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Developing Purchasing and Inventory Management of filters in Storent Oy

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<p>The aim of this thesis was to develop purchasing and the inventory management of spare parts in the case company Storent Oy by highlighting the key improvement areas. During the time of this study the case company used an ERP system, which had basic data of current inventory, but the system did not support reordering or stocking decisions. Therefore, the purchasing of spare parts was not automated and purchasing decisions were made when the demand occurred in real time.</p> <p>The research approach was qualitative, and the data was collected by interviewing the Head Manager and Technical Manager of the case company and using the author's own observations while working in the company and data from the ERP-system. The author conducted a SWOT analysis based on the results of the interviews. An ABC analysis was also made for one specific spare part product group, filters, which are used for maintenance for rental machines. Academic articles and literature were used as secondary data to create the theoretical framework which focused on understanding the purchase processes, inventory management techniques and policies, and how to analyse inventory data.</p> <p>Problems with product naming and interchangeable filters were identified, and these were solved by implementing a better product naming and a cross-reference-list for the target product group of filters. Processes where these spare parts were processed changed during the writing of this thesis. Categorising the inventory to support stocking decisions, inventory size reduction, improving data quality were the actions suggested to be developed in the case company. Results of the study can be used to develop the inventory management of other product groups in the case company.</p>	
Keywords	Inventory management, Inventory optimisation, SWOT analysis, ABC analysis, Purchasing

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Terminology

- **Inventory level** - the amount of stock company has on hand plus backorders included. (Axsäter, 2015, 40)
- **Reorder level** - a point in inventory levels where a new replenishment order for a product is required. When a specific product goes below certain calculated level, new purchase orders must be made to be ensure the required amount of materials is on stock. (Davis, 2013, 90-92)
- **SKU – stock keeping unit** - numeric codes assigned to products or services, which allow companies to identify and track them for turnover and flow. Using SKUs as unique product identifiers provides single item approach which support in inventory management and purchasing activities.
(Hudson, 2020)

1 Introduction

Almost every organisation has inventory in some form. Therefore, having efficient inventory management is extremely important nowadays. Competition for small and medium sized businesses is tough and having a working inventory control suited for company needs can be the competitive advantage, which separates organisation from its competitors. Creating trust with customers by being reliable in providing services and products, whilst saving costs, might be the most important factors for companies and utilising the available inventory correctly, may be the key to it.

The target company of this thesis is specialising in lifting services, equipment rental and hauling and jacking services. The company has three distribution centers in three locations in Finland and few around Europe. The original name was Leinolift Oy, but it was acquired by Storent Group in 2016. Storent Oy had a turnover of 12,8M € in 2018 and has continued to grow in the Finnish market since the rebranding in 2019. The company has activities in three locations in Finland, where the rental equipment is stored and repaired. The main spare parts inventory is in Vantaa. While conducting this research the author of this thesis was working currently as Spare Parts Manager in a warehouse in Vantaa. The job was to manage the spare parts inventory and process related to purchasing products into stock and directly to the equipment. Storent has a variety of suppliers for their spare parts due to the diversity of the equipment stock. Storent also has an ERP system, which is used companywide in all the locations within the Storent Group. In inventory management and purchasing of spare parts, the ERP system is mainly used to add and remove products from the system, and this has its shortcomings. Currently the system does not support purchasing functionalities with suppliers and buying is conducted over phone or by email.

Companies with a high expansion speed, need to have well organized systems and processes, a capability to have a fast response and to have demand fulfilled and move the required products out of the inventory to the customer. While working as a spare part manager since 2019 in Storent Oy the author has experienced the challenges in managing the spare parts business. These are mainly due to the business growing fast

and becoming more complex. There are multiple slow or non-moving products in the inventory, which does not only increase the bonded capital, but also makes the spare parts management disorganised and challenging.

One of the main challenges is to find the correct spare parts for the machines, which require repair or maintenance. The correct parts might be available, but not booked to the system the right way. Not finding the right part might result in purchasing additional and sometimes duplicate spare parts to the inventory or causing delays to machine maintenances. There are various companies in Finland providing equipment rental and service. Having the machinery ready and available immediately is a huge competitive advantage. To have the right spare parts available for the repairing process and to optimise the inventory management with right stocking decisions and timely purchasing, can be seen advantageous. Therefore, it was important and interesting to study how the purchasing and inventory management in Storent Oy could be improved.

1.1 Research objectives and scope

The main goal of this research is to analyse the development needs and to improve inventory management of spare parts in the target company. The objective is to provide information for cost-efficient inventory management by reducing inventory size and to have correct spare parts in stock in case a maintenance or repairing is required for the equipment, ensuring equipment availability and customer satisfaction.

Bottlenecks detected in the company that this thesis aims to solve are how to reduce inventory size by finding and reducing excess stock, and how to clarify the accounting of the inventory by categorising the products based on requirements set by the target company while creating a better use for the capital of the company. There are no predetermined inventory levels and order sizes utilising fixed reorder-point inventory management system in use in the case company. Instead all purchasing decisions are made based on immediate demand. Therefore, understanding of what is in the inventory has become unclear for certain spare parts on the shelves. When there is a clear understanding of what is in the inventory, it would be possible to make better deals with

suppliers. However, this requires planning reorder points or other guidelines for purchasing decisions where needed. One of the main research targets was to find out how ERP systems can help in simplifying purchasing decisions. The other important target was to analyse how the inventory management can be developed and to provide suggestions what new inventory management techniques could be implemented.

This thesis aims to answer to the following research questions:

- How to analyse inventory data?
- What are the main challenges in master data management and purchasing processes in the target company?
- How to utilise ERP system in inventory management?
- How to reduce inventory size for the company to release capital to be used elsewhere?

1.2 Methodology

The thesis is based on a case study about Storent Oy. Research was conducted by using both quantitative and qualitative. Quantitative primary data was collected from the company's ERP system and qualitative data by conducting a semi-structured interview to the Head Manager of the repair workshop and to the Technical Manager who are responsible for purchasing decisions. The target of the interviews was to gain more knowledge about the inventory management and purchasing process of spare parts in the company and about the main development needs. Also, knowledge based on writer's own observations and experience by working in the target company from 2019 onwards was used as one source of primary data. Research was made on the current situation of products in the ERP-system and by using ABC analysis on product group called "Filters".

Also, relevant academic articles and literature were utilised as secondary data to create the theoretical framework that shows the benefit of creating a well-managed inventory and to support the analysis of the primary data.

SWOT analysis was made to figure out the current state of the of the company's inventory management processes based on interviews to Head Manager and Technical Manager of the workshop and writer's own experience. SWOT analysis is a strategic tool to analyse companies' status such as performance, competition, risk, and future potential. SWOT is an abbreviation of strengths, weaknesses, opportunities, and threats. SWOT can be split to internal and external factors, where strengths and weaknesses highlight current circumstances whereas opportunities and threats come often from external environment creating consequences for the business in the future. It can be used in strategic planning and decision making.

Strengths show what the organisation excels in, what gives them a competitive advantage compared to their competitors in the same industry, highlighting what organisations are good at. Essentially, strengths are internal success factors of the company such as operational efficiency, market share, company image and efficient inventory control processes and tools.

Weaknesses are internal negative factors that hinder organisations at present and need improvement to be more competitive. Weakness analysis review areas that don't serve the business as efficiently as potentially possible and should be improved. These can be related to people, resources, systems, and procedures.

Opportunities are positive external factors in the business environment, that can add to organisations success. It is possible to take advantage of opportunities and change them into strengths. Opportunities can arise from competitors, market trends, business partners, information systems and tools.

Lastly, threats are negative external factors which can affect business negatively. Threats can't be completely avoided, but the effects can be minimised with good preparation and with preventive measures. An example of the content of SWOT is shown in table 1. (How SWOT (Strength, Weakness, Opportunity, and Threat) Analysis Works, 2021)

Table 1. SWOT analysis example (How SWOT (Strength, Weakness, Opportunity, and Threat) Analysis Works, 2021)

<p>Strengths</p> <p>Factors which the organisation excels in and continue pushing the success of business.</p>	<p>Weaknesses</p> <p>Factors that need improvement to allow organisations develop their potential.</p>
<p>Opportunities</p> <p>Is there trends, strategies, policies, or conditions businesses can take advantage of to turn them to strengths?</p>	<p>Threats</p> <p>Factors that may have negative effect to company profitability such as market influence, economic situation, or competition.</p>

Also, an ABC analysis was conducted to categorise products to different segments. This analysis tool is explained in more detail in chapter 3 about inventory management policies. Products, which were in the focus in this thesis, were filters due to them having the biggest demand in regular maintenance. Results of this case study can be used as a base on what to develop and upgrade in the inventory management processes.

Storant Oy systems, processes and data quality created challenges and limitations to conduct a comprehensive study. Sources used were mainly taken online due to the current pandemic around the world. It would've been beneficial to have a wider scale of academic sources.

2 Purchasing

2.1 Definition and objectives

Purchasing is one of the most common activities, but at the same time one of the most important procedures for a business. Having enough spare parts on stock is mandatory for functioning equipment rental business. "Purchasing" in its simple form means acquisition of goods or services through accepted pricing. "Purchasing" is often used

interchangeably with “procurement”, which refers to other functions of acquiring goods such as the process of finding out what materials or goods must be acquired, correct selection of suppliers, agreement on order details, delivery of goods or services and the final payment to the supplier as can be seen from figure 1. In this thesis “purchasing” will be used more often. (Chunawalla, 2008,10-11; Leenders et. al. 2006, 4.)

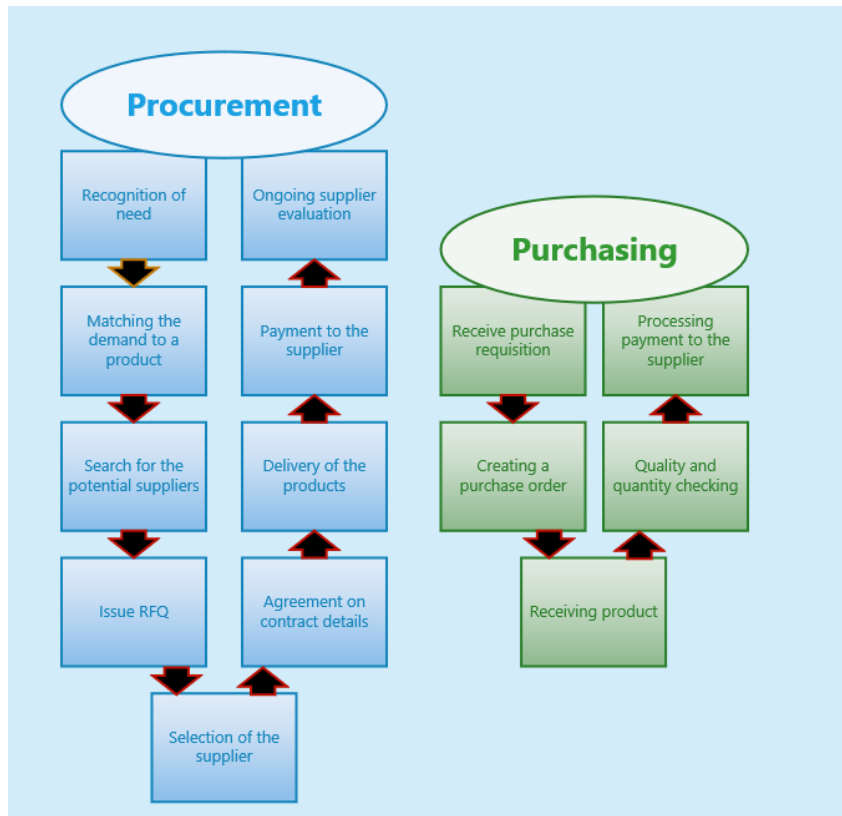


Figure 1. Difference of Procurement and Purchasing (adapted from Johnson et. al., 2011, 4-6)

Purchasing can be classified into two groups in a business world: Industrial purchasing or mercantile purchasing. Mercantile encompasses buying items, which are intended to be resold with profit. Industrial purchasing is used when goods or products are bought for the purpose of consumption or reorganisation. (Chunawalla 2008,12.)

Objectives of purchasing has been defined by Baily, Farmer, Jessop, and Jones (2005, 3) as follows:

"Acquiring correct material, at the right time, in the right quantity, from the right source, at the right price."

This allows us to look at the framework for how a business uses industrial purchasing. However, we must be able to measure purchasing in some way, which is why there are multiple purchasing functions. These functions include acquiring goods and materials based on the needs of the organisation, selecting best suppliers from the market, buying efficiently while maintaining the best quality and value and protecting company's costs. Additionally, organisations must monitor the supply market trends, ensure alternative sources for supplies in case of urgencies and develop the procedures to ensure all necessary objectives are reached (Baily et. al., 2005, 4).

2.2 Purchasing process

As shown in figure 2 purchasing process starts with recognizing the need and determining the specifications. The second step is to search for possible suppliers through market sourcing and tendering processes. Third step requires negotiation between supplier and buyer for the terms and conditions regarding the goods that are being purchased. This contains how and where goods are delivered, payment terms including the pricing and when payment is in effect. Fourth step is proceeding with a purchase order, pro-forma invoice or a contract after which expediting order and delivery takes place. When the goods are delivered to the buyer, goods are checked to ensure required needs are met according to the contract after which supplier issues an invoice and the buyer proceeds with the payment. (Baily et. al. 2005, 4-5; Trade facilitation implementation guide, 2012)



Figure 2. Purchasing Process (adapted from Baily et al. 2005, 370)

These processes will be explained in following subchapters in more detail.

2.2.1 Identifying needs and specifying requirements

First step in the purchasing process is determining the need and specifications for the items or services. Need for product or service come usually internally from company's internal personnel in the form of purchase requisitions. It is essential for the purchasers to know exactly what and how much is needed. Accurate description of requirements includes information on if it's a tangible good, a service, or goods and services packed together. Unclear data may lead to unnecessary costs. Products or services should be identified using proper naming and product codes. Catalogues or databases with product codes are beneficial in creating a clear picture of what kind of product or service is needed. (Johnson et. al., 2016, 55.)

Items and services have two ways of being determined: technical specification or functional specification. Technical specifications comprise of the technical characteristics of the product or service in question, whereas functional specification clarifies the function of the product as to what it does. (Van Weele 2005, 48.)

In manufacturing, information to buy a product or service appear usually in the form of purchase requisitions. There are different kind of formats on purchase requisitions, but

all must cover certain information. Specified description on what sort of material or service is needed and in what quantity. Price of the product or service should be included in addition with the account which it is charged from. Finally, date of the requisition should be mentioned and authorisation signature to ensure the requisitioner has the right to request purchasing for said product or services in the company. (Johnson et. al. 2010, 81-82.)

Material planning focuses on deciding a schedule for materials in advance. Information on specifications are known completely and with demand forecasting companies make material planning schedule where materials are ordered from preselected suppliers in certain time intervals. In case demand forecasting is done inefficiently, shortage and over-stocking of certain materials might take place. Materials planning schedule must be adjusted new forecasts in such cases. (Chunawalla, 2008, 31-32.)

2.2.2 Identifying and selecting supplier

Next step in the purchasing process is to seek and evaluate potential suppliers to fit the requirements mentioned in the purchase requisitions. Selecting a supplier depends on criteria's the company has in requisitions. Supplier selection should match requirements from the purchaser such as quality, quantity, delivery time, price and service but there are cases where additional criteria's may be needed to take into consideration. Companies might have suppliers which handle most of the frequent purchases where requirements are known, resulting in easy decision to buy from them, since there is past knowledge of supplier service capabilities and prices. Frequent purchases can be bought from these regular suppliers which saves time in the supplier selection phase. Second option is so start looking for new potential sources for supplies. (Johnson et. al. 2010, 314-317.)

In case there is a need to look for new sources for supply, knowledge of where to look for sources is important to a purchaser. There are multiple places where to inquire information such as websites, e-catalogues, and online searching. Good purchase manager has a possibility of having professional contacts in the field or previous records

where goods or services have been bought. Nowadays electronic catalogues are used often since the availability is simple to everyone due to internet. However, purchasers need to be able to categorise and select correct catalogues due to there being abundance of material available. Catalogues in manufacturing generally contain information about technical specifications even possible replacement parts and the price as well. Companies who frequently make purchases from suppliers use these catalogues as reference to find required items. (Johnson et. al. 2010, 317-319.)

Whenever purchaser has found potential suppliers to buy from, they will send a request for information (RFI). RFI is sent to the supplier usually electronically or by mail to gather information on suppliers' products or services to verify if the suppliers are able and interested in offering the requirement. Secondly, a request for quotation (RFQ) is sent, which basically offers the supplier to start a bid to fulfil the need for said product or service. RFQ inquiry must include all possible knowledge regarding the purchase itself, such as, individualisation of the product, standards and certifications which need to be fulfilled, technical specifications and drawings to explain product characteristics, quantity of required products, delivery time, the term of delivery which is often based on Incoterms 2020, price and payment term to define the period for the buyer to pay off amount. (Johnson et. al. 2010, 84-85.; Baily et. al. 2005, 371-372.)

2.2.3 Contracting and ordering

When the supplier has been selected and details on product have been agreed, next stage is to create a contract between the purchaser and supplier. Contract is essentially an agreement where goods or services are exchanged between buyer and seller in return for payment. Contract is established after purchaser and supplier have reached an agreement on all terms regarding RFQ. Creating a written contract or a purchase order where all conditions such as product specification, quantity, delivery time, delivery terms, price and payment terms are, ensuring safety on both sides in case legal problems arise since a contract is a legally binding between both parties. Contracts are also subject to laws such as contract law. (Johnson et. al. 2010, 85.; Baily et. al. 2005, 372-373).

When contractual demands have been met on both sides, next sequence is to set up a purchase order, which in many cases is done in electric form during the digital age. Format and designs may differ depending on the designs of the system used, but certain information must be written down. Purchase orders should at least contain order number, date of the order, address and name of the supplier, quantity purchased, description of goods which are being bought, price, delivery time, shipping instructions, and terms of payment. When PO is placed, it is not a contract until the supplier has accepted the order. In most cases when seller has accepted the purchase order, they will send an acknowledgement of acceptance and only then is a contract established officially. In most cases confirmation order is sent to the buyer which matches original information place on the purchase order. (Johnson et. al. 2010, 86-87)

There is another format of purchase order, which is called blanked and open-end purchase order. The difference with a normal purchase order is that blanket order can cover multitude of items instead of just one and open-end orders allow buyers to add extra products or change the duration of the orders. In repairing business, which is the focus of this thesis's company, a variety of products are bought for maintenance and repairing (MRO), thus blanket orders are a good way of ordering certain required items repetitively. (Johnson et. al. 2010, 87-88).

2.2.4 Follow-up and expediting the order

Once the purchase order has been placed and accepted, the buyer may proceed to follow-up and expediting the order. Following the order basically means order tracking to make sure supplier can meet with the delivery demands which have been made. Buyer may contact the supplier and inquire information on the delivery status through different means by phone, e-mail, or in-person. There is also a case where a tracking number is given, and buyer may check where the items are in certain periods. Follow-up in cases where lead-time is long, prices of the purchase are large or importance of matching the agreed delivery time is crucial for the business, follow-up is an important part of business. In cases of low-value-purchases with no critical value, follow-up may not

happen at all, or there may be an electronic system which informs in case changes in delivery exceptions take place. (Johnson et. al. 2010, 88-89)

After the purchase order is issued expediting the order may concur. This means that the buyer urges the supplier to match agreed delivery times, push forward the delivery in case of emergencies or to speed up the delivery if it is delayed. Expediting may occur due to variety of reasons but is mainly caused by poor planning by the buying organisation. This calls for improvements in internal processes for the purchasing company. (Johnson et. al. 2010, 88-89)

Normally expediting the order should not happen as Johnson et. al. (2010, 89) are stating: "If material requirements planning is adequate, the buyer should not need to ask a supplier to move up the delivery date except in unusual situations."

There is a ten-point checklist written by Baily et. al. (2015,166), which can be used to evaluate if the expediting orders is required although it is only a guideline to ensure everything in the delivery has been done correctly thus reducing need of expediting:

- Lead times are known and accepted.
- Mutual concern exists between buyer and seller.
- Information is shared by buyer and seller
- User do not frequently reschedule requirements
- Expeditors do not raise the alarm too often unnecessarily
- Capacity and capability of suppliers is checked pre-contract.
- Specifications are clear, understood by seller and fall within seller's technical capability
- Specifications are not frequently altered
- Delivery required is specified properly
- What the salesman says can be done reflects the actual situation

2.2.5 Receiving goods and evaluation

Important part of the purchase process happens on the arrival of goods to the agreed points of delivery. Depending on the size of the organisations, they may have focused their reception to one department, but this is usually the case in smaller organisations. In larger organisations multiple reception points may operate. Main point of reception of goods and evaluation is firstly to confirm that the order has been delivered. Secondly, to check that the shipment condition is as agreed, and no unplanned exceptions have occurred. Thirdly, reception procedure is to ensure correct quantity is delivered. Fourthly, reception must make sure the order is being delivered to proper parties, which may include inventory, use, or resale. Finally, the last point of reception and evaluation of goods is to provide correct receipt documents to proper parties involved. (Johnson et. al 2010, 90.; Baily et. al. 2015, 376)

Evaluation of goods is crucial to businesses in ensuring processes go as planned. In case the goods or services are must be returned or rejected, purchaser organisation must inform supplier of such case and negotiate how the goods are handled. Items may be returned to the seller and multiple options of disposal methods are possible. In some cases, goods are returned to the seller, who will send a credit invoice to the buyer, which will either compensate full amount of the purchase or part of the price depending on the negotiation between parties. Because the seller owns the rejected goods the methods of disposing must be agreed with them. When goods are rejected and disposed according to the acceptance of the seller, they will send a debit invoice to the buyer. Result is usually that the purchaser side will be compensated the amount paid from their account. (Baily et. al, 2015, 376-377)

2.2.6 Invoice payment

Final stage of the purchasing process happens when goods have been received and evaluated and goods and services match with reception notice, purchase order and invoice. Invoice is then cleared for payment, where either purchase department or accounting department handles the payment procedure. In some organisations payment

is done by the buyer since he has made the purchase and can therefore verify whether the information on the order is correct. Usually the accounting department is the one who handles payment after confirming the details from the buyer who approves the invoice in the accounting system. Once the payment has been made the purchase process is completed. (Baily et. al. 2015, 378)

3 Inventory management

3.1 Main inventory types, costs and KPI's

Every organisation holds inventory, no matter what kind of organisations. Müller (2011, 13) states, that "inventory includes a company's raw materials, work in process, supplies used in operations, and finished goods."

Raw materials are mainly used when producing completed manufacturing goods. Work-in-process (WIP) inventory holds raw materials or unfinished products that are in the process of being completed and finished goods are items that are ready for sale or usage. (Müller 2011, 12-14)

In addition, there are inventory types, which should be categorized based on their practical use: consumables and services, repair replacement and spare items (S&R items.) Consumables in their simple form are small items of low value, which are not being sold or produced such as pens and copy paper. S&R items are items used in machines in for repairing or maintenance purposes, mainly in manufacturing and should be separated from finished goods when planning a forecast for stock levels. Lastly, there are safety stocks, which are additional inventory kept by organisations in case surges in demand or shortage of supply occurs. (Müller 2011, 13-15, 21)

Depending on the nature of the organisation, inventory types and functions vary greatly. Financial departments tend to look at inventory levels from cost perspective while trying to keep costs low, since inventory from their view is cash that is tied up. The viewpoint

of Finance is to keep the costs as low as possible and therefore to keep a low level of inventory. On the other side sales department only wants to ensure profit. (Müller 2011, 21)

Having inventory will always accrue costs, no matter the organisation. In general, you can find three kind of inventory costs.

- **Ordering costs** occur whenever purchaser creates a new purchase order to buy new products or items. While these costs are fixed, all expenses that are accumulated from placing a purchase order and delivering, are also included.
- **Holding costs** are costs of carrying inventory, where price of the items stored is tied to. Other expenses included contain salaries of the personnel handling the inventory management, counting costs, storage costs, damage for the products, insurance, and taxes.
- **Penalty costs** accumulate when inventory is out-of-stock (OOS) or backorders. If OOS situation occurs, purchase department might run into following problems; requirement to order in an urgency, resulting in the need to buy more expensive product than planned or the substitution is less profitable for the company. In case there is no S&R items available and machine, which is supposed to be rented to a customer, is not working with no chance for repairing, there is a chance to lose goodwill from customers. They might not want to use the same company since the service was unsatisfactory. (Davis, R.A, 2013, 85-86)

Key performance indicators, also known as KPI's, are metrics that focus on business performance. These metrics are crucial for organisations' success. KPI's can be financial, operational, or time-based depending on the company structure and strategies. In inventory management, KPI's help in decision making such as buying products to stock. Using KPI's provides information about product turnovers, demands and costs. (Parmenter, 2015, 7-13., Min, 2015, 425-426)

According to (Kaplan, R.S., 2009) and later referenced by (Min, 2015, 425-426) there are three types of KPIs: Process KPIs which measure the efficiency or productivity of a business process such as product repair cycle time, Input KPIs that measure assets and

resources and Output KPIs, which measure financial and nonfinancial results of business activities.

Inventory turnover ratio

Inventory turnover ratio indicates the time it takes for the inventory to be replaced over a certain period. Inventory turnover is important to companies since it shows the company's liquidity. Higher turnover indicates if goods are sold or used fast and that there is no excess inventory when slower turnover demonstrates more binding capital in stock and inefficient demand planning and volatility in demand forecasting. It is a good indicator for stocking decisions as it highlights potential pitfalls, for example when stock is consumed too fast it can be a risk factor if the supply replenishment doesn't meet the requirements. It can be used as a tool to calculate the health of the inventory. Formula below shows how this KPI is calculated. (Müller 2011, 26-27)

Inventory turnover ratio = Cost of goods sold or used / Average Inventory

Lead times

Lead time is considered as the time it takes for a process from the initiation phase to completion phase. In inventory management it means the amount of time it takes to place a purchase order to a supplier and receiving the product on hand. Lead time reduction is an important KPI that can be used to evaluate supplier reliability and efficiency. It is an important deciding factor which suppliers use for different products and services. Reducing lead time is beneficial, since it also mitigates variation in lead times and thus improves the reliability of the suppliers allowing businesses to make more accurate purchasing decisions. (Logistiikan Maailma)

3.2 Inventory management policies

Demand forecasting is a process where businesses make estimations about future demand for materials or products based on historical data from inventory and sales over

a certain period. Forecasting demands helps businesses in making decisions regarding new purchasing and stocking decisions. Having reliable forecasts eliminates the possibilities of understocking or overstocking that can result in unnecessary inventory costs or loss of sales due to there being not enough materials on stock. (Johnson et. al., 2011, 201-202)

Safety stock is used as a buffer stock to cover variations in supply demand. Companies buy goods to inventory to reduce risks in case sudden changes in inventory levels occur, reducing the risk of stockout situations. (Min, H., 2015, 129) Changes in inventory levels may occur due to changes in demand. Changes in demand occur when the lead times are not fixed or the usage of materials and products increases. Safety stock is calculated by multiplying the maximum number of units and the longest period it has taken to deliver the product from supplier to stock and then subtracting average usage of units and average lead time from it. (Logistiikan Maaailma) Safety stock can be calculated with the following formula: (Min, H., 2015, 139)

Safety stock = max. daily usage x max. lead time in days) – (avg. daily usage x avg. leadtime in days)

Companies that use ERP programs to manage their inventory often check their inventory levels for materials or products by using review methods. Usually these reviews are done periodically, and this is called periodic review. An artificial lead time is placed that might show when unnecessary excess stock appears. Depending on cost and demand, this periodic review can be made daily or sometimes in longer periods such as every quarter in a year. (Davis, 2013, 88)

Economic Order Quantity (EOQ) was developed by F.W Harris in 1915 and as cited by (Müller 2011, 76), it allows stock handlers to determining the following in inventory control:

- the optimal quantity to order
- when it should be ordered
- the total cost
- the average inventory levels

- how much should be ordered each time
- the maximum inventory levels

To calculate EOQ you can use the following formula:

$$EOQ = \sqrt{(2 \times A \times R) / P^2 \times K}$$

In this calculation A is the total value of SKU per year, K is holding costs, R is replenishment costs, which occur when ordering products and P which is the price of the unit. When calculating EOQ there should be no variations in demands, carrying and ordering costs are the same no matter how many are bought. There can be no differences in lead times but no stockout situations or any kind of backorders can occur. Usually EOQ is only used on a single product or material at once. Below is an example of a calculation using this formula:

$$A = 25000\text{€}$$

$$K = 12\%$$

$$R = 90\text{€}$$

$$P = 25\text{€}$$

$$\begin{aligned} EOQ &= \sqrt{(2 \times A \times R) / (P^2 \times K)} \\ &= \sqrt{(2 \times 25000\text{€} \times 90\text{€}) / (25\text{€}^2 \times 0.12)} \\ &= \sqrt{(4,500,000 / (25\text{€})^2 \times 0.12)} \\ &= \sqrt{4,500,000 / 75} \\ &= \sqrt{60\,000} \\ &= 244 \end{aligned}$$

Result shows that when using this calculation, 244 units is required on every order. (Müller 2011, 76)

The reorder point (ROP) is a level of inventory that indicates when a material needs to be purchased. It is a trigger indicating that an action is needed, and replenishment should take place. It is a minimum level of inventory the stock is not allowed to fall below. (Müller 2011, 74-75)

Reorder point is calculated by using the following formula:

$$(Usage + Lead Time) + Safety Stock = Reorder Point$$

(Müller 2011, 75)

EOQ and reorder point are used in the continuous review inventory management policy. Continuous review means inventory levels are monitored constantly and the items are ordered automatically whenever inventory level falls below a certain level. In continuous review it is assumed that demand and lead time are constant, holding and ordering costs are always known and fixed, and there is no change in prices of the units.

(Davis, 2013, 87)

3.3 ABC and XYZ analysis

ABC analysis is a method of inventory management where inventory is classified based on the consumption values during a specified period. It follows the Pareto principle; materials are classified to three categories. It is based on the 80/20 rule, where 20% of items in inventory represent 80% of sales budget. Class A are materials with the highest consumption value that require tightest inventory control, class B with second highest consumption value that take less control and class C with the lowest consumption value and the least priority value but with the highest level of inventory. (Johnson et. al., 2011, 217-219)

Table 2 illustrates how materials belonging to class A include 20 percent of the materials in total inventory and value of these materials is 70-80 percent of total sales volume. Class B has 40 percent of total materials belonging to the inventory and with 15 percent of total sales volume. Class C is the category with 40 percent of the total materials, but the sales value is only 5 percent making it the group with the lowest value products. Class C on the other hand has a great number of items, but the sales value of these items is only 5 percent, hence 80/20 principle. The analysis helps in focusing on the

differences in the separate segments and to optimise the purchasing process by focusing on right categories. ABC shows where the stock is binding capital and storage space. (CGMA, ABC Inventory Management; Johnson et al. 2011, 217-219)

Table 2. (ABC analysis classification, adapted from Johnson et al. 2011, 217)

Class	Percentage of materials in Inventory	Percentage of consumption value tied to the inventory
A	20	80
B	40	15
C	40	5

ABC-analysis is sometimes used in conjunction with XYZ analysis to segment inventory items according to the variability of the demand. XYZ is categorised as follows:

- X – Items which have very little variation in demand and have a steady turnover. Items in category X can be forecasted accurately due to no fluctuations in demand.
- Y – Items which have medium level of variation in demand, but the fluctuations can be predicted to a certain extent. Fluctuations are often caused by factors which are known such as economic factors, seasonal items and product lifecycle ending.
- Z – Items that have the most variation of demand in inventory. Demand for items can fluctuate strongly making it impossible to predict the demand. (CGMA, XYZ Inventory Management)

XYZ analysis can reduce stock-out situations since the reliability of predicting the demand is more accurate. Obsolete items can also be pointed out in case when there are items, which have zero demand. (CGMA, XYZ Inventory Management)

Whenever ABC and XYZ analysis are implemented to inventories, it is important that inventory management systems are able to provide reliable data in correct form for ABC and XYZ analysis to be applicable. When applying ABC and XYZ, companies need to be sure which items are included and which are not, and what is the best time period to for calculation efficiency. (CGMA, XYZ Inventory Management)

3.4 Just-in-time inventory management

Just-in-time (JIT) is an inventory management technique that focuses on ordering only when needed. It lowers holding costs of inventory and eliminates inventory, which is not used, thus allowing companies to use capital elsewhere. When adopting JIT approach, companies must take into consideration that the materials can be provided in short periods when required and if the suppliers are efficient enough in providing materials. If the ERP system being used is not flexible enough in updating and managing stock levels quickly, it is extremely difficult to use this strategy for companies. In conclusion, JIT approach doesn't allow any variations regarding the materials for JIT principle to be functional and usable. Quality, delivery, and demand standards must be met every time materials are sent. JIT purchasing requires accurate information as mentioned and different forecasting methods can be used to calculate this information, such as reorder point, economic order quantity, and safety stock. (Davis, 2013, 23-24; Johnson et. al., 2011, 220-221)

3.5 Supplier managed inventory (SMI)

Supplier managed inventory (SMI) is a form of inventory management where buyer shares their inventory data and demands with the supplier allowing the supplier to manage the buyers inventory and determine order sizes. This type of contract is often used for low value materials such as maintenance and repair materials (MRO). When SMI is applied supplier is responsible for storing the inventory and handling purchases based on the information the buyer has provided. Whenever the buyer requires certain materials from the supplier requisitions are made to the supplier who then collects the materials from their stock and sends them to the required location. When SMI is applied

correctly it will reduce holding costs of inventory and reduces the need of safety stock of the buying company. SMI enables faster acquisition of materials when the demand is forecasted in advance and the supplier sends required items in timely manner. Furthermore, there are fewer restocking needs since the inventory is fully managed by the supplier. This method of inventory management is only possible if the buyer provides accurate data to the supplier about demand and types of materials that are required. (Johnson et. al., 2011, 219)

4 Enterprise resource planning systems

Digitalisation has led companies to use enterprise resource planning (ERP) systems, which are software systems that integrate business processes of the organisations into one system. Different departments are put into segments, which combined create a view of the organisational structure. For instance, purchasing, finance, sales, repair and HR departments each have their own segments and each take care of their own specific functions. ERP systems create a unified database for companies where reliable information on company data can be found. (Ganesh et. al.,2014, 7-8)

Purchasing processes can benefit from ERP systems. When there is a requirement for products or services, inventory managers can check current inventory levels and determine if there is enough stock available or is there demand to buy more supplies. Secondly, activities can be made more efficiently and at the same time, reducing time required to handle a single function. If there is a working ERP system, whole purchase process can be automated. In addition, having databases with information of the previously used suppliers, helps buyers in finding and selecting potential suppliers. Practical example of this is when personnel requires a spare part to a machine for repair or maintenance, it is possible to quickly check, if there is a required spare part available on stock. In case a new spare part is required, data of similar past purchases with correct technical specifications can be found with real time information on suppliers and prices, saving time in finding out correct suppliers, resulting in a simplified business process. (Ganesh et.al., 2014, 11-12)

Nowadays most organisations use ERP systems for their business processes. In inventory management, having reliable data on SKU's in inventory is crucial when making replenishment decisions. ERP systems allow inventory optimisation since it allows to track product turnover and make better stocking decisions. When implemented correctly, having optimised inventory results in less carrying costs of inventory and purchasing costs, since excess stock and shortage of stock can be optimised. Companies may plan their budget for the year more efficiently since most ERP systems include periodic or continuous review when managing inventory. To be truly effective, there should be a clear requirement what kind of modules are needed for different organisations. (Müller, 2011, 82-83)

Integral part of all the data that is used in company's systems and tools especially ERP-systems when it comes to inventory management is master data. Depending on intent of the usage of the data, the data must match the strategies and purposes of the organisations. Basis of master data management is the standardisation of the data format and how it is entered to the system. (Allen,M., Cervo, D., 2015, 25-27)

5 Results and analysis

5.1 SWOT analysis of current inventory control status

SWOT analysis was done to understand the status of the current level of inventory control and to understand what determines the purchasing decisions in the target company. This information was acquired by interviewing the Technical Manager and the Head Manager of the workshop, as well as by utilising the own experience of the thesis writer as a Spare Parts Manager. The interview questions focused on the main challenges and strengths on how inventory is managed and what could be further optimised or developed compared to the current way of controlling inventory as can be seen in Appendix 1. The main results of the SWOT-analysis are collected into table 3.

Table 3. Swot Analysis for Inventory control for the target company.

<p>Strengths</p> <ul style="list-style-type: none"> - Large selection of suppliers - Good availability and short lead times - Most common filters quickly obtained - Multiple machines use same filters - Monthly inventories 	<p>Weaknesses</p> <ul style="list-style-type: none"> - Phased out filters/obsolete Filters - Unnecessary tied capital - Problems finding correct filters from inventory due to inefficient product naming/product identifiers - No overview on interchangeable filters - No reorder calculations - Carrying costs/space
<p>Opportunities</p> <ul style="list-style-type: none"> - Possibility for SMI with filter supplier - Product naming standardisation - Correct usage of ERP-system database/Cross reference list for filters - Filters processing through inventory before being assigned to machines to see correct flow of goods - Sending obsolete filters to other countries 	<p>Threats</p> <ul style="list-style-type: none"> - Loss of sales and profit due to filter availability due to rental machines not being maintained efficiently - Double/overstocking - Inefficient product naming, resulting in unreliability on demand calculations - Challenging to find correct filters from stock

As strengths the Head Manager and the Technical Manager of the workshop pointed out during the interview, that there is a large selection of suppliers with good availability of filters and with short lead times. Head manager of the workshop stated as follows: "Most filters are quickly obtained due to the large selection of the suppliers in nearby locations."

This allows the company to maintain fast and efficient maintenance for rental machines. Rental fleet has machines, which have similar engine types allowing the company to narrow filter selection and reduce filter variability on stock. Periodic inventory reviews are conducted to maintain up to date information on filter levels once a month.

As weaknesses the following were found; there are obsolete and phased out filters which are not used, mainly because rental fleet has changed. This was pointed out by the technical manager when asked about the disadvantages of the current inventory

Obsolete and phased out filters are tied capital, which could be used elsewhere. Also, Head Manager of the workshop said the following: "Due to all filters being named only based on the spare part number, there is no clear indication which machines use selected filters."

When looking at the inefficient product identifiers and how every spare part is not assigned through the inventory it can be stated that demand calculations for filters can vary to a certain level. Carrying costs of inventory and lack of space on the shelves has accumulated due to the variety in demand for filters.

As opportunities, the following was found; first step would be to create a cross-reference list to product group "Filters" based on the engine type and secondly to create a standardised naming system for Filters by using data from the cross-reference list for interchangeable parts. This would allow the target company to lessen the amount of product codes in the inventory and make the information in the IT-system more coherent. Thirdly, to see the correct flow of goods and accurate product turnover ratios in the inventory, the target company could change the procedure by adding all filters to inventory before being assigned to use. Fourthly, the target company could use only the ERP-system as a database and when consuming spare parts from stock also make a receipt of them into the ERP-system. If possible, developing a module to the ERP-system where it is possible to see usage, inventory levels and demand in the same window would help in monitoring the filters more clearly. Currently in the company's ERP-system, there are only modules where you can see the usage of filters and inventory levels in separate sections, and it must be manually combined to list form for a full report. Lastly, implementing a SMI inventory management system with local suppliers for certain filters after all above-mentioned opportunities and procedures are handled, it could be possible to reduce inventory size.

As for threats, the following were found; with the current inventory control there is a risk of double and over-stocking of filters, increased amount of obsolete and phased out items.

During the writing of this thesis, cross reference list for filters was created based on the motor types for all machines. Also, all products in "Filters" category were renamed, depending on the engine type. Lastly, all spare parts, filters included, were marked as a spare part to the inventory before being assigned to machines instead of being assigned as repairing costs straight away. This change in procedure will allow the target company to see correct turnover for all products and will reduce excess stock, since it is possible to point out obsolete filters and use alternative filters due to the cross-reference list.

5.2 ABC analysis for filters

As the inventory is too complicated and challenging for full categorisation and analysis at once, category of filters was selected for this study to clarify the use of ABC approach. Similar analysis can be made to the rest of the inventory at a later stage. Goal of the ABC analysis is to highlight what kind of filters there are in the inventory.

ABC Analysis included 74 separate filters. Analysis was made using the data from the company's ERP-system from one-year-period of 2019. Data was then transferred into Excel where the analysis was performed. The results are summarized in table 4. ABC analysis segmented the products using the following:

- A-category =30% of filters, with 80% of inventory consumption value
- B-category =25% of filters, with 15% of inventory consumption value
- C-category =45% of filters, with 5% of inventory consumption value

Table 4. Results of the ABC analysis for product group "Filters" in Storent Oy

Category	Annual consumption value %	Number of filter types from inventory	% of filter types from inventory
A	80 %	22	30 %
B	15 %	19	25 %
C	5 %	33	45 %

In total, there are 74 different filters, where 30% or different items are allocated to category A and these take 80% of the total consumption value from inventory annually.

In category B, 25% of filters were included, which is around 15% of the annual consumption value. The last 45% of filters were classified as category C and they make 5% of the annual consumption value. Normally, in ABC classification of items the split in most inventories can fit the following threshold: 20/40/40. We can see the split for filters in Storent Oy is 30/25/45. This may occur since some of the prices don't vary greatly.

Category A – Needs to be monitored constantly, since these are used the most. According to the current processes, whenever filters drop below a certain level, new batch needs to be ordered. Supplier research should be conducted to receive fixed prices for all filters in category A.

Category B – Preferable method of inventory control for B is to use periodic review control every month and calculate reorder points. After the monthly inventory reviews are performed, items in the category B should be ordered in batches to reduce ordering costs.

Category C – Items in category C are used sporadically and are challenging to predict accurately. These items are also low on value, thus periodic review during monthly inventory checks is enough to ensure there are enough in stock. Since there are a lot of filters in the low value C category, Storent Oy should ensure items are not obsolete and are used, instead of wasting space and capital. If certain filters are obsolete, formulating a plan to sending them to other depots or disposing completely should be created to reduce inventory size and creating more space to the storage.

6 Conclusions and recommendations

Storent Oy has potential in improving inventory control processes and systems around it. At the start of the thesis there was no systematic way of inventory control practices and purchasing processes were made without analysing the inventory needs accurately.

During the writing of the thesis, some of the changes were implemented as mentioned in chapter 5, creating a more coherent understanding of what the filter inventory contains.

When asked about the main factors concerning purchasing and stocking decisions in the interview, fast delivery and short lead time were highlighted. The prices of the filters are relatively low, although space and carrying costs of inventory are unnecessarily high when compared to the price of the items itself. Filters are generally not that expensive but are used often and are crucial to the business. Exceptions include products, which have phased out and are only holding capital, which were not highlighted during the writing of this thesis.

As a recommendation, Storent Oy could approach filter suppliers and propose SMI contracts so that the inventory size and carrying costs of inventory could be reduced. The ABC analysis should be extended to other product categories in the future to provide more information about the whole inventory. When analysing other product groups, goals and values for the products should be clearly defined. Additionally, XYZ analysis could be utilised on top of ABC analysis to show clear demand variabilities of different products and additionally Storent Oy can reconsider reorder points and safety stocks for filters.

ERP- system should be utilised more systematically in order to allow for the data to be used more widely. As mentioned in chapter 5, some changes to activities and were made such as creating a cross reference list for filters, filters were renamed to match the cross reference list and spare parts are now added through the inventory as a spare part. Therefore, all data provided by the system will be more accurate. Due to the insufficient ERP-system usage for inventory management and the limited data available, the writer of the thesis was unable to create XYZ analysis. Nevertheless, in the future if the implementations of data management and ERP-system enhancements are successful, it recommended to conduct wider XYZ analysis together with the ABC analysis.

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Appendices

Appendix 1.

Interview with the Head Manager of the workshop and the Technical manager
30.11.2020

1. What would you point out as an advantage regarding current inventory?
2. What would you point out as an disadvantage regarding current inventory?
3. What are the main factors of purchasing decisions when looking at filters?
4. Is there specific filters we should focus on?
5. Are there restrictions which affect the decision of buying items to stock?
6. What should the company focus on when looking for suitable suppliers for filters?
7. Is there problems finding correct filters from the inventory?
8. Should SMI/VMI be applied to filters?
9. Has ERP-system been sufficient for inventory control?
10. If answer to question 9 is no, what should be implemented or developed to the system?
11. Do you think company requires reorder points to all filters?