SAVONIA

Development of Forecasting at Franke Finland Oy

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Master's Thesis

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Master's Degree

SAVONIA UNIVERSITY OF APPLIED SCIENCES **THESIS**
Abstract

Field of Study Engineering and Technology			
Degree Programme Master's Degree Programme in Industrial Management			
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Title of Thesis Development of Forecasting at Franke Finland Oy			
Date	21.5.2012	Pages/Appendices	34
Supervisor(s) Jarmo Pyysalo			
Client Organisation/Partners Franke Finland Oy			

Abstract

Detailed planning is essential for managers that they can achieve good operations performance. An accurate forecast is a key input for these different plans, for example inventory and resource planning. Also it is very important that company's different functions do not have individual plans, but one common plan in order to achieve company's financial goals and meet customers' needs.

The aim of this thesis was development of the forecasting process at Franke Finland. Franke Finland provides kitchen system products for households, and washroom and sanitary system products for the public and semi-public sectors. Current forecasting was on common level and based on only Euros and therefore did not give enough information for the managers to make their decisions.

The first part of the thesis was to compare different forecasting methods and find out the best one with best accuracy for Franke Finland. The chosen method was implemented to the product level. The other goal was to find out a process to communicate the results of the forecast and to improve the co-operation of different functions better than before.

Development of forecasting system processes and management of logistics were the writer's daily work. His Master of Engineering studies gave extra long term inputs to study and improve these processes for the company.

As a result of the thesis a new improved forecasting system has been implemented into company, and in order to achieve strategic fit sales and operations planning (S&OP) process has been also taken place in the company. These solutions have been evaluated successfully and they provide a good base to develop the organization in the future.

Keywords

Forecast, demand planning, S&OP process

CONTENTS

1 INTRODUCTION

Forecast is a detailed definition of the future statement. It should tell the company what products will be sold, how much and when. Planning the future is one of the most important tasks of the managers and without accurate forecasts it is very difficult for managers to make their decisions on solid base. A good forecast is needed in order to plan inventory and operational resources. Note also that operation does not mean only production; it means all operating activities like production, logistics, supply chain and procurement. Therefore it can be said that a good forecast is necessary to run operations smoothly and effectively.

Sales and Operations Planning (S&OP) is also important for the companies so they may achieve good business performance. A S&OP-process eliminates the situations where finance, sales and operations have their own plans while they develop independently. Advanced S&OP-process can solve many challenges beforehand and at the end of the day, all functions should have a common plan how to satisfy customers' needs.

The aim of this thesis was the development of Franke Finland Oy's forecasting process. Current forecasting was on common level, and based on Euros and did not give enough information for the managers to make their decisions. On solid base, the goal of this thesis was to create and implement a product level forecast based on pieces with the standard process.

The first part of the thesis was to compare different forecasting techniques and select the technique which gave the best accuracy. When the right technique was found the forecast application was implemented to the product level.

In addition to the forecast process the goal of the thesis was also to improve co-operation between company's different functions. The development of these processes was writer's daily work and helped his job as a Logistics Manager. Also the company had a real need to improve these processes. The improvement work was aimed at improving some of the financial figures in terms of the stock turnover and adds value to the customers in terms of a better service level and shorter lead times.

The focus of the thesis was in Franke Finland's kitchen and washroom system activities. Franke Finland sells also stainless steel parts to the Franke Medical, but this is

other business, and therefore these Franke Finland's medical activities are out of scope of this thesis. The methods used in this study were interviews of different managers and much information was based on the writer's own experiences.

1.1 Franke Artemis Group

The industrial activities of Franke Artemis Group include Franke Kitchen Systems Group and the Franke Commercial Systems Group. The Franke Kitchen Systems Group is the world-leading provider of kitchen systems with products like sinks, extractor hoods, fittings, hobs, ovens etc. The Franke Commercial Systems Group includes Franke Foodservice Systems (kitchen systems and services for quick-service restaurants), Franke Washroom Systems (washroom and sanitary systems in the public and semi-public sectors), Franke Coffee Systems with a wide range of super automatic, professional and semi-professional coffee machines, Franke Beverage Systems (beverage containers) and industrial engineering. Furthermore, the Franke Artemis Group manages an extensive real estate portfolio (Franke Artemis Real Estate Group) in Switzerland and abroad and holds various strategic participations in Swiss listed companies (Franke Artemis Asset Management Group). The Franke Artemis Group employs around 10,500 employees worldwide and is established in over 40 countries with about 70 subsidiaries. The Franke Artemis Group generated consolidated sales of EUR 2.0 billion in 2011. (Franke Artemis Group, 2012)

1.2 Franke Finland Oy

Franke Finland has been part of the Franke Group since 1994. The factory was built in 1970 and is located in Naarajärvi. The product range includes domestic sinks, sink tops, kitchen hoods, kitchenette units, bathroom equipment, sanitary. Franke Finland has three different cost centers and these operate on different business areas. These business areas are KS Kitchen System Solutions, WS Washroom System solution and ME Medical Equipment. Medical equipment business is to sell stainless steel components to the Franke Medical. Franke Finland employs 75 persons and the turnover was EUR 14.5 million in 2011. (Franke Washroom Systems, 2012)

Medical equipment separated from the Franke Finland Oy in January 2011 and since then it has been a separate company Franke Medical Oy. Franke Medical employs 40 persons and turnover was EUR 6.0 million in 2011. Franke Medical products are automatic washer-thermal disinfectors for healthcare and laboratory applications.

2 INTEGRATED OPERATIONS PLANNING

2.1 Supply Chain Planning

The supply chain planning system integrates information and coordinates overall logistics and supply chain decisions with the help of supportive information system. Supply chain planning considers all functions and processes of the firm at same time. There are three basic elements for effective planning which are supply chain visibility, simultaneous resource consideration and resource utilization. (Bowersox, Closs & Cooper p. 133)

Supply chain visibility means the visibility of locations, inventory levels and resources. Visibility is required that all these topics can be evaluated and managed effectively. Supply chain is very sensitive for interruptions and therefore supply chain visibility needs a very strong management of resources and activity plans. Strong management helps to minimize potential problems or prevent these completely all. Limited visibility causes uncertainty for product availability e.g. if the products inventory replenishment time is not known. Lack of certainty leads example over inventory levels. (Bowersox, Closs & Cooper p. 133)

Simultaneous resource consideration regards combined supply chain demand, capacity, material requirements, and constraints. The supply chain structure reflects customer demand for product quantity, delivery, timing, and location. Even if some of these customer requirements are not negotiable, logistics has to perform according to the agreed requirements and standards. The barriers to meet customers' needs are materials, production, storage, and transportation capacity. Many times planning has been done independently where capacity restriction occurs. For example the very first plan is the review of production capacity restriction. After that the material and sourcing restriction. One independent step has been reviewed storage and transportation restrictions are reviewed. These processes might be different but if decisions have been made individually and at different times this leads for partial and worse utilization of planning and capacity. A good supply chain level performance requires simultaneous resource consideration. That means that all needed capacity restrictions are identified at the same time and many times some compromises are done. Sometimes that leads to a higher cost of some functions, like manufacturing or storage, but the company's total costs are lower. Therefore the company has to compare and evaluate its' plans at the same time and make compromises if these are needed. That

leads to an overall better supply chain performance. (Bowersox, Closs & Cooper p. 133-134)

Resource utilization is one of the key activities of functional management. Production, distribution facilities and equipment, transportation equipment, and inventories consume a significant share of a typical firm's fixed and working assets. Many logistics and supply chain decisions influence these resources mentioned above. For example, production manager is focused on minimizing production resources and that leads to bigger lot sizes with minimum set ups. That leads to a bigger finished inventory which leads to increased working capital requirements as well as space requirements. Increasing production also requires longer period and more accurate forecasts. Coordinated approach to take care of customers' needs and minimize combined supply chain resources is a critical character of the firms. (Bowersox, Closs & Cooper p. 134)

2.2 Demand Management

Demand management is an intention to understand and estimate level of the markets demand, and with the help of this information needed actions are taken that optimal supply chain and operation performance are achieved. When estimates on future demand are made, the sales forecast has taken an essential role. The final goal of the demand management is to create value to the end customers. The point when companies start to improve demand management they meet many challenges. One is lack of the coordination between different functions. Sometimes focus is also too much on forecast of demand but actions and plans based on forecast are forgotten. Demand information is also used too much for tactical and operational purposes rather than for strategic purposes. Demand information should be used to create different scenarios of the future. The emphasis should be on relationships between the demand scenario and product supply alternative. The finally level of the demand and availability meets each others. (Coyle, Bardi, Langley, p.77-79); (Murphy, Wood, p.130)

2.3 Supply Chain Planning Applications

2.3.1 Demand Planning

The target of the Supply Chain is to satisfy customers' demand. Customer's demand is not only the demand that is known and the orders received. Also customers' future intentions to buy products have to be taken into account. When the buying decision is only level of the intention, any fact is not available. Many decisions in the supply chain are made before customer's demands are known. For example, decision of replenishment for production quantities for make-to-stock products has to be made before the customers' orders arrive. Also raw material and components have typically long lead times and these are needed for the finished products. Without any exact information, these decisions are based on forecast customer demand. That forecast process is called demand planning. (Stadtler, Kilger, p. 134)

Product versions and models are increasing all the time and products' life cycles are decreasing at the same time. That means requirements of the inventory increase as well, like inventory accuracy and flexibility. Demand management system tries to offer solutions to these requirements. Demand management prepares a forecast and that forecast steers supply chain proactively. The forecasts are based on monthly, weekly, or daily demand and that defines production and inventory requirements. Demand management process is based on history information with some other information of the future which could be sales activity, promotional plans, price changes, or new products. Effective demand management process creates a single forecast for each item and facility. The demand management system is the information component of sales and operations planning (S&OP) process which develops a marketing plan. A base forecast is a starting point of the demand management system. It contains also topics like product life cycle, distribution channels, pricing and promotional tactics, and product mix variations. The demand management system also generates a detailed logistics plan with a unique forecast for each warehouse and products. (Bowersox, Closs & Cooper p. 134-135)

2.3.2 Production Planning

Demand management gives rate of requirements for production planning. These requirements define what products are needed and when. With the help of this information production planning produces a manufacturing plan. As all products are not

make-to-stock products and trend is towards make-to-order (MTO) and assemble-to-order (ATO) product, these manufacturing types are not always possible because of production technology, capacity, or resource constraints. There are these kind of occurs like facility, equipment, and labor availability. The goal of production planning is to satisfy a requirement which means correct products at the right time. This has to be done at the minimum production cost and minimum inventory. (Bowersox, Closs & Cooper p. 135)

2.3.3 Logistics Planning

The responsibility of logistics planning is to coordinate transportation, warehousing, and inventory. Many times purchasing and finished goods try to optimize their transportation costs individually. Purchasing minimizes the cost of raw materials with suppliers and inbound carriers. Logistics minimize the cost of finished goods of customers and outbound carriers. Sometimes there is also a third part that is international transport. This kind of individual improvements approach leads to limited information sharing and unnecessary transportation costs. Logistics planning integrates movement demand, vehicle availability, and tries to minimize freight expenses. Logistics planning also analyzes the best choice on how shipments can be shifted between transportation companies and generates information for the carriers that they can get better utilize assets. Logistics planning is essential for companies so that they can use their resources effectively. Lack of planning leads in poor utilization of production, storage, and transportation capacity. Effective planning is a combination of information system to provide data and managers to make decisions. (Bowersox, Closs & Cooper p. 135-136)

3 SALES AND OPERATIONS PLANNING (S&OP)

When demand goes up and down, the managing value chain needs more than only a good demand forecast. Demand is the first half of the equation and other half is supply. The firms need to plan how they supply the resources they need, like work-force, materials, inventories, Euros, and productions equipment capacity. The process of making sure that demand and supply are in balance is called sales and operations planning (S&OP). Sometimes it is also called aggregate planning. The sales and operations planning is projected for several time periods, for example months, into the future. (Krajewski, Ritzman & Malhotra p. 568)

S&OP process has become increasingly necessary for new swift and effective the supply chains. The S&OP process guarantees coordinated planning in order to match customers' requirements and also to make sure that companies do not have any constraints of resources to meet these customers' expectations. Very often firms have independently developed separate financial, sales, and operations plans. First finance develops the revenue plan to meet the requirements of the owners. Then sales develop marketing plans to meet the revenue targets. Marketing plan contains topics like product innovations, pricing, and promotion plans. After that, supply chain operations develop materials, manufacturing, and logistics plans to satisfy customer demands. Normally some conflicts occur and these are shown in figure 1. Sales would like to sell a lot of products with many variations and short lead times. That is reasonable when they try to maximize revenue and satisfy customer's needs. Supply chain objectives are sometimes opposite compared to sales. They would like to keep product variations and production changeovers on the minimum level. Economy of scale is a topic, supply chain operations try to achieve. This advantage can be used in the area of manufacturing, transportation and handling. Because sales and operations have very different objectives, there is a lot of potential for conflicts. Therefore it is very important to consider compromises and common plans, which means developing forecast, product introduction, marketing and operating plans. (Bowersox, Closs & Cooper p. 136)

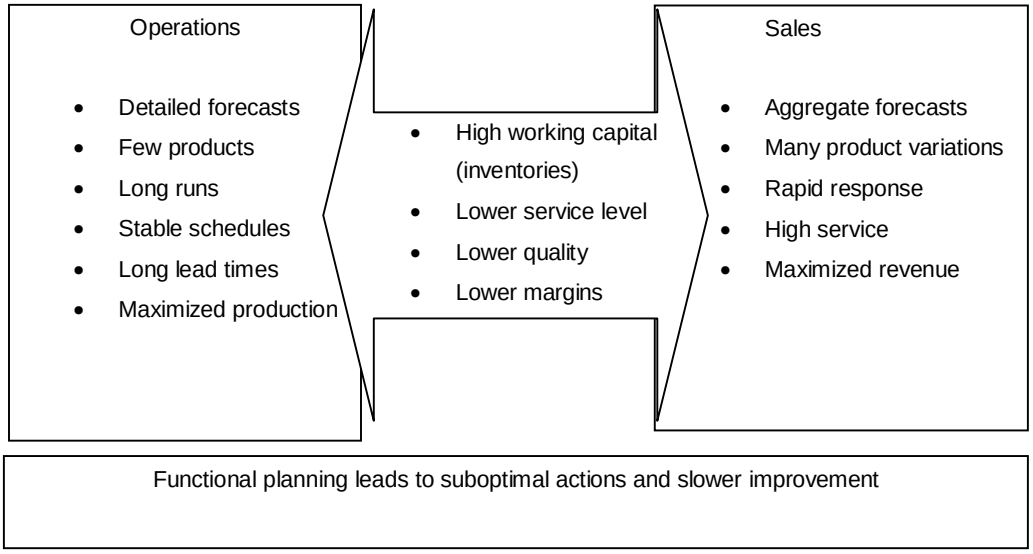

FIGURE 1. Planning process conflicts (Modified from Bowersox, Closs & Cooper p. 136)

S&OP is not only information technology consideration. It is a combination of information system and organizational process. It includes financial, marketing, and supply chain elements. It is a clear process with clear responsibilities, where all of these functions are developed together with common plans. Effective S&OP is a mix of the process and technology with a collaborative organization. Figure 2 demonstrates the S&OP process. The first component of the S&OP process is a business plan. Under the business plan topics are financial forecast and corresponding budget. This plan drives activities, volumes, and resources requirements. After the business plan comes sales plan and its' purpose is to develop an unconstrained marketing plan. Unconstrained marketing plan defines the maximum sales and profitability level. That level could be achieved if there are no supply chain operating constraints. As figure 2 shows, unconstrained marketing plan handles information like orders on hand, current customers, new customers, competition, selling margins, new product potential, pricing, and overall maximum sales if any constraints do not occur. The last part of the S&OP process is a resource plan. That develops the firm's internal external partners' resource constraints. Not every firm uses the S&OP process, but all firms develop their business, marketing and operational plans. When S&OP process does not take place, there are no feedback loops. Without the S&OP process it is very likely that conflicts will arise. As shown in figure 1, these conflicts lead to unsatisfied customer needs and poor resource utilization. It is important to note that the arrows in

figure 2 are two-way. That means that an effective S&OP process needs two-way information flow and collaboration. Firms are increasingly interested in formal and collaborative S&OP process with which they can meet their customers' requirements and be aware of their constraints. (Bowersox, Closs & Cooper p. 137)

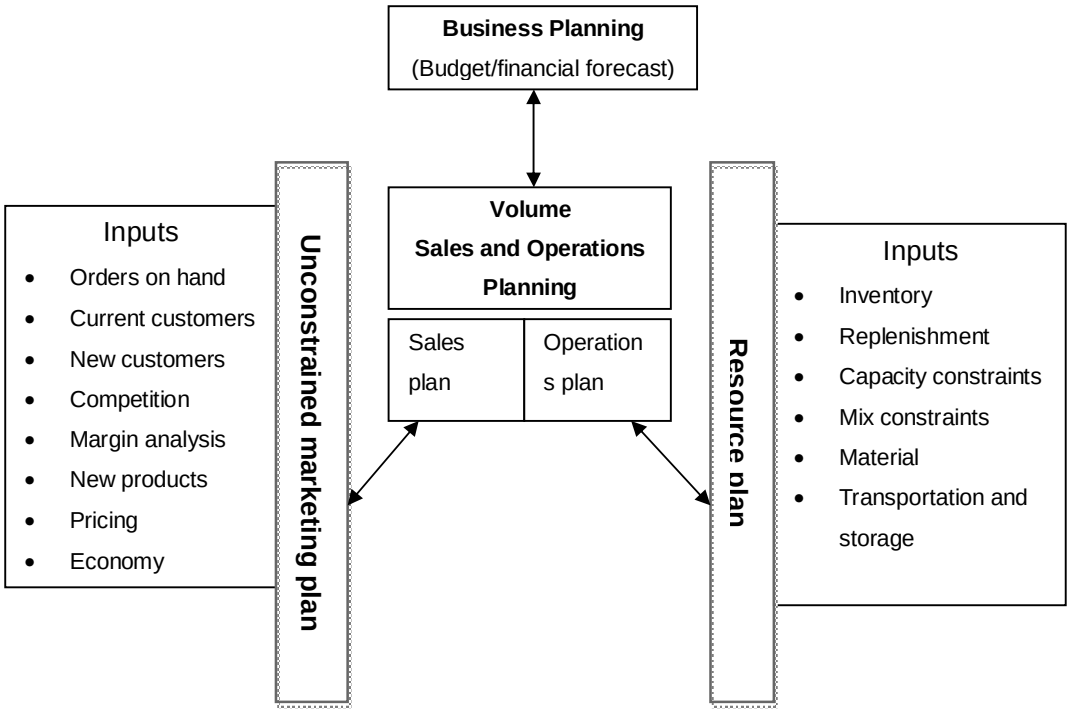

FIGURE 2. S&OP process (Modified from Bowersox, Closs & Cooper p. 137)

It is important to understand the S&OP-process organizational positioning. S&OP-process is a cross-functional process and not a specific job. A lot of work is needed that S&OP-process works successfully. The S&OP-process has to be gathered on a regular basis and also monitored. At least a new or updated plan is necessary for each period. Successful S&OP needs detailed work and therefore senior management might nominate an organizational unit to take care of continuous planning. Eventually the responsibility of the S&OP-process should be cross organizational joint responsibility. All key functional leadership from all operating areas should be committed and be responsible so that good performance of the S&OP-process would be achieved. In additional, general management level involvement on regular basis is also important. (Bowersox, Closs & Cooper p. 138)

4 FORECASTING

One of the critical drivers of an effective supply chain is customer demand planning which accurate forecasting is based on. Demand planning is a business planning process which enables sales teams to develop demand forecasts as input to the other planning processes. These other planning processes are, for example, service planning, production and inventory planning, and revenue planning. (Krajewski, Ritzman & Malhotra p. 521)

Forecasts provide information of future demand and this information is the base for operations management's future decisions. A forecast is absolutely very important and it is the key information for operations management. The target for forecasts is that supply and demand match. A forecast gives information on how much capacity or supply will be needed to satisfy demand. Production planning needs to know how much capacity, workforce, and equipment are needed. Purchasing needs to know how much to order from suppliers and supply chain management makes inventory and transportation planning. Forecasts are used for two purposes. First is long-range planning. That determines the timeline of what kind of products and services will be sold and what kinds of facilities, equipment, location and so on are needed. Second purpose is short-range and middle-range planning. There are tasks like inventory and workforce levels planning, purchasing and production planning. Nowadays forecasts are done using computers and there are mathematical models which are sometimes very sophisticated. Nevertheless, forecasting business is not high science. Basic skills like experience and judgment are still needed for successful forecasts. Also good luck and humility are needed as well, because even the best forecast models miss sometimes. Preparing the forecast is more on sales or marketing responsibility, than on operations, since they should know the customers side, and operations know the cost side. (Stevenson p. 72)

Demand forecasts are based on supply chain planning and there are push and pull processes. Push processes in the supply chain work according to expectations of the customers' demands and pull processes work as a response to customers' actual orders. Push process means that managers have to plan the level of activity like production, transportation and other activities, whereas, in a pull process managers have to plan the level of available capacity, but not the actual amount of production. In both cases, managers need demand forecasts first in order to make their decisions. (Chopra & Meindl p. 198)

4.1 Elements of a Good Forecast

In the next list there some elements are mentioned that a good forecast includes or managers should be aware of.

- The forecast should be implemented at the correct time. Actions after forecast need time, so forecast time horizon should be right. For example production capacity or inventory levels cannot change immediately.
- Forecasts are always inaccurate and therefore forecast's error content is important. Controlling is a base for comparing an alternative method.
- The forecast should be reliable and consistent enough. Users should trust the forecast, but still be aware that some errors might occur.
- The forecast should be shown in the right units. Production planners and purchasing need to know how many units are needed. Financial department needs to know how many Euros will be needed. Users and purpose of the demand forecast should define meaningful units.
- The forecast should be written in the right format. That helps users to use the same information and only this way errors can be measured after actual results.
- The forecasting technique should be easy to understand. Users should have confidence in the forecasting technique and they should understand how it works and what limitations there are. That is the reason why the simplest techniques are often the most popular.
- Benefits of forecasting should be bigger ones than the costs.
- Short term forecasts are more accurate than long term and must find out the right time period.
- Distortion is greater when the supply chain sets longer. One reason for that is the bullwhip effect. (Stevenson p.74) ; (Chopra & Meindl p. 199)

4.2 Basic Steps in the Forecasting Process

There are six basic steps to be followed to forecasting in the process:

1. Understand the purpose of the forecast. How and when it will be used. Information of forecasts is used for different plans and decisions, so the different users should be defined.

2. Determine the time horizon of the forecast. Appropriate time horizon should be defined. Normally when the time line increases, the accuracy decreases at the same time.
3. Determine forecast technique from among the different methods.
4. Obtain, clean and analyze data. Sometimes data has to be cleaned before use. If incorrect data is analyzed, it might lead to wrong actions.
5. Prepare a forecast.
6. Follow up forecast. Forecast accuracy should be measured and accuracy should be evaluated. If accuracy is not satisfactory, then study of the reasons is needed. Reasons might be invalid data, a wrong method and so on. After the reasons are solved, a new revised forecast is made. (Stevenson p.74) ; (Chopra & Meindl p. 201-203)

It is good to keep in mind also that some other action might be needed as well. For example if demand is less or more than forecast. In the case that demand is much less than the forecast, actions like price reduction or promotion may be needed. In the case that demand is higher than demand, more capacity and output are needed. (Stevenson p.74)

4.3 Forecasting Techniques

Forecasting techniques can be classified as qualitative and quantitative (Figure 3) and they are divided into four categories which are qualitative, time series, causal, and simulation. (Sabri & Shaikh p. 158); (Chopra & Meindl p. 200)

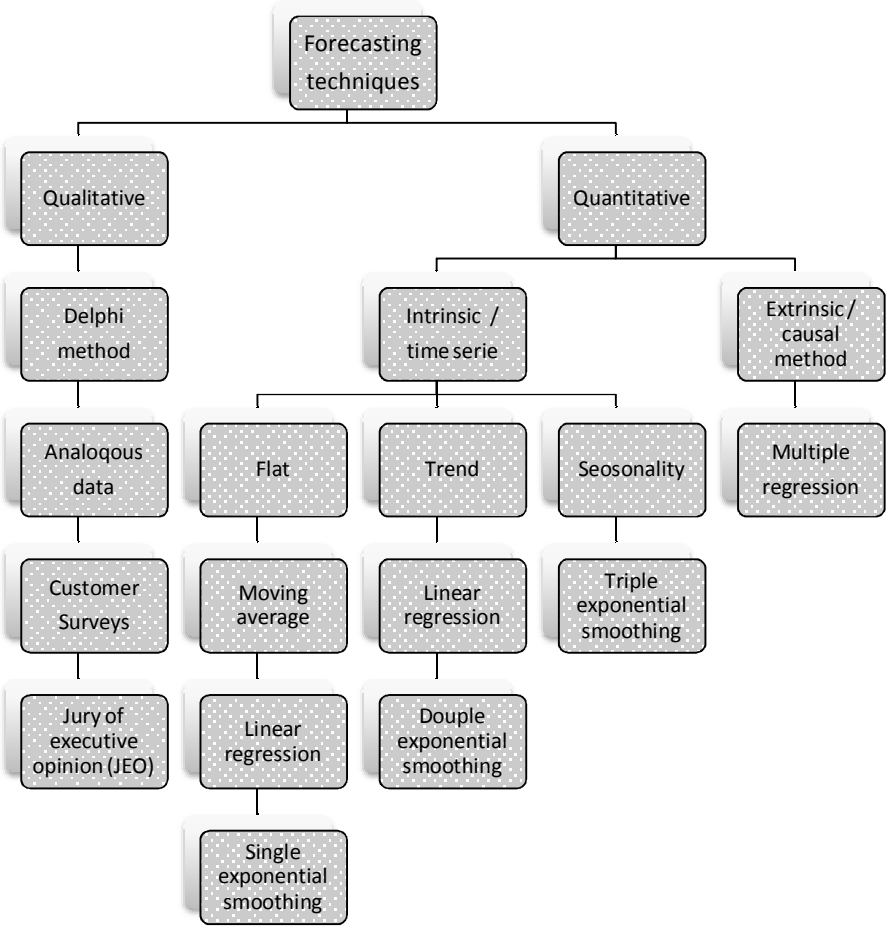

FIGURE 3. Forecasting techniques (Modified from Sabri & Shaikh p. 158)

4.3.1 Qualitative Forecasting Methods

Qualitative techniques need expert human judgment. Disadvantage of these methods is that they are expensive and time consuming lot. Sometimes historical data is not available, for example on new products. In these cases qualitative techniques are the most appropriate ones. Qualitative methods are not appropriate techniques for detailed product level forecasts, because these are so time consuming. Surveys, panels and consensus meetings are used to assist in these forecasts. (Bowersox, Closs & Cooper p. 147)

Delphi method is a consensus of the panel of the experts. When using analogous data method, then similar products are compared. Method of the customer surveys means use of test marketing, focus groups and panels. Jury of executive opinion contains group discussions. (Sabri & Shaikh p. 158)

4.3.2 Time Series Forecasting Methods

Moving Average

Moving average is the average of the most recent periods. The number of the previous periods that are used can be chosen freely. Commonly used numbers of periods are 1,2,3,4 or 12. Every time when a new period becomes available, it replaces the oldest one. Moving average is evaluated as follows:

$$F_t = (D_t + D_{t-1} + \ldots + D_{t-N+1}) / N \quad (1)$$

Where F_t is forecast for time period t. D is demand for the chosen time period and N is total number of periods. For example, the last demand of the three periods between January and March was 100, 80, and 120. Forecast for the April is

F_{April} = (100 + 80 + 120) / 3 = 100

Moving average is very easy to use. There are also limitations to use this model, like that more periods are used, the more historical data has to be stored. (Bowersox, Closs & Cooper p. 147-148) (Chopra & Meindl p. 208-209)

Weighted Moving Average

A weighted moving average is very similar as simple moving average, but there it is possible to use different weights for different periods. For example, used weights for last four periods are 0.4, 0.3, 0.2, and 0.1 where the heaviest weight 0.4 is the latest period's weight. Note that total sum of the weight has to be 1.00. Users are free to choose what weight they use. Weighted moving average is evaluated as follows:

$$F_t = w_t (D_t) + w_{t-1}(D_{t-1}) + \ldots + w_{t-n}(D_{t-n}) \quad (2)$$

Where F_t is forecast for time period t. W_t is weight for the period t and W_{t-1} is weight for period t-1. D_t is demand for period t. For example, the demand of last four periods between January and April was 80, 80, 110 and 140. Forecast for the May is

F_{May} = 0.1(80) + 0.2(80) + 0.3(110) + 0.4(140) = 113

The advantage of weighted moving average compared to the simple moving average is that the demand of the latest period has taken a major role. The challenge is to find out the most suitable weights to be use. (Stevenson p.83)

Simple Exponential Smoothing

Exponential smoothing is also weighted average method but it is more sophisticated. Still it is quite easy to use and understand. In the calculation the last period's forecast and the last period's actual demand is used. In other words the last periods forecast error is used. These two facts are adjusted by alpha factor. Simple exponential smoothing is evaluated as follows:

$$F_t = \alpha\,(D_{t-1}) + (1-\alpha)F_{t-1} \qquad (3)$$

Where F_t is forecast for time period t. F_{t-1} is the last period forecast. D_{t-1} is the last period actual demand and α is smoothing constant. Alpha should be between 0 and 1. It may be beneficial if this is looked also different way. The next evaluation gives exacting the same result, but it is visualized how this method is regarded as a forecast error. Simple exponential smoothing is evaluated in a little different way than before as follows:

$$F_t = F_{t-1} + \alpha\,(D_{t-1} - F_{t-1}) \qquad (4)$$

Where F_t is forecast for time period t. F_{t-1} is the last period forecast and D_{t-1} is the last period actual demand. α is smoothing constant. There$(D_{t-1} - F_{t-1})$ represents (last actual demand – last forecast) forecast error. This mathematical formula is shows better how forecast error is observed. For example, forecast for the most recent period February was 120 and actual demand of February was 100. It is assumed that alpha factor is 0.1. Forecast for March is

F_{March} = (0.1) (100) + (1 – 0.1) (120) = 118. Same calculation in different way is
F_{March} = 120 + (0.1) (100 – 120) = 118

The advantage of the simple exponential smoothing is quite an easy calculation without long period historical data. As it was shown before, this calculation is used only in the most recent period's forecast and demand. Also smoothing constant can be changed very easily and that will be changed as a result of the forecast. When smoothing constant alpha factor is chosen, judgment and trial is needed. If very low alpha factor is used then forecast is almost simple moving average. If alpha factor is

high, then forecast is reacted very much for latest demand. (Bowersox, Closs & Cooper p. 148-149) (Stevenson p.83-85) (Chopra & Meindl p. 209-210)

Causal Method

In causal forecast, or it can be called regression forecast model also, it is used some value of the independent factor. Between this independent factor and demand there has to be a strong relationship. For example price can be correlated to the demand. This method works very well if this kind of factor has been found, but is not very common in the supply chain. If one of these kinds of factor is used, then it is simple regression. If there is more than one factors used, and then model is called multiple regression. Problem in the use of this model is to find out this kind of factor. (Bowersox, Closs & Cooper p. 149-150)

Douple Exponential Smoothing (Holt's Model)

The double exponential smoothing is also called Holt's Model. That is an exponential smoothing method but it is trend corrected. Trend means some upward or downward movement. For example time after product launch is time of the growth and many other forecast models would give too low a forecast. As single exponential smoothing is based on alpha factor, in double exponential smoothing are used two alpha factors alpha and beta. This method is used when demand has a trend but no seasonality. (Chopra & Meindl p. 211) (Sabri & Shaikh p. 161)

Triple Exponential Smoothing (Winter's Model)

This smoothing forecast method is more sophisticated and it is trend and seasonality corrected. That means one more smoothing constant is added to the Holt's Model, gamma, so there are three constant in use, alpha, beta, and gamma. Seasonality factors mean some short-terms factors like weather, holidays, etc. Usually there are annually repeating factors. (Chopra & Meindl p. 212) (Sabri & Shaikh p. 162)

4.4 Measures of the Forecast Error

A good forecasting technique should not include a random component. The random component is called forecast error. Every forecast gives some error, even the best one, but it is important to analyze these errors every time after the actual demand is known. Forecast may be every time too high and it is given positive error. Therefore

this overestimating has to be analyzed carefully and needed actions need to be taken. All action plans based on forecasts should take forecast errors into consideration also. If forecast errors increase more higher than historical error data, then the current forecast method should be reviewed again. It could be that the current forecast method is not workable anymore. Also the current forecast method cannot show under or overestimated forecasts all the time. (Chopra & Meindl p. 214)

In many forms safety stocks are one way prepare for forecast errors. High forecast errors lead to poor service level or/and high inventory levels. With low forecast error good service levels and low inventory levels can be achieved. (Sabri & Shaikh p. 162-163)

Forecast error E_t is calculated as follows:

$$E_t = F_t - D_t \quad (5)$$

Where F_t is forecast of the period and D_t is actual demand of the period. Managers should analyze and estimate forecast errors. As well as they should take errors consideration when they are making actions. For example if supplier lead time is three months, forecast error should be evaluated three months before demand is known. In the following some forecast error measurements are shown. One of these is MAD, mean absolute deviation. In the calculation of MAD, absolute deviation is needed and it is calculated as follows:

$$A_t = |E_t| \quad (6)$$

Mean absolute deviation is average of the absolute deviation of all periods and it is calculated as follows:

$$MAD_n = \frac{1}{n} \sum_{t=1}^{n} A_t \quad (7)$$

The mean absolute percentage error (MAPE) is also a useful method for error estimating. It is average absolute error, shown in percentage and is calculated as follows:

$$MAPE_n = \frac{\sum_{t=1}^{n} |\frac{E_t}{D_t}|100}{n} \quad (8)$$

Bias and tracking signal (TS) is shown if forecast is shown too high or too low all the time. Especially tracking signal shows very easily if the current forecast method does not work anymore. Bias is calculated as follows:

$$BIAS_n = \sum_{t=1}^{n} E_t \quad (9)$$

The bias should be around 0 and then the forecasts are not under or over estimated consistently. Tracking signal is calculated as follows:

$$TS_t = \frac{bias_t}{MAD_t} \quad (10)$$

The result of the TS should be between -6 and +6. If TS is outside of this range, then the forecast is over or under estimated. TS < -6 means too low a forecast and TS > 6 means too high a forecast. For example if demand start to grow, forecast may give too low forecasts and tracking signal starts to alert. (Chopra & Meindl p. 214-215)

5 FORECASTING AT FRANKE FINLAND

In this chapter we will go deeper to Franke Finland Oy's forecasting process and try to find needs of the different functions and possible improvements.

5.1 Current Forecasting Process

The turnover of different business areas is comprised of different production types. The productions types in Franke Finland are own fabrication (OF), buying out from other Franke companies (BOF), and buying out from third parties (BOT). Franke is a global corporation with more than 20 factories located around the world and every factory has its own strengths and its own products. Therefore it is one of the corporation's strengths that products are produced in the best country. The biggest changes of the shares are between production types of its own fabrication and buying out from other Franke companies, but it is for example very important to know beforehand where its own fabrication production is going. If it is increasing or decreasing it is necessary to know how much resources are needed for the coming months. It is also important to know and understand the structure of the business because different manufacturing types have different owners. For example the purchase department needs to get more detailed information of the buy out products, and production needs information of their own fabrication.

Franke Finland has forecast process in place in some level. Forecasting is done on a very rough level and the main purpose of it is to estimate total sales of the next three months based on Euros. It can be said that forecasting is done mainly to fulfill the financial purposes. Forecasting is done by Excel and database is open for different departments and different users that everybody is able to see the present state. Sales Managers are responsible for updating the forecasts. The forecasts are done using qualitative techniques which are mainly Sales Managers opinion.

5.2 Challenges in Forecasting

One of the challenges in Franke Finland was that forecasts were in a very common level and the measurement was only in Euros. The both main business areas had their own forecasts, which were split between different manufacturing types. The information of the forecasts for different departments like production planning and purchasing was still on common level, so at the end of the day they had to do their own

judgements anyway. Future forecast was only the indicator for them to known in which direction demand was changing. Inside of the production groups demand for some of the products might increase and for others decrease. This led very easily to either poor service level of the some products or overgrown inventory levels.

Actual sales were updated after each month and forecast error was therefore available. Forecasting was not frozen at any point of the month so updates of the forecast were allowed until end of the current month. Therefore forecast error was not shown error as of the first forecast, but it was shown error as on the last update forecast. Of course it was easier to update forecast during the month or even at the end of the month, but the problem was it was not possible to take necessary actions anymore in the area of the production or purchase.

Future forecasting should solve at least these problems that are mentioned above. Forecasting should be at the product level and it has to freeze enough early after updating and forecast error has to be measured against the first forecast.

6 DEVELOPMENT OF THE FORECASTING PROCESS AT FRANKE FINLAND

6.1 Comparing Different Forecasting Techniques

First of all, it had to be decided what forecasting technique will be used in the future. The first step was comparing different techniques between each other. The goal was to select the most appropriate technique that gives the best result on the terms of forecasting error. The comparison has been done using the demand of the year 2011 without July's demand, because factory was closed during summer holidays and therefore demand was out of line. The demand used for comparing techniques represented only some important product groups' demand. So it was not total demand of the company, because total demand figures can't be made public knowledge. At the first stage it was analyzed whether the demand contained any trend or seasonal factors. In future forecasting quantitative technique should be used when history data is available, because qualitative techniques are more opinions or judgements and rather some mathematical models should be used. Therefore it has to be one of the flat techniques as illustrated in figure 3. Comparing was done so that only flat techniques have been compared between each other. In the next part of the thesis, the results of the different techniques are shown.

Moving Average

The moving average was based on three periods. As results show in table 1 $MAPE_{11}$ was in quite a good level, in area of the Kitchen System, being 13 %. TS were also between ranges of ±6 in both business sides. In Washroom System the moving average gave a little worse result than Kitchen System. Also the highest TS was quite high, almost 5. In both business areas, two months were included when accuracy was very bad. The worst months give over 50 % errors. It should be noted, it was not possible that all necessary cleaning activities have been done. For example, there was a special campaign or special pricing for customers and that one of these was held in December. Also there were any additional sales force judgements which would give better results of the forecasts.

TABLE 1. Kitchen System forecast using three period moving average

Period t	Demand Dt	Level Lt	Forecast Ft	Error Et	Absolutely Error At	Mean Squared Error MSEt	MADt	% Error	MAPEt	TSt
1	2925									
2	4118									
3	4649									
4	3976	3 897								
5	4040	4 248	3 897	-143	143	20 354	143	4	4	-1,00
6	5254	4 222	4 248	-1 006	1 006	516 530	575	19	11	-2,00
7	4219	4 423	4 222	3	3	344 356	384	0	8	-2,99
8	4479	4 504	4 423	-56	56	259 042	302	1	6	-3,98
9	4156	4 651	4 504	348	348	231 501	311	8	6	-2,74
10	4107	4 285	4 651	544	544	242 179	350	13	8	-0,89
11	2981	4 247	4 285	1 304	1 304	450 375	486	44	13	2,04

TABLE 2. Washroom System forecast using three period moving average

Period t	Demand Dt	Level Lt	Forecast Ft	Error Et	Absolutely Error At	Mean Squared Error MSEt	MADt	% Error	MAPEt	TSt
1	3838									
2	3811									
3	5517									
4	4350	4 389								
5	2976	4 559	4 389	1 413	1 413	1 995 627	1 413	47	47	1,00
6	4857	4 281	4 559	-298	298	1 042 116	855	6	27	1,30
7	4823	4 061	4 281	-542	542	792 666	751	11	22	0,76
8	3436	4 219	4 061	625	625	692 155	719	18	21	1,67
9	3767	4 372	4 219	452	452	594 525	666	12	19	2,48
10	3962	4 009	4 372	410	410	523 454	623	10	18	3,31
11	2597	3 722	4 009	1 412	1 412	733 361	736	54	23	4,72

Weighted Moving Average

Weighted moving average was calculated, where the most recent value was given more weight. In this case, the most recent value weight was 0.4, the next most recent value weight was 0.3, the next weight was 0.2, and the next was 0.1. Total sum of the weights were 1.00. Interesting point was that KS side $MAPE_{11}$ was higher and WS side was smaller (table 3 and 4) if it is compared to the moving average method. Testing was done also by using different weight values, but these weights gave the best accuracy.

TABLE 3. Kitchen System forecast using weighted moving average

Period t	Demand Dt	Level Lt	Forecast Ft	Error Et	Absolutely Error At	Mean Squared Error MSEt	MADt	% Error	MAPEt	TSt
1	2925									
2	4118									
3	4649									
4	3976									
5	4040	4 101								
6	5254	4 150	4 101	-1 153	1 153	664 474	576	22	22	-2,00
7	4219	4 574	4 150	-69	69	444 551	407	2	12	-3,00
8	4479	4 469	4 574	95	95	335 655	329	2	9	-3,42
9	4156	4 512	4 469	313	313	288 168	326	8	8	-2,50
10	4107	4 375	4 512	405	405	267 491	339	10	9	-1,20
11	2981	4 207	4 375	1 394	1 394	507 003	490	47	15	2,01

TABLE 4. Washroom System forecast using weighted moving average

Period t	Demand Dt	Level Lt	Forecast Ft	Error Et	Absolutely Error At	Mean Squared Error MSEt	MADt	% Error	MAPEt	TSt
1	3838									
2	3811									
3	5517									
4	4350									
5	2976	4 541								
6	4857	3 980	4 541	-316	316	49 896	158	7	7	-2,00
7	4823	4 257	3 980	-843	843	270 203	386	17	12	-3,00
8	3436	4 417	4 257	821	821	371 286	495	24	16	-0,68
9	3767	4 090	4 417	650	650	381 399	526	17	16	0,59
10	3962	3 988	4 090	128	128	320 576	460	3	14	0,96
11	2597	3 884	3 988	1 391	1 391	551 151	593	54	20	3,09

Simple Exponential Smoothing

The next method was Simple Exponential Smoothing where α = 0.1. Alpha was chosen by comparing different alpha values and 0.1 gave the best accuracy. Level for the period 0 was average demand of the year before, so it was demand of the year 2010. As the results show in tables 5 and 6, $MAPE_{11}$ gave smaller error than average methods.

TABLE 5. Kitchen System forecast using simple exponential smoothing

Period t	Demand Dt	Level Lt	Forecast Ft	Error Et	Absolutely Error At	Mean Squared Error MSEt	MADt	% Error	MAPEt	TSt
0		4137								
1	2 925	4 016	4 137	1 212	1 212	1 468 944	1 212	41	41	1
2	4 118	4 026	4 016	-102	102	739 694	657	2	22	1,69
3	4 649	4 088	4 026	-623	623	622 498	646	13	19	0,75
4	3976	4 077	4 088	112	112	470 027	512	3	15	1,17
5	4040	4 073	4 077	37	37	376 297	417	1	12	1,52
6	5254	4 191	4 073	-1 181	1 181	545 892	545	22	14	-1,00
7	4219	4 194	4 191	-28	28	468 016	471	1	12	-1,22
8	4479	4 223	4 194	-285	285	419 653	447	6	11	-1,91
9	4156	4 216	4 223	67	67	373 519	405	2	10	-1,95
10	4107	4 205	4 216	109	109	337 355	376	3	9	-1,81
11	2981	4 083	4 205	1 224	1 224	442 909	453	41	12	1,20

TABLE 6. Washroom System forecast using simple exponential smoothing

Period t	Demand Dt	Level Lt	Forecast Ft	Error Et	Absolutely Error At	Mean Squared Error MSEt	MADt	% Error	MAPEt	TSt
0		3 994								
1	3 838	3 978	3 994	156	156	24 336	156	4	4	1,00
2	3 811	3 962	3 978	167	167	26 179	162	4	4	2,00
3	5 517	4 117	3 962	-1 555	1 555	823 814	626	28	12	-1,97
4	4 350	4 140	4 117	-233	233	631 410	528	5	11	-2,77
5	2 976	4 024	4 140	1 164	1 164	776 328	655	39	16	-0,46
6	4 857	4 107	4 024	-833	833	762 581	685	17	16	-1,65
7	4 823	4 179	4 107	-716	716	726 811	689	15	16	-2,68
8	3 436	4 105	4 179	743	743	704 946	696	22	17	-1,59
9	3 767	4 071	4 105	338	338	639 282	656	9	16	-1,17
10	3 962	4 060	4 071	109	109	576 539	601	3	15	-1,10
11	2 597	3 914	4 060	1 463	1 463	718 694	680	56	18	1,18

Error Estimates for Forecasting

After testing of the all appropriate forecast techniques the results are shown in table 7. In this case, the biggest weight was value of the MAPE, when the best method was chosen. In the area of both business sides, Kitchen and Washroom, the simple exponential smoothing gave smaller MAPE error and therefore best results. Based on the information of the error, simple exponential smoothing was the best forecast technique at Franke Finland. There were couple of months where error % was very high, but the number could be decreased with judgement of the sales force. For example,

lower demand of the period 11 was known beforehand, but adjustments were not used.

TABLE 7. Error estimates for Franke Finland forecasting

Forecasting Method in Kitchen System	MAD	MAPE (%)	TS Range
Three-period moving average	486	13	-3,98 to 2,04
Weighted moving average	490	15	-3,42 to 2,01
Simple exponential smoothing	453	**12**	-2,76 to 1,54
Forecasting Method in Washroom System	MAD	MAPE (%)	TS Range
Three-period moving average	736	23	0,76 to 4,72
Weighted moving average	593	20	-3,00 to 3,09
Simple exponential smoothing	680	**18**	-2,77 to 2,00

6.2 Product Level Forecasting

As it has been shown in the previous chapter, simple exponential smoothing gave the best forecast accuracy. The other target was to get more detailed forecasts. Solution for that was to implement product level forecasting using simple exponential smoothing. Also error tracking should be continuous. Every month when a new forecast is published, the previous month forecast is compared to the actual demand (Table 8). The main error values are error-% of the individual products and MAPE. Error % is calculated only if actual demand is more than 20 pieces. There should be limit on the product level, because sometimes consumption might be very low. For example new products or phase out products. As it is shown below (Table 8) error % is not calculated for example for products e.g. 4. If error % was calculated also for products e.g. 4 it was given 50 % error. That would increase the value of MAPE to 35.6. That means only 1 piece forecast error would increase the total MAPE 5 % and therefore there should be a limit for low demand products. Forecast was shown in pieces and Euros. Euros were calculated using the average sales price of the three last months and multiplied forecast pieces. There is also a place where forecast adjustments can be done. Many times forecasts have to be adjusted manually. For example, a sales department puts extra effort for the marketing of some products. It is obvious that mathematical calculation cannot notice these situations. In addition to the forecast information, values of the stock coverage are beneficial information. That is value where current stock amount is divided year's consumption and is multiplied by 360. Stock coverage information is more for analyzing slow moving items and improving stock turnovers.

Also colors were used when it is easier noticed critical values. For example over 50 % forecast error should be analyzed more carefully to find out what is the reason behind high error. Also high stock coverage might be a consequence of too high lot sizes or suddenly dropped demand.

TABLE 8. Product level forecasting

Prod.	FC Prev. Month	Actual Demand Prev. Month	Avg price prev. three months	Stock value PCS	Year Consumption	Error E	Absolutely Error A	Error %	MAPE	FC Next Month PCS	FC Adjustment PCS	FC Next Month Total PCS	FC Next Month TEUR	Stock Coverage Days
α	0,1									0,1				
e.g. 1	100	110	500	600	1 100	-10	10	9,1	9,1	101		101	50,5	196
e.g. 2	200	300	500	600	2 200	-100	100	33,3	21,2	210		210	105,0	98
e.g. 3	300	600	500	600	3 300	-300	300	50,0	30,8	330	300	630	315,0	65
e.g. 4	1	2	500	1	11	-1	1		30,8	1		1	0,6	33
Total	601	1 012		1 801	6 611	-411	411		30,8	642		942	471,1	

As it is illustrated with colors, (Table 9) forecast error below 15 is satisfactory. When errors are more than 40 per cent this kind of forecasts may cause big problems for operations. Nowadays stock coverage has been analyzed quarterly in the company. It would be very beneficial to analyze this also on a monthly basis at least some level. For example phase out products where stock level is high and demand has decreased, sales may give additional discounts for these products. During this phase out period extra sales activities are easier to make but if this over inventory is noticed later on after coverage analysis, it might be useless to try to sell these products anymore. Green stock coverage means a coverage less than 90 days. In other terms 90 days stock coverage means stock turnover value of 12. In cases where stock coverage is more than 90 there might be over inventory at least when it is more than 180.

TABLE 9. Colour coding for visualize values

Color Code	Error %	Stock Coverage	Level
Green	< 15	< 90	Good
Yellow	15 - 40	90 - 180	Critical
Red	> 40	> 180	Bad

6.3 S&OP Process at Franke Finland

The current S&OP co-operation was not standard approach and problem was that sometimes different departments work too much separately. In general needed information was shared for departments who need that most. Many times there were also other important stakeholders who need that information also, but very easily they had to work without the same information. The focus of current S&OP co-operation was on the points where some actions were needed and problems were solved.

Many time problems occurred in cases when demand differed from the average. When demands of some products started to increase or decrease, the information was shown too late after some months and many times first actions were needed faster. The problem was also that judgments of the new demand level were done individually by some functions or departments, but it was not generally approved by all functions.

One challenging points was also the launch of new products. Sometimes forecasts of the new products were given by sales departments and sometimes sales or production did their own evaluation. In these cases also the error estimate was missed. It would be very beneficial to get feedback from the errors that would develop the process of the future. The opposite case was when products were at the end of the life time. In general demand started to decrease or stopped suddenly and this happened without any special actions. That led to an inventory without consumption and these products were obsolete without any value. In these cases also sales persons were without important information. It would be very important that they would have the needed information at the point when demand of the products starts to decrease. That is the point when they can take some actions like special discounts or special marketing.

These cases mentioned above show that the biggest problem is lack of information. The future approach should be a real planned process where all key persons are involved and everybody has the same information at the same time. Also the S&OP process is more planned when actions can be done beforehand together with all functions.

6.4 Summary of Forecasting at Franke Finland

Comparing of different forecast methods showed that simple exponential smoothing gave the best forecasting accuracy. Based on these results simple exponential smoothing method was implemented to the product level. Product level forecast was shown on a monthly base and it was shown in pieces and in Euros. At the same time when a new future forecast was published the previous month's forecast accuracy was reviewed. Probably the same method does not give the best accuracy for all product groups, but in this thesis comparing was not looked into in more detail. It should be noted that it is not possible that all necessary cleaning activities were done. For example, there was a special campaign or special pricing for customers. Also there were not any additional sales force judgements which gave worse results of the forecasts than it would be with judgements.

A new forecast should be published at the beginning of the month. That gives enough time for managers to do their actions based on the forecast. The forecast should be published not later than the fifth working day of the month. A proper place for forecast publishing is S&OP meeting. S&OP meeting should take place at the beginning of the month, where all necessary managers should take part in. At least there should be sales managers, production manager, purchasing manager, production planner and logistics manager. New forecast is possible to make after the first working day of the month. Between the preparing stage and the published forecast, sales managers should make their own adjustments because they have the best information from the market. Future plan focus would be short term period for example next three months.

7 CONCLUSION

Accurate forecasts are the base for managers' future plans and decisions. Need of accurate forecasts has been increasing all the time. Forecast should give information in the right units. Some managers need to know how many Euros will be sold, some others have to know how many pieces will be sold. The purpose of the forecast must be determined when the forecast process is planned and implemented.

S&OP process is needed to guarantee that a company has only one future plan. Many times without shared and communicated information, every function has they own individual plans. The S&OP process guarantees a coordinated plan how to match customers' requirements. Together these two processes, forecasting and S&OP, are essentially important in order to run operations smoothly and effectively.

The goal of this thesis was to develop and implement a more detailed forecast and improved information sharing between different functions. As a result of this study, forecasting at Franke Finland has been implemented to the product level using simple exponential smoothing model. Also Excel application has been implemented for all SKU's (Stock keeping units) and also make-to-order products. All products are not make-to-stock products, so there are also own product groups for make-to-order (MTO) products. In these MTO cases where inventory levels are not needed to plan, future capacity has to be planned. New forecast is published in S&OP meetings. At starting phase the biggest focus is on the coming next month but planning is done also short-term period for coming three months.

At first it is important to run the forecast process for short periods and get feedback from forecast accuracy. If forecast accuracy is not good enough in some products group, new comparing should be done. It was mentioned earlier, comparing has not been done for each product groups individually. For some product groups some other forecasting model may give better accuracy than simple exponential smoothing. Forecast errors can be evaluated with many different measurements. In the developed forecast application, only the most important measurements have been implemented. The purpose was to keep forecast application on a quite simple level and add additional measurements later. At least measurement of tracking signal TS, would be useful, that continuous over, or under estimation could been noticed.

Focus of the S&OP-process is on short term period. When forecasting and S&OP-process starts to run continuously, time horizon can be expanded to middle term period. In the future, long term period sales and operations planning with strategic point of view would be an advantage. The main purpose is to plan resources so that the products are available for customers when needed at the right time. In the future this process can be expanded to the financial purposes to meet some of the financial goals.

REFERENCES

Bowersox, D. & Closs, D. & Cooper, M. 2010. Supply Chain Logistics Management. McGraw-Hill.

Chopra, S. & Meindl, P. 2010. Supply Chain Management – Strategy, planning, and operation. Pearson Education.

Coyle, J. & Bardi, E. & Langley, J. 2003. The Management of Business Logistics: A Supply Chain Perspective. Thomson South-Western.

Franke Artemis Group 2012. Franke internet sites [reference made 2.5.2012]. Available at http://www.franke.com/frankegroup/main/en/home/about_us/franke_artemis_group.html

Franke Washroom System 2012. Franke internet sites [reference made 2.5.2012]. Available at http://www.franke.com/washroomsystems/main/en/home/about_us/companies/Franke_Finland.html

Krajewski, L. & Ritzman, L. & Malhotra, M. 2007. Operations Management - Processes and Value Chains. Pearson Education.

Murphy, P. & Wood, D. 2011. Contemporary Logistics. Pearson.

Sabri, E. & Shaikh, S. 2010. Lean and Agile Value Chain Management – A Guide to the Next Level of Improvement. J.Ross Publishing.

Stadtler, H. & Kilger, C. 2008. Supply Chain Management and Advanced Planning - Concepts, Models, Software, and Case Studies. Springer – Verlag.

Stevenson, W. 2009. Operations Management. McGraw-Hill.