Bachelor's thesis

Industrial Management Engineering

Purchasing

2015

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USE OF DEMAND FORECAST IN OPERATIONAL PURCHASING

– Case: Vaisala corporation component level forecast purchasing

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BACHELOR'S THESIS | ABSTRACT

TURKU UNIVERSITY OF APPLIED SCIENCES

Industrial Management Engineering | Purchasing

2015 | 62

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USE OF DEMAND FORECAST IN OPERATIONAL PURCHASING

This thesis is a case study of Vaisala, a Finnish technology company. Vaisala uses LEAN manufacturing models and assemble-to-order production strategy to better serve its customers. Material availability is ensured by using an enterprise resource planning program and component specific forecasting that is derived from demand forecast.

A demand forecast offers the possibility to make the operations more efficient but still offer the customers' higher value through better delivery times. It provides the purchasing department information about the safety stocks that should be kept in order to overcome the fluctuations in demand. The implementation of forecast has however increased the work load of buyers because the higher volume of goods that need to be purchased.

This thesis discusses how forecast is formed and how it impacts on Vaisala's operations and key performance indicators as well as on individual buyer workload. The main focus is on the operational purchasing level and on routine buy process using a forecast plan.

The key objective was to analyze if use of forecast has had a positive effect and to study the buyer workload in routine buy process using a forecast plan. The results of the analysis and study are used to find ways to better manage the buyer workload through the development of routine buy and demand forecast process as well using other ways. Suggestions on how to increase forecast accuracy using statistical forecasting, development idea for forecast excel tool and simple ways to decrease buyer workload are given based on these results.

KEYWORDS:

Demand forecast, procurement, work load, demand planning, operational purchasing

OPINNÄYTETYÖ (AMK) | TIIVISTELMÄ

TURUN AMMATTIKORKEAKOULU

Tuotantotalouden KO | Osto

2015 | 62

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KYSYNTÄENNUSTEEN KÄYTTÖ OPERATIIVISESSA HANKINNASSA

Tämä opinnäytetyö on case-tutkimus Vaisalasta, suomalaisesta elektroniikkateollisuuden yrityksestä. Vaisala käyttää tuotannossaan Lean tuotantofilosofiaa ja assemble to order tuotantostrategiaa, jossa jokainen tuote valmistetaan vain asiakastilausta vastaan. Materiaalian saatavuus tuotannossa on varmistettu käyttämällä toiminnanohjausjärjestelmää ja komponenttikohtaista ennustetta, joka on johdettu kysyntäennusteesta.

Kysyntäennusteen käyttö on keino tehostaa yrityksen toimintoja samalla tarjoten asiakkaille parempaa palvelua paremman toimituskyvyn kautta. Kysynnän ennustaminen antaa osto-organisaatiolle tietoa oikean kokoisten safety stockien pitämisestä, jotta muutoksiin kysynnässä ollaan varauduttu. Ennusteen käyttöönotto Vaisalassa on kuitenkin lisännyt merkittävästi ostajien työmäärää, sillä ostettavien nimikkeiden määrä on moninkertaistunut.

Tässä opinnäytetyössä kerrotaan miten ennuste muodostetaan ja miten se on vaikuttanut Vaisalan toimintoihin sekä tärkeisiin suorituskykymittareihin sekä ostajien työmäärään. Tutkimus kohdistuu pääasiassa operatiiviseen ostoon ja rutiiniostoprosessiin käyttämällä ennustetta.

Tavoitteena on analysoida sitä onko ennusteen käyttöönotolla ollut positiivinen vaikutus Vaisalan toimintoihin sekä tutkia ostajien työmäärää rutiiniostoprosessissa jossa käytetään ennustetta. Tuloksien pohjalta kehitetään rutiiniostoprosessia mahdollisen automatisoinnin kautta, annetaan kehitysideoita ennusteprosessin kehitykseen liittyen sekä annetaan muita ideoita joilla vähentää ostajien työmäärää. Tuloksina saatiin ehdotuksia ennustetarkkuuden parantamisesta käyttämällä tilastollista ennustamista, ennuste excel-työkalun parantamisidea, sekä ostajien työmäärän vähentäminen muutamalla helpolla tavalla.

ASIASANAT:

Hankinta, operatiivinen osto, kysynnän ennustaminen, lean

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LIST OF ABBREVIATIONS

*item	Star item, individual item code that is generated by configuration choices (Kanninen 11.12.2014)
APS	Advanced planning system (Stadtler & Kilger 2008, 141)
ASCP	Advanced Supply Chain Planning, a part of Oracle EBS (Oracle eBusiness Suite Advanced Supply Chain Planning)
ATO	Assemble to order, a production strategy (Investopedia 2014)
ATP	Available to promise (Stadtler & Kilger 2008, 91)
BOM	Bill of materials (Stadtler & Kilger 2008, 90)
DOS	Days of supply (Herranen 2014)
DSB	Vaisala's demand planning process (Kanninen & Häkkänen 2014)
EBS	Oracle eBusiness Suite ERP program (Oracle eBusiness suite 2014)
ERP	Enterprise resource planning (Blanchard 2010, 50)
Lead time	Time between order entry and planned delivery (Stadtler,Kilger 2008, 88)
Lean	Manufacturing philosophy that tries to eliminate waste (Investopedia, 2014)
MPS	Master production scheduling (Stadtler & Kilger 2008, 89)
MRP	Material requirements planning (Sheldon 2007, 3)
OTD	On time deliveries (Hannonen 2014)
Planning percent	Percentage of a certain purchased item included in the configuration of the product. (Kanninen 11.12.2014)
Service class	Timeframe when a certain amount of certain products are delivered (Vaisala intranet 2014)
VMI	Vendor managed inventory (Sabri & co 2006, 67-68

1 INTRODUCTION

Customers today are demanding customized and a quick delivery of products. On top of this international companies may have to deliver their products to a very remote locations, meaning that the transport time needs to be added to the lead time of the product. This leads to minimizing manufacturing lead time or keeping a finished goods stock. Since keeping finished products around in the company's warehouse means that there are large amounts of money invested in these products and there is no room for customization many companies have begun to use make–o-order production strategy.

A hybrid of between make-to-stock and make-to-order is called assemble-to-order (ATO). In assemble to order the basic parts of the product are already manufactured and can be assembled when an order is received from the customer. Assemble to order products can also in some extent be customized. (Investopedia 2014)

Vaisala is one of the companies that uses the assemble-to-order production strategy in its production of meteorological and industrial measurement instruments and equipment. To manage incoming customer orders Vaisala has incorporated use of service classes on its products. A service class is a certain quantity of goods that are manufactured in a given time. There are small standard service classes and large standard service classes. An example of a small standard service class is 1-10 pieces ready to ship from the factory in 3 working days.

The assemble-to-order production strategy and service classes require constant material availability. Vaisala's purchasing department has the responsibility to make sure that there is always enough material in stock for production. They use an enterprise resource program (ERP) to monitor stock levels, to adjust safety stocks and to make routine buys from suppliers based on demand. The buyers also follow up and expedite purchase orders and are in daily contact with the supplier.

Vaisala's purchasing has been a using reactive purchasing method in its routine buy process. A routine buy refers to a purchase of a known product from a known supplier. (Van Weele 2010, 42)

This manifests in the company as the usage of no-forecast plan in advanced supply chain planning (ASCP) which is a part of the Oracle e-business suite (EBS) enterprise resource planning program. Purchase orders are only placed when there is a visible demand in ERP. Due to long lead times of some components as well as potential large future orders, reactive purchasing has, however, lead to material shortages and in some cases delayed customer deliveries.

To combat these problems, Vaisala's purchasing department has started to use demand forecast and component specific forecasting to help them with routine buys. In practice this means that the buyers now use a forecast plan of ASCP instead of no-forecast. The use of demand forecast has been proven to be an excellent tool in many modern companies.

1.1 Business problem definition and object of research

Since the implementation of a forecast plan the buyers' workload in Vaisala has increased dramatically. When the routine buy work process of no-forecast plan usually required 0.5-1 hour of work every day, the forecast plan process takes significantly longer.

The forecast plan contains more purchased items and suggests planned orders longer into the future according to the forecast. Handling hundreds of planned orders almost daily is, however, extremely time consuming and leaves very limited time for other important work buyers must do daily, for example following up on orders, communicating with suppliers and expediting orders.

This thesis analyzes how a forecast plan is formed and how it has impacted important metrics such as on-time deliveries, material shortages, days of supply and

inventory value as well as how it has affected the workload of the buyers compared to the use of a no-forecast plan.

Objective of the research is to find solutions on decreasing buyer workload in a routine buy process. The aim is to minimize the time spent on the process through possible automatization, development of routine buy process and demand forecast process as well as give other ideas on how to decrease buyer workload.

1.2 Methodology

This research is conducted primarily as an action research. The author of the thesis was a part of Vaisala everyday operations and has previously worked in the purchasing department.

The purpose of an action research is to solve a particular problem and to produce guidelines for best practice. (Descombe 2010, 6)

In addition to action research, qualitative and quantitative methods are also used in this thesis. Qualitative methods are used in discussions with the buyers and associated Vaisala personnel.

In chapter 3.6. ASCP plan output analysis, a simulation is done using Microsoft excel file on planned orders in the forecast, where every suggested planned order within 3 months by the forecast is purchased. An analysis of the data produced by this simulation as well as analysis on time deliveries, material shortages, days of supply and inventory value data is done using quantitative methods.

1.3 Research limitations

This thesis focuses on analyzing operational purchasing and demand forecast process in Vaisala. Other supply chain functions such as sourcing, supplier selection and price negotiations are only mentioned.

Forecast is viewed as a component level forecast, which is formed in the demand planning process. No forecast to actual products and product families are used in operational purchasing and will not be addressed in depth in this thesis. Personal decision making of segment and product managers on a product family forecast level is also only mentioned but not analyzed.

Purchasing of project items and goods does not always use component level forecast and is excluded from this research. Indirect purchasing is also excluded as it is not a part of operational purchasing in Vaisala and does not use forecast.

2 PURCHASING AND FORECAST

2.1 Procurement and purchasing

There are many different definitions regarding procurement and purchasing.

Iloranta and Pajunen-Muhonen (2008, 58) define procurement as a process that includes all the activities that are required to get a product or service from a supplier to its final destination.

Purchasing is included in procurement but is still a broader term than buying and usually includes at least part of item specification and supplier selection. Buying is an activity where purchase order is made to a supplier using agreed upon terms and conditions. (Iloranta & Pajunen-Muhonen 2008, 58)

As can be seen in figure 1 Van Weele (2010, 9) defines the purchasing function as a wider activity than Iloranta and Pajunen-Muhonen, but it is still included in procurement.

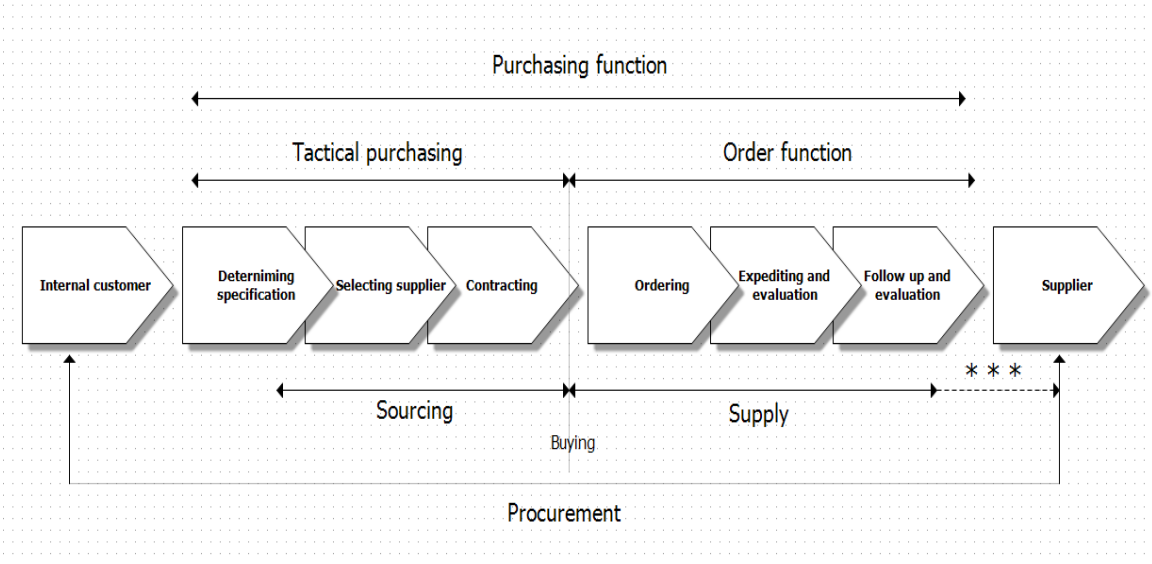

Figure 1 Purchasing process model (Van Weele 2010, 9)

Procurement is a wider term and includes the activities of purchasing and additional functions regarding material management. Purchasing is a function where goods like equipment, components, raw material and machines are acquired for the use of production and the company. (Shridhara 2009, 34)

Although definitions and scope of different terms used in procurement and purchasing may vary depending on field, author or school of thought all seem to have unified opinion about the importance of procurement for business.

Van Weele (2010, 12-14) finds three major ways of how procurement impacts on business using a DuPont analysis, a financial tool to calculate company's return on investment:

- Reducing all direct material costs which will improve company's sales margin
- Reducing company's employed net working capital which will have a positive effect on capital turnover ratio
- Improvement of revenue generating potential in company through innovations in supply chain and efficient technical management of supply chain.

2.1.1 Purchasing goods classification

According to Van Weele (2010, 15-16) there are generally 8 different kinds of categories of goods and services that can be purchased:

- Raw materials. These are physical basic materials for the production process. For example oil, minerals and grains.
- Supplementary materials. These types of goods are used in the production but are not included in the final product or service. For example industrial gases.
- Semi-manufactured goods. Products that have been processed in some way for at least once and are included in the final product, such as aluminum plates and steel wire.

- Components. Components are finished products that will not be processed more and are a part of the final product. Components are assembled and joined together with other components to manufacture the end product. Examples are cables, plastic moldings, component boards and mechanical parts. There are standardized supplier specified components and customized components that are produced according to specifications and design of the customer.
- Finished products. These are products that have been purchased to be sold with other products such accessories for bicycles and cars.
- Investment goods. Machines used in production, buildings and company owned vehicles are investment goods. Their value is stated in the balance sheet annually and that value decreases during their life cycle.
- Maintenance, repair and operation materials. Sometimes called indirect materials which are necessary for the company to keep its day to day operations running, such office and maintenance materials.
- Services. These are services that are done by a third party and not the company itself, such as cleaning services and consulting services.

As Vaisala operates using a Lean assembly to order model the main focus of this thesis will be on purchasing of components for the production.

2.1.2 Purchasing tasks

Primary task of purchasing is to ensure steady secure supply from reliable suppliers with agreed upon quality and lowest possible cost to satisfy need of internal customers. (Van Weele 2010, 53)

Purchasing tasks can be divided into three different levels:

Strategic level

Long term and market position related purchasing decisions are made in strategic level. These decisions are usually made by top management and may have effect on a company's competitive position. Some examples of purchasing decisions are (Van Weele 2010, 282):

- Outsourcing of services or products to suppliers
- Development of procedures, guidelines and task descriptions which give purchasing department authority
- Long-term contracting with preferred suppliers
- Large investment decisions like buildings
- Decision making regarding supplier and sourcing strategies
  (Van Weele 2010, 282)

Tactical level

Product, process and supplier selection is done in tactical level. Examples of tactical level purchasing decisions are:

- Annual and corporate framework agreements
- Product standardization and design review value analysis development
- Supplier selection and contracting in general level and supply-base reduction programs
- Improvement of quality through audits and certifications programs
  (Van Weele 2010, 282)

Operational level

All activities regarding ordering and expediting orders are handled in the operational level. Monitoring of deliveries, material ordering and handling quality disputes with suppliers are done in this level. Examples of activities in operational level are:

- Ordering process
- Expediting of orders
- All daily problems regarding quality, supplier relationship and payment
- Supplier performance evaluation and monitoring
  (Van Weele 2010, 283)

2.2 Operational purchasing

Operational purchasing duties are handled by a purchasing department and the function of this department is to procure material, supplies, machines and services for the company. It is also the duty of the purchasing department to maintain quality, continuity of service, company's reputation and of course competitive position of the company. (Shridhara 2009, 35)

Shridhara (2009 36-37) has identified 12 specific objectives of purchasing department:

- To acquire proper quality materials and supplies
- To have materials and supplies delivered in time for production and other requirements and at the right place
- To buy them at the lowest possible cost
- To maintain as low as possible inventory levels without affecting production flow
- To establish satisfactory source of supply and maintain good relationship with the suppliers

- To make sure that supplier performs well and makes on-time deliveries with acceptable quality
- To co-operate closely with other departments in the organization
- To notify top management with developments regarding purchasing and materials management that could impact company's performance
- To keep purchasing department cost as low as possible
- To ensure steady supply of materials and components while reducing the cost of the end products

Information technology solutions are extremely important for purchasing to work efficiently. Enterprise resource planning should have designated and integrated purchasing functions to simplify and optimize buying. (Van Weele 2010, 194)

2.2.1 Pull systems

"Pull system refers to the way material requirements system generates the signal for material to move" (Sheldon 2007, 13-14)

Pull systems is a term which is used in Lean manufacturing and it is what companies use to manage their materials management more efficiently.

Material requirements planning (MRP)

This chapter focuses on MRP as a purchasing pull system and does not contain information about MRP calculations.

Material requirements planning is a pull system where required quantities according to bill of materials (BOM) of the product are compared to available quantities and the remainder between these generates signal for a purchase order through MRP software. (Sheldon 2007, 3)

Nowadays MRP software is usually either replaced by enterprise resource planning programs (ERP) or imbedded in the ERP.

In MRP systems when inventory is lower than acceptable level or safety stock signal is electronically generated in ERP as a purchase order requisition. Buyer makes a routine buy based on requisition. In integrated and advanced ERP or MRP software this requisition can be electronically turned into an actual purchase order to the supplier. (Van Weele 2010, 42)

Kanban

Kanban is a widely used pull system that is triggered by a signal, usually a card. It is used for easily administrated items like packaging, fasteners and raw materials. In some cases it is also used for finished goods. (Sheldon 2007, 21)

Pull system card is the most popular form of Kanban. A card is placed in the buffer inventory and when inventory is consumed to a certain point card becomes a trigger to the supplier. Usually the card is either placed at the bottom or the top of the stock container. Supplier receives the signal from the card in form of a purchase order and sends more material to fill the stock. (Sheldon 2007, 21-22)

Vendor Managed Inventory (VMI)

Vendor managed inventory is stock that is physically located in buyers facility but is owned by the supplier. It is a replenishment program that allows supplier to control stock levels of VMI items. This managing and restocking of the inventory is done in collaboration with the buyer. Supplier restocks the inventory based on the information about inventory consumption. When supplier retains control and ownership of the VMI inventory the arrangement is called consignment. (Sabri & co 2006, 67-68)

Supplier is responsible for maintaining a certain level of inventory in the VMI stock. This level is usually governed by minimum and maximum levels, which are agreed upon by the supplier and the procurement department. Replenishment triggers when stock level, in-transit material and planned future shipments are below agreed minimum quantity. (Sabri & co 2006, 68-69)

VMI is a replenishment program which is beneficial for both the buyer and the supplier. For the buyer it reduces inventory, shortages and stock outs as well as activities regarding inventory management. For supplier it decreases the need for safety stocks and reduces purchase order discrepancy. VMI also strengthens partnerships between supplier and buyer organizations. (Sabri & co 2006, 69-70)

2.2.2 ABC classification

ABC classification is an inventory control technique that uses annual consumption value of the items to classify them into different categories. An annual consumption value of the item is the annual consumption quantity multiplied by a unit price. Usually three classes are used. (Shridhara 2009,160-161):

- A – Most important items. 10% of total quantity but 70% of the annual consumption value.
- B – Medium importance. 20% of total quantity and 20% of annual consumption value.
- C – Trivial. 70% of total quantity and 10% of annual consumption value.

When all items are correctly categorized using a ABC classification can materials management and purchasing focus on vital and important A items to reduce inventory costs. (Shridhara 2009,160-161)

Table 1 Control guide lines for A, B, C category items (Shridhara 2009, 162)

No.	Control procedure	A items	B items	C items
1.	Type of control	Very strict control	Moderate control	Low control
2.	Safety stock quantity and ordering pattern	Low, frequent ordering	Low, ordering once a quarter	High, ordering annually
3.	Consumption control	Weekly or daily	Monthly	Quarterly
4.	Material planning	Accurate	Past consumption used as a basis	Rough estimates
5.	Effort to reduce lead time	Maximum	Moderate	Minimum
6.	Number of suppliers	1 or 2 reliable sources	2-4 reliable sources	More sources
7.	Follow up	Maximum follow up and regular expediting	Periodic follow up.	No follow up necessary
8.	Value analysis	Extremely thorough	Moderate	Minimum
9.	Forecast in material planning	Accurate	Estimates based on past data	Rough estimates
10.	Review of obsolete and surplus	Once in 15 days	Quarterly	Annual

Table 1 illustrates how different categories must be controlled in order to efficiently use ABC classification in materials management and purchasing.

2.3 Demand forecast

”Accurately forecasting product demand is probably the single most important - and most challenging – measure of company’s supply chain proficiency” (Blandchard 2010, 44)

Forecast in this case means demand forecasting, which is a part of demand planning. Demand planning is a process of forecasting future demand. The purpose of demand planning is to prepare for executions of future decisions. Knowing what will happen in the future is uncertain and thus the use of a forecast is needed. Forecasts are subject to mistakes and planning errors and these errors must also be taken into account in demand planning. (Stadtler & co 2008, 67)

2.3.1 Demand planning

Demand planning is used in three different scopes: Long-term, mid-term and short-term. Planning includes procurement, production, distribution and sales. (Stadtler & Kilger 2008, 88)

As the focus of this thesis is on procurement the main focus of this chapter of demand planning is also on activities that are linked into procurement and into the case study.

Long term planning

Long term planning includes product program and strategic sales planning. The product portfolio the company wants to offer in the future is based on forecast

that includes product range wide possibility of sales and future developments in product lines as well as new potential sales regions. Product life cycles and economic and political competitive factors are also a part of this kind of long range forecast. Individual products are combined into product families or groups that share characteristics in production or sales. This aggregation is done because no long term sales figures for each product can be estimated. (Stadtler & Kilger 2008, 87-88)

Final products consist of raw materials and components and hence materials program is often connected to the product program and portfolio. A-class materials which are the most expensive to procure should be incorporated into materials program and sourced using special channels from few selected key suppliers. Cooperation with the key suppliers is also recommended as it increases the whole supply chains competitive advantage. Collaboration with suppliers should reduce inventory value. A vendor managed inventory, just in time supply and every-day-low-price are concepts that can be used. (Stadtler & Kilger 2008, 89)

Mid-term planning

Forecasting product family sales in specific regions is the main task of mid-term sales planning. Master production scheduling (MPS) uses forecast as one of its inputs. Products are categorized into product families according to manufacturing characteristics like similar components and manufacturing methods. Master production scheduling and capacity planning shows how to most efficiently use available capacity and facilities, MPS plan does not take into account single product manufacturing process and focuses on product families. Balancing cost of inventory against cost of capacity is the main task of MPS. (Stadtler & Kilger 2008, 89)

The mid-term forecast is calculated for one year with monthly or weekly basis. Finished goods safety stocks are calculated on the basis of forecast error and forecast quality which has to be taken into account in a forecast procedure. (Stadtler & Kilger 2008, 89)

Material requirements planning (MRP) is used to calculate order and production quantities of other items than finished goods and critical material that are calculated in MPS. This is done by using ERP systems that have imbedded traditional MRP calculation or stochastic inventory control systems. A traditional MRP concept is usually used for important A-class materials and stochastic inventory control systems for C-class items. When calculating material requirements, bill of materials (BOM) and lot sizes of different items should be compared and taken into account. Weekly and monthly order quantities and adequate safety stock levels to service production are defined in mid-term planning. Contracts regarding A-class items based on requirements derived from monthly MRP calculation can be made with selected suppliers. (Stadtler & Kilger 2008, 90)

Short term planning

In companies that use a make-to-stock production strategy short term sales planning means customer order delivery from stocks. Stock can be divided into a committed stock and an available to promise (ATP) stock that a sales person can sell to a customer if stock level is high enough. Available to promise stock is converted into a committed stock when customer order is received. ATP quantity is calculated by combining planned production quantities and current on hand. (Stadtler & Kilger 2008, 91)

Short term production planning is done according to machine lot sizes and sequences. Planning is implemented with minutely accuracy and has to balance between cost of changeovers and stock holding costs. Orders need to be actively monitored and rescheduled if necessary because in complex manufacturing environments delays and interruptions often happen. Most of the material planning is already done in mid-term planning but short-term planning still has the responsibility to fill commitments cost efficiently. (Stadtler & Kilger 2008, 91-92)

Demand planning in computer assembly type supply chain

Computer assembly type supply chain is closest to Vaisala because of component purchasing and assemble-to-order production strategy.

Table 2 Planning tasks for computer assembly -type supply chain (Stadtler & Kilger 2008, 100)

Attributes and contents	**Impact on planning**
large number of items procured	mid-term master plan coordinates
long lead times	purchasing and order promising
unreliable lead times	safety stocks of components
short materials life cycle	high risk of obsolescence
2-stage distribution system	only rough capacity planning required
forecast and orders available	forecast netting
short life cycles	no sales history available
customized BOM convergent BOM	configuration check demand-supply matching
assemble-to-order	forecast and safety stock of components, order promising, allocation planning
Material constrained	master planning synchronizes materials
supplier oriented	long- and mid-term contracting
customer oriented	short delivery times, high delivery reliability aspired

As can be seen from table 1 in computer assembly type supply chain the focus is more on material constrained supply chain and production capacity only has limited focus in mid-term planning. Long lead times and availability of critical components require procurement to order goods based on a demand forecast. Mid-term balancing of demand-supply must be enforced in order to combat material

constraints and long lead times. If this is not done properly backlogs may arise. Table 1 shows that in order to give customer reliable delivery dates component availability must be known first. (Stadtler & Kilger 2008, 99)

Customized customer order is the initial kickoff in assemble-to- order and configure-to-order. In these kinds of production strategies purchasing must be based on a forecast of components or indirectly on a forecast of finished products. (Stadtler & Kilger 2008, 100)

In a direct component specific forecast demand can be estimated from sales and assembly histories. In some cases no historical data can be found due to short item life cycles and this data can be replaced with related components data. Use of the direct component forecast is mostly useful for C-class items with long life cycles. . (Stadtler & Kilger 2008, 100)

Because of high risk of obsolescence for A-class components with high monetary value and short life cycle, an indirect component forecast based on final product forecast should be used. This forecast is derived from a planned production program done in the long term phase of the demand planning. First a product specific demand must be estimated from the product families. After this a component level demand is derived from planned production quantities using BOM explosion. This is more easily done when using assemble-to-order production strategy. The component level forecast used in demand planning also takes into account supplier lead-times and material constraints such as lot sizes. (Stadtler & Kilger 2008, 101)

In short term planning, actual customer orders are available and share higher part of actual demand. Company needs to use forecast netting which means integrating customer orders into the forecast and matching incoming customer orders with the old forecast. The forecast accuracy is monitored in short term planning and safety stock levels are changed accordingly. In case of too low forecast safety stock is refilled and in case of too high forecast safety stock is reduced. There exists a danger of under stocking and overstocking due to short life cycles

of the components. A forecast regarding component replacement because of better more modern components should also be made. (Stadtler & Kilger 2008. 101)

Careful matching of supply and demand is needed in order to determine which production orders or jobs can be released next into the production. Purchased components have to be assigned into specific customer orders. In shortage situations company must decide which customer orders are important enough to be sent on time and which customers to inform about the delay of production due to material shortages. Procurement needs to handle shortage situations with negotiating expediting shipments with the critical suppliers. (Stadtler & Kilger 2008, 102)

Short term planning main focus is on the supply side. Component safety stocks have to be set and kept on a certain level depending on supplier reliability and component lead times. Close coordination with the suppliers with much power should be established and material availability, demand and the forecast shared with these suppliers. Master plan data should be synchronized with information from sales, production, order management and procurement. Output of master plan data is the planned inflow on components. As figure 2 illustrates this outcome is used to synchronize all different intra-company departments. (Stadtler & Kilger 2008, 102-103)

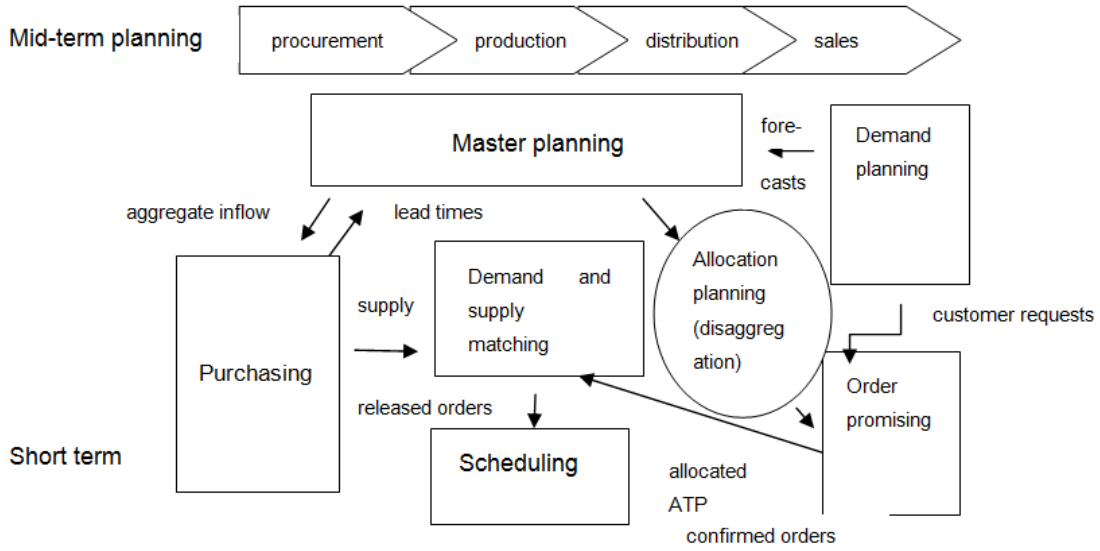

Figure 2 Example of operational planning concept for computer assembly type supply chain (Stadtler&Kilger 2008, 104)

2.4 Demand planning process

Demand planning is a process that includes multiple phases. Figure 3 illustrates a process that is used in many different companies. First phase of the process is preparing the historical data, adding of new products, adjusting product families, changing product statuses (for example discontinued if product is no longer sold) and updating demand planning structures. The historical data is loaded into demand planning module of advanced planning system (APS) and accuracy of previous forecast is computed. This activity is done in central planning department. (Stadtler & Kilger 2008, 141)

Statistical forecast is computed using updated historical data and loaded into system in phase two. Statistical forecast is done by software and uses mathematical methods. For the demand planning process to be as efficient and wide as possible judgmental forecast is also included in the process in phase three. In this phase sales, product management and marketing create forecasts based on their knowledge and judgment. It is vital to integrate the statistical forecast data and

judgmental forecast data in order to avoid overestimating or underestimating the demand (Stadtler & Kilger 2008, 141-142)

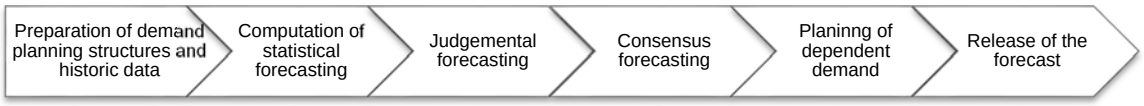

Figure 3 Demand planning process (Stadtler & Kilger 2008, 141)

Combining different forecast can be done in many different ways:

- Revised judgmental forecast: The initial judgmental forecast is usually done by demand planners based on relevant data like historical data and causal factors. After that they compare that forecast to the statistical forecast which is done using mathematical models and statistical methods. Planners then revise their forecast if needed. Use of this procedure may lead to more accurate forecast than judgmental forecast that is not aided by statistical forecast.
- Combined forecast: In combined forecast procedure judgmental and statistical forecast data is combined using a predefined weighing scheme. This procedure is not subject to bias or influenced by political means and better more accurate forecast is possible.
- Revised extrapolation forecast: Statistical forecast may be modified to take into account specific information which is usually predefined, like promotions and weather.

- Rule-based forecast: In rule based forecast methods used to generate statistical forecast are selected by judgment of experts. Usual characteristics of methods are time series and causal factors.
  (Stadtler & Kilger 2008, 142-143)

In phase four of the demand planning process a meeting is usually held where the judgment forecast process phase result is discussed. Objective of this meeting is to address open issues like different opinions about promotion locations and effects and to reach a consensus. Feedback needs to be given to the demand planners in order for them to know quality of their inputs. (Stadtler & KIlger 2008, 143)

The actual future demand of products (or product families) is represented in a consensus forecast. A dependent demand can be planned based on consensus forecast. However in many industries it is important to compute demand on a component level. This can be done in three different ways (Stadtler & Kilger 2008, 143):

- Constrained availability of a key component: If a critical component that affects the supply of the products exists, it may be mandatory to check the feasibility of the forecast based on the demand for that critical component resulting from the forecast.
- Demand constraints that can be expressed by a key component: In for example computer industry the market demand is constrained. Almost all finished products contain one critical key component: the processor. The overall demand can be used to check the conformance of the forecast with market development.
- Product bundling: During promotions products are often bundled together. These bundles are forecasted as individual products but still include other products and influence actual demand of those products.The forecast must be adjusted according to analysis of these effects.
  (Statdtler & Kilger 2008, 143-144)

A component level dependent demand is also generated in master planning and material requirements planning according to BOM of the products as told in the previous chapter. (Stadtler & Kilger 2008, 144)

The final phase of the demand planning process is the approval and release of the forecast, which makes it available for use in other processes. (Stadtler & Kilger 2008, 144)

2.4.1 Disadvantages of demand forecast

One of the biggest disadvantages is bias, which usually happens in the judgmental phase or when only a judgmental forecast is used. Bias is a pattern of behavior where different departments in the company prioritize on their goals and products in forecasting and ignore the bigger picture. In many companies employees are penalized for producing too little and stocking out, so they react by over forecasting and buffering up the safety stock. (Blanchard 2010, 45)

Over forecasting demand leads to increased inventory value, rise of expedited shipping costs, increased cost of obsolescence, increased cost of warehousing and everything else that is affiliated with too optimistic forecast. Under forecasting leads to same problems as if there was no forecast to begin with. (Blanchard 2010, 46)

In short, having a high level of forecast accuracy is the most important thing to reach perfect order fulfillment and on time deliveries. (Blanchard 2010, 10)

3 COMPONENT LEVEL FORECAST PURCHASING IN VAISALA CORPORATION

3.1 Company profile

Vaisala corporation is a Finnish high tech company that develops, manufactures and sells applications to environmental and industrial measurement. The company is a market leader in selected markets and 98% of net sales come from abroad. Around 1400 employees from around the world work for Vaisala and the company operates in more than 150 countries. (Vaisala 2014)

Vaisala's business is divided into two different areas: Weather observations and controlled environment. Weather observations includes five markets which are meteorology, airports, road and rail, defense and new weather markets. Controlled environment includes life sciences and targeted industrial applications markets. Figure 4 illustrates Vaisala's two business areas. (Vaisala 2015)

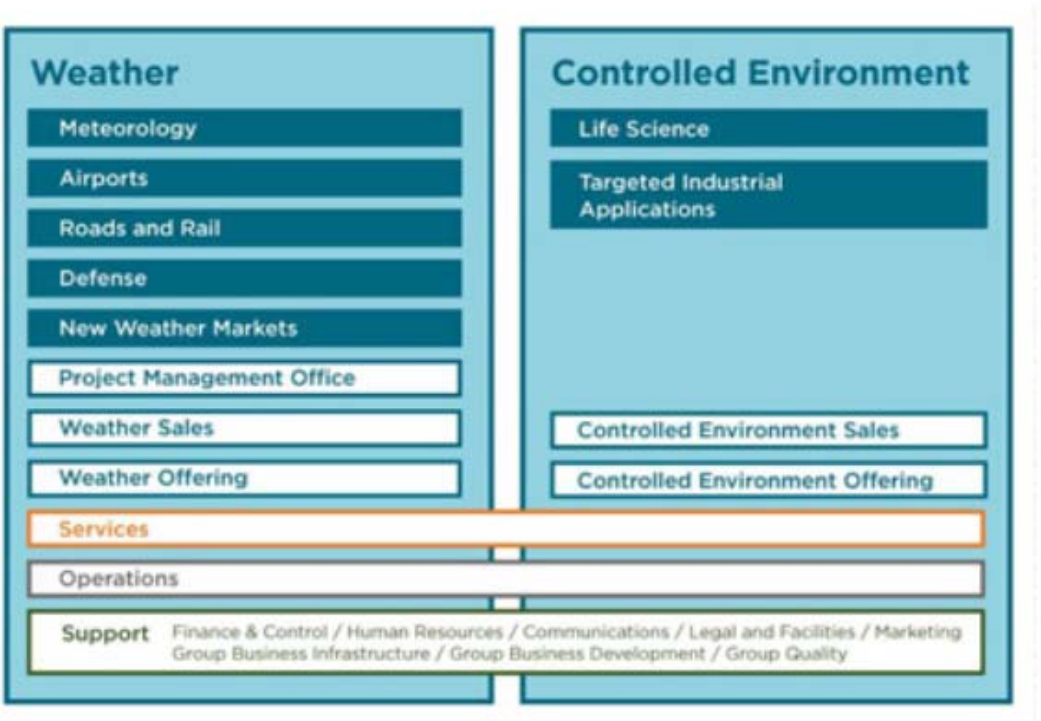

Figure 4 Vaisala business areas (Vaisala 2015)

In 2013 Vaisala's net sales were 273.2 million euro consisting of 200.0 million euro from the weather observations area and 73.2 euro from the controlled environment area. Operating result was 18.1 million euro. (Vaisala 2014)

3.2 Procurement in Vaisala

Vaisala procurement is divided into sourcing and operational purchasing. As mentioned in the research limitations section this thesis will only focus on operational purchasing. The operational purchasing department is a part of Demand and Supply Chain management team in Vaisala operations. Sourcing is a part of the sourcing and supply chain development.

The role of operational purchasing in Vaisala is to ensure material availability in production. Suppliers are divided between categories and purchased goods are managed trough different control systems. Operational purchasing handles procure material process which is a part of a product sales order to delivery process. As seen in figure 5 the product sales order to delivery process is one of the Vaisala's core processes. (Vaisala intranet 2014)

Figure 5 Vaisala process map (Vaisala intranet 2014)

3.2.1 Used pull systems

The purchasing pull systems used in Vaisala are Material Requirements Planning (MRP), Vendor Managed Inventory (VMI), kanban and shelf replenishment service.

Due to Vaisala's Lean model of not having finished product warehousing and product customization almost every product is categorized as assembly to order. This leads to company having to define service classes for most of it products. Short service classes (in some cases 3 days for 1-30 pieces of products) lead to materials either having a large inventory value and large safety stock or perfectly timed shipments from suppliers.

As perfectly timed is not easily achieved, safety stocks are defined for MRP and kanban purchased goods. If material stock is under safety stock level the ERP will advise buyer to buy more material.

The kanban card system is used for low value items such as manuals, seals and O-rings. MRP is used on wide variety of products with different cash values and different physical sizes. It is the most used purchasing pull system in Vaisala procurement. Main focus of this thesis will be on the MRP purchased goods.

Vendor managed inventory is stock that is located in Vaisala's facilities but is owned by the supplier. The supplier has agreed to maintain certain level of inventory in the VMI-stock. These levels are governed by using minimum and maximum levels. Levels are defined by negotiations between sourcing managers and supplier contact persons. VMI is used for items that are used in large quantities daily and have a need for a steady supply.

Shelf replenishment service is stock that is owned by Vaisala, but supplier handles its replenishment in Vaisala's facilities. This kind of control model is used for low value items such as screws and product packages.

3.2.2 Tools used in operational purchasing

As described in the theory of this thesis buying is nowadays done by MRP or ERP software. Usually enterprise resource planning systems with built-in or customized features for purchasing activities are used. ERP is a way to integrate the data and processes of an organization into one single system.

Same applies to Vaisala's operational purchasing. Vaisala has chosen the Oracle E-Business Suite (EBS) as its ERP system. In purchasing (and in some extent in production planning) EBS is divided into two different areas with designated functions. These areas are the "standard" EBS and the advanced supply chain planning (ASCP).

Oracle E-Business Suite (EBS)

Each buyer has multiple responsibilities in EBS which allow them to perform many different activities within the system. Most relevant for this case study is the purchasing responsibility which includes different tasks for purchasing and inventory activities (Oracle eBusiness Suite 2014):

Examples of purchasing functions:

Buyer work center, requisitions, purchase orders, receiving, supply base

Examples of inventory functions:

On-hand availability, Kanban, transactions, receiving, bills of material

(Oracle eBusiness Suite 2014)

Most used activities are purchase order summary which allows buyer to view, modify and create purchase orders and item supply/demand which tells the current on-hand availability of a chosen item as well as the future demand and incoming PO shipments.

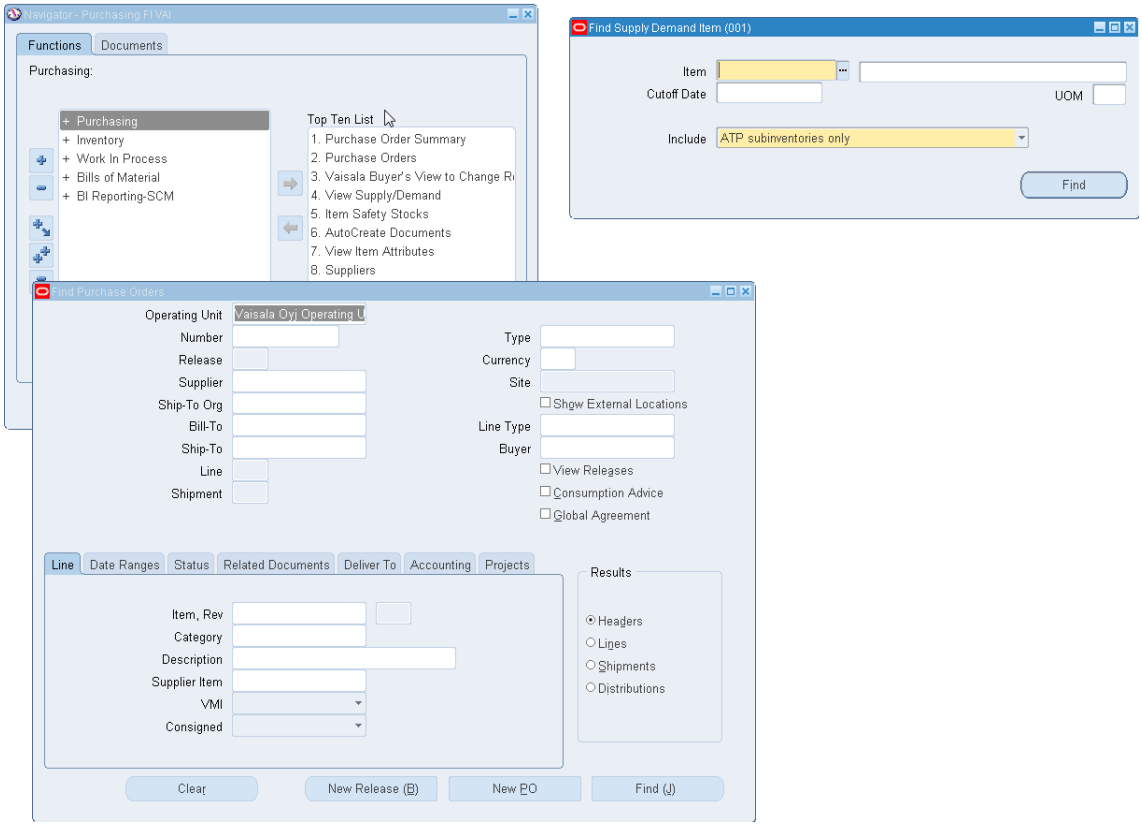

Figure 6 Oracle EBS Purchasing responsibility and most used functions. (Oracle eBusiness suite 2014)

Another used activity in routine buy process is auto-create which creates purchase orders from ASCP planned orders.

Advanced Supply Chain planning (ASCP)

ASCP on the other hand is completely different kind of tool with very few functions. The buyers use the advanced planning work bench function. The main function of ASCP is to act as a planning engine. (Oracle eBusiness Suite Advanced Supply Chain Planning 2014)

The ASCP analyzes different factors and makes planned orders for buyers in two different plans: forecast and no-forecast. Factors defining the forecast plan will be addressed in chapter 3.3. . (Oracle eBusiness Suite Advanced Supply Chain Planning 2014)

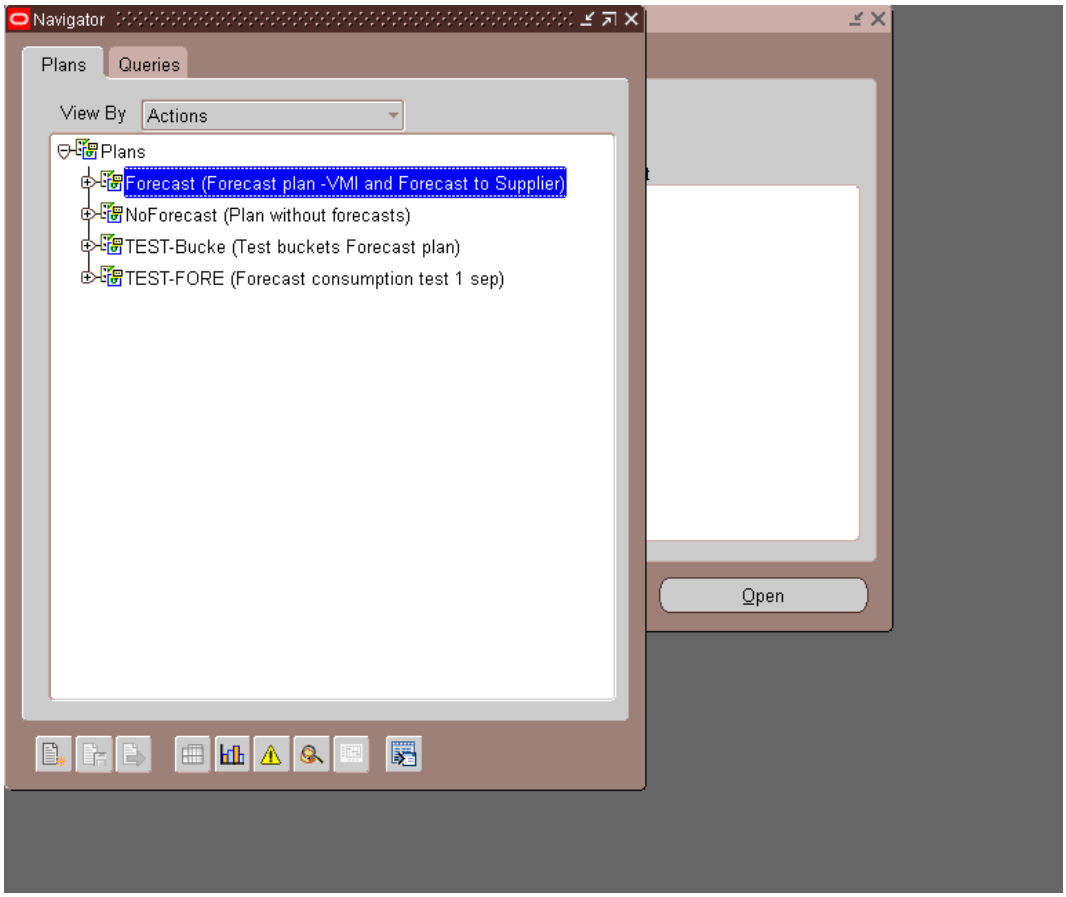

Figure 7 ASCP Advanced Planning workbench (Oracle eBusiness suite Advanced supply chain planning 2014)

The ASCP also generates exceptions for buyer to monitor and act on. Exceptions can be accessed from a separate exceptions function. Exceptions include several different categories, but only reschedules, items with shortages and past-due orders are monitored to ensure that orders are on time and there is always enough supply for production. (Oracle eBusiness Suite Advanced Supply Chain Planning 2014)

3.2.3 No-forecast plan routine buy process

Before second quarter of 2014 Vaisala's buyers only used a no-forecast plan of the ASCP. In practice this meant that the buyers only made routine buys and placed purchase orders if there was visible demand shown in the ERP. (Häkkänen, 5.12.2014)

This process illustrated in figure 8 only includes the material requirements planning controlled purchased items, which conclude most of the items purchased in Vaisala. VMI, Kanban and shelf replenishment service do not require buyer to make a buying decision.

Every day the buyers view planned orders of ASCP and check the current demand and supply from EBS. If there seems to be demand for more material or material quantity is in risk of going below safety stock they check the order for release.

In some cases there is no demand visible in the EBS but the ASCP still makes a planned order, in this case buyer checks the ASCP horizontal plan for future demand that does not yet appear in the EBS. If there is a demand for a component, item is checked for release.

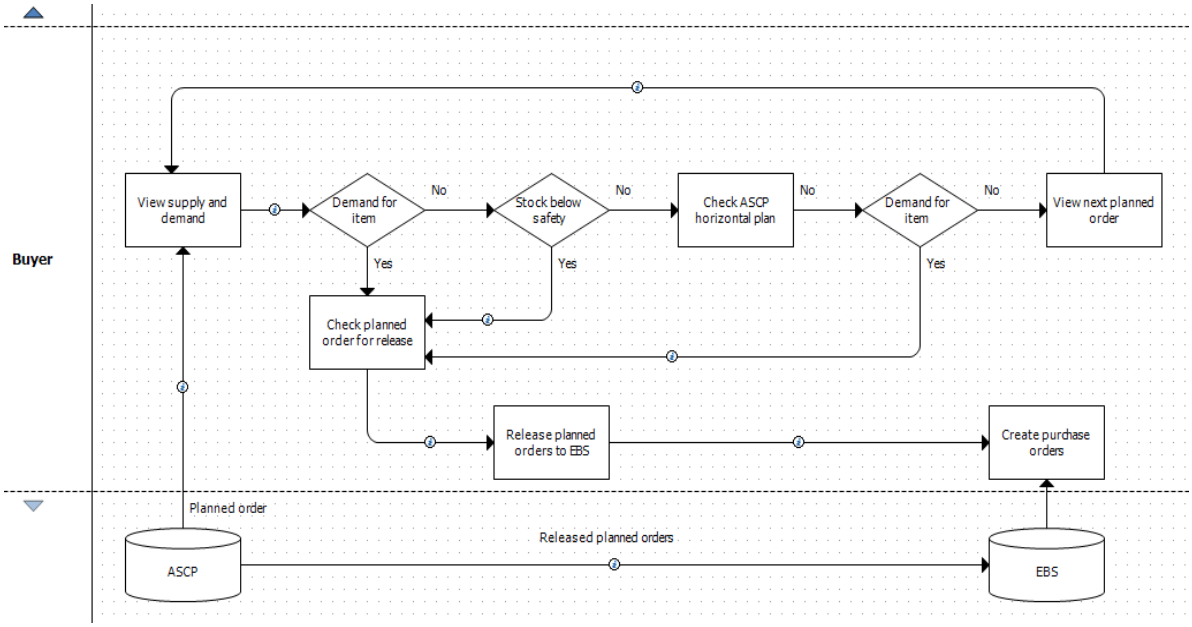

Figure 8 Routine buy process using ASCP No-forecast plan

If there is no demand visible for an item in demand and supply or in horizontal plan buyer can check how it has been purchased in the past and makes a decision based on this information. Sometimes low value items are also purchased without visible demand.

After all planned orders have been checked by the buyer, the buyer releases these planned orders into the EBS, which collects all the planned orders into the auto create orders function where buyer can continue to create purchase orders from planned orders.

The no-forecast plan routine buy process is reactive, but does not take into account incoming possible large orders or any other data than orders that have already been placed and appear in the EBS. Due to long lead time of some the components and no long term scope of possible order use of the no-forecast plan has in some cases resulted in material shortages and delayed deliveries to customers.

3.3 ASCP forecast plan

To prevent material shortages and to improve on-time deliveries Vaisala's Demand and Supply Chain management has decided to prioritize the use of the forecast plan of the ASCP. The forecast plan includes order backlog and DSB forecast.

"DSB is a monthly process for rolling 12 month time horizon and includes both CEN and WEA businesses and the majority of Vaisala's product offering. The product-level rolling 12 month forecast is agreed on once a month in the Demand Review and materials and capacity are confirmed by the end of the month.
The product-level forecasting is run in Excel-based tools from which the forecast is loaded into eBS and automatically broken down into a component-level forecast.
The component-level forecast is shared with and confirmed by our key suppliers. " (Vaisala intranet 2014)

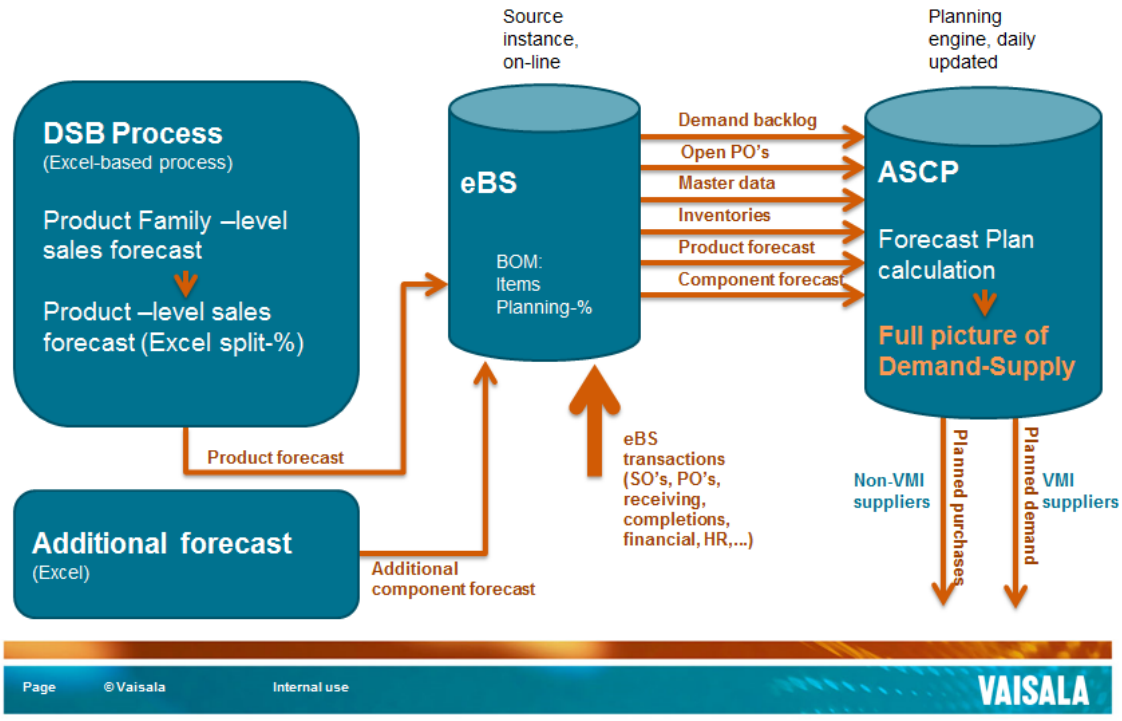

Figure 9 DSB Process (Kanninen & Häkkänen 2014)

3.3.1 Input

Input includes the order backlog and the DSB forecast. Order backlog includes sales orders that are already booked into the EBS.

As can be deducted from figure 9 in the beginning of DSB forecast process product managers and segment sales managers fill a planning template. This template shows how much of a certain product family is expected to be sold in certain regions in the next 12 months. Shipment history, order backlog and product life cycle status are used as inputs for sales planning templates. Shipments and backlog reports are run to capture transactions in EBS. (Kemppainen 2014, 2)

After the planning templates for all product families have been filled all data is compiled separately for controlled environments and weather business areas. A demand review is held with the segments to verify the forecast data. If any anomalies are found, forecast project coordinator will check the data.(Kemppainen 2014, 5-9)

Next, the weather production planners will check and verify human resources and test equipment capacity and compare it to the product family forecast. In controlled environments, the head of instrument factory and process engineer check and verify human resources and test equipment capacity. If there is need for new resources or capacity factory heads will check if more people can be obtained to manufacturing or more test equipment can be acquired. (Kemppainen 2014, 11-13)

When resources and capacity have been checked, the product family forecast will be split into a product detailed forecast using split percent. Split percent is determined by historical sales figures, but can be modified later if large orders are received on certain products. (Kemppainen 2014, 12-13)

3.3.2 Forecast plan calculation

A product detailed forecast and an additional forecast that contains forecast for spare parts and order backlog are uploaded into the EBS.

The EBS compiles the forecast and the master data and sends it to the ASCP. The ASCP explodes forecast to component level forecast using data collections. It is important to note that the amount of data included in this calculation is extremely high, just the data in demand is 257 862 Microsoft excel lines. (Kanninen 11.12.2014)

The ASCP uses the following data collections in the fully automated calculation which is done every night at midnight:

- Instance
- Collection group
- Number of workers
- Timeout
- Purge previously collected data
- Analyze staging tables
- Approved suppliers list (supplier capacities)
- ATP rules
- Bills of Materials / Routings / Resources
- Bills of resources
- Calendars
- Demand classes
- End Item substitutions
- Forecasts
- Items
- Key performance indicator targets
- Master demand schedules
- Master production schedules
- On hand

- Planning parameters
- Planners
- PO receipts
- Projects / Tasks
- Purchase orders / Purchase order requisitions
- Reservations
- Resources availability
- Safety stock
- Sales orders
- Sourcing history
- Sourcing rules
- Sub inventories
- Supplier responses
- Suppliers /Customers /Organizations
- Transportation details
- Unit numbers
- Units of measure
- User company association
- User supplies and demands
- Work in process
- Sales channel
- Fiscal calendar
- Internal receipts
- Internal repair orders
- External repair order
- Payback demand / supply
- Currency conversion
- Delivery details
- Install base under contracts
- Notes (Attachments)
- CMRO OSP Supplies

(Oracle eBusiness Suite Advanced Supply Chain Planning2014)

As some of the data included in the calculation is self-explanatory and explaining all would not be efficient only the most important data will analyzed in depth.

Bill of materials

The bill of materials works in two different ways in ASCP plan calculation:

First it uses the order backlog to collect data from work in process products which have a specified star item (*item) code and a specified bill of materials. *item code is unique and links to the configuration and the bill of materials of the product in the backlog. (Kanninen 11.12.2014)

Secondly it uses a planning percentage to define bill of materials of products that are in the DSB forecast. The planning percentage is the percentage of a certain purchased item included in the configuration of the product. For example for a RWS200 weather station the planning percentage of a solar panel could be 15%. This means that 15% of the expected sold RWS weather stations will include solar panels. (Kanninen 11.12.2014)

When ASCP plan calculation is run again and there are actual sales orders with *item it replaces part of the DSB forecasted demand with the correct bill of materials of the product. (Kanninen 11.12.2014)

Forecast

The difference between the ASCP forecast plan and the no-forecast plan is defined in the forecast selection. If no is selected the ASCP plan calculation does not include the DSB forecast. If yes is selected the DSB forecast is included in the calculation. (Kanninen 11.12.2014)

Items

Items includes all the master data that is behind item codes. Most important of this data are: make or buy, lead time, fixed lot multiplier, minimum order quantity, demand time fence, planning time fence, release time fence and fixed days of supply. (Kanninen 11.12.2014)

Make or buy is the difference between purchased item or manufactured item. Lead time is the amount of time it takes the purchased or manufactured item to be ready for use in Vaisala production either from a supplier or from the sub manufacturing. (Kanninen 11.12.2014)

The fixed lot multiplier can be understood as a package size of an item. For example a package size for screws could be 1000 pieces, which means that minimum amount that could be ordered would be 1000. A minimum order quantity can be the same as fixed lot multiplier and means the minimum amount that can be ordered. In some cases minimum order of certain item that can be ordered is defined in the contract with the supplier. (Kanninen 11.12.2014)

The demand time fence refers to the time window where ASCP only considers actual demand. Outside the demand time fence, ASCP considers the DSB forecast demand. Planning time fence is a time window where ASCP does not create planned orders. Instead it may create rescheduling suggestions that suggest some orders to be expedited into planning time fence if required by the demand. Release time fence is a time window which is used in ASCP automated planned order release process. In this process every order in the release time fence time window is released. (MacLean & co 2014, 1230)

The fixed days of supply combines demand from work in process and sales orders that are within a defined time window into a single planned order. This eliminates the need for buyer to combine demand from multiple sources into a single planned order. (Kanninen 11.12.2014)

Sales orders, purchase orders, purchase order requisitions and on-hand

In planning calculations actual sales orders are taken into account as an actual demand in the order backlog. Supply is included in the calculation as the data from incoming purchase orders, purchase order requisitions and current on-hand of the inventory. (Kanninen 11.12.2014)

After the ASCP has run collections calculation it launches the forecast plan.

3.3.3 Output

Gross demand forecast

A gross demand forecast is consumption and forecast data that is sent to VMI suppliers daily through web tool called Supplier web. This data includes current consumption of items in VMI stock as well as future consumption based on the order backlog and the DSB forecast. (Kanninen 17.12.2014)

The supplier reacts to gross demand forecast accordingly by buffering its own inventory and maintaining the VMI inventory level between minimum and maximum levels.

Net purchase order forecast

Forecast data is also sent to key non-vmi suppliers through supplier web so that suppliers can prepare for future demand from Vaisala accordingly. If a supplier does not use supplier web tool, the forecast is sent as a Microsoft excel file which is derived from the forecast excel tool that buyers use. Sourcing managers handle the delivery of the excel file to the selected key suppliers. (Kanninen 17.12.2014)

The number of suppliers that receive net purchase order forecast is increasing constantly.

Typical error sources

As in any process, the ASCP forecast plan has errors. If an error is found in a forecast of an item it can be reported into Vaisala's internal intranet site.

Most typical error sources are:

- Not a forecast problem – problem is usually in item master data, for example too short lead time is defined.
- BOM Planning percent incorrect – Planning % has been too high or too low for an item which has caused too many or too few planned orders.
- DSB sales plan incorrect – There has been a miscalculation or estimation error in DSB process. For example segment manager has underestimated the sale of a certain product.
- Not included in DSB – Not all items in Vaisala are yet included in DSB forecast
- Item parameters incorrect - Item has missing parameters in EBS. (Vaisala intranet 2014)

Most of the errors are in cases where forecast is too high and ASCP generates too many planned orders.

In the end of the DSB process a supply review is held with sourcing and manufacturing to see if there are any disruptions in supply of materials from the suppliers or any problems with human resources or capacity. If there are no problems forecast is confirmed for the next 12 months. (Kemppainen 2014, 19)

Buyers receive the updated forecast excel tool once a month with the newest forecast to help them make buying decisions in their routine buys.

3.4 DSB component level forecast effect

The effect of the DSB forecast usage in the operational purchasing will be analyzed on how the implementation of forecast plan has affected key performance indicators. Days of supply, inventory value and on-time deliveries are performance indicators. Material shortages is a control indicator.

Actual monetary values are not displayed in figures and not analyzed as this information is for Vaisala internal use only. Instead fluctuations and trends in graphs are analyzed.

3.4.1 Inventory value and days of supply

Inventory is measured in two different indicators in Vaisala: inventory value and days of supply.

Inventory Value

The inventory value tells the value of standard and available inventory currently in Vaisala's stock that is procured by the Vaisala purchasing department.

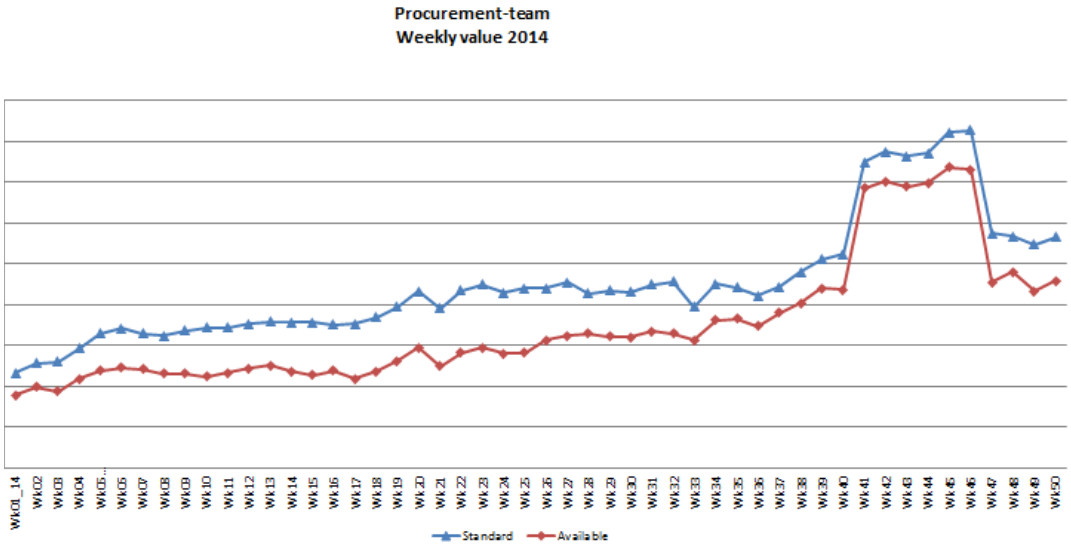

Figure 10 Procurement team inventory value in 2014 (Herranen 2014)

As we can see from figure 10 both the standard and available inventory have been steadily increasing since the beginning of 2014. Minor peaks and low points occur but the overall trend has been upwards. Except for the significant increase on week 41 which was an error in item pricing and was fixed once the error source had been identified.

Since the implementation of the forecast plan in second quarter of 2014 there is a slight peak visible in graph. This is explained by the increase in item safety stock values which was an emergency measure performed by the buyers when forecast plan was taken into use. Inventory value's overall increase can also be explained by large numbers of last time buys which were done in the end of 2014.

In August 2014 DSB extra forecast which includes Vaisala services' future demand and spare part future demand was implemented and is also a factor in the inventory value increase in the end of 2014.

Days of supply (DOS)

The days of supply is a profitability indicator that uses the following formula in its calculation:

$$Inventory\ value/(last\ 3\ months\ cost\ of\ goods \div 90)$$

(Vaisala intranet 2014)

In Vaisala DOS is calculated separately for every item category. A and B are the most valuable so they also affect the buyers' bonuses and thus bonus A & B is included in the figure 11.

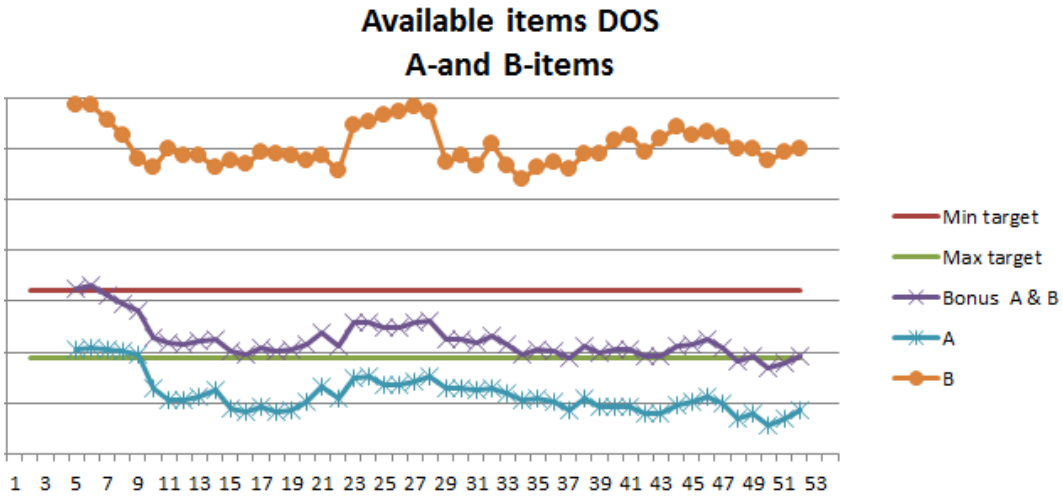

Figure 11 A and B items days of supply (including bonus targets for procurement team) (Herranen 2014)

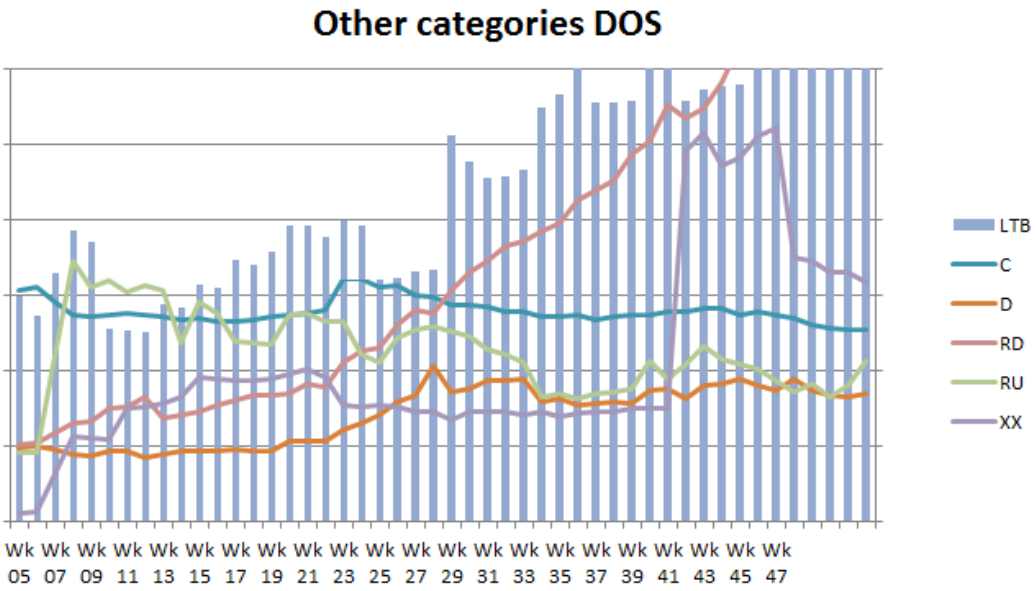

Figure 12 Other categories days of supply (Herranen 2014)

The current Vaisala ABC classification varies a little from the classification described in the theory part of this thesis and is as follows:

- A1 - 40% of last 12 months consumption value
- A2 - 35% of last 12 months consumption value
- B1 - 10% of last 12 months consumption value

- B2 - Next 10% of last 12 months consumption value
- C – Last 5% of last 12 months consumption value
- D – no consumption value during last 12 months
- LTB Last time buy - item that is bought for service purposes, usually large orders both in value and quantity
- RD Ramp down – item that is used in product that are in ramp down phase of their life cycle. Ramp down means that the product is being discontinued and usually replaced by another newer product.
- RU Ramp up – item that is used in product that are in ramp up phase of their lifecycle. Ramp up is the opposite of ramp down, supply is being ramped up for future sales of the product.
- XX – project items, configured items and make items and everything else (Saario 2012, 3)

As we can see from figures 11 and 12 the overall trend in A, B and C item DOS has been downwards in 2014. Especially in A and B items where there has been a decrease of about 10%. C item DOS is also going down after minor peak in week 23.

On the other hand DOS of rarely purchased D items has been increasing almost exponentially since the beginning of 2014. Greater increase can be seen after week 23.

Implementation of forecast in second quarter could be the explanation for the dramatic increase of D item's DOS and a minor peak in C items. Since more items are bought all item DOS should be greater when using a forecast. However the development and fine tuning of the forecast and especially adjustments in forecast accuracy has resulted into the buyers adjusting item safety stocks to lower quantities than before which has had a decreasing effect on item DOS.

Ramp up, ramp down, last time buy and XX items are not analyzed, as their fluctuations are affected by different factors than forecast. However, as we can see there has been increase in last time buy DOS which may be one of the causes for the increase of the inventory value in 2014.

3.4.2 On time deliveries (OTD)

On time deliveries is a performance indicator which is influenced by many different departments in Vaisala operations. On time deliveries are product deliveries to the customers that have been shipped from Vaisala on time.

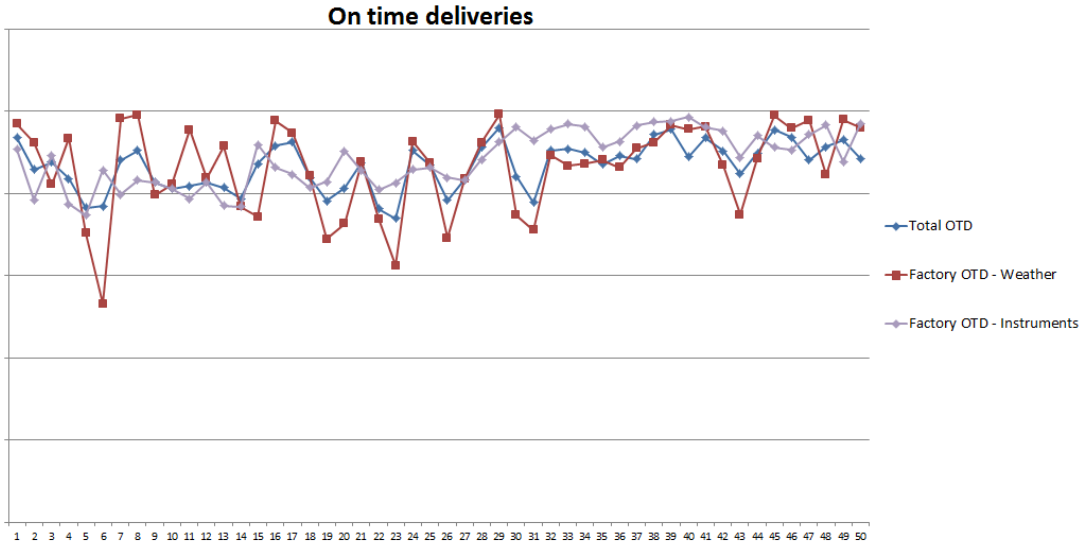

Figure 13 Total and factory specific on time deliveries (Hannonen 2014)

As seen in figure 13 the beginning of 2014 of had significant fluctuations in total OTD and in both Helsinki based factories OTD. In second half of 2014 major fluctuations in both of the factories and the total OTD have decreased dramatically and OTD has been almost constantly about 90% and in best cases almost 100%.

It is highly possible that the use of the forecast plan in purchasing has been one of the key reasons in steady OTD. The report suspicious forecast form in Vaisala intranet has also improved forecast and resulted in better OTD through more accurate forecast and fewer material shortages.

3.4.3 Material shortages

The material shortages are item shortages which are reported to the material shortage board in Vaisala intranet. Shortages are reported by the production workers ore logistics staff when the item's shelf location in the warehouse or in the manufacturing team supermarket is empty. The buyers monitor and act on items that have been added to the material shortage board.

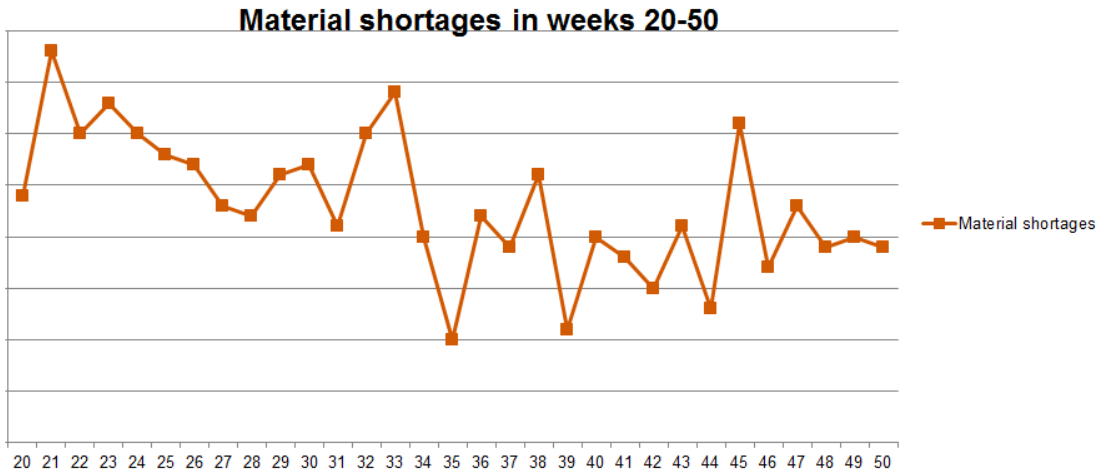

Figure 14 Vaisala material shortages in weeks 20-50 without pre warnings (Herranen 2014)

Although major fluctuations in material shortages occur, figure 14 shows that the overall trend of material shortages has been downwards since week 20. One of the main goals behind the implementation of the forecast plan was to decrease material shortages and in that way to increase on time deliveries. And as seen in the figure 14 it has been effective. Another factor affecting the downwards trend is improved use of material shortage board through training that was held for the production and logistics staff.

3.5 Forecast usage in operational purchasing

Use of no-forecast plan requires the buyers to view ASCP planned orders daily, but when forecast plan is used this is no longer practical due to large number of

planned orders. The buyers have however still used same routine buy process with few variations.

Purchasing manager, along with demand and supply chain development team has been developing a new work guide for buyers to use when using ASCP forecast plan. This work guide includes two routine buy processes that are based on a new ABC classification of items. (Herranen 2014, 3)

The ABC classification is defined in theory part of this thesis and the classification that Vaisala currently uses is explained in chapter 3.4.1. The new proposed classification varies a little from both and is based more on item price and on how steady is the consumption of the item as well as the accuracy of the forecast. When taken into use the new classification will make a quite large difference to the current classification as we can see in the chapter 3.6.

New proposed Vaisala ABC classification:

- A – every item over 100 euros and items between 50 and 100 euros with unsteady consumption
- B – items between 50-100 euros with steady consumption and items between 3-50 euros with unsteady consumption
- C – items between 3-50 with steady consumption and items below 3 euros
- C+ - items below 3 euros with steady consumption. Forecast accuracy taken into account.
- D – items that are purchased less than 5 times annually and items which were previously classified as XX
  (Herranen 2014, 3)

XX category is removed but other categories are the same as before. (Kanninen 8.1.2015)

3.5.1 Forecast plan routine buy process

In the new purchasing guide two different routine buy processes are used to manage buyer workload more efficiently: C+ items routine buy process and A, B, C – items routine buy process. (Herranen 2014, 3)

C+ items are cheap items that can be bought with a very simple process twice a month. Buyers use the forecast plan of ASCP and a 30 day time window.(Herranen 2014, 3)

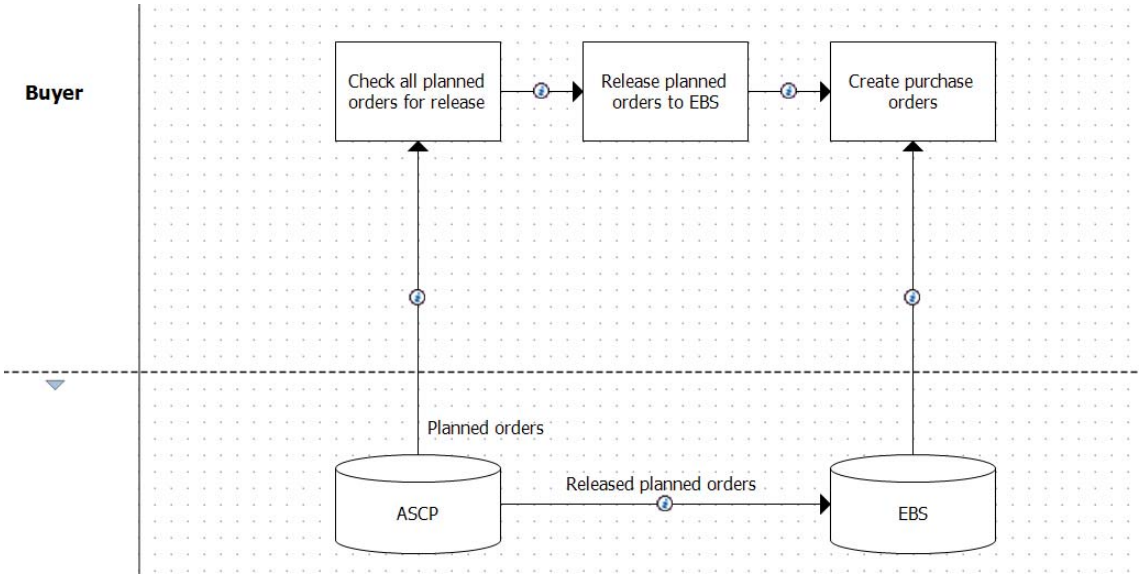

Figure 15 C+ items forecast plan routine buy process

Figure 15 illustrates how easy it is to buy C+ items when the new ABC categorization is used. Buyers simply check all planned order for release in the ASCP without checking demand for them from many different locations. Orders are released to the EBS and purchase orders are created using auto create function. There also a possibility to automate this process in the ASCP.

A, B and C class items still have to be bought with caution and both the forecast and the actual demand has to be checked carefully from forecast excel tool and from EBS. (Herranen 2014, 3)

As we can see in figure 16, the process has more steps than in the no-forecast process and consumes more time to complete, especially when the amount of planned orders in the forecast plan is taken into account.

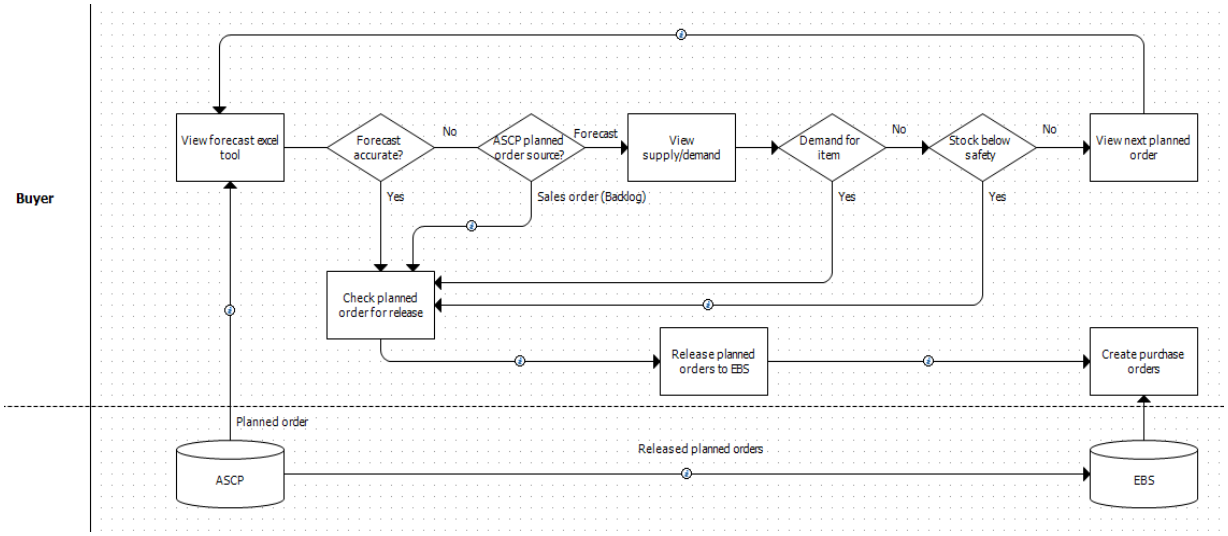

Figure 16 Forecast plan routine buy process for A, B and C items

The forecast excel tool plays an extremely important role in forecast plan routine process. When buyer views planned order for item, he/she then checks item's forecast percentage from the excel tool. A forecast percentage is past consumption compared to the future forecasted consumption. If the forecast percentage is near 100% item is checked for release. If it is much higher or much lower buyer moves to the next step of the process which is checking planned order source from the ASCP. Source can be checked from the same window as the planned order is released. If source is actual demand such as a sales order or safety stock fulfillment order is checked for release. If planned order source is forecast, the buyer goes to supply/demand in the EBS and checks if there is actual demand visible. If there is demand such as sales orders or work in process jobs, order is checked for release, if no demand is visible the buyer checks the safety stock level. If fulfillment in safety stock is needed, planned order is checked for release, if not, the buyer moves to the next planned order. After all planned orders have been viewed orders are released into the EBS and purchase orders are created using auto create function. (Kukkonen 15.01.2014)

Forecast plan routine buy process is extremely time consuming and is done only three times a week. The buyers use shorter time window to view planned orders in the forecast plan than in the no-forecast plan but in some cases planned order still needs to be checked from three different places (Excel tool, ASCP and EBS) before it can be either checked for release or buyer can move to the next planned order.

3.6 ASCP plan output analysis based on ABC classifications

In this chapter a simulation was done using forecast excel tool where every planned order within three months of item with ABC classification was done: First with the currently used ABC classification and then with the new proposed ABC classification.

Grand Total old ABC

Row Labels	Sum of Simulated spend	Sum of Planned order quantity
A1	410326	2073
A2	1798656	295315
B1	766021	53173
B2	1030418	182626
C	773208	417743
D	43488	16620
Grand Total	**4822117**	**967550**

Figure 17 Simulation output using current ABC classification (Tarvonen 2014)

Figure 17 illustrates the simulated spend using old ABC classification. A1 category only has a very small amount of planned orders with high price per item. A2 category spends the most amount of money and also has second largest quantity of planned orders. B2 category has also large simulated spend and large quantity of planned orders. As expected C category has most planned orders with low spend and simulated spend in D is extremely low.

Current classification generates significant amount of planned orders into all categories. In some cases items classified as C have a monetary value that is equivalent to A class item. Average price for C item is almost two times higher in figure 15 than average price for C+ item in figure 16. Using current classification forces

the buyers to check every planned order in ASCP using forecast plan routine buy process illustrated in figure 14.

Grand Total new ABC

Row Labels	Sum of Simulated spend	Sum of Planned order quantity
A	2204004	9227
B	512725	21378
C	1278575	658819
C+	260959	275197
D	699234	8604
Grand Total	**4955496**	**973225**

Figure 18 Simulated spend using new proposed ABC classification (Tarvonen 2014)

As we can see from figure 18, the amount of orders in most expensive A class items is only a fraction of combined A1 and A2 planned order quantity in figure 14 although the sum of simulated spend is about the same. In B class items both the sum of planned orders and sum of simulated spend is significantly lower than combined B1 and B2 items. Decrease in A and B class items is explained by the increase in the sum of C class planned order and spend as well the implementation of the new C+ class. As mentioned before C+ class includes items with low monetary value with steady consumption and accurate forecast. They can be bought with C+ class forecast plan process described in figure 15. D items are bought extremely rarely so the difference and effect on buyer workload between current and new proposed classification is irrelevant.

New proposed classification will remove a tremendous amount (275197) of planned orders from buyer work load with the implementation of C+ class.

4 CONCLUSION

The objective of this thesis was to analyze the effect of forecast on key performance indicators and buyer workload and to determine if the implementation has had a positive impact on operations.

In chapter 3.4. DSB component level forecast, the effect on four most important key performance indicators was analyzed. The results show that the use of forecast has increased the inventory value a little but has had a positive effect on all the other key performance indicators. Even though the days of supply should have been increasing, it has actually decreased due to development and adjustment of forecast and better forecast accuracy.

The most positive effect has however been on on-time deliveries. OTD before the implementation of forecast had significant fluctuations and was extremely low at some points. In the second half of 2014 OTD has stabilized and has been around 90% for Vaisala operations. This is due to the decreased amount of material shortages and constant material availability in production as well better planned production capacity which is also thanks to demand forecast Especially stable and high OTD can be found in the Helsinki instrument factory in the last quarter of 2014.

Overall the implementation of forecast has been successful and has had a positive effect on operations. It has, however, had a negative effect on buyer workload. Differences in the routine buy process in using a no-forecast plan and forecast plan are quite small. When using forecast plan, buyer has to check the forecast percentage first and after that the process regarding EBS usage is almost identical. The increased workload is not due to the process itself rather than the amount of times the process has to be repeated.A forecast plan generates more planned orders and hence it takes more time to go through all these orders.

Using the current ABC classification makes this even worse. Since there are C-items with a monetary value of an A-item the buyers cannot trust item classification and have to check every planned order carefully using the A,B, C forecast

plan routine buy process. If and when the new proposed ABC classification based on item price and steadiness of consumptions is implemented, it will decrease the amount of planned orders that have to be more carefully checked. The new C+ class items can be all checked in for release in ASCP. This will result in dramatic decrease of planned orders that have to be checked using A,B, C forecast plan routine buy process.. Although the C+ item routine buy process is extremely fast it can also be automated in ASCP and will free even more time for other important activities.

4.1 Suggestions

First of all the, old ABC classification should be replaced with the new classification as soon as possible. Eliminating over 275 000 planned orders (in a three month time window) from buyer workload will make a tremendous difference. Purchasing of C+ -items should also be automated.

However even with these actions buyer workload in forecast plan routine buy process is too high. The one thing that will speed up the process is the first step of the process: viewing forecast excel tool. As described in chapter 3.5.1. if forecast percentage is around 100% buyers will check the planned order for release. If not, they will go through other steps.

In other words the most important thing to decrease buyer workload is forecast accuracy. This means that DSB process should be developed to produce more accurate forecasts. Vaisala's demand planning process uses primarily judgmental forecasting as the data input of future sales of product families. Like explained in the chapter 2.4., statistical forecasting techniques that use mathematical models often result to more accurate forecast. Vaisala's judgmental forecasting could be combined with statistical forecasting using methods described in the chapter 2.4. For example use of compiled forecast where predefined weighing factor for each forecast is set could make the forecast more accurate. Use of revised judgmental forecast could also be a viable options but it would require Vaisala to hire

and train more demand planners. Component level forecast accuracy could be also developed using methods described in the end chapter 2.4.

As well as development of forecast accuracy buyer workload can be reduced in other ways. As previously said if the forecast percentage is not around 100% buyer will not check that order for release. But what if there was a column in the excel tool that could explain why the forecast percentage is particularly high or low?

If in the beginning of DSB process regional or product managers know about a large potential sale, promotion campaign or launch of new product they would include this information in the forecast template with a predefined code. For example new product launch for HM42PROBE could be coded with PL for HM42PROBE product or the whole product family. This information would stick to the product and product family through DSB process and eventually reach component level through ASCP forecast calculation and BOM explosion. Then when forecast excel tool is prepared for the buyers there would a be a column next to the forecast percentage including PL (new product launch) information for components that are a part of HM42PROBE.

Now when a buyer views planned orders and comes across an item with unusually high forecast but with a code PL in the next column he/she would know that the forecast is high for a reason. Buyer could just check the planned order for release and view the next planned order without having to view supply and demand or having to do other process steps. Different codes could be assigned for different kind of reasons for products and items to have unusually high or low forecast. Even ramp up and ramp down of item information could be included in this new column in the excel tool as it would save time for buyer not having to check item class from excel to understand why forecast is particularly low or high.

Other ways to reduce buyer workload is to view planned orders with a smaller time window than 30 days, like for example 14 days and doing routine buy process only twice a week on a dedicated time where meetings and other work could not be scheduled into.

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As well as literature, electronic and Vaisala internal sources, author's own work experience as a buyer and own knowledge of Vaisala's operations has been used as source in this thesis.