. (Tuomikangas & Kaipia, 2014)

Tools & data support S&OP process and that's the reason why it is located below that process. S&OP culture and leadership support the organization and cross-functional coordination is at the center and requires process and organization as complementary elements. (Tuomikangas & Kaipia, 2014)

For managers framework in figure 3. offers a better understanding of the potential mechanisms that enhance cross-functional planning and decisions making. Tuomikangas & Kaipia (2014) sees that processes and organizations are important in S&OP but maybe the most important thing is to create S&OP culture and climate in the organization.

2.3 Selecting forecasting method for S&OP process

The overriding consideration in choosing a forecasting method is that method should facilitate organizations managers the decision-making process. The main requirement is that the chosen method should produce a forecast that is understood by the management, so the forecast can help in decisions. Also the process must produce benefit that is in balance within costs. (Hanke et al., 2001)

Makridakis and Hibon (2000) thinks following things when adapting different forecasting practices:

- Statistically sophisticated or complex methods do not necessarily produce more accurate forecasts than simpler ones.

- The ranking of the performance of the various methods vary according to the accuracy measure being used

- The accuracy of the combination of methods outperform on average the specific methods being combined and does well in comparison with other methods.

- The performance of the various methods depends upon the length of the forecasting horizon

Armstrong (2001) have examined six ways in selecting forecasting methods: convenience, market popularity, structured judgment, statistical criteria, relative track records and guidelines from prior research. Armstrong sees that in selecting method the criteria should not be convenience or market popularity. He sees that using statistical criteria, such as distribution of errors, can be useful in some situations.

As a conclusions Armstrong present a selection tree for forecasting methods in figure 4. That tree gives some answering when finding the most suitable forecasting method for company, but it’s not explicitly stated how the answer can be found to these questions. (Armstrong 2001)

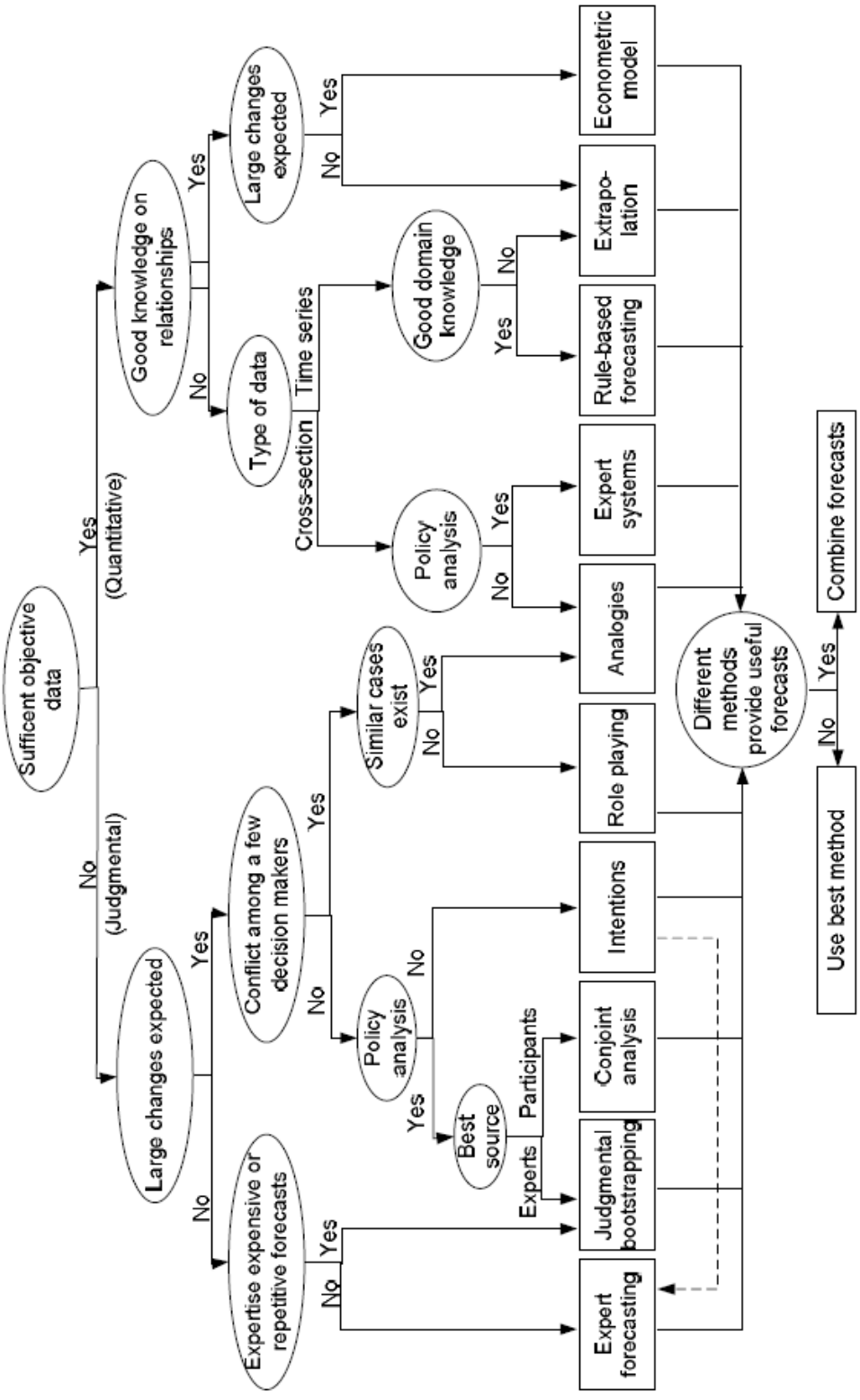

Figure 4. Selection tree for forecasting methods (Armstong, 2001 pp. 376)

3 DEMAND FORECASTING METHODS

In this section are different forecasting methods for case company operational environment descripted. There are a lot of different forecasting methods available from simply methods to complex methods. In literature, there exists two basic categories for methods: qualitative and quantitative methods. (Mentzer & Moon 2005)

Qualitative methods are used typically when there's no information for mathematically models. Although qualitative methods offer often high-class information about future demand. (Chase 1997)

Quantitative methods can be divided into time series methods and causal methods. Time series methods are used for a short period forecasting and there's used historical data about demand. Although causal methods are used to forecast medium and long time period demand. (Fitzsimmons & Fitzsimmons 2006, s.324) In

3.1 Time series forecasting

Time series methods are quantitative methods that use exists information for forecasting the demand. Information is typically historical demand data. Time series main purpose are based on the hypothesis that in future will happen the same improvement than in past. That hypothesis and historical data can calculate for future demand forecast with different functions. (Arnold et al., 2008)

Time series manage demand with different factors. Along to Mentzer & Moon (2005) these factors are:

- Trend
- Stability
- Cycle
- Randomness

These factors describe demand in different circumstances: demand can be stable or there can be changes to notice. Time series analysis try to understand current situation and forecast demand with that information.

There are two type of time series forecasting: open model time series techniques and fixed model time series techniques. When these are calculated together there are more than 60 different techniques that fall into time series techniques. (Mentzer & Moon 2005, pp. 76-77) In this section there are three models introduced: mowing average, exponential smoothing and exponential smoothing with trend and seasonality.

3.2 Mowing average

Moving average technique uses historical sales data to forecast. It is very useful way to forecast if demand is quite stationary. (Haksever et al., 2000 pp. 455) Mentzer & Moon (2005, pp. 81) presents following formula to forecast with moving average:

$$F_{t+1} = (S_t+S_{t-1}+S_{t-2}+\ldots+S_{t-N-1})/N \quad (1)$$

Where: F_{t+1} = Forecast for Period t+1
S_{t-1} = Sales for Period t-1
N = Number of Period in the Moving Average

Problem with moving average is to decide how many periods of sales to use in forecast. The more periods used, the more it start to look like a basic average. On the other hand the fewer periods used, the more reactive the forecast becomes but the more it start to look like naïve technique: (the forecast for the next period equals the sales from the last period). (Menzer & Moon 2005, pp. 81)

So, with moving average there's a question need to be answered: how many periods of data to use and how much weight to put on each of those periods? There's no

direct answer to that question but exponential smoothing forecast method was developed to answer this question. (Mentzer & Moon 2005, pp. 85)

3.3 Exponential smoothing

Originally exponential smoothing was called an "exponentially weighted moving average", which is easy to understand and it is easy way to explain what does exponential smoothing means. (Mentzer & Moon 2005, pp. 85) Technique was developed around 1950s and there are a many different possibilities to do with exponential smoothing. (Hyndman et al., 2002)

Brown & Meyer (1961) presents forecast with exponential smoothing in following way:

$$F_{t+1} = \alpha S_t + (1-\alpha)F_t \quad (2)$$

Where: F_t= Forecast for Period t
S_t = Sales for Period t
$0 < \alpha < 1$

So in this methods the forecast for next period is function of last period's sales and last period's forecast, with parameter α. (Mentzer & Moon 2005, pp. 85) If F_t will be replaced with previous rounds of forecasting formula will change like this: (Hyndman & Athanasopoulos, 2014)

$$F_{t+1} = \alpha S_t + \alpha(1- \alpha)S_{t-1} + \alpha(1- \alpha)^2 S_{t-2} + ... \quad (3)$$

The forecast in formula 3 weights moving average of all actual values. With parameter α can be set weight to value that wanted to act biggest role. This is the concept of exponential smoothing: forecast are calculated using weighted averages where the weight decrease exponentially as observations come from further in the past. (Hyndman & Athanasopoulos, 2014)

Table 2. shows the weights attached to observations with different values of α. As can be seen from table 2., when α is close to 1 the exponential model will react quite fast for changes in demand. While α is close zero model will provide a lot slower react for demand changes.

Table 2. Examples of α values.

Observation	α = 0,2	α = 0,4	α = 0,6	α = 0,8
S_t	0,2	0,4	0,6	0,8
S_{t-1}	0,16	0,24	0,24	0,16
S_{t-2}	0,128	0,144	0,096	0,032
S_{t-3}	0,1024	0,0864	0,0384	0,0064
S_{t-4}	$(0,2)(0,8)^4$	$(0,4)(0,6)^4$	$(0,6)(0,4)^4$	$(0,8)(0,2)^4$
S_{t-5}	$(0,2)(0,8)^5$	$(0,4)(0,6)^5$	$(0,6)(0,4)^5$	$(0,8)(0,2)^5$

3.4 Exponential smoothing with trend and seasonality

Exponential smoothing can be used also within trend that is called Holts method. Changes that happens within trend is noted with adding to past time t-1 flatten trend $T_{t-1)}$ to past flatten level. (Fitzsimmons & Fitzsimmons 2006, pp. 334) Calculating forecast that notes trend is used formula x: (Mentzer & Moon 2005 pp. 95)

$$L_t = \alpha S_t + (1- \alpha)(L_{t-1}+T_{t-1)} \quad (4)$$

$$T_t = \beta(L_t-L_{t-1})+(1- \beta)T_{t-1} \quad (5)$$

Where: L= Level

T=Trend

$0<\alpha<1$

$0< \beta<1$

As can see from equation 4 that formula looks very similar to earlier exponential smoothing: the difference is to addition of trend into the second part of equation 4. The best values for α and β can have when trying different kind of combinations. From tried variations company picks the values that produces least error. The more randomness in demand, more difficult it comes to pick the right values. (Makridakis & Wheelwright 1989, pp. 78)

When using exponential smoothing with seasonality the model needs data for whole season that the forecast can be made. That season can be a day, a month or a year. That data has to first flatten with seasonality index I_t. (Fitzsimmons & Fizsimmons 2006, pp. 334) That index is calculated with following formulas:

$$L_t = \alpha(S_t/SA_{t-c})+(1- \alpha)(L_{t-1}+T_{t-1}) \quad (6)$$

$$T_t = \beta(L_t-L_{t-1})+(1- \beta)T_{t-1} \quad (7)$$

$$SA_t = \gamma(S_t/L_t)+(1- \gamma)(SA_{t-c}) \quad (8)$$

Where: L= Level

T= Trend

SA_t=Seasonal Adjustement for Period t

C= The cycle Length of the Seasonal Pattern (that is, the cycle length for 12-month pattern is C = 12)

$0< \alpha<1$

$0< \beta<1$

$0< \gamma<1$ (Mentzer & Moon 2005, pp. 99)

Mentzer & Moon have made a forecast for real data with exponential smoothing with trend and seasonality (presented in figure 5.) that uses following values for mathematical symbols: α=0,1, β=0,2 γ=0,15. These values have tested to work with this kind of sales data and presents that with testing and analyzing can exponential smoothing leads to working demand forecast practices.

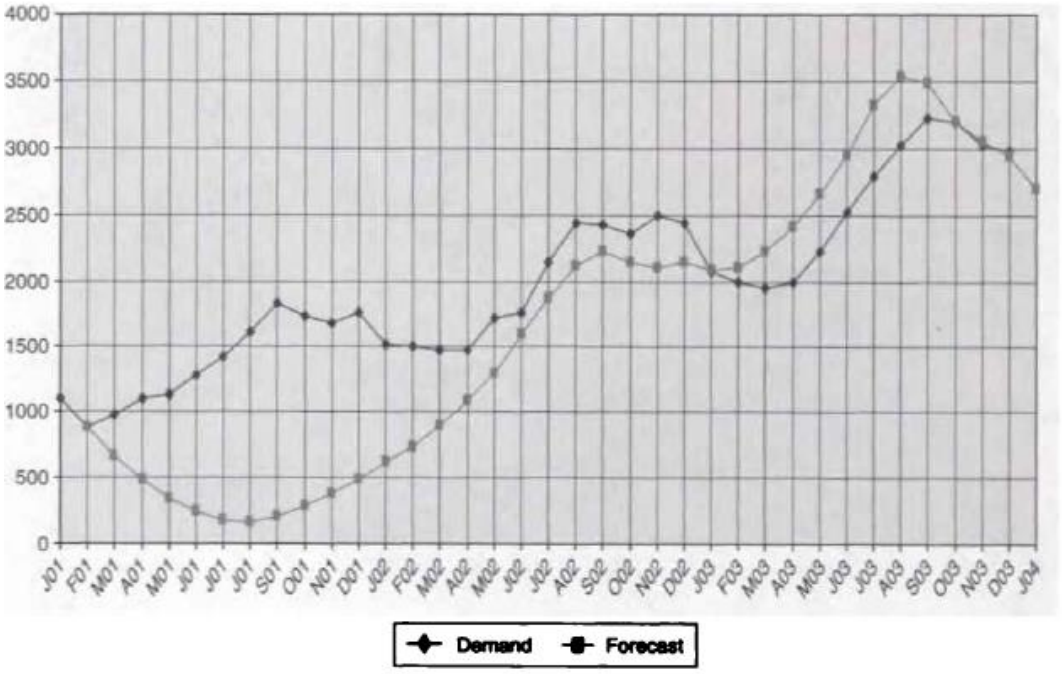

Figure 5. Exponential smoothing with trend and seasonality as a forecast. (Mentzer & Moon 2005, pp 101)

3.5 Forecasting performance measurement

Like any process and done work in companies also the demand forecasting needs to be measured. With forecasting organization wants to do business better and that means lowering the marketing and operations costs with better customer service. So that process ability need to be measured. (Mentzer & Moon, 2005)

Measuring forecast accuracy serves two main purpose:

- Managers can use error analysis to determine whether the current forecasting methods predicts the systematic component of demand accurately.

- Managers estimate forecast error because any contingency plan must account for such an error. (Chopra & Meindl, 2001)

Mentzer & Moon (2005) sees that different error measures can divide these three groups:

- Actual measures
- Measures relative to a perfect forecast
- Measures relative to a perfect forecasting technique

There are several measures of forecasting accuracy but all are based on the simple calculation of:

$$Error_t = E_t = Forecast_t - Sales_t \quad (9)$$

Where:
t = the time period in which the sales occurred

The first actual measure of forecasting accuracy is called the mean error and is simply a running average of how much the forecast has been off in the past.

$$\text{Mean Error} = ME = \sum E/N \quad (10)$$

Where,
N = The number of periods for which we have been tracking the error

In literature there are also other absolute error measures e.g. mean absolute deviation, mean absolute error, sum of squared errors and mean squared error. (Kerkkänen, 2010)

4 IMPORTANCE OF THE REALTIME INFORMATION IN SUPPLY CHAIN

Recent interest in supply chain management centers around coordination among various members of a supply chain: manufactures, distributors, wholesalers and retailers. One important mechanism for coordination in a supply chain is the information flows among these members. These information flows have a direct impact on the production scheduling, inventory control and delivery plans of individual members in the supply chain. (Lee et al., 2004)

In this chapter is first described what is bullwhip effect and how it affects for business within company, customers and suppliers. Then there are present some typical solutions how to prevent bullwhip effect.

4.1 Bullwhip Effect

The tendency of orders to increase in variability as moving up in supply chain is known as the bullwhip effect. (Forrester 1958) In a typical arrangement, suppliers provide raw materials to manufacturers, who provide finished goods to wholesalers, who provide finished goods to wholesalers, who combine one or many products to retailers. And finally these retailers sell products to final customers. In this kind of supply chain there's two kind of flows: material flow and information flow. In figure 6. there's description of this kind of supply chain with flows. (Metters, 1997)

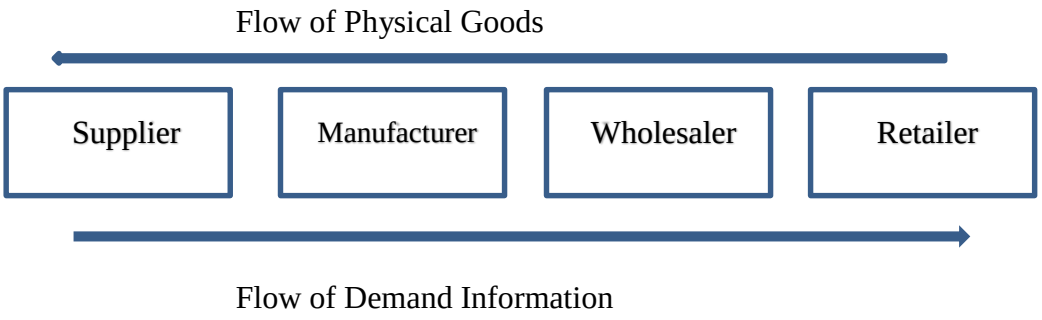

Figure 6. Goods and information flows in a supply chain. (Metters, 1997)

In figure 7. is shown how bullwhip effect works with retail store: sales means stores sales out and orders stores orders to suppliers. As figure shows there's a lot of distortion in demand information. The retailer's orders do not coincide with the actual retail sales. (Lee et al., 2004)

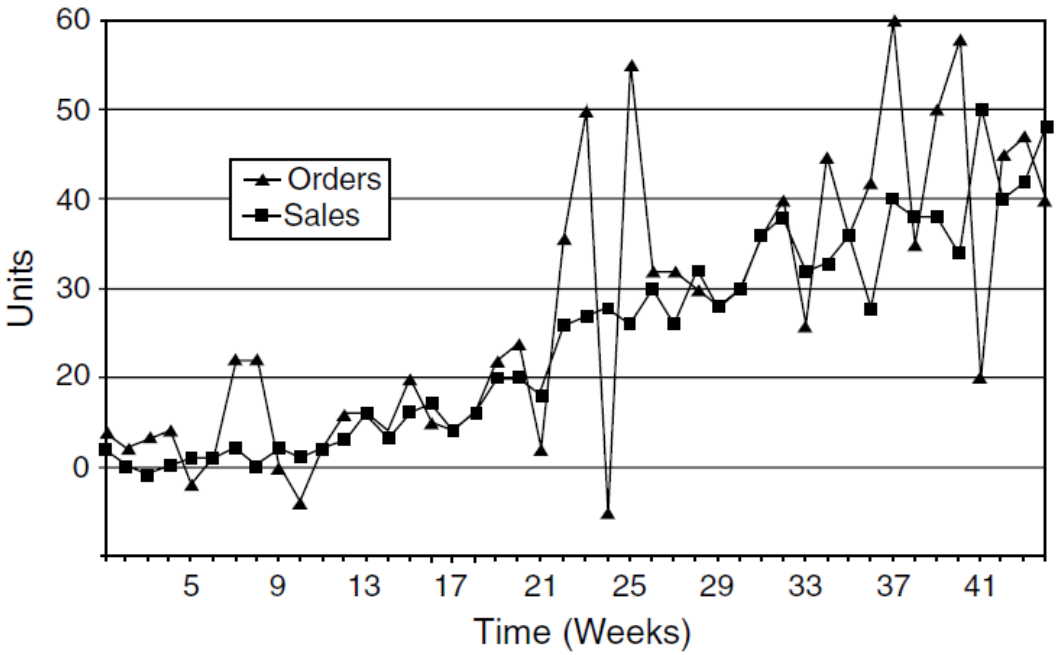

Figure 7. Bullwhip effect: Orders vs. Sales (Lee et al., 2004)

The bullwhip effect can have dramatic effects on companies that doesn't know the final demand within customers. There are for example two kind of effects within Metters (1997):

- Forward buying practices for seasonal items by downstream wholesalers and retailers amplifies the seasonality seen by the manufacturers. As a general practice wholesale level buyers often induce larger seasonality's for manufacturers by purchasing very large quantities of product during the peak demand season.

- Batching of orders by participants in the downstream of supply chain. Demand may be relatively continuous by consumers, but due to ordering costs or periodic ordering system runs it is batched early in the supply chain. This batching of orders induces demand variance up the supply chain that is not prevent at lower levels.

One well known effect within bullwhip is that it lead to excessive inventory investment throughout the supply chain as the parties involved need to protect themselves against demand variations. (Sucky, 2008) There are present at least two ways on reducing bullwhip effect and both are valid in this study considering case company:

- Different managerial practices to reduce bullwhip effect (e.g. the centralization of demand information) (Lee et al., 1997)

- Using different forecasting methods to reduce bullwhip effect in the supply chain. (Sucky, 2008)

Forecasting methods are present in chapter 3 of this study and information sharing methods are present in next part of this chapter.

4.2 Information sharing

There's general belief within industry that capturing and especially sharing real-time demand information is the key to improve supply chain performance. (Cachon & Fisher 2000) Sharing sales information has been viewed as a major strategy to counter the bullwhip effect. (Lee, 1997)

By Letting the supplier have visibility of point-of-sales data, the harmful effect of demand distortion can be minimized. Demand information sharing by a downstream operator to his supplier is the main point of initiatives such as Quick Response and Efficient Consumer Response. It it's also typical that information sharing is embedded in programs like Vendor-Managed-Inventory (VMI, discussed more later) or Continuous Replenishment Programs (CRP). (Lee et al., 2000)

Lee et al. (2000) have analyzed that within information sharing there will be two kind of cost savings for all parts of supply chain:

- Information sharing can provide significant inventory reduction and cost savings to the manufacturers. With these savings the retailer can negotiate arrangements with manufacturer, for example using VMI to reduce the retailer's processing costs, price reduction to reduce the retailer's variable cost, or lead time reduction to reduce the retailer's inventory cost, before sharing sales information

- Underlying demand process and the lead times have significant impact on the magnitudes of cost savings and inventory reductions associated with information sharing. Manufacturer would experience great savings when

    - The demand correlation over time is high
    - The demand variance within each time period is high
    - The lead times are long

These conditions seem to fit the profile of most high-tech products. Therefore Lee et al. sees that information sharing would be especially useful for improving the efficiency of the supply chains in the high-tech industry.

4.3 Vendor Managed Items (VMI)

It is established that removing an echelon can lead in improve of dynamic performance in a supply chain. (Wikner et al, 1991) This is because there is potential for a two-fold improvement (Towill and del Vecchio, 1994):

- Elimination of delays in both information and material flow
- Decision-making activity that customarily increases distortion in the order waveform as it is flows upstream is eliminated

Vendor managed inventory (VMI) is one practical way of seeking to obtain the benefits of echelon elimination. (Disney and Towill 2003) In VMI both the retailer and the manufacturer can retrieve the customer's demand information in a synchronized manner. This means the manufacturer takes the initiative to make major inventory replenishment decisions for the retailer in parallel with its own inventory decisions. In this case, the manufacturer will not depend on the retailer's ordering information, but on the customer's demand directly. (Zhenxin et al., 2001)

In VMI the supplier is given the freedom to plan its own production and decide upon the replenishment schedule as long as the agreed customer's service are met. This enables suppliers to stabilize their production and to optimize the transportation costs. (Waller et al., 1999)

For the buyer administration and inventory costs can be decreased. Enhanced collaboration between both supply chain partners should reduce lead times and also minimize the risk of demand amplification in the supply chain. (Reiner and Trcka, 2004)

In figure 8. there's Disney & Towell (2003) view of VMI-model implementation in full mode. From figure 8. it can be noted that company that manage VMI-model takes responsibility almost whole supply chain: the VMI-system controls manufacturer inventory and customer's inventory. Main difference there is that demand can got straight from the end customer.

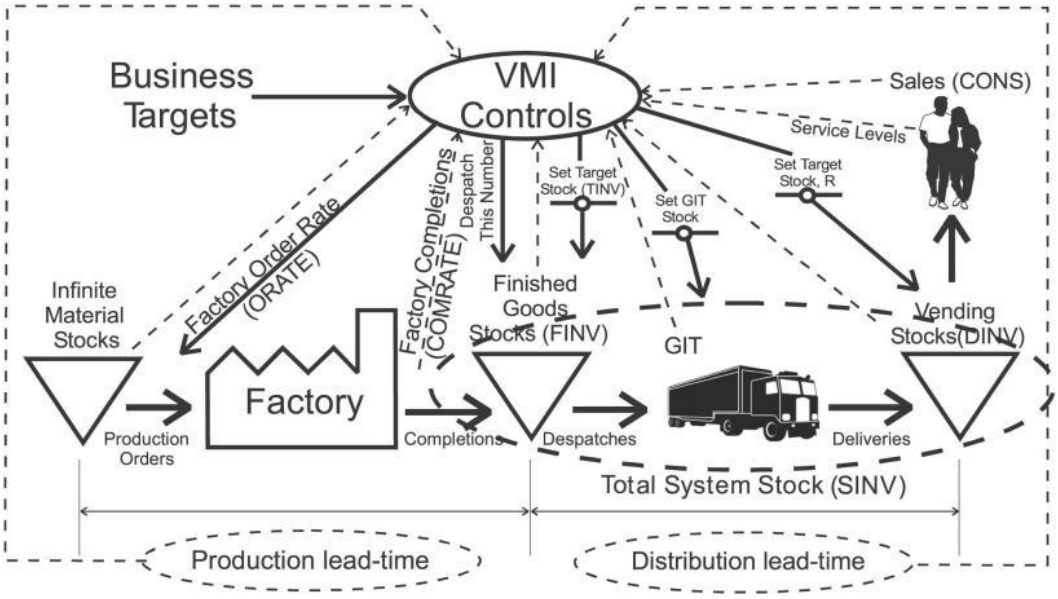

Figure 8. Overview of the VMI scenario. (Disney & Towell, 2003)

There are some additional benefits when taking the entire supply chain into account. Maybe most importantly is the prevention of sub-optimization. In the traditional supply chain the customer decides about the date and the volume or replenishments to be made by the supplier. These decisions are based on the buyer's actual inventory and handling costs and the costs for maintaining flexible capacity by the supplier. This result in suboptimal decisions. (Cousins and Spekman, 2003)

VMI provides the supplier with all information about stock levels and demand and in most cases all supply chain costs, which enables him to make better decisions for the entire supply chain, resulting in a higher overall margin. The early and continuous exchange of information between buyer and supplier should also result in a reduction of the bullwhip effect. (Claassen et al., 2008)

5 CURRENT SITUATION IN CASE COMPANY

The meaning of the whole empirical study is to:

- Describe whole process environment
- Take the most important parts from theory to company processes
- Implement the new processes in action

First there will be a part where the target process is analyzed at the moment. That includes defining where forecasting and demand management is needed and what kind of solutions is needed that operational ability could involve. Environment in this case is quite large because almost every department could use demand information.

Writer is employee in company and this thesis is ordered to solve problem with demand forecasting and management. The main point is to find solutions that can be implement to company's process and can lead to better profitability.

5.1 Case company description

The case company is medium sized industrial firm that produces professional products for professional customers and some products for consumer buyers. About 80 % from revenue comes outside of Finland and company operates in every continent. Company has about 110 employee and most works in Finland. Company has one factory and it is located also in Finland.

Company has growth calmly within years and profitability has been excellent. Although there's been appeared need to manage demand better and in that way make profitability much better. In figure 9. there's described companys supply

chain process. After that is analyzed where demand management and forecasting shows the biggest role.

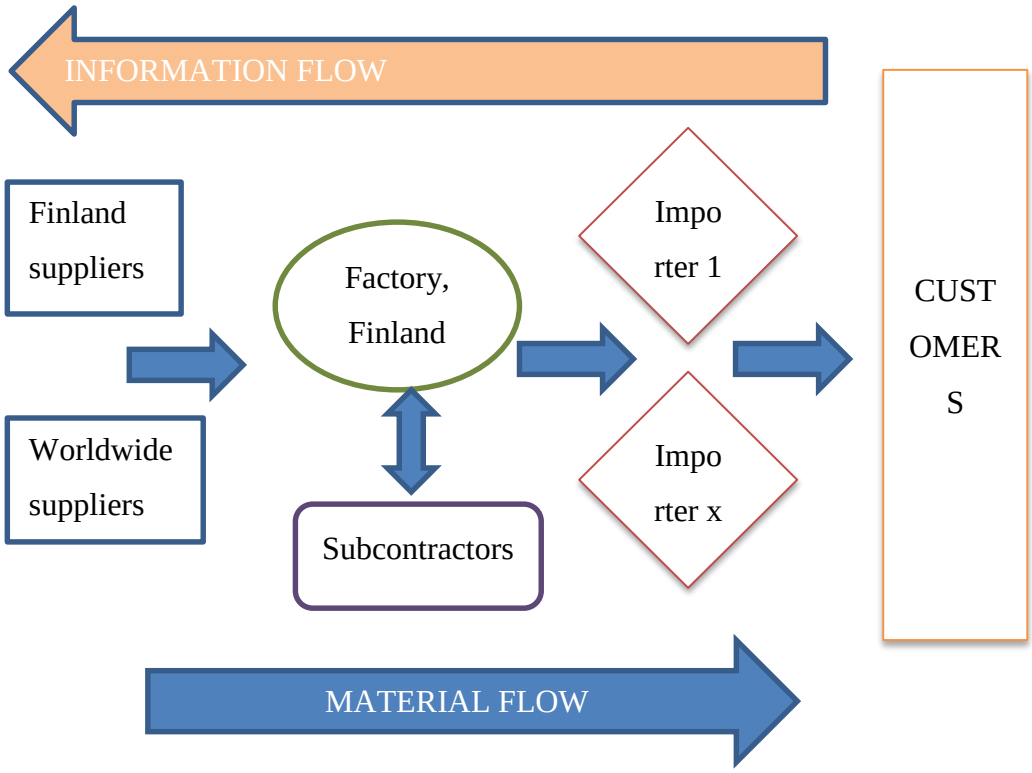

Figure 9. Companys supply chain process

As shown in figure 9. company delivers products to final customers via importers. So to company it is sufficient to handle demand and communicate with importers. Although it is very important for whole supply chain that all information changed and discussed will be shared to subcontractors and suppliers.

Whole manufacturing process is done in one factory in Finland. Some parts of products are made with subcontractors and of course components come from supplies. But whole assembly is done in Finland.

Company does not have end product warehouse, so every product is make to order-based. So updated information and view about situation is one of the most important things that company has to manage. Although simple and suitable forecasting methods can add more value to business process.

Company define delivery weeks for main customers for next year in the end of current calendar year. So there's some kind of understanding that in which week company will deliver products for which customer. And looking back in history there's some kind of understanding how much the main customers will order in current delivery week.

5.2 ABC-analysis for products

In the beginning of this study the updated ABC-analysis for end products were made so it was possible to pick up the most important products for this study. In figure 10. are the results of analysis presented.

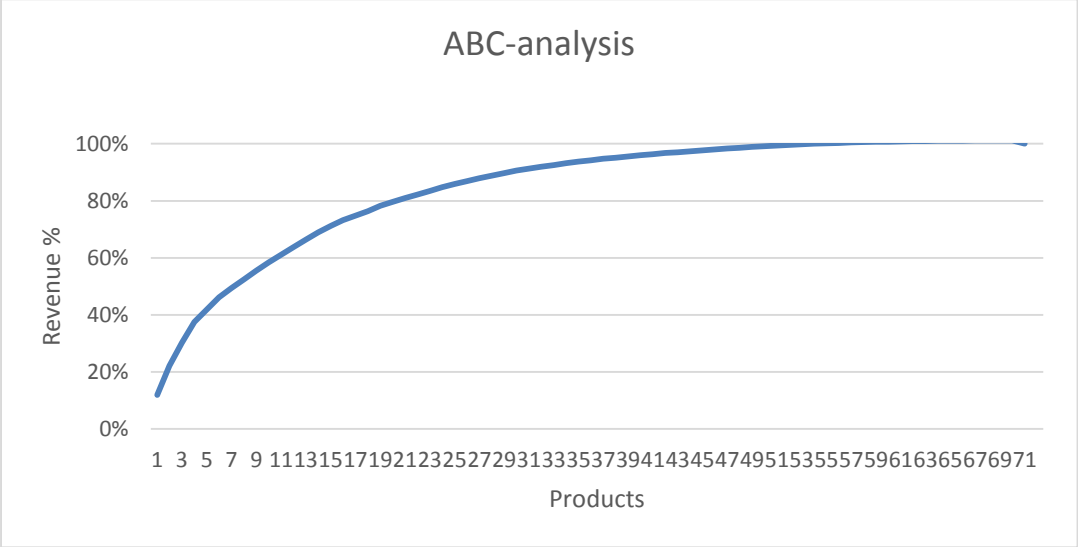

Figure 10. ABC-analysis for end products

Product names are replaced with numbers. Gab in end of analysis comes from given discounts for customers. It can be seen that in 2013 company sold around 70 products (actually product map is around 130, but all products aren't sold every year) and 20 products gave 80 % revenue.

Two products give 22 % revenue, so this study will focus to make these products forecasted and managed. Later company can take other products along management and forecasting process.

Within this analysis it is important to remember that there are product variations in the product list. Product variations for product 1 are presented in figure 11. Product 2 variations are the same than product 1.

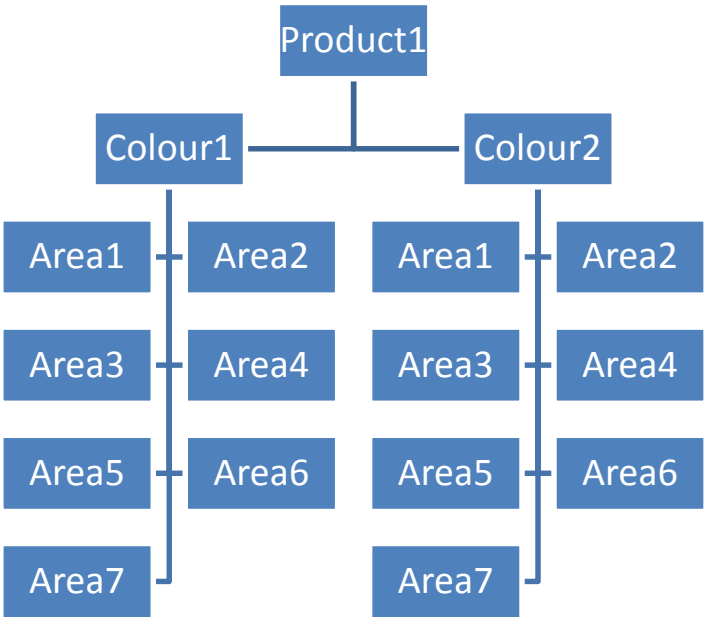

Figure 11. Different product variations.

As seen in figure 11. for one product there's 14 different variations. That gives a lot of challenges when managing demand, production and purchasing. Although it is important to remember that changes in area codes are not so big: typically there's some changes in products components or packing marks can be different depending to which country product is going.

But it is hard for purchasing and final assembly to know what product exactly will be sold in which week. And forecasting every BOM (build of materials) is not possible for available resources. So in company where following simplification made for forecasting and management:

- Calculation the ratio between different BOM's from historical sales data
- Forecasting made for upper level products
- Sharing forecast for different BOM's within ratios calculated from historical data

That simplification makes forecasting and management simply and easier to calculate every month of year.

5.3 Target process and need for forecasting

Company does not have organized process for demand management and forecasting. Company uses three kind of information when planning purchasing and production:

- Intuitive information from past time demand: "in this way demand went last year"

- Sales target, which is target € for whole business. This is only target for one product group, so different BOM aren't included for sales target.

- Order book information. Of course order book is the best way to plan in short time but order book is checked in week level.

Company's new ERP system offers much more possibilities to use order book information and demand forecasting in planning processes. The new ERP was implemented in 2013 and so within initialization there arose need for new management process for forecasting.

Discussions with key people (sales manager, production manager and purchasing manager) lead the fact that most benefit with forecasting comes from purchasing and capacity planning: with good information purchaser and production engineer could prepare better for 2-3 months demand. So main target for study became to make forecast and management help purchasing and production planning to do better decision.

There's also other parts of organization that would of course make benefit with better demand management and forecasting and these are also considered in this study. In figure 12. there's target process environment for target budget and target sales described.

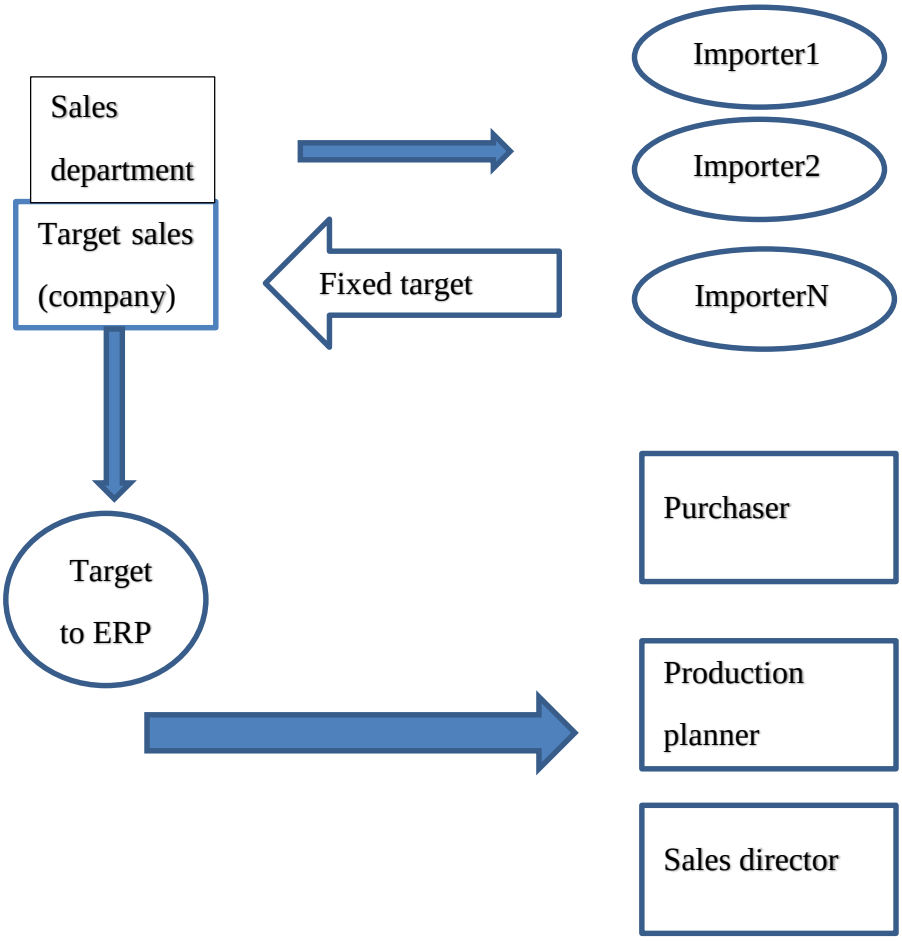

Figure 12. Target process for sales target

As shown in figure 12 company set some € target for the next financial year and it is set by product group. Then that target are sent to importers which make some fix if needed. Then it comes back to company and that target will be the final sales target. So there is not any talk about forecasting future demand, only target where should company go.

6 DEMAND MANAGEMENT IN CASE COMPANY

6.1 Creating target budget to ERP

New ERP system where introduced in 2013 and in that year sales target where put to ERP system only for 8 biggest countries, so in that year forecast there where only around 60 % about total target revenue. First task in this thesis was to put whole sales target to ERP so that seasonality and trend was considered. That information is central to purchaser that ERP system create purchase suggestions using that information and order book information.

Company starts planning process for next year in the end of current year. There will be next year sales defined for current area and for current product. Then as seen in figure 12. that target will be sent to importer and they check it and send back to company.

Problem in sending that information to ERP's forecast software is that the information doesn't contain data about different BOM's; only information for 0-level BOM. It was noted that to made forecast for every BOM was out of resources, so there needed to simplify that process. Second problem was the fact that within financial year demand are not stable but seasonality. So target should be made also seasonality.

To these problems decided use historical data from 3 past years demand. The demand data were calculated as an average and that average is presented in figure 13.

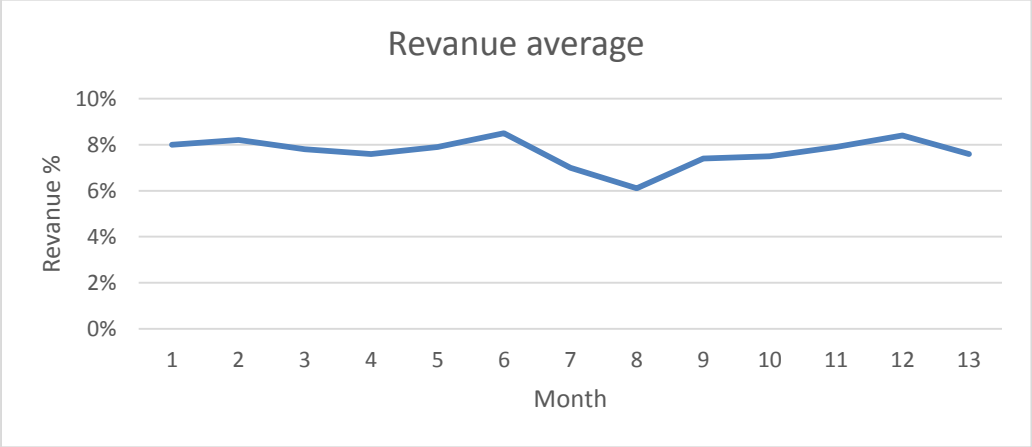

Figure 13. Revenue average in 3 years.

With that average were demand shared to each month. But still there were problem with different BOMs. Again the result where that using past time average for different BOMs is the best way in given time to manage target setting.

In real monthly demand data there are a big changes within weeks: in some week demand can be massive comparing the next week when there are no big deliveries. When looking historical demand these changes does not are in same week in year, so this kind of average presented in figure 13. is pretty good especially for purchaser: it is not important to know the demand in weekly-level, the important thing is to know demand in monthly-level.

That average where calculated for every area separately, so every areas specialties did not mixed in whole average. As a result company got specific sales forecast target for whole year, for every product and for every product variation.

6.2 Forecasting demand

Company's need for forecasting came from the fact that without good information in 1-3 month timeline it is complicated to manage purchasing. Second fact is that only information about demand is company's order book that contains information only for 1-4 week level.

In the beginning it was really clear that solution for visibility problem would be some kind of mathematical calculations that would calculate future demand from past demand. Mathematical model would have been easy in two ways:

- When formulas and data connections would have been made the new forecast would have calculated quite fast. Also parameters for importing forecast to company's ERP system would have been ready for that

- Performance measurement could have been easy because forecast would have been as numerous analysis and also realized demand would have been as numerous. So forecast error would have been for example %-analysis.

But when looking for products actual revenues presented in figure 14. and 15. it can be seen that if moving average and exponential forecasting method would have been in use the fact is that forecast would always be late. In figure 14 there are diagram for product 1 sales in year 2013 and in figure 15 for product 2 sales in year 2013. For January there are no demand data because the new ERP were implemented in February of 2013 so data were not available for January. Products 1 and 2 are same as in ABC analysis in figure 11. and these are two most sold products in company's catalog.

Figure 13. Product 1 Sales in 2013.

Figure 14. Product 2 Sales in 2013.

Within year there are some time lines for product 2 that exponential smoothing would manage properly. But the fact is that although there are seasonality in demand the mathematical model would not give enough reliable information about future demand.

So using that analysis large mathematically forecasting decided to leave out from demand management processes. With mathematic would company benefit if there would be more resources in calculations but in this situation more simple methods are better solutions for demand management processes.

When analyzing year 2013 and current year 2014 demand for same products (presented in figures 15. and 16.) there can see changes that were known before happening:

- In 2014 company had challenges in delivering product 1 because a lack of important component, so in March demand were lowly. On the other hand when company solved that problem the demand rose to 20 %.

- In 2013 were introduced new versions of both products 1 and 2 in beginning of the year. So demand rose because of introductions when importers fulfilled their warehouses. Then demand evened for rest of a year.

Both of these changes were known before happening and with mathematic there would not be any answers for questions about demand changes. Exponential smoothing could work if company would use parameters that comes from human judgment in calculations. But that is out of resources at the moment.

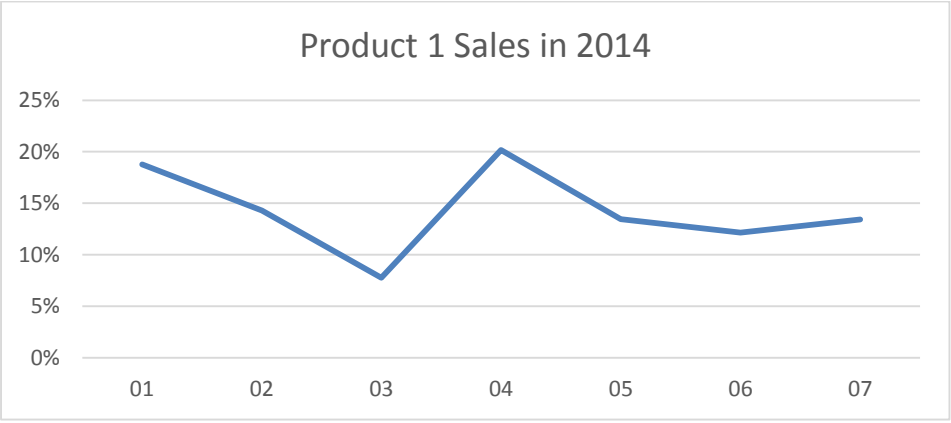

Figure 15. Product 1 Sales in 2014

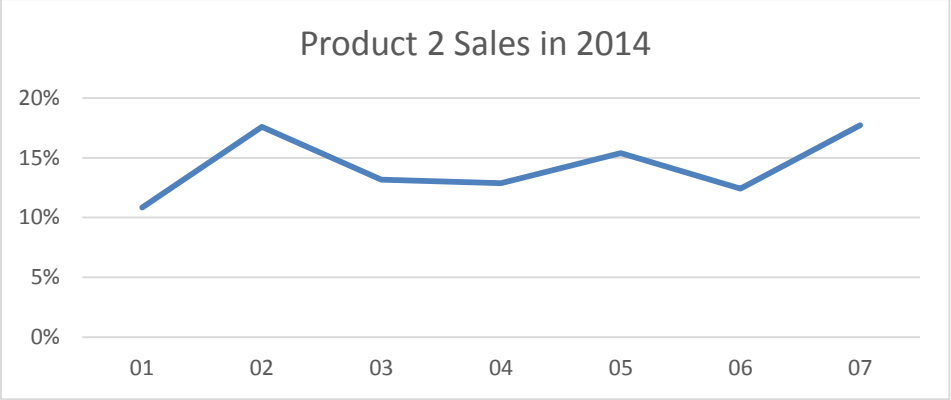

Figure 16. Product 2 Sales in 2014.

6.3 Information sharing with importers

As said company does not know the end demand that comes from end customers. That affects the problem that signal from demand changes comes only from importers orders and when that signal comes it is always after that market situation has changed.

A lack of information causes a different kind of problems. Company decides delivery weeks for next year in the end of current year. These delivery weeks are decided for the biggest importers around the world, mostly in Europe. Basic hypothesis is that orders will share quite stable for each delivery week. But there's different kind of reasons why orders do not share stable:

- Importer can't sell products as much as estimated
- Political situation is bad in country -> investments are cut out
- World economy crises
- Inventory optimizing: importer could have made limits for company's products and then optimize it

In figure 17. there's description about one products relation to orders and invoicing. Already relation between these can show us that end demand and company's delivery do not match. There can see that orders do not come optimized to company.

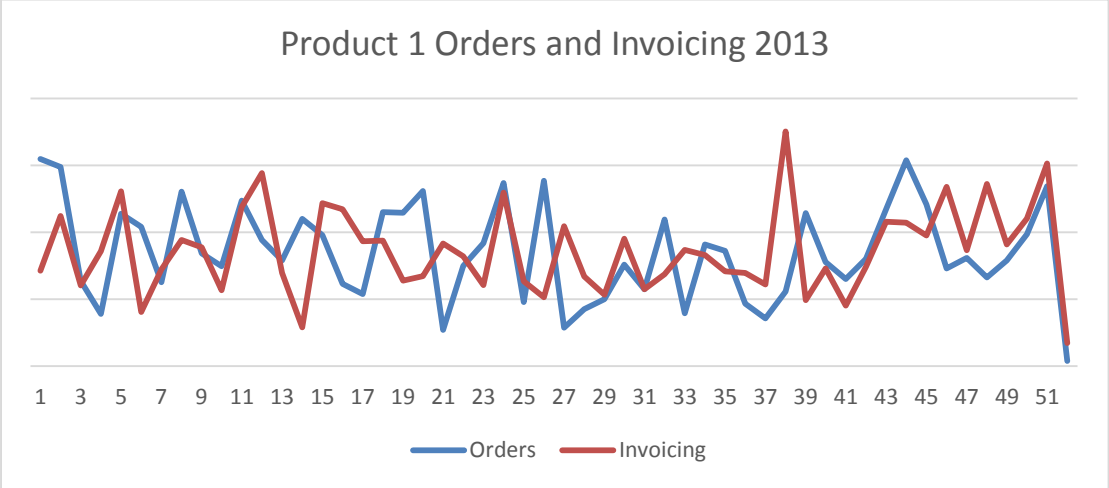

Figure 17. Bullwhip effect for product 1.

During this study it came quite clear that company needs more data from end demand. At the moment the situation is that if customers ends buying company's products for some reason it takes 1-2 months to note that and solve the problem.

Information sharing with company's importers is one solution for lack of information. Information sharing is especially important with customers that order products regularly and produces the most of company's revenue. Company's sales department run of course meetings with importers and their talk about market situations but that's not enough when creating good numerical information platform.

Company collects some countries warehouse information already but using that information is too low. In figure 18. there's warehouse information for product 1 and 2 from January 2013 to June 2014 in some countries. This information could company use for following needs:

- Analyzing future orders when knowing what is typically warehouse level

- Analyzing historical warehouse situations: what have been warehouse situation in a specific month

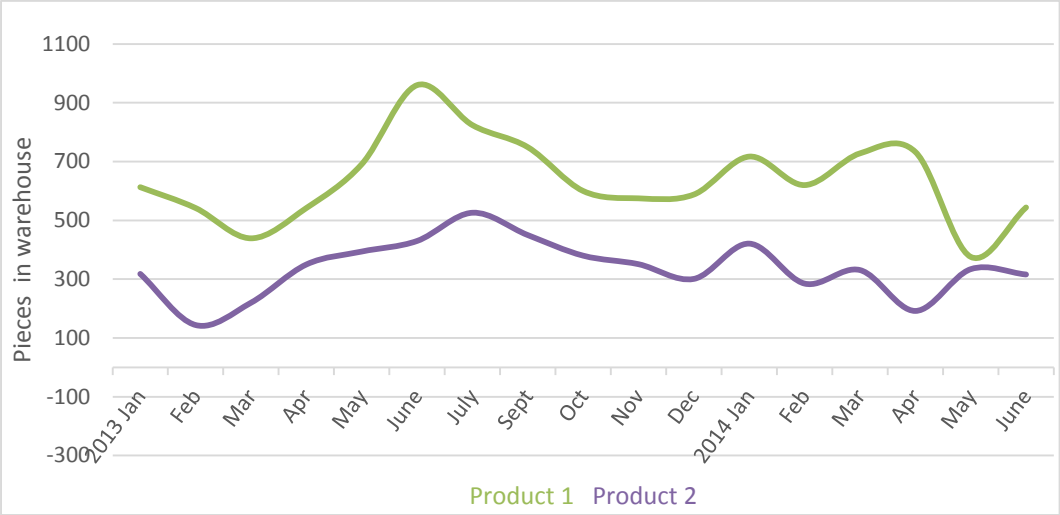

Figure 18. Warehouse information for products 1 and 2 from 2013 to June 2014.

With that information company can make decision in capacity planning: their know what kind of total demand these products will affect. But there's possibility to calculate how much the importer sells products and to measure their forecasts to actual sales.

Next there's example from one European customer that is quite big customer for company. During this thesis there's created a model that uses three kind of information when analyzing market situation around the firm:

- First company analyzes current inventory levels in importers warehouses. That information is gathered for a long time but using the information is quite poor: there can be seen some trends but analyzing that information in number-level is not done yet.

- Second company analyzes current timeline sales for current importer. This analyze looks for main products that are gathered in inventory level analyze.

- Third company can calculate importer sold products number when their know past month warehouse level, current month warehouse level and what their have delivered to importer. So company knows how much importer sells products to customers.

In following figures there's gathered these information from company's ERP system. In figure 19. there's warehouse levels in chosen importers in one year. In figure 20. there's total delivering's for the same products from factory to the customer. And finally in figure 21. there's calculated the importers end demand with this information.

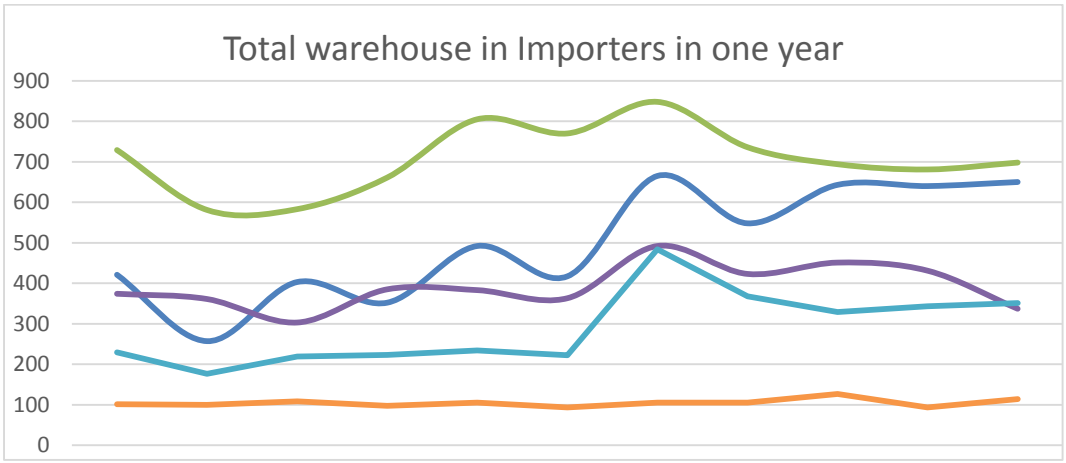

Figure 19. Total warehouse in importers in one year.

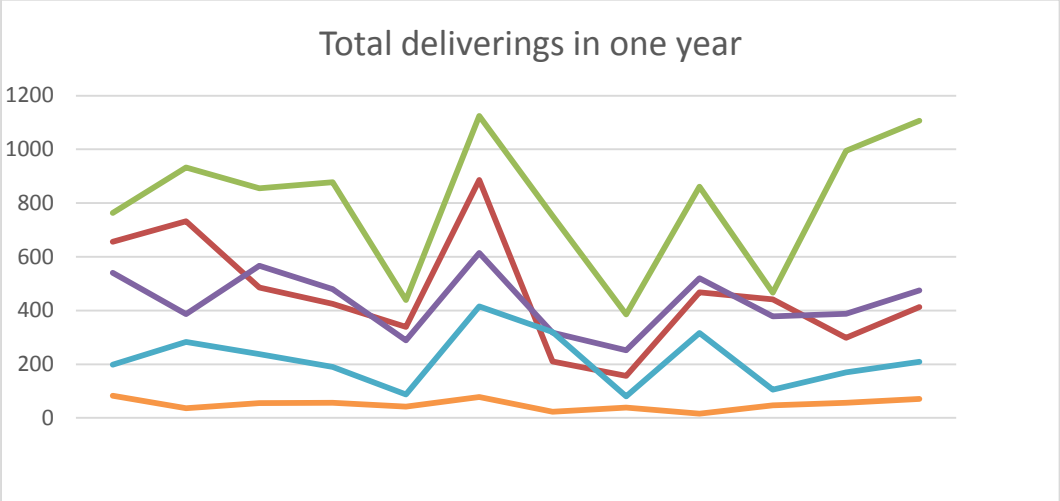

Figure 20. Total delivering to importers in one year.

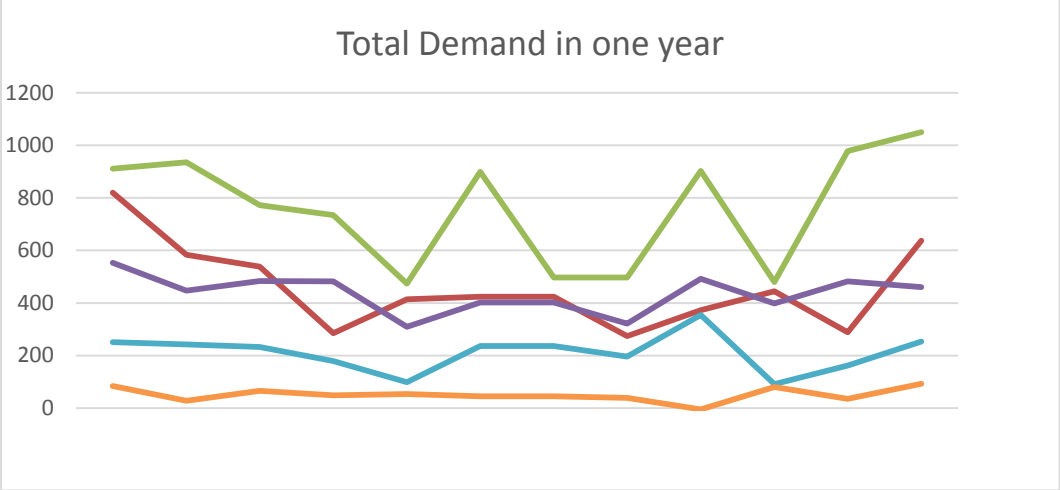

Figure 21. Total demand in one year.

As can see from the figures 19, 20 and 21 the end demand, total delivering's and warehouse levels works together as it should do and with that information company can make analyses about demand moves. Analysis are very simple:

- When end demand falls and warehouse levels go up -> orders falls also in future

- When end demand rises and warehouse levels go down -> orders increase

Another thing that can be found from figures is that the bullwhip effect is quite big for some products. It can be seen that demand stays quite normal whole year but importer's orders vary from small orders to huge orders. So in long distance company can try to flatten this difference within communication.

That system is carried out in following process:

- Area sales manager sends simple email that includes questions about warehouse levels
- Importer sends answers in email
- Sales manager collects all levels and ads them in excel file in company server
- Company's sales took from reporting software for current importer
- Analysis presented in figures 19-21 are composed

6.4 Importers forecast and performance measurement

In second stage in information sharing company will ask importers own view about demand development in medium timeline; 2-3 months. The meaning of this process is to extend warehouse and total demand view.

In warehouse information-system company gets fact information about 1-2 months demand. There's no forecasting and so company can make decisions that are based on fact. Adding importer's opinion and forecast about future demand to information system brings valuable information to demand analysis. That forecasting is made in the same process than warehouse levels asking.

Difference is that company measures importers forecast about future demand. That makes the process self-improving and tells to importers that company appreciates their view and needs it to improve operational ability. Also with measuring

company can involve importer's forecasts: when they know that there are measured and they got feedback regularly that makes activity more profitable.

When estimating demand for some product company have two estimates about it. First own view about demand that is function about warehouse levels, orders and total demand. Second the view of importer about future demand. So in numbers there are example in table 3. about demand management for one product for two importer.

Table 3. Demand management tool for two example importer and for example product.

Importer	Product	Inventory (4.9.2014)	Inventory Change	Average inventory	Sales	Total Demand	Next Month Demand	Importer Forecast	Actual demand	Measure
AE	1	315	55	300	210	160	160	x		-
SE	1	93	-45	100	200	245	290	x		+

With table 2. company starts new demand management calculations and these calculations are the heart of S&OP process. For these company can found their purchasing and production planning decisions. Unfortunately within this thesis for model testing there were no time so in table 2 there are no importer forecast, actual demand and measuring information.

7 S&OP MEETING

The aim of the S&OP meeting is to match demand and supply capabilities in medium timeline so the organization have a full understanding about current demand evolvement and possibility to answer it. In a case company there are different kind of meetings already that handle these things but agenda and participants are not suitable for S&OP meeting. So new meeting is needed to create for S&OP process.

Every week company's delivery team gather and handle next week's deliveries. That delivery team includes participants from financial, purchasing, production and order handling units. The main objective there is to check can company deliver in next week products that customers have ordered and are there some limitations in materials or production capacity.

There are also meetings that handle strategic and 6-12 months delivering and demand issues. These are long period planning and do not handle medium timeline demand changes. However there are parts that are suitable for S&OP meeting: how demand have evolved in each area and what are the company expecting to happen in future.

7.1 S&OP Organization and Culture

The first objective in S&OP process is creating culture and organization for this kind of operation. As said in framework presented in figure 3 past in this thesis 75 % of S&OP is something else than calculations. First it needed to determine which parts of organization could benefit S&OP results and which part organization could add more value for process.

Clear is that sales department, production, purchasing and delivering is needed to co-operate if S&OP system would work properly. So it is decided that in personal

level participants comes from these organizations. S&OP organization is tentatively agreed as following:

- Sales manager (leader)
- Area sales managers (2-3 personnel)
- Production manager
- Purchasing manager
- Logistics manager

The organization wanted to be in manager level because it experienced so important in planning processes. The leader of the S&OP organization is sales manager, who invites meetings and take care that process flows how it should.

The second important task was the creating of S&OP culture. The importance of demand management was clear for purchasing and production organization but sales and marketing organization attending was difficult because the main benefit for process is in purchasing and production and for sales & marketing it bring only preparing work for process. So motivating and finally ordering people in sales and marketing is needed to make organization available to answer challenges.

7.2 S&OP Process

The main objective in S&OP process is to make a year clock for sales and operations planning and what have to be made in which part of year. The process begins in November of year when target budget for next year is made. That target budget is the budget that company should reach to make satisfying revenue and profit.

After that follows target budget discussions with importers and there are discussed next year’s sales targets in country-level. After that follows these targets transferring to ERP-system. That makes bottom for whole planning process for company: every month sales and delivering’s is mirrored to this target.

Monthly sales and operations begins in the beginning of the month. The last month demand and warehouse levels are gathered by sales managers and they produce report for total demand for current importer. The monthly sales and operations process is presented in figure 22 and there are also target sales process added in upper level planning process.

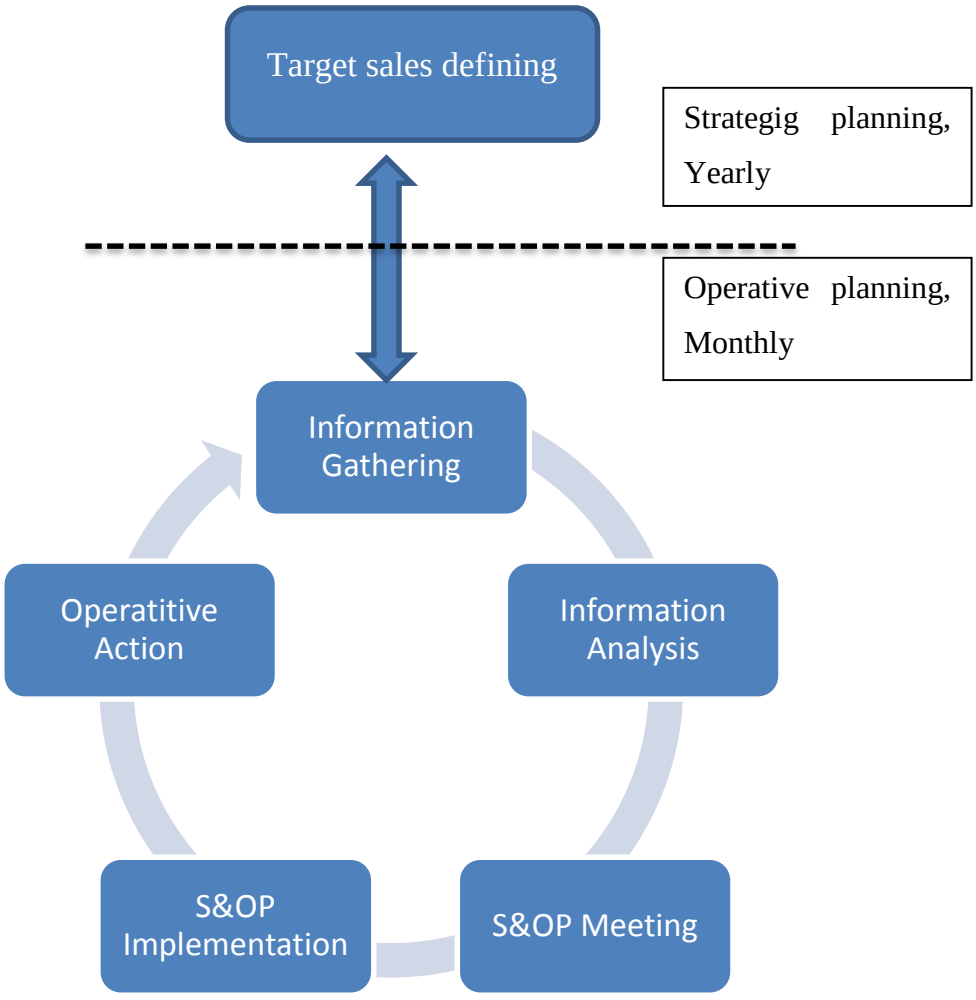

Figure 22. Monthly Sales and Operations Planning Process

- **Information gathering** includes warehouse information gathering and sales data gathering in importer-level. There area sales managers collect data with simply inquiry's and reports that to company's server

- **Information analysis-**stage is analyzing of collected warehouse and sales data. In this section is numerical analysis made by area sales managers, logistics manager and reporting software. This analysis produces total demand calculation that presents current market situation for company.

- **S&OP Meeting** is the discussion forum for total demand changes and marketing situation changes. There is under discussion future events: how demand will change in 2-3 months level and how that effects to purchasing and production. In ideal situation sales and marketing brings information that production and purchasing can exploit. Also S&OP meeting gives possibility to sales organization to react changing demand if possibility. These kind of react options are for example pricing changes and different campaigns for product groups.

- **S&OP Implementation** is the process where decisions and estimates done in meeting are implemented in action. There production changes production schedules and can possible take more orders for some production weeks. At the same time purchasing can change orders and increase or decrease reserve inventory by estimates made for demand.

- **Operative Action** is stage where production and purchasing works with information that implemented in implementation stage. There normal routines are done using forecast information that is calculated in

7.3 Implementing S&OP results to ERP-system

When managerial process is implemented and working and in that level company can make analysis about future demand, it is needed to bring those results to ERP-level. The most important thing is to make S&OP process work and bring out full

understanding about the demand of five product groups. After that comes ERP-system implementation.

For purchasing it would be necessary that demand management practice results would transfer to ERP system. When changing the forecast all changes would proceed to component-level via build of material. But it was decided that in this stage of this project monthly update to ERP cut out of process.

8 RESULTS

The results of this study are presented in this chapter. The starting point for this study where that in company there were no planning process for sales management and forecasting. Also the need for better understanding about demand and its changings were observed.

8.1 Three main results area

Theory part were shared in three parts trying to find solution for company's needs:

- Process planning and management
- Demand forecasting methods and performance measurement
- Importance of real-time information

There are presented results for current theory area in following tables. Each table includes shortly main objectives from theory and how that theory is exploited in empirical study.

Table 4. Results of demand forecasting process management

Demand forecasting process management	**Results**
Organizational issues How and why to forecast? Who uses the forecast? What kind of process is needed to management process?	Forecasting is needed in purchasing and production planning. Sales managers do forecasting. S&OP process is needed to make forecasting and implementing the results. Process includes numerical analysis and organization & culture creating.

In demand forecasting process management the main topic was to find an answer to the question who needs and uses the forecast and why it is made? Second important thing was to find out a suitable process for demand management and it is in this case sales and operations process.

Table 5. Demand forecasting methods and results in empirical study.

Demand forecasting methods	**Results**
Time series forecasting Moving average Exponential smoothing	Time series methods forecast with historical data. Company tried to forecast with exponential smoothing but decided that forecasting with historical data is not valid in this case.
Forecasting performance measurement	In this case performance measurement is not done for actual forecasting but company will measure own view and calculations about future demand and will measure importer-level forecasting. Involves own performance and in best case importer performance in forecasting.

Table 6. Results of information sharing

Importance of real-time information	Results
Bullwhip effect in supply chain	Company noted that in supply chain there affects bullwhip effect that effects own operation negative.
Information sharing	Company started information sharing with importers to manage total demand and to measure. Information sharing executed with sharing warehouse information for 5 the most important products.
Vendor managed items	Company started to research possibility to manage importers warehouse for products that they store. Within this master's thesis research did not done.

As can see the main focus in forecasting moved for information sharing and reducing the bullwhip effect in supply chain. Company noted that in this way the information and forecasting are always fact information that can be used in decision making processes more likely than time series data.

8.2 Evaluation of results and discussion

From a practical point of view the main objective of this project was to create a demand forecasting process and implement it in action. Also it was clear that tools to support for that process had to be created. At this time of writing this thesis project is started in chosen countries and for two products. Also two S&OP meeting have been held in company and participants knows each sector to manage in S&OP process.

Research question one asked different kind of processes that can be found in literature for demand management and forecasting. Literature analysis tried to answer to this question and main focus was to try found processes that were suitable for case company in their challenges.

Literature were full of different kind of time series analysis and forecasting with past demand numbers. Exponential smoothing could be one tool in forecasting but it is not suitable for short time purchasing and production planning processes. The main problem within this study were literature focusing on time series methods and for this study the main objective was to find process solutions.

There are design choices related to forecasting process that have to be noted in organizational level and effects directly to the end result. For example roles and responsibilities have to be decided when implementing new forecasting process. In this case the hardest thing was finding and motivating people that will gather and analyze information about demand changings.

The results of this study can be divided in three different parts. First there were analysis of different kind of demand management processes and what needs to be noted when creating sales forecasting process. Also in first part of study was framework for things to be noted released.

Working in company and interviews with key people made very clear that purchasing manager and thus inventory level and purchasing would be the biggest target that would take advantage about demand forecasting practices. Although in this point of project updated forecast will not import in ERP-system, it gives view about MRP items warehouse situation: do purchaser have to rise up warehouse levels or rise down cause of poor demand.

Company does business as make to order production model and order book is typically full only for 1-3 weeks ahead. Now production planner knows 1-3 months

ahead how many products importers will order. That gives company predictability for production and possibility to accept more orders in earlier stage of planning month.

Another big step ahead was that purchaser have visibility in 1-3 months ahead. Components in case company have normal delivery time from 1 month to 4 month, so visibility for 3 months ahead gives possibility to optimize inventory levels. During this thesis inventory level for specific components got lover so demand management is center in evolving operational capability.

The biggest change for company was S&OP process implementation. And as said the biggest evolvement was not calculations for total demand; these were maybe the simplest part of S&OP implementation. The biggest challenge was and is to make people work properly for S&OP process and to manage it. That need manager for process who were defined during this thesis.

Vendor managed items was discussed several times in company and implementing it as soon as possibly in action. It was noted that for 2-3 customers it would be possible to implement VMI immediately and that would bring possibilities to purchasing and production manage better demand. Unfortunately within this thesis company had no time to focus on developing VMI model so implementing it would be possible in future but not now.

9 CONCLUSIONS

Literature and case examples gives a lot of techniques for guides and methods for forecasting practices: time series forecasting and for example exponential smoothing are typical ways to forecast demand. But one missing link was finding solutions in designing demand management processes and how to handle this kind of management operations in organization. Also frameworks in choosing suitable methods for forecasting is found but there's no literature on process models and how to manage these operations in action. In this study was found how to manage demand with sales and operations process and what kind of sub-processes is needed that S&OP would work. That includes information sharing and total demand calculations for S&OP meeting.

In the empirical part of this study was three main parts found for development. First the new model for demand management was found and that model is S&OP process. That was one the most popular process in literature and that brings together all operative parts of organization to create estimate about future demand and using that data. Second founding was the information sharing with customers in two ways. First, customers share monthly their warehouse data and estimate their own demand in 1-2 month level. With that information company can calculate own estimate about future demand and make purchasing and production planning with that information.

Third there were two parts handled in theory part but implementing passed in future. Vendor managed items would bring operational effectiveness for company but during this study implementing this kind of massive changing let for future. Also different kind of time series forecasting models let for future implementing because of lack of time and resources. It was noted that creating process and using existing information is the first and most important thing in this point of study.

There were some limitations noted during this study. First and biggest limitation was that this study was the case study focusing on one companys challenges and

future needs. Also because of medium size of company it was hard to find exactly same cases from literature. So solutions found from literature was almost all meant for bigger sized organizations with a lot of resources available.

In future it would be necessary for small and medium enterprises that research would focus on process design and how with a lack of resources company would benefit the most productive results. That would need case researches in company and analysis made from those results.

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S&OP coordination mechanism	Description	Objective	Constructs
S&OP organization	Formal organizational S&OP structure	To define the organizations actors and organizational units involved in S&OP	Decision making authorities, configuration for centralization/decentralization and roles and responsibilities
S&OP process	Formal and standardized process for conducting S&OP	To define how different sub-plans are created and communicated in S&OP	Decision making practices, collaborative planning involving both internal and external actors
S&OP tools and data	Processes and tools for capturing, sharing, storing and refining data needed for S&OP decision making	To provide S&OP with good quality data according to the needs and requirements, and to support S&OP with purposeful IT tools	Input information, methods for processing and storing information, output information and IT tools to support S&OP
Performance management	Measurement and optimization of firm performance	To ensure reaching the set business targets	Practices for managing financial performance, operations performance, and process performance, target setting and follow-up process
Strategic alignment	S&OP role as a link between company strategy and operational planning, and reinforcing the reaching of the company's strategic business targets	To reach the company's strategic goals the role of implementing strategy in operations	Linking company's strategic targets to operational planning and reinforcing the reaching of the company's strategic business targets through creation of new products, services, customers and business models
S&OP culture and leadership	Culture and leadership required to support and enhance S&OP	To create leadership and organizational culture favorable for successful S&OP implementation	The organization's culture, such as commitment, trust, top management setting an example, collaborative manner, empowerment; and practices that facilitate and advance formal planning, such as communication, training and staff development

Attachment 1. Description of S&OP coordination mechanisms.