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CONTRIBUTION OF OPERATIVE PURCHASING TO WORKING CAPITAL OPTIMIZATION

Master's thesis

Supervisor / Examiner: Professor Jukka Hallikas

ABSTRACT

Author:	Valtteri Immonen
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This thesis is conducted as a single case study for a case company. The main objective of the thesis is to evaluate the case company's purchasing practices to find out if the case company's operative purchasing behavior could be improved in order to optimize the amount of working capital tied up in inventory. Theoretical framework of this study is based on working capital management and its measuring, purchasing unit's organizational role, purchasing process as well as inventory management. The research was carried out utilizing both quantitative and qualitative research methods.

The conclusion of the study is that the operative purchasing unit's contribution to working capital management is heavily limited by a challenging environment mainly caused by high demand variation and lack of coherent working capital and inventory management strategy, transparency, S&OP, demand planning and appropriate tools. Hence, multiple development recommendations are given for the case company concerning the aforementioned issues.

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Tämän case-yritykselle toteutetun Pro gradu –tutkielman päätavoitteena on arvioida case-yrityksen ostokäytäntöjä ja selvittää, voidaanko case-yrityksen operatiivisia ostokäytäntöjä parantaa sitoutuneen käyttöpääoman määrän optimoimiseksi. Tutkielman teoreettinen viitekehys perustuu käyttöpääoman hallintaan ja sen mittaukseen, hankintayksikön rooliin organisaatiossa, hankintaprosessiin sekä varastonhallintaan. Tutkimus toteutettiin sekä kvantitatiivisten että kvalitatiivisten tutkimusmenetelmien avulla.

Tutkielmassa kävi ilmi, että operatiivisen ostoyksikön kykyä käyttöpääoman hallitsemiseen rajoittaa haastava ympäristö, joka johtuu suurelta osin kysynnän suuresta vaihtelusta, sekä johdonmukaisen käyttöpääoman ja varastonhallinnan strategian, tiedonjaon, S&OP -prosessin, kysynnän suunnittelun ja työkalujen puutteesta case-yrityksessä. Tutkielma sisältää erilaisia parannusehdotuksia kyseisten haasteiden ratkaisemiseksi.

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It is almost exactly five years since I moved to Lappeenranta and started studying at LUT and I must say the four years I spent living in Skinnarila were one of the best years of my life so far. There are a lot of people who have been involved in the whole process for whom I want to express my gratitude to. First of all, kudos to my family and friends including but not limited to Mari, Mosa and especially the PK guys with whom I spent most of my time at Lappeenranta and shared many memorable moments. I would also like to express my gratitude to my supervisors for guiding me throughout the research, and also to my co-workers, especially the purchasers and people from delivery and sourcing department, who took part in the thesis.

In Helsinki 26.7.2018

Valtteri Immonen

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1 Introduction

Although efficient working capital management increases companies' profit margins and reduces financial costs, companies have necessarily not recognized the actual importance of efficient working capital management. However, during recession or other times of constrained incoming cash flows, companies neglecting working capital management start facing problems due to having too much cash tied in processes. In fact, several companies went bankrupt during the recent financial crisis (Mullins, 2009, 5). One could say the crisis acted as a "wake up call" for academics, too. According to Lukkari's (2011) review, academics have paid increased attention to efficient management of working capital since the crisis.

The larger a corporation, the more difficult it is to manage cash tied up in processes within the company. When tasks and responsibilities of employees are limited to cover only small part of a process, the bigger picture of a whole is often left with too little attention. Although purchasing and procurement play a significant role in working capital management, the responsibility does not solely lie on purchasing unit. Areas of working capital management such as inventory management require not only supervision and decision making inside the purchasing unit but also horizontal cooperation across different organizational units. This requires well established planning function and practical tools developed especially for the purpose.

An optimal way of managing working capital varies between different industries and companies (Hill, Kelly & Highfield, 2010; Chiou, Cheng & Wu, 2006, 155). In this thesis, the purchasing unit under examination operates in project oriented B2B service business. Hence, the case company's purchasing unit is responsible for purchasing devices that are delivered to customers as a part of a service. Majority of literature and

different concepts and models are based on manufacturing or retail environment which makes the subject of the thesis both challenging and interesting.

At the moment of writing this thesis, the case company already has some tools and practices in place. These tools and practices are somewhat limited due to lack of systematic purchasing process and related IT system development during the recent decade. This thesis addresses the need for further development regarding the case company's purchasing practices and tools.

1.1 Objectives and research questions

The main objective of the thesis is to evaluate case company's purchasing practices to find out if the case company's operative purchasing behavior could be improved in order to optimize the amount of working capital. Working capital management and the role of purchasing are first examined through theoretical foundations after which the theories will be reflected to a real world situation in the case company. Rather than formulating completely new kind of inventory management policies for the case company, the purpose of the thesis is to identify plain flaws in the case company's current practices and propose ways to fix the flaws.

The second objective is to find out how the case company's current practices and processes that affect the purchasing unit's capability to manage working capital currently. Instead of examining the operative purchasing unit as a silo, the goal is to gain a wider understanding of most relevant practices outside the purchasing unit that affect the purchasing unit's capabilities.

The third and final objective is to identify if the case company's processes and practices could be developed to optimize operative purchasing unit's contribution to working

capital management. Based on the findings, different recommendations will be given to the case company.

Based on the research's objectives, the main research question is:

> ***How can case company's operative purchasing contribute to optimizing working capital?***

The supporting sub-questions are:

1) *How do case company's practices and processes affect case company's operative purchasing unit's capability to manage working capital currently?*

2) *How should the case company's processes and practices be developed to optimize operative purchasing's contribution to working capital management?*

1.2 Limitations

The research is limited to case company's operative purchasing unit responsible for B2B device and equipment purchases and within this to two services offered to B2B customers. The goods purchased are first purchased to an inventory operated by a third party logistics provider and then delivered to customers as a part of a service. The limitation into specific services was done to simplify the research and the particular services were selected as the two services are similar in terms of purchased items and delivery processes. Rather than defining optimal levels of working capital and striving for that level, the thesis focuses on ways to decrease the amount of working capital tied up in processes.

As the topic of the thesis is case company's operative purchasing, it will focus on operational matters of improving working capital management rather than financial.

Therefore, operative definition of working capital is used instead of financial one. Due to the study being company specific, the findings should not be applied into other environments. It should be especially noted that as there is no such thing as an exact definition for operative purchasing and its roles, the role and responsibility of such purchasing unit varies between different companies.

Although management of account receivables is a very central part of working capital management, it has been limited out from the empirical part of this thesis due to procurement having little to no role in the management of account receivables. It also appeared that the particular purchasing unit does not participate in contract management and hence, its role in working capital management is limited to capital tied up in inventory.

1.3 Theoretical framework

Theoretical framework of the thesis consists of two main sections. The first section concentrates on previous research on working capital, its management and measuring. The second section focuses on purchasing’s role in working capital management.

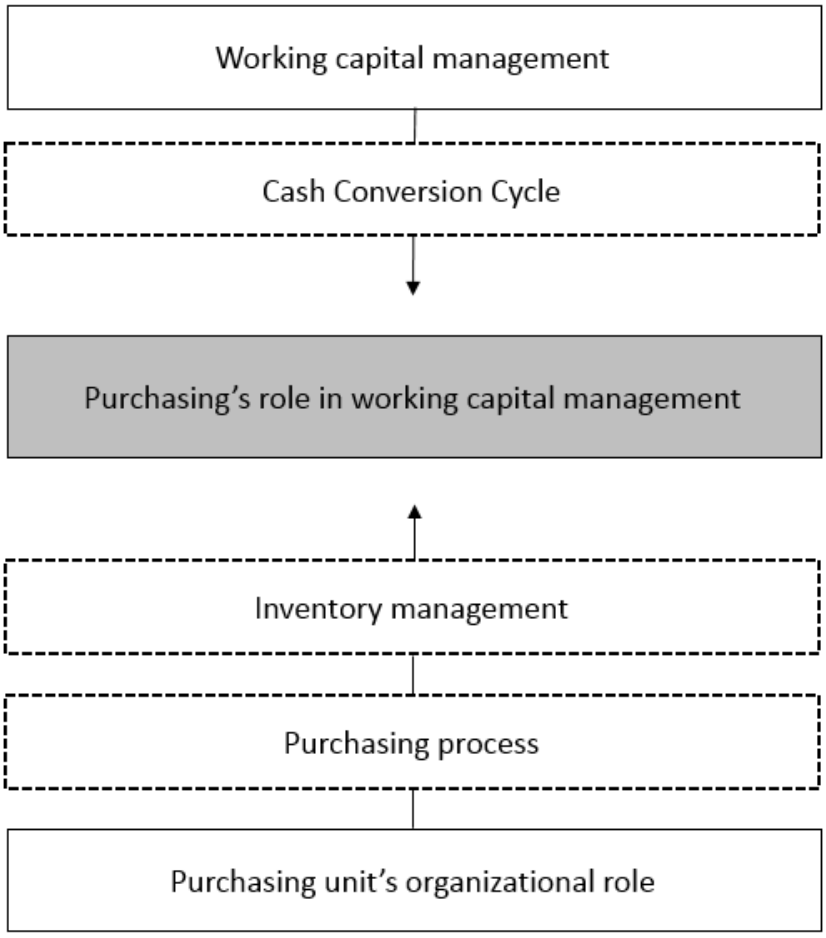

Figure 1. Theoretical framework of the thesis

The theoretical framework for the study is presented in Figure 1. The framework consists of two main concepts: working capital management and purchasing's role in working capital management. The concept of working capital management focuses on its definition, optimization and measurement through Cash Conversion Cycle.

As the role of purchasing in working capital management varies inter and intra organizationally, the role of purchasing in working capital management is approached first through theoretical foundations regarding purchasing unit's organizational role and purchasing process. Previous literature regarding inventory management including material replenishment models, selective inventory management, lot sizing, safety

stock and demand and sales & operations planning gives a framework within which purchasing policies should be developed.

1.4 Research methods

This master's thesis is conducted for a company as a case study. The purpose of a case study is to study phenomenon in a real life context (Yin 2009, 2). Due to the research being limited to one case company, the research can be described as a single-case study. The thesis consists of two sections; literature review and empirical research. Both qualitative and quantitative research methods are utilized in the empirical part. In order to gain comprehensive understanding of the case company's internal processes and purchasing behavior both methods are necessary.

Qualitative data is gathered by conducting semi-structured interviews with the case company's employees. Semi-structured interviews involve a set of open-end questions that allow the researcher to understand the phenomenon on a detailed level by spontaneous and in-depth responses (Ryan, Coughlan & Cronin, 2009). By interviewing, the researcher gathers information regarding current processes, policies and practices influencing case company's purchasing unit. Quantitative data was gathered from primarily from the case company's ERP system and it consists of inventory data such as historical stock levels and demand data, based on which the case company's past purchasing behavior and inventory management is analyzed. In addition to the previously mentioned quantitative and qualitative data, observing is in a central role in the research. The researcher is a current employee of the case company, meaning that the researcher had general understanding of the case company's internal processes already prior to the research and was able to observe the case company continuously by participating in meetings.

1.5 Structure of the thesis

The study consists of three sections which are theoretical framework, empirical research and discussion including conclusions of the study. The theoretical framework consists of two chapters. First, chapter 2 discusses existing literature regarding working capital, its management and measurement. Chapter 3 addresses purchasing's role in working capital management and it reviews existing literature regarding purchasing unit's organizational role, purchasing process, main factors influencing inventory management and last, demand and sales and operations planning

Chapter 4 presents the research methodology utilized in the thesis including research methods and phase-by-phase research process utilized in the thesis. The empirical section of the study starts on Chapter 5 with a brief introduction into the case company and characteristics of the two services. Then, after reviewing the purchasing unit's role in the case company and the current delivery and purchasing process, different kind of inventory management practices and current working capital measures are reviewed. The final part of the empirical analysis focuses on findings mainly based on inventory data. Chapter 7 ends the study with discussion including recommendations for the case company and conclusions.

2 Working capital management

This chapter gives theoretical foundation for the research regarding working capital management, its optimization and measurement.

2.1 Definition of working capital

In its simplicity working capital can be defined as assets needed by companies to run their day-to-day activities (Charitou, Elfani, Lois, 2010). However, the concept of working capital can be utilized and studied in different kind of contexts and thus, working capital can also be defined in various ways. Whilst net working capital defines working capital as a difference between current assets and current liabilities, a derivative of the aforementioned called operational working capital, also defined as process-related working capital focuses on capital tied in processes only. (Talonpoika, 2016) Furthermore, the traditional or so called financial working capital is originally defined by Fleuriet et al. (1978) as a difference between financial assets and financial liabilities. As stated by Talonpoika (2016), net working capital addresses the capital employed by a company, whereas the operational and financial definitions indicate whether the capital is employed by operations or financials.

One should make a clear distinction especially between financial and operational working capital as the optimal values for the aforementioned are completely opposite. As financial working capital measures a company's ability to pay its short term liabilities, the higher the value, the better the company's ability is. However, due to operational working capital measuring the amount of capital tied up in processes, the optimal value is as low as possible.

$$Working\ capital\ =\ Inventories\ +\ Accounts\ receivable\ -\ Accounts\ payable \quad (1)$$

Since this thesis addresses the capital tied up in case company's operative purchasing practices, working capital is defined by the operational definition which is calculated as presented on Equation 1. Pirttilä (2014) elaborates that the definition is derived as such since other items of current assets and liabilities affect daily operations of companies in an indirect manner. The inventories companies purchase to create deliverables are usually bought on credit after which the deliverables are sold to customers, correspondingly on credit. This activity generates accounts payable and accounts receivable without generating actual cash flow before the companies collect accounts receivable and compensate accounts payable. She continues by denoting that accounts payable and accounts receivable are often together referred to as trade credit.

2.2 Management of working capital

Working capital's components, including inventories, accounts receivables and accounts payables, often form a significant proportion of companies' total assets which is why working capital management has a significant effect on companies' profitability (Deloof, 2003). Considerable amount of research indicate that low levels of working capital often results in higher profitability as Deloof (2003), Nobanee, Abdullatif & AlHajjar (2011), Enqvist, Graham & Nikkinen (2014) and Jose, Lancaster & Stevens (1996) have all found a negative correlation between amount of working capital and profitability.

As operational working capital management plays an essential role in effective short-term finance and asset management companies, Marttonen, Monto & Kärri (2013) state that companies should apply aggressive operational working capital management strategies by decreasing cycle times of inventories and accounts receivables and increasing the cycle times of accounts payable. According to Noreen et al. (2010, 169) working capital management strategies are not initiated on local or regional level but

on corporate level, which also reflects the importance of proactive working capital management. In addition to increased profitability, successful working capital management improves companies liquidity, gives operational flexibility and readiness to respond to fluctuating economic situations (Taylor, 2011, 12).

2.3 Working capital optimization

Working capital optimization is a subject of finding a balance between minimizing capital tied up in the processes of a company and mitigation of risks related to low working capital level (Refuse, 1996). According to Hofmann & Kotzab (2010), majority of companies require particular level of working capital to protect themselves from unpredictable financial inflows and outflows. They continue by stating that different kind of financial challenges, such as suboptimal loan decisions, inadequate trade credit terms and also operative issues such as disconnected supply chain processes and unnecessary levels of inventories, often result in excessive working capital.

Although companies often strive for minimizing levels of working capital, it should be noted the levels should be optimized according to contextual features rather than minimized. Academics have suggested different kind of influential factors affecting the optimal level but a consensus among researchers regarding different dependent variables and their importance is lacking (Marttonen et al. 2013). From a company's point of view, these factors or variables can be either internal or external. Hill et al. (2010) found out in their study that the levels are clearly industry dependent. Chiou et al. (2006, 155) state that the most important internal factors are company's operating cash flow, growth rate, company performance and the size of the company.

Some researchers even go as far as saying that the most optimal level of working capital is zero, but the aforementioned internal and external factors increase the levels

(Manes & Zietlow, 2002; Hill et al. 2010). As already mentioned, companies must protect themselves from uncertainty and therefore an optimal level of zero is very difficult to achieve in practice. Uncertainty in this context can for example refer to unforeseeable supply chain disruptions caused by long lead times, for which companies must reserve excessive stock. Chiou et al. (2006) state the optimal value should be found by setting it at the lowest value where unexpected capital requirements can be met; too low values can result in companies missing profitable investment opportunities and liquidity crisis.

2.4 Cash conversion cycle

Although traditional measurements such as quick ratio and current ratio are sometimes used as measures of working capital management, using them as measurement indicators can result in bad working capital management as companies often try to maximize these values in hope for better ratings by bankers (Kaiser & Young, 2009). Also, taking into account the context of this thesis, the aforementioned ratios do not represent relevant values as they indicate the ability of a company to pay its short-term debt rather than efficiency of managing working capital.

An alternative for the traditional measures is Cash Conversion Cycle (CCC), also known as Cash-to-Cash Cycle, which has been used as a measure of operational working capital management in various researches (Deloof, 2003; Richards & Laughlin, 1980; Farris & Hutchinson, 2002). CCC is an effective standardized working capital measurement tool which can be utilized to evaluate how well companies are managing working capital and it is often used as a key performance indicator for supply chains (Richards et al. 1980; Farris et al. 2002). CCC can be considered as a practical measure as it demonstrates operational effectiveness of a company although it is derived from financial statements (Lambert & Pohlen, 2001).

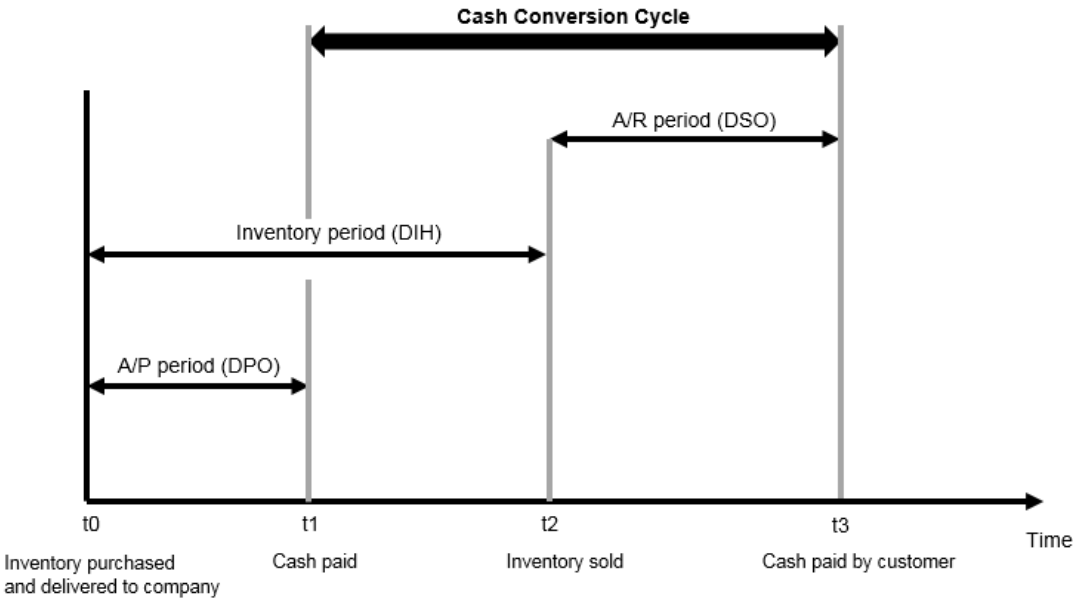

Figure 2. Cash Conversion Cycle (Hofmann & Kotzab, 2010)

As seen on Figure 2, CCC reflects the time period between a cash outflow resulting from purchase of raw material and the cash inflow occurring from the sale of finished goods and the collection of accounts receivable (Hofmann et al, 2011; Falope & Ajilore, 2009). There are many different definitions in the literature for CCC although they all indicate the time required to convert money invested in material into money received from customer. For example Moss and Stine (1993) define CCC as "the length of time between cash payment for purchase of resalable goods and collection of accounts receivable generated by sale of these goods".

$$CCC = Days\ Inventory\ Outstanding + Days\ Sales\ Outstanding - Days\ Payables\ Outstanding \quad (2)$$

CCC is calculated by the Equation 2, in which the sum of Days Inventory Outstanding (DIO) and Days Sales Outstanding (DSO) is deducted by Days Payables Outstanding (DPO) (Farris & Hutchison, 2003; Lind, Pirttilä, Viskari, Schupp & Kärri, 2012). The shorter the cycle time is, the higher is the value of present cash flows and thus, the higher the value of the company is (Shin & Soenen, 1998). In other words the lower the

value is the less a company has capital tied up in non-value adding processes, hence optimal value being as low as possible. Furthermore, a short cash conversion cycle results in high opportunity costs whereas longer cash conversion cycle is associated with high carrying costs (Nobanee & Alhajjar, 2014). Hofmann et al. (2014, 56) indicate that companies should be careful when optimizing the levels; expending DPO, shortening DSO or forcing smaller partners with relatively high cost of capital to hold inventories will eventually be reflected into prices which the partners are forced to raise to cover the cost of financing their activities.

As CCC is a measure of working capital management, it is no surprise literature does not define optimal levels of CCC either. As optimal levels highly depend on various factors such as industry, defining generic levels is challenging. Companies can however try to determine optimal levels by their own. (Nobanee & Alhajjar, 2014) In order to achieve low levels of CCC, companies must receive account receivables before paying its accounts payable (Farris et al. 2003). There is evidence companies can operate with a null or even negative CCC (Lind et al. 2012). To succesfully manage CCC, managers should comprehend how CCC performance has changed historically (Farrsi et al. 2003).

2.4.1 Days Inventory Outstanding

The first component of CCC, Days Inventory Outstanding (DIO) reflects the average number of days a company holds inventory items before selling them.

$$DIO = \frac{Inventory * 365}{Cost\ of\ Goods\ Sold} \quad (3)$$

DIO is calculated by equation 3, in which total value of inventories are divided by cost of goods sold within a year and the result is multiplied with 365 (Farris et al. 2003). From a single company's view, too aggressive reduction of inventory outstanding period would result in additional costs due to shortages (Nobanee & AlHajjar, 2014). Accordingly to working capital optimization in general, the optimal level of DIO depends on the company's internal and external factors. Therefore, companies need to derive their own and specific inventory strategy to optimize the amount of DIO days (Scherr, 1989, 289-290). Cheng (2009) lists DIO as a primary KPI for supply chain planning along with forecasting accuracy, planning cycle time and CCC.

Inventory management, and thus also reduction of DIO is discussed further in chapter 3.3. Smid (2008) however lists six potential areas to improve DIO ratio:

- Standardized supply chain management across the organization
- Integrated system for continuous communication and tracking of performance
- Management focus on slowly cycling and excessive inventory
- Stock Keeping Unit (SKU) rationalization
- Introduction of Vendor-Managed Inventory
- Integrated and Robust forecasting and demand planning process

2.4.2 Days Sales Outstanding

Companies often sell their products or services on credit instead of requiring immediate payments. This type of activity generates account receivables. (Mian & Smith, 1992) Days sales outstanding (DSO) describes average time period during which company is able to collect receivables. The DSO ratio is highly dependent on negotiated payment terms between the Buyer and Supplier and also on efficiency of accounts receivable management. (Nobanee & Alhajjar, 2014) Worth noting is that as the sole purpose of selling on credit is to achieve more sales, companies could suffer the loss of profitable customers due to reducing receivable collection period.

$$DSO = \frac{Accounts\ receivable * 365}{Sales} \quad (4)$$

DSO is defined Outstanding is defined as a ratio between accounts receivables and sales, multiplied by 365 days (Farris & Hutchinson, 2003). Receivables management and therefore DSO ratio too can be improved for example by (Smid, 2008):

- Low amount of unbilled receivables
- High direct debit penetration
- Effective organizational structure of collections management
- Implementation of a proactive collection strategy for each type of customer
- Enhancement of dispute management process
- High automation in the dunning letter process
- Unification and harmonization of billing processes

2.4.3 Days Payables Outstanding

The third component of CCC, Days Payable Outstanding (DPO), indicates number of days between receiving a receipt and paying the bill. Accordingly to DIO, sometimes sales are used as denominator.

$$DPO = \frac{Accounts\ payable * 365}{Cost\ of\ Goods\ Sold} \quad (5)$$

As shown on equation 5, DPO is calculated as dividing accounts payable by cost of goods sold multiplied by 365 days (Farris et al. 2003). Deloof (2003) indicates that management of payables can be mainly improved by delaying payments to a supplier, which can be done by negotiating longer payment terms with the supplier and be used

as an inexpensive financing method, too. Deloof (2003) reminds that one should note that the extension of payment days might not be the most profitable solution as suppliers often offer discounts for early payments. In addition to negotiating longer payment days, management of payables can be improved for instance by utilizing central functions, infrequent payment runs, joint procurement approach, initiating strict rules to limit or refuse early payments and consolidation of spend (Smid, 2008).

3 Purchasing unit's role in working capital management

Chapter two discusses purchasing's role in working capital management.

3.1 Purchasing unit's organizational role

During the recent decades, the role of companies' purchasing units have evolved from reactive role into a strategic function. In other words, purchasing units no more focus solely on purchasing goods at a minimum price, but their purpose is to deliver value and competitive advantage for the whole organization (Krause, Pagell, Kurkovic, 2001; Knoppen & Sáenz, 2015, 123). Companies often have both strategic (often called as sourcing or procurement) and operative purchasing units in their organization. As the roles of purchasing units vary across different companies, it is difficult to define a general role for purchasing within working capital management. A good example is Ganesan's (2015, 29) statement, in which he mentions that it is usually companies' supply chain organization responsible for inventory management, but in some cases the responsibility can belong to procurement, distribution or manufacturing department.

As this thesis addresses the role of operative purchasing, it is vital to understand level of centralization in company's purchasing unit as they play a significant role in the responsibilities and capabilities the respective purchasing unit has. These responsibilities and capabilities are in an essential role in the particular purchasing unit's capability to contribute to working capital management. Van weele (2014, 266) divides purchasing tasks and responsibilities to three levels: strategic, tactical and operative levels. Strategic level covers activities that includes purchasing decisions that affect the company's market position in the long run, e.g outsourcing decisions, negotiating long-term purchasing contracts and major investment decisions. The

tactical level includes activities affecting product, process and supplier selection such as negotiating annual supplier framework agreements and contracting of suppliers.

The operative level includes activities related to ordering process, for example ordering of materials, monitoring deliveries and making payments. In other words, operative purchasing places orders on the contracts negotiated by strategic or tactical levels. Operative tasks include daily problem solving on quality, supply and payment with suppliers. Roles in operative level purchasing include e.g purchasing engineers and operative purchasers (or materials planners), who continuously monitor and manage inventory and suppliers based on their delivery reliability and quality. Usually, operative purchasers focus mainly on logistics aspects such as order quantities, packing requirements and delivery times. (Van weele, 2014, 25;266-268;280) As the operative purchasing's focus is on inventory management related tasks, it can be generalized that operative purchasing's contribution to working capital optimization is limited to inventory.

In a centralized purchasing organization model, all corporation's purchasing and sourcing activities including operative purchasing or order placing, contract management and supplier management are situated in the same unit. The opposite of the former is a decentralized model where the responsibilities are distributed across different independent purchasing units responsible of purchasing activities for their respective business unit. In a hybrid purchasing model, the more strategic tasks such as contract and supplier management are situated in corporate's central purchasing unit, and operative purchasing and order placing is located at separate units located closer to business units. (Van weele 2014, 267-270;286)

3.2 Purchasing process

Van Weele (2014) suggests a generalized model for purchasing process which includes six phases. Various other models exist too, such as Van der Valk's and Rozemeijer's (2009) service purchase model which extends the Van Weele's model with two additional phases. Moreover, Fitzsimmons, Noh & Thies (1998) propose a service purchasing model consisting of four phases only. As this research focuses not on purchasing of services but physical items such as devices and equipment, the focus on this thesis will be on Van Weele's (2014) model.

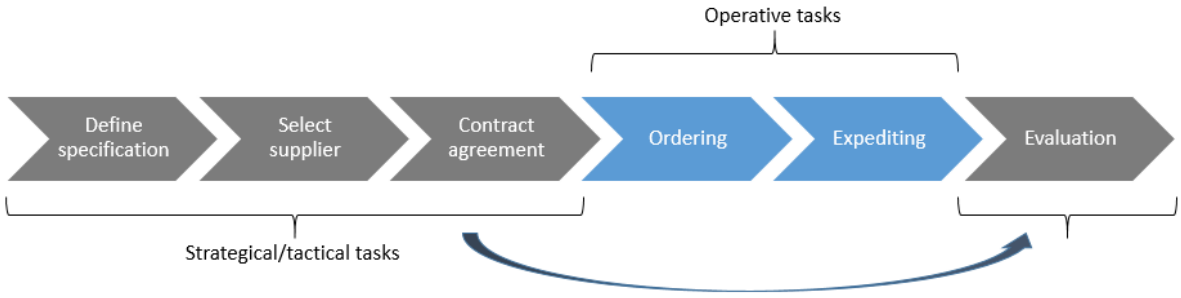

Figure 3. The purchasing process (adapted from Van Weele 2014, 28; 266-268)

The model's six phases – defining specification, selecting supplier, contract agreement, ordering, expediting and evaluation - are shown on Figure 3. At the first phase, the specification phase, the company is facing the "make-or-buy" decision. When a decision to purchase is made, more detailed specifications and requirements for the purchased items must be made such as functional and technical specifications. Specification phase is followed by supply market research that ends up in selecting the supplier. Before selecting the supplier, the company needs to first determine the method of subcontracting and perform preliminary qualification of suppliers, after which tendering process can start and analyzing of the bids occurs. Ultimately one or in some cases various suppliers will be selected, with which contractual terms will be negotiated. (Van Weele, 2014, 28;32-36)

After finalizing contracts, operative purchasing can place orders on them in a form of a purchase order. This phase has been given very limited attention in researches; out of the three different models, Van Weele (2014, 40-41) is the only one to discuss purchase ordering. For production and inventory items, a purchase order is usually initiated through a purchase order requisition when Material Resource Planning (MRP) system detects that inventories are getting lower than their minimum acceptable level is. Advanced MRP systems enable the requisition to be transferred to a purchase order electronically, after which the purchase order will be sent to the supplier for confirmation.

The fifth phase and the second operative task, expediting, refers to monitoring of suppliers performance. Supplier's delivery documents together with the purchase order and invoice form the basis for supplier's evaluation system. The better these activities have been executed, the easier it is for the buyer to go through the order handling stages. In reality, the buyer needs to perform additional efforts to ensure the supplier is complying to what is agreed. Therefore, continuous expediting is extremely important to ensure that for example late deliveries do not cause disruptions in the company's internal processes. In cases where the stakeholder notifies the purchaser that a delivery has not arrived, the purchaser is already operating after-the-fact. Instead, the goal for the purchasers should be to act proactively by having routine status checks. Here, proper reporting system also plays a significant role so that the stakeholders can notify the buyer about quality and delivery time flaws. Having constantly updated information regarding suppliers' capabilities and performance and reporting it to management cannot be stressed enough, as the information is used in the evaluation of the supplier which then can be utilized in future bidders' short list for new projects and contracts, for example. (Van Weele, 2014, 42)

3.3 Inventory Management

Inventory management is a significant part of working capital optimization as DIO is one of the key measures of CCC. By having effective inventory management policies, companies can have more efficient use of working capital through lowering the average days of outstanding inventory.

Companies set up inventories for several reasons and they can be seen as both cost reduction and security functions. By bundling lot sizes, fixed ordering costs decrease and procurement costs are often degressive due to volume discounts offered by suppliers. Companies are able to protect themselves from uncertainty as safety stock levels can be used to ensure the availability of goods during demand and supply fluctuations. Sometimes inventories can be seen as a speculation function, too; they can be used to compensate for fluctuations in market price and exchange rates in case the prices or rates are expected to increase. (Hoffman, Maucher, Piesker & Richter, 2011, 33-34)

Inventory management should be done actively as it is a success factor for efficient working capital management. According to Hoffman et al. (2011, 32), inventories are the largest item in working capital with a 34 % average share. Despite the security and potential cost reductions for companies, inventories are subject to different costs. In addition to the actual purchasing cost, inventory costs such as the costs caused by the use of warehouse infrastructure, technical facilities and personnel should be taken into account and opportunity costs too as funds invested in goods are not available for other investments (Hofmann et al. 2011, 33-34). Furthermore, Azzi, Battini, Faccio, Persona & Sgarbossa (2014) stress that knowing the unitary holding cost of goods is becoming continuingly more critical for managers due to more complex warehousing systems. Companies should also find a balance between the cost of inventory risk and Out-of-

stock costs as poor establishment of inventory levels may lead to excessive inventory levels and thus to outdated and depreciated products, and at the other extreme too low inventory levels result in products being out of stock and loss of sales revenue (Hofmann et al. 2011, 34).

3.3.1 Material replenishment models

To tackle the abovementioned challenges, companies should determine how often, when and by which quantity the inventories should be replenished. The answer for this is dependent on the SKUs' importance, review interval, inventory policy and service objectives. The importance of the SKUs can be defined with the help of selective inventory management methods such as ABC classification. For the review interval, either continuous or periodic review manners can be utilized. (Silver, 1998, 235-236) In continuous review, inventory levels are monitored continuously and whenever the level is low enough, a request for replenishment is sent. When utilizing a periodic review manner, the levels are monitored only periodically within certain time intervals. In general, continuous review results in less safety stock but it is more time consuming to do due to the continuous monitoring. (Axsäter, 2015, 47)

Axsäter (2014, 48) denotes there are two most common material replenishment models: (R, Q) Policy and (s, S) Policy, both of which can be implemented with continuous and periodic review. He continues by explaining the two models: In the (R, Q) policy, a batch quantity of Q is ordered whenever the stock level reaches the reordering point R. If the inventory position is significantly lower than R is, multiple batches may be ordered to get above R. The main difference between utilizing continuous and periodic review in the context of (R, Q) policy lays behind the inventory position at the time of ordering; when utilizing periodic review, the inventory levels are often below R, where as in continuous review, given that demand is one item at a time, the reordering point R will always be hit. The (s, S) policy, in which an order up to the

maximum level of S is ordered whenever inventory position declines to or below the reordering point s. Instead of ordering multiple fixed batches, the (s, S) policy always orders a quantity up to the maximum inventory level S. The (s, S) policy is often referred to as min-max method (Sakki, 2009, 125).

3.3.2 Selective inventory management

Due to inventories often holding large numbers of different kind of SKUs not all of them can be efficiently managed. Customers are continuously demanding for more differentiated products which results in increasing amount of SKUs (Ramanathan, 2006). As benefits of inventory management need to be greater than cost of the management, companies should initiate selective inventory management (SIM) in order to design a cost-effective inventory (Vrat, 2014, 39). In other words, companies should prioritize SKUs according to which activities and resources should be allocated. The most common SIM method is ABC analysis which groups all SKUs held in inventory into three categories: A, B and C based on their annual usage value (Vrat, 2014, 40).

$$Annual\ usage\ value\ =\ annual\ consumption\ in\ units\ x\ unit\ purchase\ price \quad (6)$$

The annual usage value can be calculated by Equation 6. Although the basis of the ABC analysis is the Pareto principle, also known as the 80-20 rule, the Figures should not be literally interpreted. (Vrat, 2014, 40-41) The following specifications by Vrat (2014, 40) for the three classes are only explanatory:

- Class A: Circa 10% of SKUs that are responsible for circa 75 % of total annual material expenditure. For these items, any sort of scientific inventory management practices are justifiable.

- Class B: Next 20 % of SKUs that are responsible for 20 % of total annual material expenditure
- Class C: Next 70 % of SKUs that are responsible for 5 % of the total annual material expenditure. For these items no scientific inventory management practices are required.

Class A items should be treated with continuous inventory status monitoring, most accurate record keeping, demand forecasting and regular monitoring of inventory turnover ratios. Purchase price negotiations, lead time reduction plans and further vendor development should be initiated for the A items. Although the number of SKUs belonging to class A is only a fraction of all items, even a 10 % cost reduction would result in a 7.5 % cost reduction of total material budget. For B classes more loose practices will do, whereas intuitive judgment is enough for class C items. (Vrat, 2014, 41). The continuous reviewing of class A items is also underlined by Mohammaditabar, Ghodsybour & O'brien (2012, 656) who continue by denoting that the review practice for class C items is often periodical.

Although ABC analysis is a useful and popular method for categorizing SKUs, it has its limitations as it focuses on SKUs' annual volume only. According to Flores, Olson & Dorai (1992), classification items based on their annual volume only may create misleading classification of items. An item can for example have high annual monetary value but highly fluctuating demand. Therefore, SKUs should be classified according to a multi-criteria, which can consist of multiple different categories such as demand distribution, lead times, criticality, stock-out penalty cost and substitutability (Ramanthan, 2006; Flores et al. 1992). For instance, C items with high criticality should be identified and moved into A or B categories (Huiskonen, Niemi, Pirttilä, 2005). One should make a very careful analysis how many criteria should be used. Too many criteria will result in too complex analysis which will have very limited value, but on the other hand too few criteria might not capture enough complexity (Christopher, Towill, Aitken & Childerhouse, 2009).

Complementary analyses such as XYZ analysis are often combined with ABC analysis in order to establish more accurate and practical classification for SKUs. XYZ analysis uses coefficient of variation as a classifying variable. The three classes X, Y and Z are defined as following (Errasti, Chackelson & Poler, 2010):

- X: Continuous consumption with some fluctuations
- Y: Moderately stronger fluctuations in consumption
- Z: Fluctuating consumption, sometimes even stochastical consumption

The more continuous the demand is, the forecastable it is. Therefore, XYZ classification can be used to categorize SKUs based on their forecastability. By utilizing ABC and XYZ classifications, SKUs can be classified in nine different categories, based on which different kind of inventory management and purchasing policies can be derived for the SKUs (Scholz-Reiter, Heger & Bergmann, 2012). The nine categories are visualized in Figure 4.

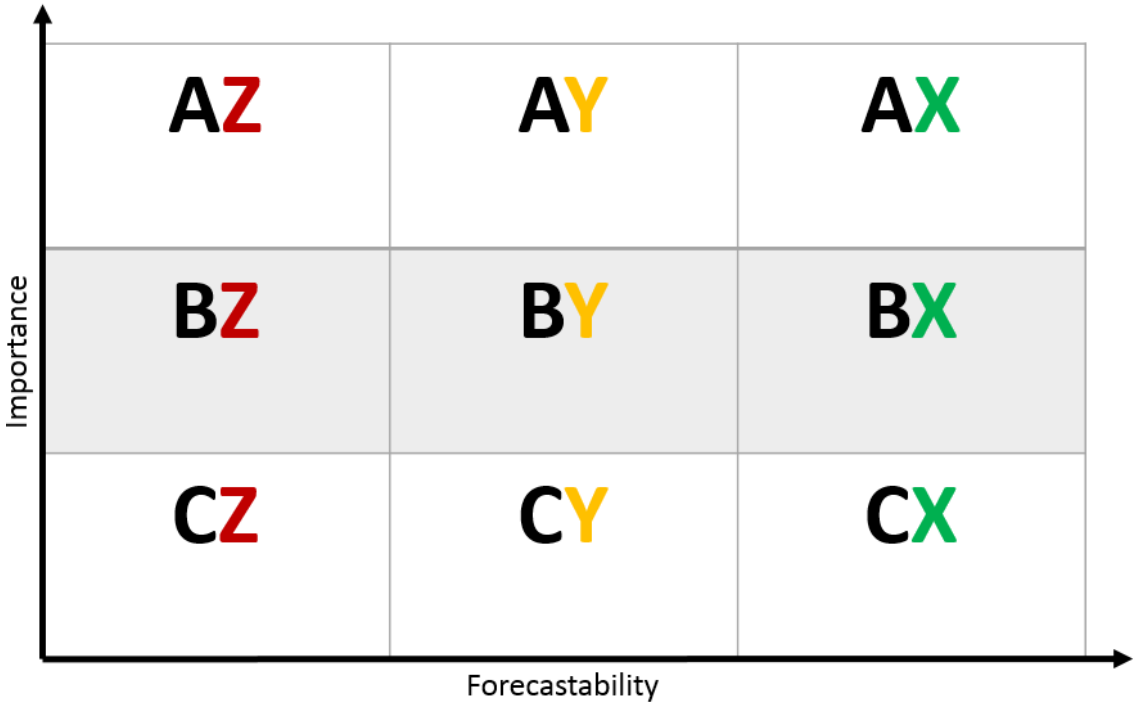

Figure 4. ABC/XYZ segmentation visualized as a matrix

Errasti et al. (2010) propose that ABC/XYZ analysis should be automatically generated with a tool, after which the results should be checked and SKUs should then be re-positioned to proper classes. After that, most effective replenishment strategies should be settled to optimize service and stock levels. The analysis should also be conducted on a repetitive basis; according to a case study by Scholz-Reiter et al. (2012) conducted on an industrial company, a yearly ABC-XYZ analysis is not enough. They propose that the analysis should be made on a monthly basis due to high dynamics in terms of consumption consistency of SKUs. Regarding the actual analysis, worth noting is that as the classifying variable in XYZ analysis is the coefficient of variation, XYZ analysis might not give an appropriate classification for SKUs with low demand as the coefficient reacts aggressively for the changes in low demand SKUs.

3.3.3 Lot sizing

There are various different ways for defining optimal ordering quantity. Probably the best known is Economic Ordering Quantity (EOQ), which takes ordering and warehousing costs and demand into account and thus, the aforementioned variables must be known as well. Additionally, the method assumes that ordering costs are the same regardless of ordering size and products ending out of stock is not admissible. (Horngren et al. 2009, 726). EOQ also requires continuous monitoring of inventory level as whenever inventory level decreases to a predetermined level called reorder point, a fixed quantity of items are ordered (Vrat, 2014, 29). EOQ is calculated as following (Maness & Zietlow, 2002, 96):

$$EOQ = \sqrt{\frac{2DS}{H}} \tag{7}$$

Where D= yearly demand (units)
S= ordering costs per purchase order
H= yearly warehousing costs per unit

Utilizing EOQ is not however a viable option under fluctuating demand as it will result in inappropriate ordering sizes (Ganesan, 2015, 62). In addition to EOQ and its variants, multiple more complex algorithm based models exist such as Wagner-Within algorithm which is often very difficult for practitioners to understand. As lot sizing is an operative task, it should be performed by simpler methods. The most conventional, simple and potentially the most proactive method is lot-by-lot, in which the ordering quantity is basically the quantity needed for a certain time period, meaning that the method does not take ordering and warehousing costs into account. Given that the ordering and warehousing costs are low and ordering can be made in a proactive manner, lot-by-lot is in fact the preferred method of defining ordering quantities. (Vrat, 2014, 160-165)

3.3.4 Safety stock

To ensure delivery reliability, companies are often required to define safety stocks for SKUs. In other words, safety stock is inventory that prevents stockouts. Safety stock is the reordering point deducted with demand occurring during the inventory items' lead time (Silver et al. 1998, 251). Stockouts can occur due to risk and uncertainty arising from fluctuating customer demand, variability in lead times and forecast inaccuracy. (King, 2011; Silver & Peterson, 1985, 254)

Tersine (1976, 210) stresses that the benefits of increasing safety stock are subject to diminishing marginal benefits. He continues explaining that if the safety stock level is defined up to a point where the probability of a stockout approaches zero, adding additional safety stock will only increase inventory holding costs. This is supported by King (2011) who underlines that the safety stocks are not intended to prevent all stockouts but to ensure pre-determined customer service levels.

Ganesan (2015, 130) points out in his study that safety stock levels should be frequently supervised and changed according to demand patterns. The study explains that in order to ensure the right levels for the safety stock, the levels should not be specified as a proportion of demand but as a simple quantity specification. Although specification as a proportion of demand assures automatic adjustments to the levels, distortions in demand will get magnified and reflected into the safety stock levels, hence causing inadequate inventory. According to King (2011), in practice the safety stock levels are often defined according to operations managers "hunch" although such approaches often result in bad performance. Instead, the definitions should be based on mathematical techniques.

3.3.5 Demand planning and S&OP as supporting functions

Lack of demand transparency is a common problem for companies and often the only information regarding demand is orders placed by customers or already occurring deliveries (Cachon & Fisher, 2000). To tackle this challenge, companies should initiate processes such as Sales and Operations Planning (S&OP) that focus on collaboration across different groups within the organization.

Sales and operations planning (S&OP) is a function that concludes demand planning by combining different business plans together in a collaborative manner. The purpose of S&OP is to sustain a balance between supply and demand and deliver early notifications whenever imbalance of the two occur. (Thome, Scavarda, Fernandez & Scavarda, 2011; Vollmann, Berry, Whybark & Jacobs, 2005) Scott (2011, 28) defines S&OP as “the process of constantly realigning decisions in sales, marketing, demand and supply planning areas with the aim to synchronize with the strategic financial plans”. He continues by opening up the S&OP process that starts by demand planning in which company’s marketing, sales and demand planning teams combine all relevant forecasting data together. Then, the demand plan is delivered to resource and supply planning team which then analyses the demand plan against production plan, inventory availability and capacity constraints and forms an operations and resource plan. Finally, the outcome of the two previous phases is reflected against the company’s financial goals including revenue and business targets, profitability targets and customer service level commitments. This cycle occurs continuously for example on a monthly basis.

Demand planning is much more than just sales forecast; a successful demand plan takes into account other variables as well, such as the company’s resources, production capacity, marketing capacity, business plan and strategy (Szozda & Werbińska-Wojciechowska, 2013). Supply chains in particular are dependent on demand forecasting, based on which decisions regarding production, material sourcing

and inventory management are made (Chae, 2009). Without demand planning and forecasting companies cannot manage their supply chain effectively as several decisions concerning supply chain activities, including purchasing of items with long lead time, must be made before a sales order becomes an occurring delivery (Mentzer & Moon, 2005, 11; Kilger & Stadtler, 2008, 133).

To conclude demand planning, companies should determine an appropriate demand forecasting method. Demand forecasting based on statistical quantitative methods is especially used in B2C driven markets where the variation of demand is less fluctuating than on B2B markets in which demand patterns can be very sporadic and forecasting based on historical data can give misleading results. (Kerkkänen, Korpela, Huiskonen, 2009) According to Chen (2009), in addition to the quantitative methods, forecasting data can be gathered in a qualitative manner from sales people, who may or may not utilize statistical methods in their own forecasting.

4 Methodology

The research was conducted as a single case study and all data was gathered in 2018. Rather than being an actual research method, a case study is more of a research strategy which consists of different methods (Laine 2015, 9). As usual for a case study, this research uses mixed methods by utilizing both quantitative and qualitative research methods. By utilizing both methods, a case study is able to explain both the process and outcome of a phenomenon by thorough observation and analysis of the case under investigation (Tellis, 1997).

The main research method used to collect qualitative information was semi-structured in-depth interviews with key employees related to the case company's purchasing and delivery processes and practices. The main objective for the interviews was to gain knowledge and understanding of the whole purchasing and delivery process regarding the two services under examination. The quantitative data gathered in the research includes SKUs' historical stock levels, purchasing quantities and delivery amounts exported from the case company's ERP system. The data gathered was from previous 12-month period. First, the researcher was given a list of different SKUs with their ERP ID's, after which the data was exported by running multiple transactions on the case company's ERP system. As the data was first collected by various transactions and then merged and standardized, the data should be treated as directional and not exact. The inventory data was enriched with pricing data collected from purchasers and delivery department.

The interviewed key employees included employees from the case company's purchasing and sourcing department, delivery department and supply chain department including supply chain managers, delivery managers and specialists, sourcing manager and purchasers. In addition to the quantitative and qualitative data

gathered by interviewing, observing is in a central part of the research. Observing included participating in meetings related to the case company's supply chain and inventory management, visiting the case company's warehousing service provider and also observing employees working tasks. The researcher had been part of the case company's sourcing unit already prior to the research, and therefore the researcher had a basic understanding of the company's processes already prior to the research. The researcher was also able to participate in open discussion surrounding the topic, therefore being able to ask detailed questions when necessary.

Usually, according to Saudner (2009, 10-11), a research process includes five phases: formulating topic, literature review, research design, collecting and analyzing data. As will be apparent from the following description of the research process, the description illustrates this study well. First, the researcher gained general understanding of the topic by conducting a literature review and participating in supply chain meetings mostly in the role of an observer. The meetings included the case company's supply chain and delivery managers. After gaining fundamental information from the meetings, it was understood that both quantitative and qualitative research methods are necessary to conduct the study. Next, several semi-structured interviews were performed with the case company's purchasers and delivery managers regarding the case company's purchasing and delivery process and inventory management policies. At this point the researcher had basic understanding of the quality of quantitative data that was needed. Initially, the purpose was to analyze the whole quantitative data at once, but due to difficulties in gathering the data, the analysis was done intermittently in different phases. Looking back, this was not a negative factor as the researcher was able to participate in detailed discussions after each phase of the quantitative data analysis. The results of quantitative data analysis were reflected into the information gathered from the interviews and discussions after each analysis phase, resulting in a comparative discussion.

5 Purchasing at the case company

In this chapter, the case company and its operating environment are first briefly introduced followed by description of the case company's processes and practices closely related to purchasing's contribution to working capital optimization.

5.1 Introduction to the case company and the two services

The case company operates in a highly service oriented industry and is involved in B2C, B2B and B2O businesses. This thesis is limited to two specific services "Service X" and "Service Y" offered for B2B customers. Most of the deliveries in the particular services are treated as projects and the largest projects may last for years. All the projects are unique and especially the projects in service Y are tailor-made following the specific wishes of the customers.

The SKUs under examination in this thesis are either devices or equipment such as cables and adapters delivered to customers' premises as a part of a service and the ownership of the devices does not transfer to the customer at any circumstance. If the customer discontinues the service the devices are delivered back to the case company's warehouse and are refurbished and re-used for other projects. The devices are also upgraded on a semi-continuous phase according to the clients' needs. The ability to refurbish already used equipment is a significant part of the case company's business concept and it results in cost efficiency both for the customer and the case company. It also makes inventory management more challenging as the inflow of reused devices is difficult to forecast. Once the inventory items become outdated or meet their end-of-life, the items are either traded back to suppliers or scrapped.

The case company has outsourced the operative installations and warehousing processes of the devices to its contractors and warehousing service provider. Although the warehousing service provider is responsible for the logistics such as holding the inventories and delivering them to contractors, the actual inventory management and purchasing are situated at the case company. Along with the outsourcing of warehousing, the company outsourced pre-configuration of the devices to the same supplier. Regarding the pre-configuration, the case company is highly dependent on the warehousing service provider as according to its employees the configuration and delivery process would take up to one year to learn for a single employee.

5.2 Purchasing's role in the case company

The purchase unit under examination is the case company's B2B device purchasing unit which places orders on the negotiated contracts. The case company's Corporate Purchasing unit, also called as "Sourcing", is responsible for the company's strategic supply chain management and supplier relationships management. Hence, activities such as contract management are situated at the Sourcing unit, too. Whilst writing this thesis, the operative purchasing unit in question was organizationally relocated from the delivery function of B2B business unit under Sourcing. For now, the particular purchasing unit is hierarchically the only operative purchasing unit under Sourcing and in general the case company's purchasing function's centralization model is very close to Van Weele's (2014, 270) hybrid model. Currently, the main focuses of the Sourcing unit include activities such as decreasing average payment days although new initiatives such as working capital tied up in inventory have recently gained more attention which can also be concluded from the relocation of the operative purchasing unit. The hierarchical location of the operative purchasing unit is demonstrated on Figure 5.

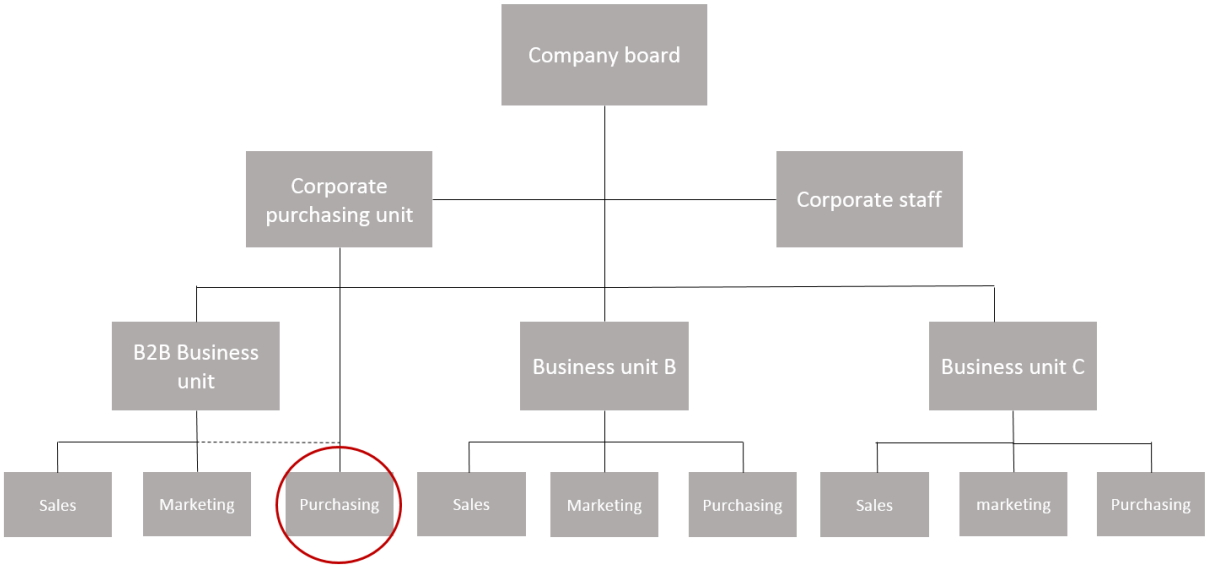

Figure 5. The particular purchasing unit's hierarchical location in the case company (adapted: Van Weele, 2014, 270; hybrid organizational model)

As mentioned previously, the role of the purchasing unit is purely operative as it places orders on negotiated contracts. Thus, the role of the operative purchasing unit in working capital management is purely based on the capital in inventories. Along with order placing, the purchasing unit expedites the deliveries. The particular services' supply chain management has not been considered as strategical and it is lacking a demand and supply chain planning function. The lack of planning function is heavily reflected into the daily work of the purchasing unit whose purchasing behavior can be classified as reactive. The reactivity is mainly caused by lack of demand forecast and lack of transparency into the company's sales funnel. The purchasing process and lack of transparency is discussed further in the next sub-chapter.

5.3 Current delivery and purchasing process

The delivery and purchasing process involves various different systems and phases. In practice the process would start from sales and end up in the devices being installed at customer's premises, but in this chapter only the relevant phases affecting purchaser's decision making are described. Therefore, phases after purchasing's involvement are left out from the description.

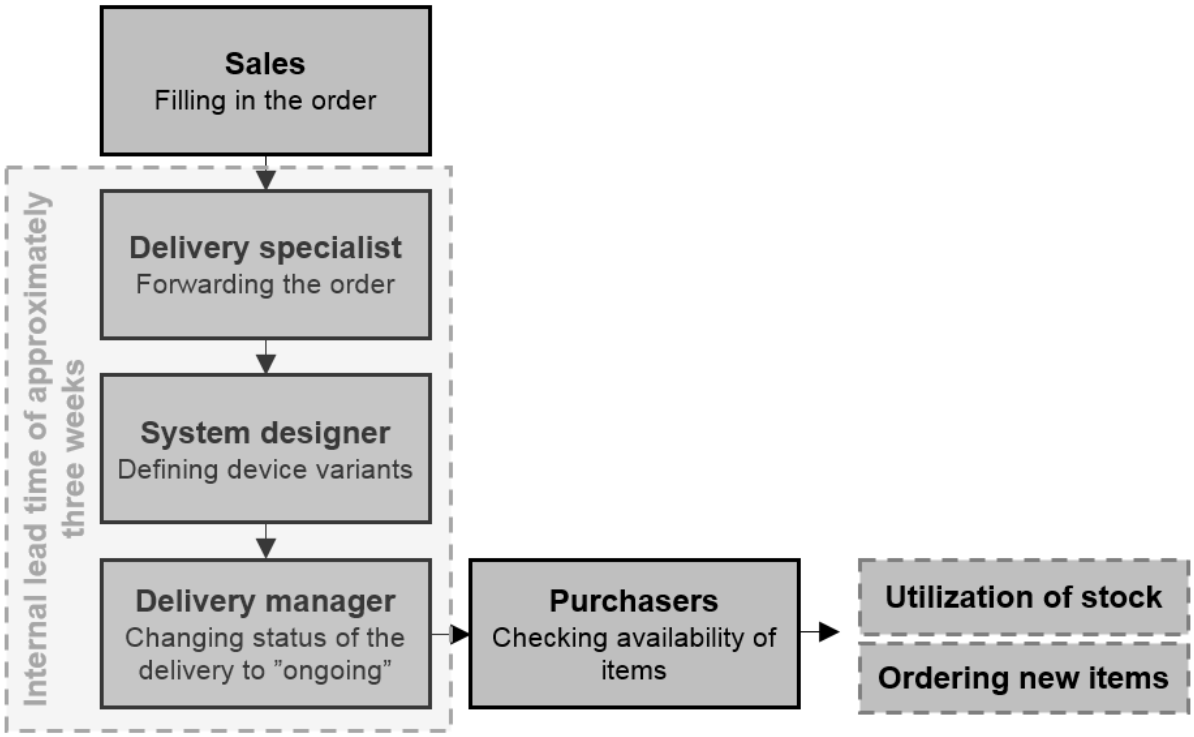

Figure 6. Generalized delivery and purchasing process at the case company

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As demonstrated on Figure 6, a sales manager starts the delivery process by filling in the order in sales system, after which the order will be transferred to a CRM system. At this point, delivery specialists' responsibility is to check whether the order has all the necessary information filled in. For details, the sales managers often just attach an email conversation with the customer which causes extra manual work for the delivery specialists and sometimes the information is incomplete.

From the CRM system the order transfers into a queue from which delivery managers pick up the order. The most important clients have their own dedicated delivery managers. Orders for less important clients have lower priority and at the time of observing delivery specialists' work, some orders at the bottom of the list were over 3 months old. According to the delivery specialists, usually delivery managers pick up the order during "few weeks". In the next phase the device variants used for deliveries are defined by system designers according to different device specifications set by customers' requirements. This phase is especially highlighted in service Y in which the device variants are highly customized according to customers' needs.

After the device variants have been defined the order transfers again into a queue from which delivery managers pick up the orders for delivery and change the deliveries' status to "ongoing". According to a delivery manager, usually the delivery managers manage to change the status within two working days. It is only after this phase when the responsibility of ensuring the availability of goods transfers to purchasers and the purchasers know what SKUs are needed for the delivery. Here, purchasers first check whether refurbished items could be used for the delivery after which the availability of new items will be checked. The importance of effective use of refurbished items cannot be stressed enough for cost efficiency of the deliveries. If no new items or refurbished items are available or they cannot be used for the specific delivery, purchasers fill in a purchase order for new items.

For the purchasers the current delivery process is problematic in terms of transparency as the purchasers are unable to have item specific demand data before the status of the delivery has been changed to "ongoing". The purchasers get occasionally approximate information about upcoming deliveries from the case company's delivery department, but from the eyes of actual demand planning the information is vague and quantities are often overestimated.

The process includes a heavy amount of manual work for the purchasers. First, the case company's delivery system and ERP system have different ID's for the SKUs as the delivery system uses "bundle codes" for combinations of items and the ERP system has individual ID's for separate inventory items. Hence, the purchasers need to manually search for the correct codes and fill them in the ERP system. Also, purchases need to be filled in both the case company's ERP system and supplier's ordering portal. Regarding inventory management and purchasing the manual work for purchasers is discussed also in chapter 6.3.

Majority of deliveries occur through the warehouse and direct deliveries to contractors are rarely used. Most of the devices delivered to customers require configuring before delivering to customers. Due to a variety of different device variants, configurations are often customized for each delivery. The configurations are created at the case company but the actual installing of configurations to devices is executed at the warehouse by the warehousing service provider. There are some differences between the two services' delivery and purchasing process; some tasks are for example performed by the warehousing service provider's employees. The above described process however applies in general. Instead of purchasing all items directly from a manufacturer, the case company is able to purchase items also through a distributor. Currently, the case company is using a distributor whenever there is an immediate need for a particular item and suppliers cannot deliver the item within an acceptable timeframe. The new material management team's manager stated that the distributors' lead times are short and reliable and the premium the distributor charges is bearable.

5.4 Inventory management at the case company

During the interviews, it became apparent that the case company had neglected active inventory management in the past. It should be mentioned though that the negligence was likely not caused by disinterest of the current or previous employees but due to lack of resources. Also, the services under examination generate only a fraction of the case company's revenue which is why inventory management related to the two services has not been considered a top priority. Recently the case company had taken steps towards improvement by opening up positions related to supply chain and forming the already mentioned materials management unit, under which the purchasing unit was hierarchically relocated. One of the primary goals for the materials management and supply chain team is to decrease working capital tied up in inventories, however not at the cost of delivery reliability.

Due to the lack of attention towards active inventory management in the past, a considerable amount of working capital has been tied up in inventories as will be demonstrated in chapter 6.2. Although the case company has had some practices in place which have features of selective inventory management, such as defined reordering points and ordering quantities for defined items, the practices have not been implemented effectively. The reordering points, for instance, are updated on an irregular basis and are based on product managers "hunch" instead of any scientific measures. The reordering points and quantities are discussed further on chapter 6.3. As already stated, the case company has no S&OP or demand planning process in place which would assist the purchasers in determining optimal inventory levels.

The purchasers are instructed to always check whether refurbished items could be used for the deliveries instead of purchasing new ones. The case company however is unable to fully keep track on refurbished items delivered back from customers premises due to lack of an appropriate system. Such system would enable purchasers to see incoming refurbished items based on which need for new items could be evaluated

better. The supply chain team is however looking into implementing a solution for this by creating a ticket on the company's ERP system whenever items are returned from customers. Worth noting is that an efficient system would require book keeping for serial numbers of the items delivered, and such practice has so far not been implemented for all items.

Regarding purchasing quantities, the case company is not able to decrease ordering costs by bundling lot sizes. Instead, the most relevant suppliers charge a percentage of the whole value of an order, therefore resulting in progressive ordering costs. Usually, no volume discounts for unit prices can be achieved either.

5.4.1 Selective inventory management

Although the case company has had some practices in place that have features of selective inventory management, such as the defined reordering points and ordering quantities for defined SKUs, the practices have not been implemented effectively. As such, it can be stated that the case company does not have a SIM system in place.

As a result of the increased attention towards inventory management the case company has categorized SKUs based on their life cycle. The ultimate purpose for the classification was to identify SKUs near or at their end of life, and then to either trade or scrap the items. Based on the classification, the case company had already achieved significant reductions of working capital tied up in inventory. Due to lack of employee resources the classification has been a one-off activity without an implemented, solid and frequent process managing the classifications. By updating the classification for SKUs frequently, the case company could trade the items in a proactive way before the items' trading value have decreased. Worth mentioning is that the previously mentioned system for keeping track of the serial numbers would also help the case company to classify the refurbished items' life cycle classification better based on the time they've been in use at customers' premises.

According to the employees, a traditional ABC analysis had not been initiated due to the project-orientation of the service; a classification based solely on SKUs' yearly volume would not describe the actual importance of an item. Furthermore, some employees stated that the project orientation of the services results in such high variation of demand that prevents effective inventory management. Other reasons for not implementing an ABC analysis included lack of pricing information caused by a financing procedure - which is elaborated further in chapter 5.5 - and also the fact the company purchased some items in bundles, resulting in no actual pricing information regarding a specific item part of a bundle. Interestingly, the warehousing service provider had already taken an initiative and compiled a modified ABC classification for the SKUs but the classification had never been utilized in any way.

Many interviewed employees highlighted the complexity caused by extensive amount of SKUs in general. Although some SKUs at the end of their life cycle had already been detected and items were traded or scrapped, the amount of SKUs has remained almost intact. The service Y, which is highly tailored to customers' needs and operating environment, especially features a high variety of SKUs that are technically almost identical. The product manager of service Y however stressed that even the slightest technical differences are necessary in order to deliver customers a cost efficient service. A standardized device would often have extensive technical attributes in order for the device to be applicable in all or majority of projects which would result in unnecessarily high costs. On the other hand, no one at the case company has evaluated average total cost of ownership for any SKUs or inventory items. It should be mentioned though that during the next five years it is in the scope of the case company to change the type of devices into next generation, in which the devices will be more standardized and different kind of attributes to them can be added through remote configuration.

5.4.2 Inventory management for large projects

An extra complication for the inventory management is the fact that the case company has made exclusive service level agreements with the largest customers. Currently, only one such customer exists. To comply with these agreements, the items for these large customers are stored on separate storage location inside the warehouse. Albeit this kind of special arrangements do not cause significant warehousing costs for the case company, they cause complexity for inventory management and higher amounts of working capital tied up in inventories due to ensuring of delivery reliability.

The separate storage locations exist since the company needs to guarantee the availability of goods for the most important customers due to the SLA's and for this, separate physical storage locations have been thought to be the most convenient way. During the time of doing the research, the case company piloted a SAP allocation tool that allowed quantity allocation for different projects to be done virtually, meaning that all items would be stored at the same physical storing location, hence resulting in less warehousing costs. Due to the old delivery system, the allocation tool proved not to be practical as the warehouse workers configuring the items had to manually change the delivery address. Therefore, if the worker forgot to change the delivery address, the goods would be delivered into customers premises instead of contractor's address. Use of the allocation tool caused extra manual work for the purchasers as well. The pilot was put on hold due to all the manual work and limited benefits.

5.5 Current working capital measures

According to the interviews, there have been very limited inventory management related system development during the last decade. Although the company's ERP system would have multiple useful modules for inventory management related measuring, the case company has not taken them into use due to various reasons. The

lack of system development and reporting tools created its own challenges for the conduction of this thesis as well as datasets needed to be constantly merged and refined.

When it comes to measuring working capital, one of the most fundamental matters is acknowledging the amount of capital tied up in inventory. Thus, the company should be aware what the purchasing price for each item has been. The case company finances the purchased active materials through its subsidiary and hence, the items will show up on case company's balance sheet only after a financing period which is normally 48 months. To prevent the financed materials showing up on balance sheets, the case company's purchasers create zero valued purchase orders, documenting the purchase price only on the free text field in ERP. This results in unavailability of purchasing price reports for the most important SKUs, although the purchasing prices could be manually checked one-by-one from the free text fields. The case company has approximate prices listed on an excel file but no exact reports can be derived by using these prices due to the fact that the purchasing price of several items vary according to the project they were purchased for. The researcher was told the case company can potentially have up to 70 % discounts on the purchasing prices due to suppliers' willingness to be involved in a project.

Despite the potentially heavy variation in purchasing price, the case company has been using approximate prices for valuing the inventory. Multiple managers from the delivery and the supply chain department were asked for the actual reason behind the broken pricing report ability. All answers stated that it is caused by the financing process, but no one really knew the root cause behind it or whether it could be fixed. The only measures in use related to working capital management were the approximate value of inventory and cycle time of inventory, both being monitored on an irregular basis.

6 Analysis of inventory data

Chapter six focuses on analysis of quantitative data gathered during the study. The results will also be reflected into the gathered qualitative information. The chapter starts with ABC and XYZ analysis, after which analysis on amount of working capital in inventories and reordering points and ordering quantities will take place.

6.1 Selective inventory management

As a whole, the two services offered for B2B customers contain 816 inventory SKUs. In this chapter, the SKUs are categorized according to two attributes resulting in categorization that could potentially be utilized for SIM at the case company. The SKUs are categorized by utilizing ABC analysis based on the SKUs COGS and their nature of demand is analyzed with XYZ analysis.

6.1.1 ABC analysis

The SKUs were first classified as either A, B or C class according to previous year's COGS with 80 % of cumulative costs being the limiting value for class A SKUs and 97.5 % being the corresponding value for class B items, therefore leaving the class C items constituting of SKUs placing over the 97.5 % cumulative threshold. Also, worth noting is that the ABC analysis was conducted purely based on SKUs that had deliveries during the 12-month examination period and were new (not refurbished). In the two services, same devices often have both new and refurbished items. Although refurbished items tie up working capital in inventories too, the ultimate focus of working capital management should be on the purchasing and storing of new items. Therefore, recycling plant was left out from the initial analysis. It was conducted in the interviews that including warehousing and logistical costs would not cause significant difference for the analysis and therefore only the purchasing price of items was used to define

COGS for the SKUs. All data should be treated as estimates due to the case company's inability to trace financed items' prices and also due to the fact that the data used for the analyses might not be precise. For instance, it was conducted that there were minor differences among different ERP transactions regarding delivery quantities.

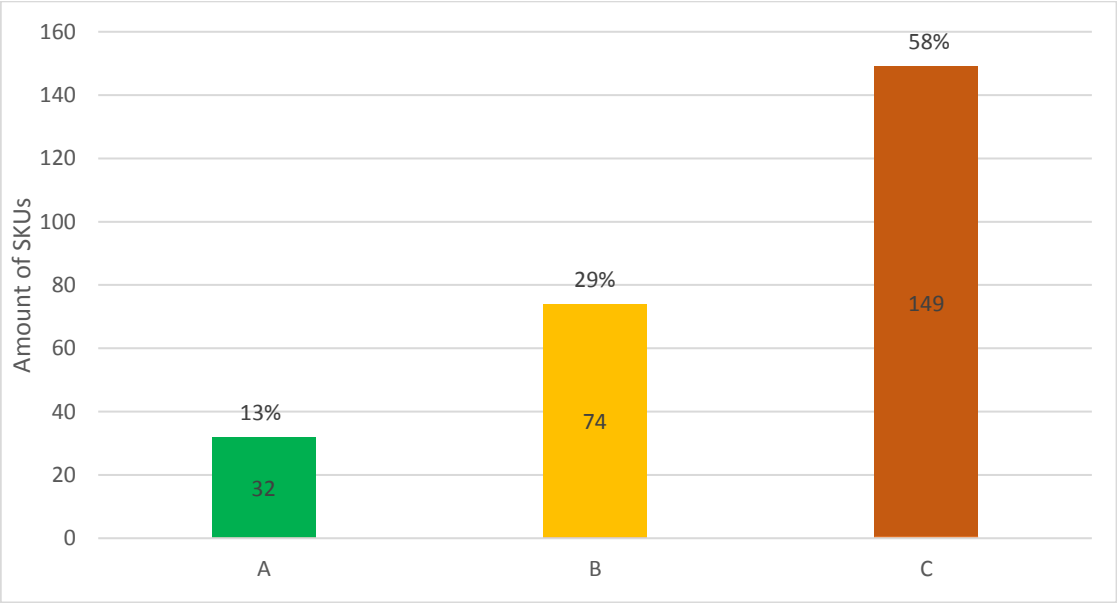


Figure 7. Result of the ABC analysis

In the analysis, only 255 out of 814 SKUs were identified to have had deliveries from inventory plants featuring new devices as shown on Figure 7. Two SKUs were deleted in the early phase of the analysis due to lack of price information – they would have been C items as both had only one delivery during the twelve month period. As a whole, the analysis indicates that the working capital in inventories is concentrated on relatively low amount of SKUs and the tail of inexpensive and less delivered items is comparatively long with 29 % of items belonging in B category and 58 % in C category. As an example, the traditional Pareto principle would presume that 20 % of SKUs would belong in the A category instead of just 13 %. As only 255 out of 814 items were identified to have been delivered as new devices, the remaining 559 SKUs had to be

categorized according to other features. By analyzing the data, it appeared the SKUs had three additional features they could be categorized with. Hence, three more categories were identified: category D for SKUs delivered from the recycling plant only, E for SKUs that had inventories but had zero deliveries holistically (no deliveries on both refurbished and new items), and F for SKUs with zero deliveries and no inventory.

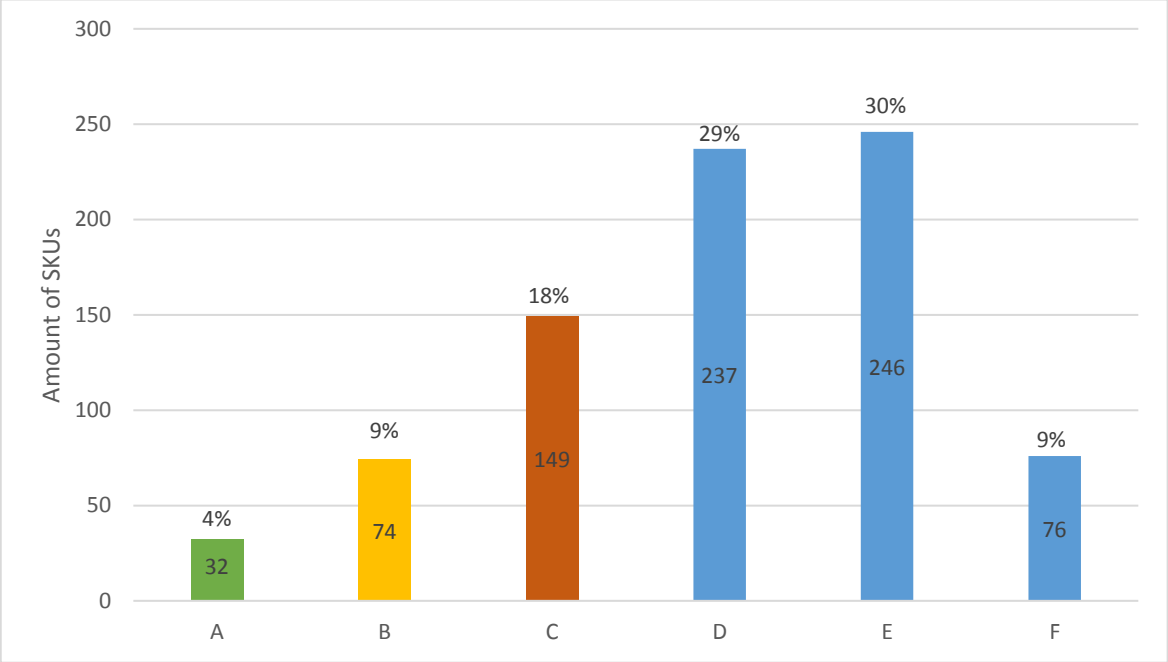


Figure 8. Result of extended ABC analysis

As demonstrated on Figure 8, when including all the SKUs in the analysis, the proportional amount of class A SKUs is extremely low; only circa 4 % of the total number of SKUs. Moreover, the SKUs included in the original ABC analysis constitute only 31 % of all SKUs. With 237 D SKUs and 246 E SKUs, almost a third of the SKUs are delivered from the recycling plant only and approximately a corresponding amount of SKUs were in stock but had not been delivered at all. The high number of SKU's belonging to D class once again emphasizes the importance of using refurbished components and equipment in producing the services. In terms of COGS, the

refurbished SKUs' share of the total volume is 24 % for which the COGS is appreciated by their trading value, which on average 20 % of their purchasing price. Hence, the delivery volume of refurbished SKU's is significant; if the refurbished SKU's were appreciated by their original purchasing price, the volume would account for 61 % of total COGS.

The high numbers of E and F class SKUs reflect the lack of active inventory management in the case company in the past. Whereas the SKUs in the class F are mostly items that should be removed from the lists, the case company should either trade or scrap majority of E SKUs to decrease warehousing costs or earn some cash in trading. The amount of working capital tied up in different categories will be reviewed and discussed later on chapter 6.2.

6.1.2 XYZ analysis

The inability to forecast and high variation in demand was indicated by several interviewed employees. However, the nature of demand and forecastability had never been analyzed with mathematical or scientific methods. In this chapter, the forecastability of demand is analyzed by categorizing the SKUs into three classes X, Y and Z based on their demand's coefficient of variation. Accordingly to the initial ABC analysis, the XYZ analysis is based on demand occurred on new items only.

The XYZ classifications were then combined with the initial ABC analysis, resulting in 9 different categories for SKUs. Thresholds of 0.4 and 0.7 were used for the coefficients of variation, meaning that SKUs with values under 0.4 belong to X category, SKUs with values over 0.4 and under 0.7 belong to Y category and SKUs with over 0.7 values are Z category. As pointed out by Errasti et al. (2010), SKUs in the X category are

forecastable, Y items are forecastable to some extent and Z items are not forecastable to any extent.

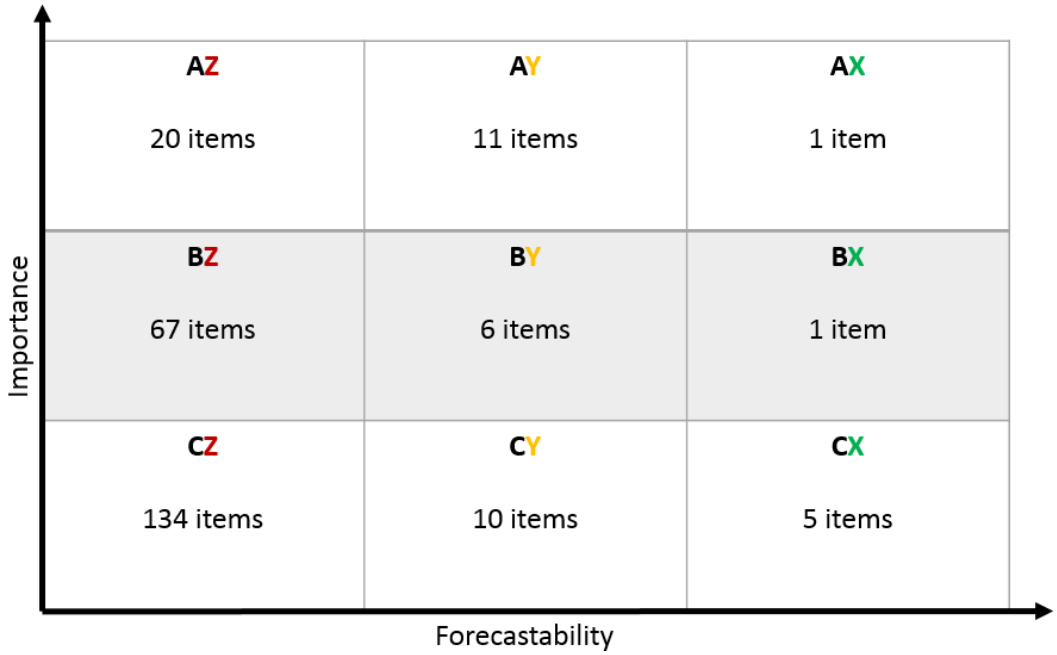


Figure 9. Result of XYZ analysis demonstrated in a matrix

Originating from the interviews, the presumption of the inability to forecast SKUs demand was verified in the XYZ analysis. As demonstrated on Figure 9, altogether only two SKUs in the ABC analysis' A and B categories could be forecasted in a reliable manner. Although there are five SKU's with high forecastability in the C category, initiating time consuming forecasting for them would not be cost effective since the C SKUs tie up only a fraction of working capital.

Due to the low amount of SKUs with low coefficient variation in demand, forecasting based on historical demand data seems not to be a feasible option for the case company. Instead, the case company should find alternative methods for demand planning. However, several employees pointed out that excluding the storage locations featuring the inventory items for the large projects could decrease the variation in demand as the nature of demand especially for the large projects is sporadic. Thus, a

separate XYZ analysis was performed which excluded all demand occurred from the large projects' storage locations.

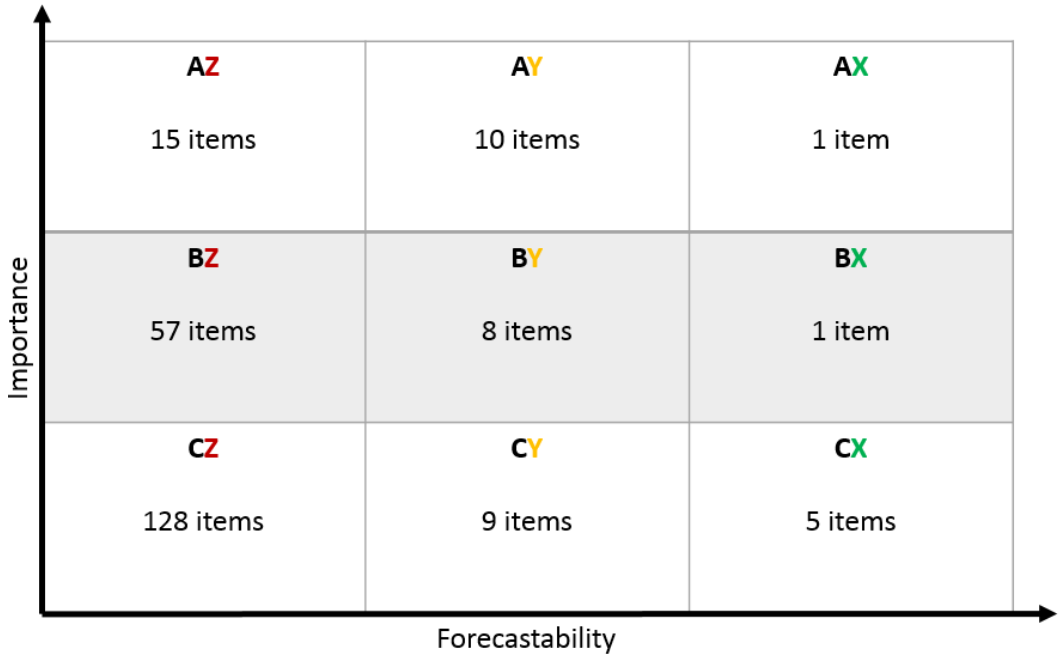


Figure 10. Result of XYZ analysis (excluding storage locations for large customers) demonstrated in a matrix

Excluding the large projects did not result in significant changes in the nature of demand as shown on Figure 10. The most significant change is the decreased amount SKUs as 21 SKUs were delivered for the excluded large projects only. Thus, and also due to changes in other items' demand and COGS, some SKUs' ABC classification changed as well. Explanatory matters for the high variation in demand include the project orientation of the services which causes demand occurring in bursts and also the aforementioned high amount of device variants, because of which demand splits across multiple SKUs. Regarding forecastability for demand of new devices, worth noting is also the already mentioned current unknown availability of refurbished items since there is no appropriate system in place to track or forecast the amount of items returning from customers' premises. Worth noting is that since the XYZ analysis is based on a 12-month data, it does not take yearly seasonality into account.

6.2 Working capital tied in inventory

After categorizing the SKUs based on the items' annual COGS in the ABC analysis, the working capital tied up by different categories was analyzed. Although the previous analyses excluded refurbished items, refurbished items are included in this analysis. Similarly to all quantitative data in the analysis, the data was exported from the company's ERP system. In the analysis, the tied up working capital is presented as a percentage of COGS during the twelve-month examining period. The financed items were once again valued by their estimated price and refurbished items were valued by their estimate trading price which is approximately 20 % of their original purchasing price.

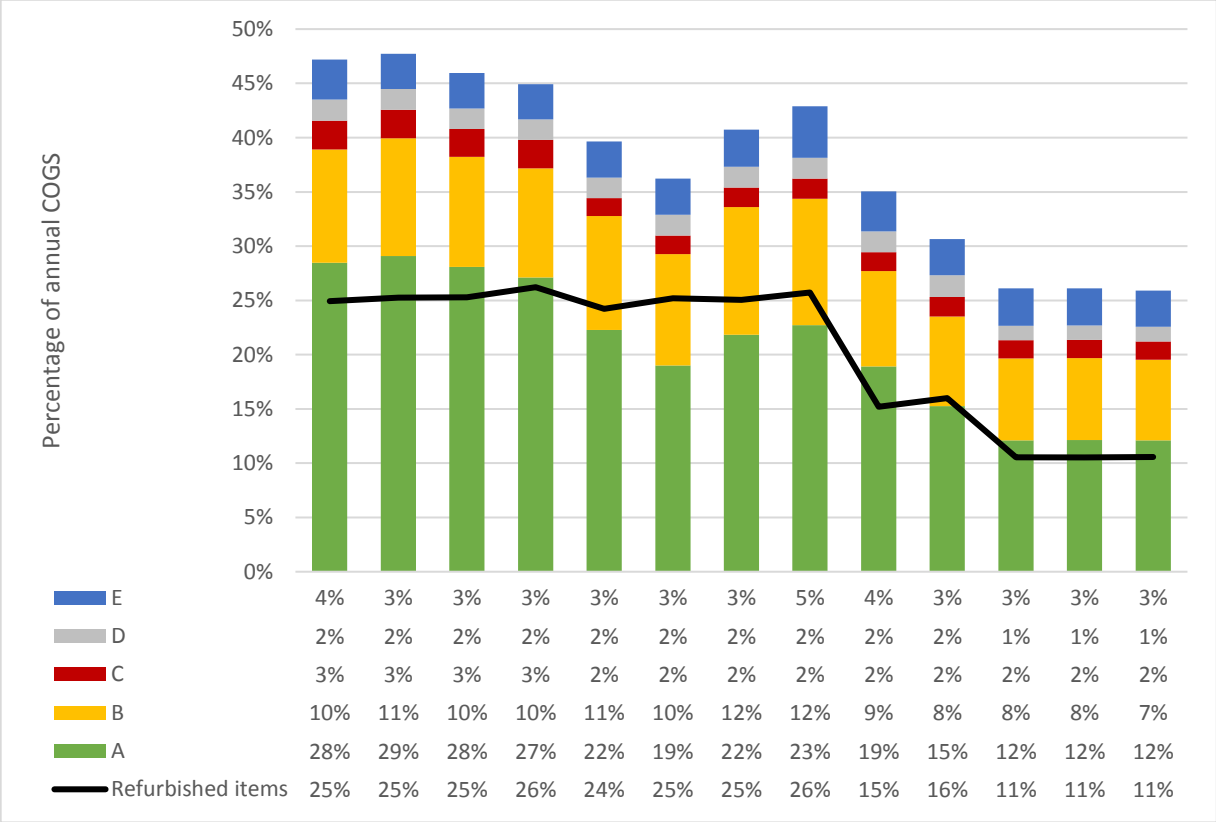


Figure 11. Monthly development of working capital tied up in inventories during the 12-month examination period

The recent initiatives taken place to reduce capital tied up in inventory can be clearly seen on Figure 11 as the case company has managed to reduce working capital across all categories but E category, in which the SKUs with no deliveries during the twelve-month examination period were included. Taking all categories into account, the case company has managed to decrease working capital tied up in inventory by circa 50 % during the examination period. The most notable changes can be seen on A category in which the decrease has occurred steadily during the examination period and also on refurbished items in which two significant decreases have occurred due to trading items back to suppliers. Despite the recent initiatives, the case company still had circa 36 % of annual revenue tied up in inventory at the end of the examination period. This is a substantial amount of working capital tied in inventory, for which the case company should react by decreasing the cycle time of items.

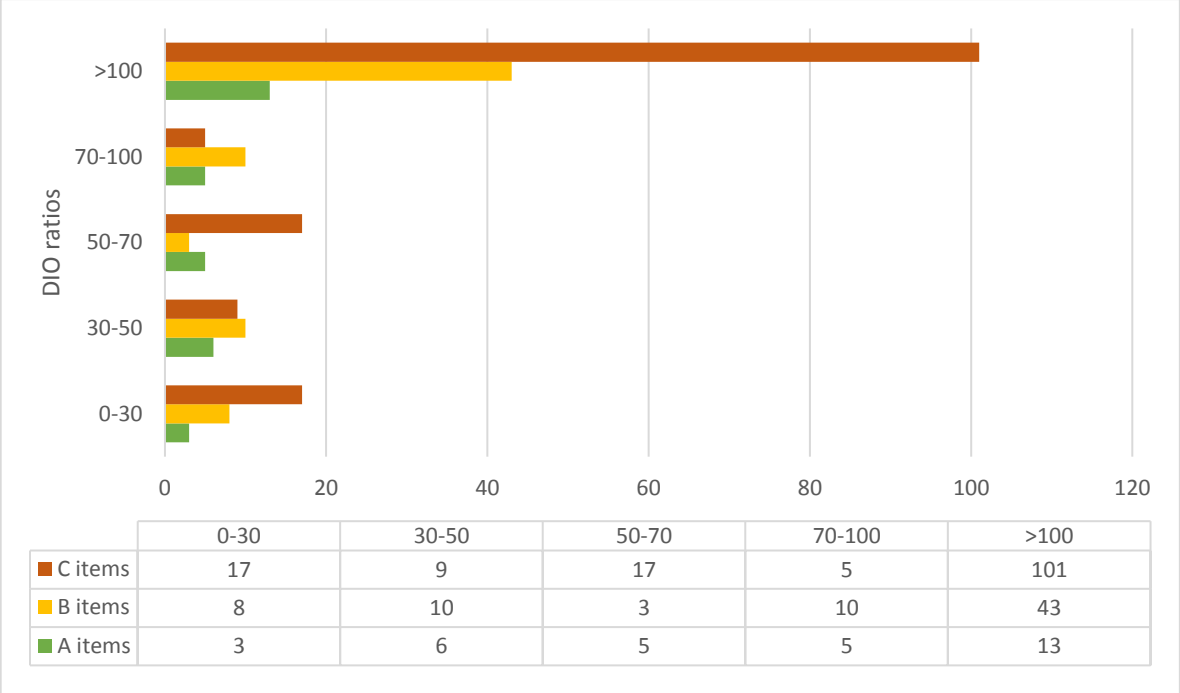
The very low fluctuation among the value of SKUs of class E items can be explained by refurbished items that have been returned from deliveries and then scrapped or traded. Based on the data, no notable initiatives have taken place for the SKU's belonging to E category although they are not delivering any kind of value for the company but causing additional warehousing costs. Therefore, the case company should either scrap or trade the items.

6.2.1 Days Inventory Outstanding ratios

Measuring DIO is part of the case company's inventory management principles in its most important business areas where inventory management is necessary. In the particular business area under which the two services belong, the measurement of DIO had not however been implemented. With the most crucial part of DIO measuring being the items' purchasing price, exact measuring would not even be possible due to the case company's inability of keeping track on financed items' purchasing price. Thus,

and also due to lack of active inventory management policies in the past, a hypothesis was that the DIO values for items would be high.

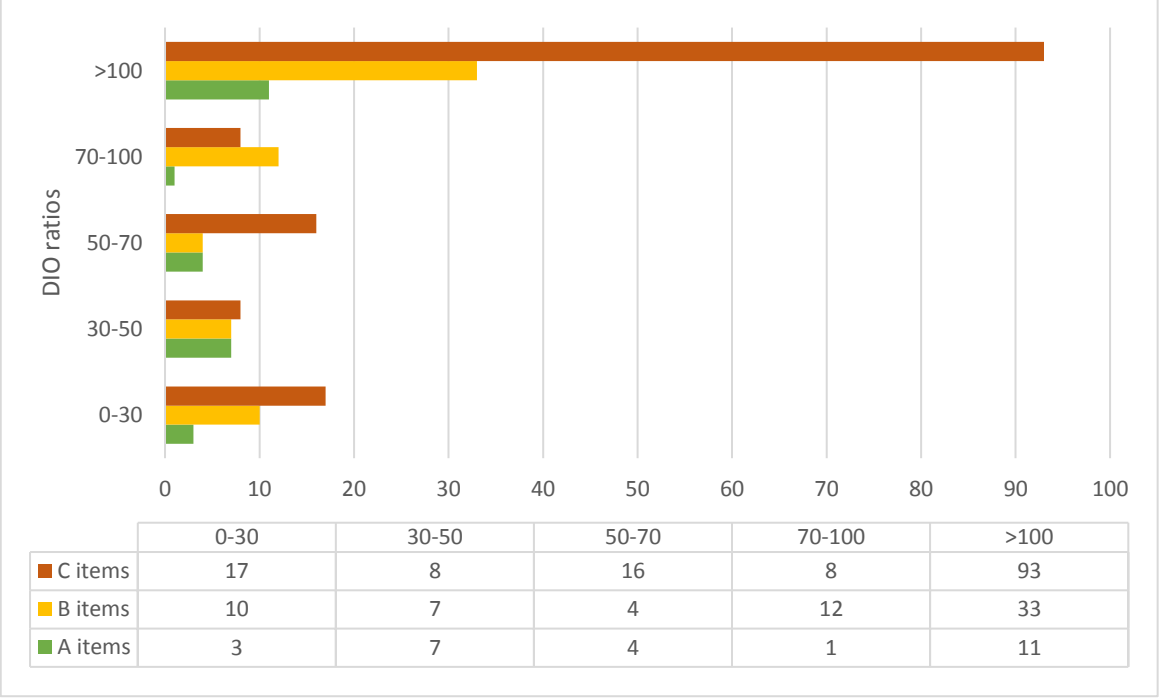
First, the DIO ratios will be examined for the whole mass of SKUs and deliveries, after which the examination will be done similarly but excluding the storage locations for largest customers. As a second hypothesis, it was expected that these storage locations cause increased DIO ratios due to the aforementioned SLA's. Therefore, DIO ratios will also be examined excluding the items allocated and delivered for largest projects. The analyses are conducted for the SKUs included in the original ABC analysis featuring new items with deliveries only. Before analyzing the SKU's DIO ratios, employees were asked for DIO ratios in other business units that could be used as a benchmark. According to the employees, average DIO ratio in one of the case company's major business areas is 30. In the context of the services under examination, an average DIO ratio of 30 is not however feasible under the prevailing high variance of demand and project orientation.



	0-30	30-50	50-70	70-100	>100
C items	17	9	17	5	101
B items	8	10	3	10	43
A items	3	6	5	5	13

Figure 12. DIO ratios for the whole mass of SKUs

As demonstrated on Figure 12 which includes the DIO ratios for all SKUs featured in the original ABC analysis during the twelve-month period, the ratios appear to be very high across all ABC categories. With only three category A SKUs scoring between 0-30 and six items between 30-50, it is self-evident that the case company indeed holds excessive inventory which does not circulate effectively. Among the A SKUs there were five SKUs that were delivered for the largest projects only; three of these SKUs had a DIO of over 100 and two had 70-100. All these SKUs were delivered for Service Y. Thus, by looking at the DIO overall DIO values for SKUs belonging to category A, it does seem that the items delivered for the large projects circulate less effectively than in general, although a presumption was that all the three SKUs would be included in the “>100” category.



	0-30	30-50	50-70	70-100	>100
C items	17	8	16	8	93
B items	10	7	4	12	33
A items	3	7	4	1	11

Figure 13. DIO ratios for inventory SKUs excluding inventory plants for large customers

Figure 13 describes the DIO ratios for items excluding items stored and delivered for the largest projects. Accordingly to Figure 10 which describes the XYZ classification excluding the large projects, minor changes in the SKUs' classifications have occurred due to changes in COGS and the analysis had 21 SKUs less compared to the original ABC analysis. The result is similar to the XYZ analysis as the exclusion did not cause significant changes in DIO ratios as DIO ratios over 100 are still dominant across all categories. Hence, the high DIO ratios cannot be explained by the large projects' service level agreements.

6.2.2 Potential decrease of working capital

In order to stress the significantly high DIO ratios and their effect to the amount of working capital tied up in inventory, the potential to release cash by reducing the ratios was demonstrated for the employees. The demonstration was conducted by calculating the amount of working capital tied up in inventory with several DIO ratios for each ABC category and then compared to the average working capital tied up in the inventory during the examination period. For the demonstration, values excluding the large projects were used. Also, in contradict to the previous analyses, the following Figures are calculated based on 6 months' values instead of the whole twelve-month examination period, with which the previous two Figures were calculated. This way, a better picture of the company's prevailing situation is achieved as the case company had already managed to reduce the amount of working capital within the twelve-month period. Worth noting is that the values are calculated as if all SKUs' DIO ratio within a class was the given DIO ratio.

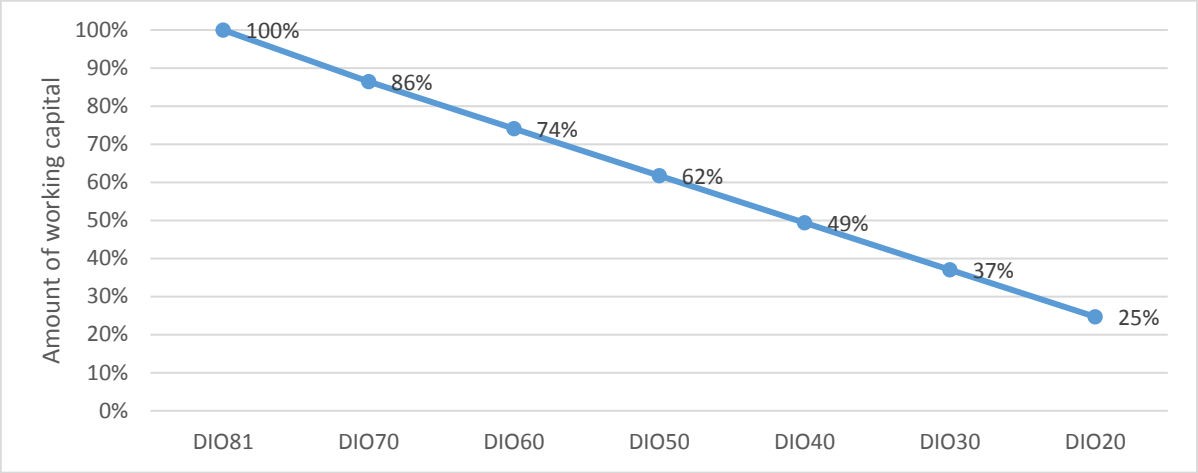


Figure 14. Tied up working capital with specified DIO ratios for category A SKUs

On Figure 14, amount of working capital in inventories is shown for category A SKUs with DIO ratios from 81 to 20. Two SKUs did not have any deliveries during the six-month period and were deleted from the analysis. During the six months' period average DIO for the items was 81, therefore showing up as 100 % of working capital. The amount of working capital in inventory could be reduced significantly by reducing DIO ratios to reasonable levels – an average DIO ratio of 40 would halve the tied up working capital in class A items.

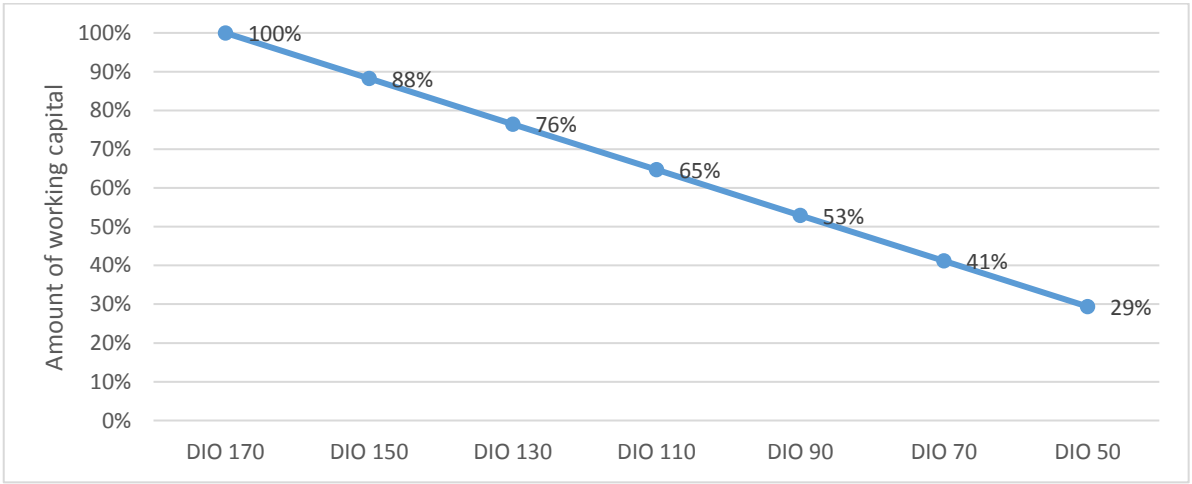


Figure 15. Potential decrease of working capital for category B SKUs

Figure 15 describes the corresponding potential decreases of working capital for B items. Nine category B SKUs were deleted from the analysis as they did not either have deliveries or stock during the six-month period, therefore resulting in no DIO ratio for the particular items. The average DIO ratio for B items is approximately 170, meaning that the items are stored almost 6 months before delivering them. By reducing the DIO ratio to 90, the case company could reduce the amount of working capital in inventory to approximately half of the prevailing state.

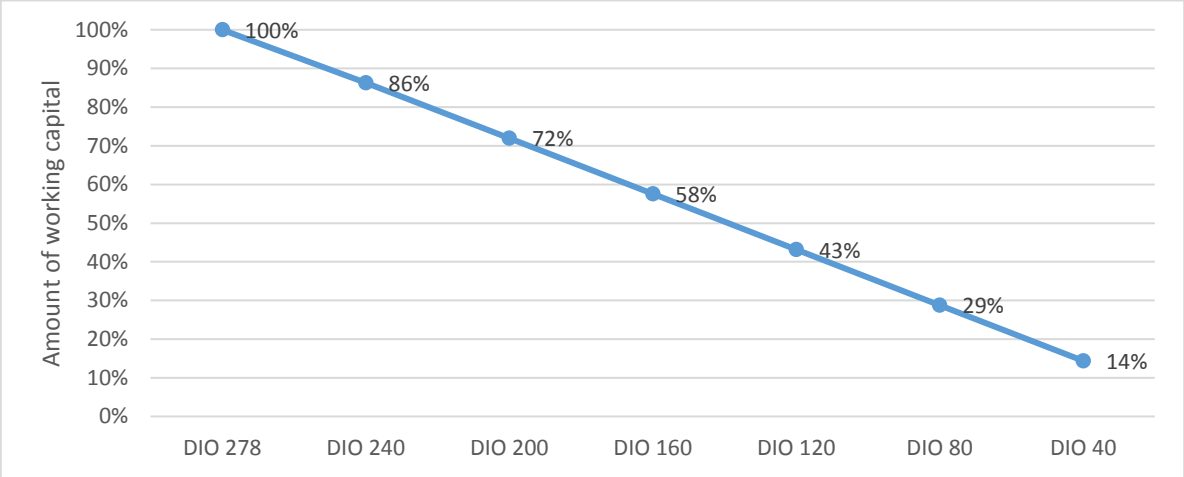


Figure 16. Potential decrease in working capital for category C items

Regarding C items, altogether 49 SKUs – which accounts up to over a third of all C SKUs - were removed from the analysis as they did not have either inventory or deliveries during the six-month period. In other words, over a third of SKUs belonging to C category were not delivered or had no inventory during the period. This finding reflects the long “tail” of SKUs especially in the C category. On average, the case company holds category C items for approximately nine months as the average DIO for C items is 278.

The above potential decreases are only demonstrative and do not take into account the fact that all categories feature items that are not delivered in substantial quantities but are still required to be stored due to the large amount of different device variants. To ensure delivery reliability, the case company has maintained stock for these SKUs regardless of their low demand. Instead of purchasing the items from manufacturer and holding these items in the inventory the case company could consider alternatives such as utilizing a distributor for the items and order the items only when they are needed.

6.3 Reordering points & ordering quantities

Although the demand for the SKUs cannot be forecasted from historical data in a reliable manner, reordering points and ordering quantities should be defined with best effort according to occurring demand and lead times. Initially, one of the purposes for this thesis was to define optimal ordering quantities utilizing EOQ, but the method resulted in inappropriate quantities. As already stated, each service's product manager has defined ordering points and quantities for handpicked SKUs. The replenishment model for these SKUs seems to be a modification of both (R, Q) and (s, S) policies with periodic reviews; the SKUs have defined reordering points with fixed ordering batches but the items are always ordered by a fixed batch quantity regardless of how much the inventory position is below the reordering point s. The product managers have set the reordering points and ordering quantities altogether for 13 A, 27 B and 35 C SKUs. In this chapter, category A SKUs' reordering points and ordering quantities are examined for the two services separately. Worth noting is that the reordering points and ordering quantities are defined for inventory locations that have items for "continuing deliveries" only, meaning that the defined quantities for inventory locations featuring items for the largest customers are managed separately. In addition to the defined ordering points and ordering quantities, DIO ratios from past 12 and 6 months' examination period are listed as they indicate how effectively the quantities are defined.

Table 1. DIO ratios, reordering points and ordering quantities for Service X

SKU	DIO 12 months	DIO 6 months	Amount of safety stock	Ordering quantity
SKU 2	13,1	9,7	80	50
SKU 3	65,5	47,5	15	20
SKU 4	124,3	116,5	N/A	N/A
SKU 5	38,4	29,3	N/A	N/A
SKU 6	32	31,7	N/A	N/A
SKU 7*	439,9	500,6	N/A	N/A
SKU 8*	115,4	109,3	N/A	N/A
SKU 10	75,8	299,8	70	100
SKU 11	219	115,7	N/A	N/A
SKU 12	19,4	22,9	N/A	N/A
SKU 13	38,6	28,7	N/A	N/A
SKU 14	40	N/A	N/A	N/A
SKU 17*	300,4	462,3	N/A	N/A
SKU 18*	355,6	273,8	N/A	N/A
SKU 24*	367,2	677,9	N/A	N/A
SKU 26	173,9	452,4	N/A	N/A

The product manager of Service X had defined the points and quantities for only three category A SKUs delivered for the service as shown on Table 1. For four SKUs (7, 8, 17 and 18), defining the points and quantities is not necessary as significant amount of items for the particular SKUs had been purchased to ensure availability of items. The conscious decision of purchasing large quantities also explains the high DIO ratios for the four items. The previously mentioned inactive updating of the quantities is clearly reflected into the amount of defined quantities for category A items in Service X. Furthermore, most of the SKUs having defined quantities are actually C items with very low purchasing price. It seems as if defining the quantities for SKUs of lower importance has been prioritized and the quantities for SKUs with higher importance have been left for the purchasers to decide.

Table 2. DIO ratios, defined reordering points and ordering quantities for Service Y

Item	DIO 12 months	DIO 6 months	Reordering point	Ordering quantity
SKU 1	36	29,9	150	100
SKU 9	51,2	36,1	10	10
SKU 15	34,3	31,5	5	5
SKU 16	58,5	32,9	10	10
SKU 19	21,1	46,9	5	5
SKU 20	51,8	38,7	10	10
SKU 21	37,4	26,1	1	1
SKU 22	112,3	204,2	10	10
SKU 23	238,7	N/A	N/A	N/A
SKU 25	131,7	83	3	3

As listed on Table 2, all the category A SKUs delivered in Service Y excluding SKU 23 have defined reordering points and ordering quantities. Worth noting is that the defined ordering quantities are alike with the Service X' quantities as they are almost without an exception as large as they defined safety stock is. Unlike for Service X, items with higher importance have been prioritized in the definitions. When examining both services' DIO ratios, a clear downward trend is distinguishable and is clearly seen especially for SKUs in Service Y. The decrease was surprising as the researcher had been told no changes in the reordering points and ordering quantities had been done during the examination period. DIO ratio had however increased significantly for Item 22 and therefore, its historical stock levels were examined.

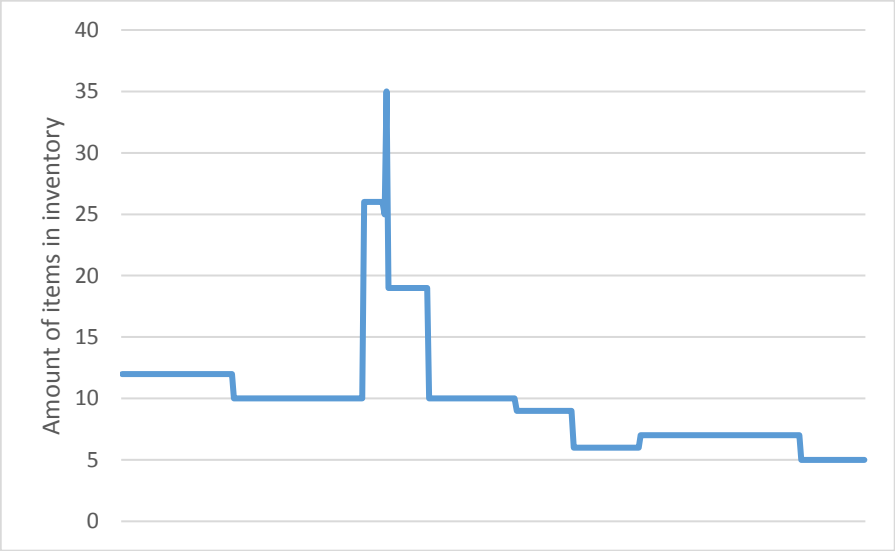


Figure 17. Inventory levels during the 12-month examination period for SKU 22

SKU 22's items had not been delivered in significant quantities but its' purchase price was significantly high which resulted in the SKU being in category A. As seen on Figure 17, the increased DIO ratio is caused by lack of demand rather than excessive stock. Still, due to vast amount of device variants the case company has to maintain stock for the SKU. Even more interesting fact derived from the Figure 17 is that purchaser had not maintained the reordering points and ordering quantities as defined by product manager but had taken an initiative and maintained lower stock. When examining historical stock levels for more SKUs, similar purchasing behavior was distinguishable. The purchaser responsible for purchasing items for Service Y confirmed that as the reordering points and ordering quantities had not been updated on a regular basis, she had started to review the nature of demand and stock levels by herself. This also explains the SKUs' DIO ratios' downward trend.

Although the case company holds significant amounts of working capital in inventory compared to the delivered items' COGS, the amounts would have been significantly higher if the purchasers had followed the defined reordering points and ordering quantities. As an example, if the purchaser followed the definitions for SKU 22, she

would have purchased 10 more items whenever the stock levels hit 10 units. Instead, the purchaser had decided to maintain a safety stock of 10 units and then even lowering the level to 5 units without purchasing additional items.

Despite the self-imposed purchasers' activity, the quantities are still officially managed and defined by product managers. Simultaneously, purchasers are expected to perform well and purchase efficiently in terms of working capital. This has left the purchasers in an unfavorable situation, in which they have to constantly balance between the official quantities and quantities they themselves consider as efficient. As a result, the purchasers have followed the defined ordering points and quantities for some items, but for some they have not. It is no surprise that a purchaser stated that they find the situation confusing.

Even if the product managers updated the quantities in a continuous manner, it should be questioned whether Product managers' role is suitable for defining the quantities as they should be defined by employees who are continuously involved in inventory management and purchasing process and have up-to-date information regarding items' demand, inventory levels and lead times. Highly variable lead times in particular require continuously managed and updated ordering quantities. Thus, involving purchasers in defining and managing the official quantities should be heavily considered. A valuable point from the purchaser was also that ordering efficient quantities is very time consuming for the purchasers as they do not have any tools in place that would support them in defining the quantities. For instance, the only method to visualize the development of stock levels is exporting the stock levels from the ERP system into excel. As one purchaser can be responsible for hundreds of SKUs, manual inspection of efficient quantities is extremely time consuming. The lack of a tool for effortless inventory monitoring was also given as the main reason for utilizing periodic review for all items.

As items' lead times are of great importance in defining the reordering points and ordering quantities, the purchasers were asked for the lead times for the inventory items. A surprising fact was that the purchasers stated that the lead times for the items are not consistently documented or monitored. One of the reasons behind this is very similar to the previously mentioned lack of tools; the only way to visualize the data is to export lead time data from the company's ERP system which is very laborious. One purchaser however exported a lead time list and it became apparent that one particular supplier has systematically declined all commitments to any SLAs, meaning that the supplier does not commit into any delivery schedules. The actual problem does not lie within long lead times, but in unreliability of the lead times. After a purchase order is made and accepted by the supplier, the supplier also often changed the delivery schedule, resulting in intermittent unavailability of items for the case company. Worth noting is that the purchasers had reported the unreliable lead times already and the matter was treated as high priority within the case company's supply chain unit. Regarding the two services, the case company is highly dependent on the particular supplier and the case company's negotiation power is limited. Apparently, the main reason for continuously changing lead times was behind a global component shortage, for which the supplier had not prepared for.

7 Discussion

This study has reviewed and discussed the role of operative purchasing in working capital optimization. To provide theoretical background for the research, working capital management theory including its measurement followed by theory related to purchasing and inventory management were reviewed, after which the empirical part of the study analyzed the current purchasing practices and processes affecting the purchasing unit's capability in working capital optimization. As demonstrated on Figure 18, based on the findings, it appears that the purchasers' capability to contribute to working capital optimization is limited due to three factors: lack of inventory and working capital management strategy, lack of transparency and demand planning and amount of manual work. This chapter includes summarization of the results of empirical research and reflects them to the theoretical framework and includes recommendations for the case company and conclusions.

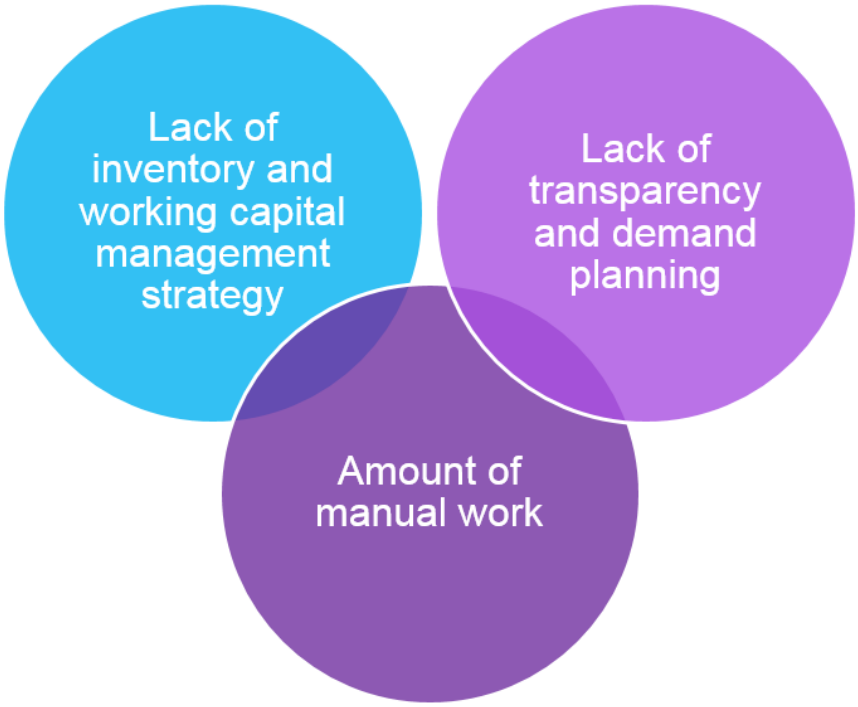


Figure 18. The three main topics affecting the purchasing unit's contribution

7.1 Inventory and working capital management

Starting from the fundamentals of working capital management, it appeared that the case company has a goal to decrease the amount of working capital in inventories but does not have a clearly defined strategy for it which is clearly reflected into the purchaser's capability in working capital optimization. Instead of measuring DIO, the company's only measures are the cycle time of inventory and approximate value of inventory which are monitored on an irregular basis. Although knowing the exact value of inventory and purchasing prices for items is fundamental for methods and concepts in working capital and inventory management, such as CCC and SIM, the case company is currently unable to keep track of them due to a flaw caused by a financing procedure. The case company is slowly moving towards the right direction though by increasing the focus on slowly cycling and excessive inventory which is the only area the case company is focusing on out of the six DIO areas listed by Smid (2008). Due to recent initiatives and purchaser's self-imposed activity, the case company has already managed to decrease the levels of working capital tied up in inventories significantly. By examining the DIO ratios, one can conclude that the levels are still excessive and could be decreased by more efficient operative purchasing. The capabilities of the purchasing unit are however limited due to the lack of inventory and working capital management policy.

Based on the findings, the case company does not have actively managed SIM in place which is clearly reflected into the amount of working capital tied in inventories at the case company. This is in line with Vrat's (2014, 39) statement, in which he implies that companies should initiate SIM in order to design a cost-effective inventory. The case company has implemented a material replenishment model for chosen SKUs which compared to Axsäter's (2014, 48) review is a combination of (R, Q) and (s, S) policies. The defined ordering points and quantities are updated irregularly and they are ineffectual. As a result, the purchasers have balanced between utilizing the outdated definitions and a self-imposed lot-by-lot method. Moreover, Inventory positions for all

items are reviewed periodically which is in contradict with Vrat (2014, 41) and Mohammaditabar et al. (2012, 656), who state that A items (or the most important items) should be treated with continuous review. As such, EOQ is not a viable method to define lot-sizing in the context of this thesis as the method gave inappropriate quantities. This finding supports Ganesan (2015, 62) who underlines that utilizing EOQ under fluctuating demand might give inappropriate quantities.

The ABC & XYZ analysis in this thesis revealed that the distribution of A, B and C items was very much in line with Vrat's (2014, 40-41) examples and that coefficient of variation is not a feasible attribute to be used in conjunction with ABC analysis due to the low and highly fluctuating demand across the SKUs. However, the extended ABC categorization including all SKUs indicated that over a third of SKUs belonged to category E. By looking at the amount of capital in inventories and DIO ratios it appears as if one of the purposes for the purchasers at the case company has been ensuring the availability of all SKUs at all times. Denoted by Tersine (1976, 210) and King (2011), this kind of policy is false as the diminishing marginal benefits should be taken into account and safety stocks should be defined only to assure a certain service level, not all stockouts. Furthermore, Azzi et al. (2014) remind that preferring out-of-stock costs too heavily over cost of inventory will result in outdated and depreciated products in inventory, which is exactly the case for the items categorized as E items in this thesis.

Unlike Hoffmann et al. (2011, 33) propose, the case company is not able to decrease unitary ordering costs by bundling lot sizes. Instead, the suppliers charge a percentage of the value of an order. Hence, unitary ordering costs will remain the same no matter how large the ordered quantity is. It seems as if this has not been taken into account when determining the current ordering points and quantities as the defined batches are relatively large.

7.2 Transparency and demand planning

As stated by Cachon et al. (2000), often the only information regarding demand is orders placed by customers or already occurring deliveries. This statement is perfectly aligned with the current situation at the case company, where the purchasers are able to receive demand information only after the delivery managers have switched the status of deliveries into “ongoing” which on average is 3 weeks after a customer has placed an order.

The lack of transparency and information sharing is an essential issue causing reactivity for the purchasers. In line with Mentzer et al. (2005, 11) and Kilger et al. (2008, 133), the purchasers are not able to manage inventories efficiently as they would need information regarding demand before the order becomes an occurring delivery. In response to ensure delivery reliability, purchasers have prepared for upcoming deliveries with inventory positions that are excessive in the context of working capital management. The highly fluctuating lead times with one particular supplier has caused the prevailing situation even more complicated.

The case company does not utilize any kind of quantitative or qualitative methods for demand planning. The lack of S&OP and demand planning function is in contrast with Smid (2008), Cachon et al. (2000), Scott (2011), Thome et al. (2011) and Vollmann et al. (2005) who all stress the importance of such functions. Instead, the purchasers are solely responsible for sustaining a balance between supply and demand at the case company. Although the quantitative data utilized in this study is based on a 12-month period and does not take yearly seasonality into account, it can be concluded that the case company is unable to forecast demand in a reliable manner based on historical data. The discovery supports Kerkkänen et al. (2009) who underline that forecasting based on historical data in B2B markets, where the demand is often sporadic, may give misleading results.

7.3 Amount of manual work for purchasers

As the purchasers are the best experts regarding daily demand and inventory management for the two services, they should be able allocate most of their working time into relevant tasks such as ensuring appropriate delivery reliability and optimal amount of inventory. However, according to the findings the purchasers are required to perform excessive amount of manual work that draws attention away from the essentials of purchasing and inventory management. In this context, the most important finding was that the only tool in place for following the inventory levels and lead times is the company's ERP which is fairly slow to use and unable to export visualized data effortlessly and efficiently. Although the theoretical framework does not discuss appropriate tools for purchasing and inventory management, it is self-evident that the lack of tool for visualization decreases the purchasers' performance regarding working capital optimization. Moreover, due to time and resource constraints, the lack of such tool disables the purchasers to perform inventory monitoring for items in a more continuous manner which is suggested especially for A items by Vrat (2014, 41) and Mohammaditabar et al. (2012, 656).

As suggested by Van Weele (2014, 267), a purchase order is usually initiated through a requisition by companies' MRP system when it detects that inventory point is at or below a defined level. At the case company this is not the case as the purchasers need to fill in the information to purchase orders manually. Also, the manual work caused by the different ID's in the case company's delivery system and ERP can be considered as a deteriorating factor for efficiency.

7.4 Recommendations for the case company

After discussing the findings and reflecting them to the theoretical framework, this chapter focuses on different recommendations for the case company. The findings including short and long term recommendations are listed on Table 3.

Table 3. Findings and short term and long term recommendations for the case company

Finding	Short term recommendation	Long term recommendation
Lack of structured working capital and inventory management strategy	- Continuous lead time reporting - A feature on ERP system to enable pricing information - Identifying most relevant SKUs - Involving purchasers in defining safety stocks and ordering quantities	- Coherent and horizontally accepted strategy for working capital and inventory management - Reviewing the need to store all SKUs - SKU standardization
Lack of transparency and demand planning	- Monthly qualitative demand data from sales -Enabling purchasers to see deliveries in the queue	- Setting up a S&OP and/or demand planning function - SKU standardization
Purchasers' excessive amount of manual work	- Tool to visualize stock levels and lead times - Robot for the interface of delivery system and ERP - Automated purchase requests for SKUs with defined quantities	

Although the best way to address fluctuating lead times would be through changing the supplier or negotiating stricter contract terms, these ways are not feasible in the context of the particular supplier that was mentioned on chapter 6.3 as the supplier is the most important supplier for the devices in question and the case company's negotiation power is limited towards the supplier. Hence, a more realistic approach is to continue monitoring and reporting the lead times to the case company's executive level and have continuous dialogue with the supplier. A software solution integrated to the company's

ERP system is recommended to ease the amount of work caused by lead time monitoring and reporting.

To measure DIO and to implement a successful inventory and working capital management strategy, the case company needs first to be able to track the value of the inventory. A development proposal of finding a solution for the pricing issue of financed items was forwarded to the case company already in the early stage of the research but no straightforward solution was found. It is strongly suggested that the case company would strive for finding a solution as currently no reliable reports related to the value of inventory can be produced. In the short term another step should be identifying at least the most relevant SKUs, for which appropriate reordering points and ordering quantities should be defined in collaboration between the purchasers and product managers. A review of the quantities should be done on a continuous basis. In the review, finding a balance between out-of-stock costs, inventory costs and ordering costs should be taken into account. In other words, purchases should be conducted frequently in as small batches as possible, however not at the cost of a desired service level. For other SKUs, the purchasers should continue defining the quantities by their own best effort, also known as the lot-by-lot method.

The former recommendations could be seen as one of the first steps into forming an actual long term strategy for inventory management in which a multi-criteria ABC method should be utilized for SIM. As the XYZ analysis proved not to be successful due to the high demand variation across almost all SKUs, other alternative attributes should be used in conjunction with the traditional ABC method such as life cycle classification or criticality of the SKUs. It should however be stressed that the other or one of the attributes is required to be tied into the SKUs cumulative purchasing price or COGS within a certain timeframe. Given that the traditional ABC analysis or its derivative was used in the future, the case company should especially pay attention to active inventory management of the A items by setting appropriate and cost effective

ordering points and quantities. For the A items, continuous review should be preferred. For B items, the case company should set up some initiatives as well, although not as active management as for A items is needed. Essential B and C items that are considered for example as bottleneck items should be handpicked for active inventory management activities, too. It is recommended that the case company would review the need to store the rest of B and C items at its own inventory unless their purchase value is extremely low or their purchase value is relatively low and they have high demand and low DIO ratios. In other words, it is suggested that the items with relatively high purchasing price and low demand should be purchased only when requested by the delivery department either directly from the suppliers or a distributor. This way, the case company would efficiently decrease the average DIO ratios and eliminate most of the E items in the future that have been stored in the warehouse but have not been delivered during the whole 12-month examination period. Although the decision to stop storing the items would likely result in an additional lead time and temporary stockouts for the items and require detailed item specific analysis with relevant stakeholders, it is very likely that the decision would be financially profitable for the case company.

Regarding to the findings related to lack of transparency and information sharing, in the short term it is proposed that the company would find a solution to gather at least some kind of demand data from the sales unit in a qualitative way. Although the specific devices cannot be defined prior to the system designers, the devices could for example be clustered so that the purchasers would at least know what type of demand is in the pipeline. Furthermore, it is suggested that the case company would conduct an in-depth analysis on the internal delivery process to shorten the internal average three weeks' lead time. The ultimate solution for the lack of transparency and information sharing would be organizing a S&OP function or at least a cyclic demand planning process that would gather up all relevant stakeholders including sales department, delivery department, supply chain department and the materials management team including the purchasers. Standardization of SKU's would of course reduce the complexity, but that is however feasible in long term only. Due to the nature of the business,

standardization seems to be the only feasible solution to enable demand forecasting based on historical data as standardization would mean the demand would be focused on less SKUs resulting in more constant demand per SKU.

The remaining recommendations address the excessive amount of manual work the purchasers are required to perform. Although these recommendations might seem minor, they can potentially have a significant impact on the purchasers' capability to manage working capital. The case company already has a software solution in place for visualizing other ERP data and the same software could be used for visualization and monitoring of lead times and inventory levels. As previously mentioned, the tool would also enable continuous inventory position review for the A items. Given that the delivery system, which is already decades old, will not be developed or replaced, a robot for the interface of the delivery system and the case company's ERP system is recommended. Also, automated purchasing requests for items with actively managed ordering points and quantities would be preferred. The recommendations to decrease the manual work of purchasers should be fairly effortless and affordable to conduct.

7.5 Conclusions

The main objective of the thesis was to evaluate case company's purchasing practices to find out if the case company's operative purchasing behavior could be improved in order to optimize the amount of working capital tied up in inventory. Based on the objectives, one main research question and two sub-questions were derived. After reviewing theoretical framework and completing the empirical research, it is possible to answer the research questions.

As the two sub-questions assist in answering the main research questions, the sub-questions will be answered first. The first sub question was: *"How do case company's*

practices and processes affect case company's operative purchasing unit's capability to manage working capital currently?". Based on the empirical findings, the case company's internal practices and processes in general do not support the purchasing unit's capability in working capital management. First of all, the case company is lacking an actively managed inventory management policy or SIM. Instead, the case company has implemented one-off activities without solid and frequent processes managing them. Hence, especially in the past the items have not been purchased effectively in terms of working capital as the purchasers have had no framework to base their actions on. Second, although partly caused by the high customization degree of the services, the case company is lacking information sharing and transparency within its internal delivery process. Consequently, the purchasers are not able to purchase in a proactive way. The third sizeable flaw affecting the purchasing unit's capability is the lack of appropriate tools which would be required for purchasing efficiently.

The second sub-question was: *"How should the case company's processes and practices be developed to optimize operative purchasing's contribution to working capital management?".* Based on the question, multiple development recommendations surfaced from the interviews, observation and analysis of quantitative data, including topics related to inventory management policies, transparency and system development. As a result, the recommendations are listed on chapter 7.4.

The main research question was: "*How can case company's operative purchasing contribute to optimizing working capital?".* It appears that the purchasing unit's role is purely operative and it focuses on ordering items and expediting deliveries from suppliers which limits the contribution into working capital tied in inventories only. Currently, the purchasing unit's contribution is heavily limited by a challenging environment mainly caused by high demand variation and lack of SIM, transparency, S&OP, demand planning and appropriate tools.

Many of the abovementioned issues could be resolved through item standardization but as it is not possible to accomplish during the next few years, the case company has to focus on other alternatives to ensure better contribution for the purchasers. The most important initiative is a coherent and horizontally accepted inventory management policy including SIM by which the most important items and reordering points and quantities for them would be defined and continuously managed in a collaborative manner. Due to the highly variable demand, the reordering points and quantities for other items should be defined by purchasers utilizing the lot-by-lot method. Instead of purchasing all items to the case company's warehouse, the case company should evaluate whether the purchasers should order items with lower importance only when needed instead of storing them at the case company's warehouse.

In order to address the lack of transparency, the case company should seek possibilities to enable the purchasers to have knowledge about upcoming deliveries. The sooner the purchasers have the knowledge, the better. Solutions for this include an S&OP process and gathering qualitative demand information from the sales unit. By developing appropriate tools for stock and delivery monitoring, the purchasers could purchase more efficiently in terms of working capital.

As the study is a single case study and is based on findings in a single case company, the findings should not be applied to any other environments. Also, as the focus of the thesis was on the case company's operative purchasing unit, the study was limited to the particular unit's role in DIO ratio optimization only. To cover other components of CCC, including DSO and DPO ratios, a further research topic covering the case company's sourcing and sales units' performance in working capital optimization would be interesting. Moreover, further research regarding implementation of a demand planning process and development of the internal delivery process would be beneficial.

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