Vaasan yliopisto
UNIVERSITY OF VAASA

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Items classifications in purchasing for order process efficiency and a basis for automation

Case: Teleste Oyj

School of Technology and Innovations

Master's Thesis

Master's Programme in Industrial and Systems Analytics

Vaasa 2020

University of Vaasa
Academic unit: School of Technology and Innovations
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Title: Items classifications in purchasing for order process efficiency and a basis for automation
Degree: Master of Science in Technology
Programme: Industrial Systems Analytics
Supervisor: Ahm Shamsuzzoha
Year: 2020 **Pages:** 75

ABSTRACT:

This thesis is made as a project for Teleste Oyj, an information technology manufacturer that resides in Turku, Finland. The purpose of this thesis is to study the procurement process of a case company, Teleste and find ways that both the inventory levels and purchasing efficiency could be improved

The theoretical framework presents a view into the theoretical models of modern purchasing and inventory management principles that are used to create models for inventory management. How are key figures calculated in inventory and item classification methods are introduced. Automating business processes and the risks, requirements and benefits of automation finalize the theory framework. The empirical research is an implementation of an XYZ-analysis extension for Telestes current ABC -analysis. In this research a years' worth of inventory requirements from six selected suppliers are analyzed to create an ABC-XYZ matrix that is refined to a set of inventory management rules.

Based on the ABC-XYZ analysis results and basing on the created matrix of rules, a proposal for an automated process with system suggestions is presented in the final empirical chapter of the thesis. The automation system bases on the idea that low value items that have low amount of fluctuation in their production demand can be automated to reduce the purchasing workforces amount of tedious number work. The thesis concludes on the idea that Teleste has the capabilities to implement an automated system basing on their current system capability, but it requires building new processes and purchasing or building a new supplier system to fulfill the proposed workflow. The ABC-XYZ matrix, ABCD-123- matrix for Teleste, can be implemented as such as a tool for sourcing and purchasing teams to improve control of resources and understanding the nature of different item demand.

KEYWORDS: Items classification, automation, procurement, purchasing process, supply portal

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Abbreviations

EOQ – Economic Order Quantity

ROP – Re-order point

VMI – Vendor Managed Inventory

ERP – Enterprise Resource Planning

MRP – Material Resource Planning

PO – Purchase Order

EDI – Electronic Data Interface

1 Introduction

Operational purchasing is a core operation in production companies. Purchasing takes care of continuous communication between suppliers and the company, ensuring economically smart inventory levels with calculated and forecasted purchasing and are largely responsible for upholding the quality of master data in the systems used for purchasing such as ERP's. In modern management, the quality of purchasing has risen to be one of the more important parts of the supply chain, which is why new better managerial and digital tools have been created to ensure that purchasing decisions are systematically controlled and economically justifiable.

This thesis was brought up to me by my employer Teleste, an electronics manufacturer residing in Southwest-Finland. Their main products are cable signal amplifiers used in TV and internet infrastructure. The materials for all the product lines consists of thousands of different item codes from over a hundred suppliers worldwide. Just making the purchase orders and handling the orders is a very time heavy process that involves 10 purchasers and material planners at Teleste While their operational purchasing has many aspects of the process that can be considered advanced and optimized, they have found a few parts of the process that they feel make the purchasers job too tedious. Since the process is so heavy to begin with, Teleste's management feels it is important to save the purchasers from doing simple input tasks and try to focus their tasks into more value-adding work. The project comes with business implications, with the automation of low value items in the inventory, purchasers get to put more focus on the high-value inventory and in lowering their safety stocks and so their inventory values.

The point of this thesis is to analyze the existing purchasing pipeline and parts of the workflow with the intent of providing optimization propositions and in the end creating a framework for implementation of new processes. This thesis is written with the idea that Teleste is aiming for a completely or at least a semi-automated purchasing workflow where very minimal human input would be required in tasks that have low operational value. This would allow allocating workload to value-adding work that has more value, making the work more pleasant and making the process more economically optimized.

Teleste has already uncovered the parts of the pipeline they want to be addressed for optimization or that have got complaints from workers. The parts of purchasing pipeline that are to be analyzed are the ABC-analysis of purchased items, confirmations of purchase orders and the supplier relationships between Teleste and its suppliers. Teleste wished that with a thorough analysis and rework of these parts of the pipeline, they could have required trust in the process for automated purchases without economic loss and less tedious work tasks. The aim is to map the prerequisites for an automatic purchasing process to provide the company with a basis for building the automation on top of an ERP (Enterprise Resource Management) system.

1.1 Research questions and methods

The research questions this thesis tries to answer are as follows:

- What are the prerequisites that must be developed into Teleste's purchasing process to allow introducing automatic purchasing methods?
- How can new processes be introduced with a theoretical framework to make the existing processes, like the ABC-analysis, better?

For the theory part of this thesis, I gathered information from various electronic sources, scientific articles and publications provided by the University of Vaasa's library and their access to academic databases lie EBSCOhost and ScienceDirect. Most of the sources this thesis is based on are gathered from these sources together with provided source material from the target company like process flowcharts, internal documentations. With a regular schedule, meetings were held with operational purchasing employees and managers for guidance in decision making for the thesis to correspond with their requirements for Teleste's process.

By nature, the thesis is a qualitative research, where data gained from the target companies ERP-system is addressed with statistical methods. By extensively examining the data it is attempted to notice the aspects relevant to the research subject. According to Kiviniemi (2001: 68) in qualitative research it is ordinary to gather data that is relevant for the study instead of random sampling. Kiviniemi also mentions that in qualitative research, the handling of the material is through and the researched effects are aimed to be understood in relation to their context, which is also typical in this study. (Kiviniemi 2001: 68)

In the study the existing ABC-analysis model of the target company is examined in reference to theoretical framework on the subject and then an ABC – XYZ -analysis is conducted on their purchased item portfolio to extend their inventory management process to take more variables in consideration. Since the company already has an existing ABC-analysis model in place, the XYZ analysis is conducted on top the existing model to understand purchasing patterns and demand variability. With this analysis the inventory is regrouped into new item groups. Then from these groups the items suitable for automatic purchasing is separated.

Because some items have volatile demand and generally changes happen in demand over time, criteria for items to change groups is also defined. When item changes group, the inventory management methods change so the criteria definition must be robust. The ABC-XYZ analysis provides a basis to determine which items purchasing process can be automated. On top of the ABC-XYZ-analysis, the process for managing the item groups for the automatic purchasing process in the existing and required systems, like the ERP and safety stock calculator and a supplier portal, is mapped.

1.2 Thesis structure

This study was started around February of 2020 and it was completed around December of 2020. The thesis was done while working as an employee for the target company. All search of scientific sources, research, gathering material and analysis was done gradually in regards of the company's needs and requirements in schedule.

The first two chapters of the thesis focus on the theoretical framework of purchasing, inventory management, modern systems in purchasing and the capabilities in reference required for the case of purchasing development to automation. The next chapter will be the definition of the case at Teleste, the problems of the existing process, organizational definitions, systems in place right now and the starting point of development. The fourth chapter explains the development process of the solutions created for the defined issues. This will be capped with the last chapter that includes the discussions for future development and conclusions of the thesis.

2 Theoretical Framework

In this chapter the focus of this thesis, purchasing, will be gone through. The role of purchasing in a company, the implications that purchasing has for the development of the business and how purchasing differs on an operative, tactical and strategic viewpoints. Different models of modern purchasing are gone through and methods used in inventory management and purchasing workflows

2.1 Role of purchasing and its objective

Purchasing is the action of procuring whatever materials the business needs to ensure the flow of production. While mostly this means raw materials, it includes office supplies machinery, services. Purchasing is mostly viewed as only the acquisition of goods to the company, but it includes a wide range of different activities that come with the process of fulfilling needs of the business. The term purchasing is many times interchanged with the term procurement, while procurement is used mostly in a much wider context and purchasing just as the attainment of goods. It is good to go back to the definition of procurement to understand its core function for a business. (Waters 2003, 28) In this thesis the term purchasing will be preferred, as it is the core focus of the body of work.

The definition of procurement according to van Weele (2010, 12) is:
"The management of the company's external resources in such a way that the supply of all goods, services, capabilities and knowledge which are necessary for running, maintaining and managing the company's primary and support activities is secured at the most favourable conditions"

In modern business, purchasing carries an important role in the production workflow since it manages the simple inputs: raw materials. According to Chunawalla S. (2008, 13) there are seven areas of objectives that purchasing has that can be considered the extensions of roles that comes with procurement. These are:

- ensuring the quality of purchased goods,
- ensuring that production is continuous,
- developing the source of supply,
- lowering costs of goods purchased,
- accurate recording of trends and reporting to management
- achieving maximum integration with the other departments of the company.

All of these require a high level of communication with the other departments to ensure purchasing is making the right decisions to support other functions of the business. (Chunwalla S. 2008, 13)

Purchasing is not only about buying items from suppliers, but it also includes using modern tools to ensure the best pricing, optimizing order quantities and order time. Over time, more strategic tasks have moved to the purchasing function of organizations, and the function has gained more developmental and controlling role in the supply chain management process. As the role of purchasing and procurement has gotten more complex over time, it has led to a more integrated workflow of supply chain management. (Trent & Mozka, 1998) According to Iloranta and Pajunen-Muhonen (2015) the role of purchasing is managing the external resources of the organization. The management, operations, support and development require different services, products and knowledge from outside the organization. Purchasing aims to make use of the supplier market in a fashion that the end-customers' needs become fulfilled in a desired way that maximizes the company’s benefit. (iloranta & Pajunen-Muhonen, 2015) This means that the purchasing function must have a broad view of the entire supply chain and its requirements to create purchases that maximize the company’s capability to create value to the customer. According to Sakki (2014) it needs to be empathized that while the earlier stands through that supply chain management has to be a part of the purchasing skillset, it does not always fit all organization models and the actions that are done in the order-delivery process can happen in different parts of the company and it involves a lot of different personnel depending on the organization structure. Therefore, it usually takes up large percentages of the company's operating costs. (Sakki, 2014)

2.2 Purchasing process model

Modern definitions define purchasing as a strategic function, which has the mission to take care that the organization has the best external resources in it use. While that is true in the entirety for purchasing, it is separated into three different segments: strategic, tactical and operational. These three parts are all independent but in terms of the business they are very dependent of each other. These three parts together form the purchasing process model. (Huuhka 2019, 13)

Operative functions of purchasing are the everyday actions in the purchase workflow. Like purchase order sending, order handling, data parameter handling. Operational purchasing has a crucial role in material ordering and saving costs for the business. It basically includes all the functions after a deal has been made with a supplier. Tactical purchasing includes budgeting and contract negotiations. Strategic purchasing is primarily operation development and planning, supplier choice, evaluation and developing the supplier relationship. It must be made clear that definitions and the process model are ambiguous depending on the author or the organization in question. Some authors make more detailed separations and others have a shorter definition. (Huuhka 2019, 13)

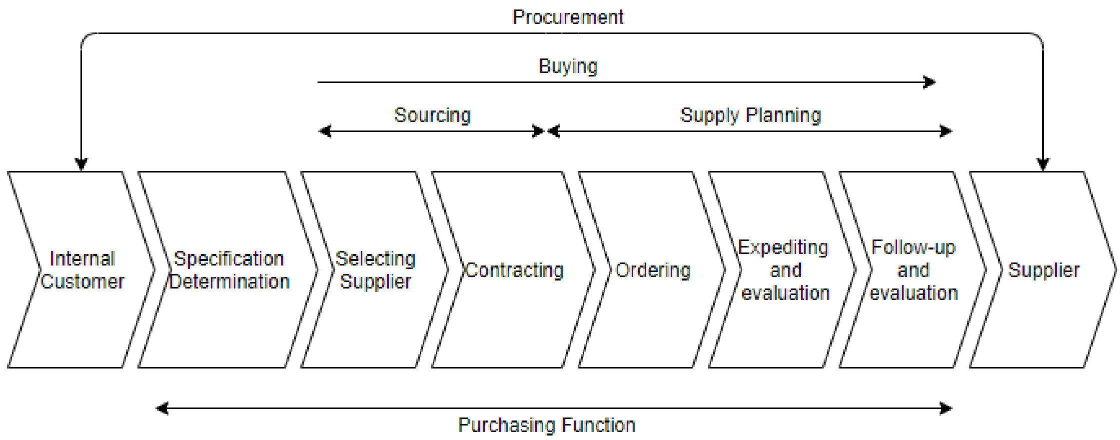

Figure 1. Purchasing Process Model (Huuhka, 2019)

In common term purchasing is also many times mixed up with *ordering* and *buying,* while they have a critical difference. Buying does not include the determination of specifications as can be seen in Figure 1, the purchasing function includes communication with the supplier of the material of their goods and specifics in for example environmental impacts and working conditions, this is followed by the contract to purchase from the certain selected supplier. Only after this comes the order process, which refers to the sending of the purchase order for the goods on arranged conditions. (Weele, 2010, 11) The order phase, or more broadly the supply planning phase, is where the operative day to day work of the purchasing function happens.

2.3 Material planning and inventory management

In purchasing, the fluctuations and the amount of demand are major factors in guiding the purchasing of a certain item. In industrial procurement as in retail, different items or materials have different demand and routes and costs. These all need to be managed in supply chain management to keep the costs low. For this there are methods to time the purchase of each item in a certain point to ensure their inventory costs stay low while they fulfil demand. This is called inventory management, where all the information for

ordering products comes from the warehouse and is followed by material planning. It is best used on items that have continuous demand. (Sakki, 2014)
Material Planning methods differ widely depending on the nature of the finished product and the type production. There have been done studies widely about the fitting of each method or different types of production, but in the end the method is usually chosen by its easiness for implementation to the workflow. (Jonsson Mattsson, 2008).

2.3.1 Just-In-Time and pull production principles

The Just-in-Time production methodologies were born in Japan in the Toyota factories and proved to be much more efficient than many traditional frameworks. This production method was born in standard item production but can be applied to any form of line production. It is a philosophy based on the idea of reducing all waste and unnecessary actions in the production process. It is closely tied to lean-management methods that focus on reducing waste in processes (Sakki 2009: 129). In modern purchasing organization JIT (Just-In-Time) refers to procuring items with minimum inventory and lead times to reduce all holding of unnecessary stock to reduce the wasted costs in the purchasing process. This makes the process pull-guided inventory management which promotes a more exactly managed and controlled process through supply and demand (Mason 1999).

In pull-oriented production strategies, all production is based on the demand for the items. The demand for a product triggers production needs and the downstream in production sends a request for the upstream for the right number of products. Then the requirements of production trigger need for purchasing to procure the right items needed. This is how pull oriented management strategies flow through the entire supply chain. (Slack 2009: 362)

The main use of pull guidance is the lowering of inventory levels and the costs that come with the storing items. Hopp (2011) though that the concrete use of pull-guided operations is lowering costs by removing unfinished production costs, lowering the variability in production and the chance for mistakes. Spearman, Woodruff and Hopp (1990) studied that the uses are in shorter lead times and better customer service.

2.3.2 Safety Stocks

In demand guided manufacturing, safety stocks are always the buffer of items in inventory to uphold a demanded service level and to counter completely running out of material. Safety stocks are a two-sided issue, on the other hand they keep you some inventory of the item to keep you from running out, but if too much safety stock is held for too long it keeps growing inventory holding costs and ties capital. Safety stock must be set to certain level that the item can stand a quick order. This means that the safety stock is tied to the change of demand in an item and must be managed continuously. It also has an impact on the service performance and how fast can an order be answered to. The safety stock also represents the re-order point for an item, since as the inventory closes to reach the safety stock, optimally the new order would arrive at the same time to keep the inventory levels above the buffer. All of it depends on the desired service level of the item. (Ruiz.. Mahmoodi, 2009)

When estimating the safety stocks, the lead time and an estimation of the variability of demand should be readily available knowledge. Sakki(2014) proposed a calculation method for safety stocks that includes standard deviation of demand, a reliability multiplier and the lead time as follows:

$$B = ks\sqrt{L} \qquad (1.)$$

In this function s is the standard deviation, k stands for reliability multiplier and L for lead time. The reliability multiplier is dependent on the desired service level. The reliability multiplier corresponding the desired service level defined by him can be seen in table 1. Sakki made a point that the standard deviation of the items demand needs to be constantly followed to information systems can update the safety stocks according to changes in demand. (Sakki, 2014)

2.3.3 Re-order point method

The re-order point method (ROP) is one of the most common methods in inventory management. It has the advantage or working better with inevitable insecurity of changes in demand than the Wilson formula. In order point methods the refill order is triggered by the reaching of a certain inventory level. The use of order points aims to uphold high service level and avoid material shortages. (Karrus 2005: 43−47: Sakki 2009: 123−124) The re-order point method is used very widely among companies according to Jonsson and Mattsson (2008) and that it is very effective raw materials, or items with production input for many finished products since they have even demand and picking frequency. It is by count the second most used material planning method according to their study of manufacturing companies' material planning method choosing. (Jonsson, Mattsson, 2008)

In an optimal situation the order point is such that is takes in consideration the lead time and at the point of the goods arriving, there is exactly the safety stock amount left in inventory. To estimate this value, the future demand, supply lead time and the safety stock parameters for the purchased item are required. Sakki (2014) made up a formula for calculating the re-order point, which is as follows:

$$T = DL + B \qquad (2.)$$

Where T stands for the order point, D for average consumption in a certain period, L is for lead-time in weeks and B is for safety stock in as a quantity unit. The re-order point formula gives out the amount in inventory when a new order needs to be set to ensure that it arrives in time when inventory value reaches the safety stock. (Sakki, 2014)

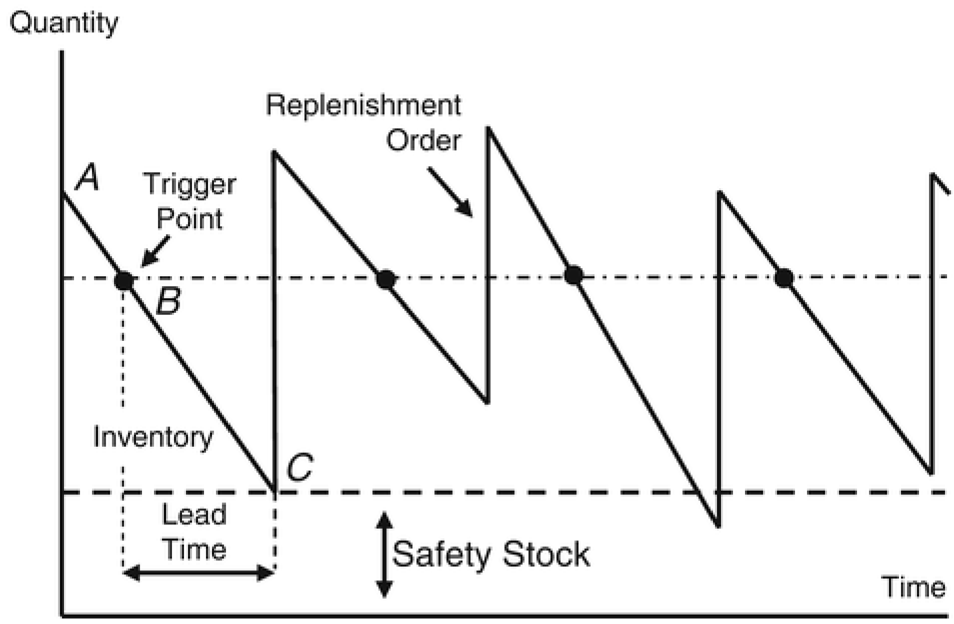

Figure 2. Re-order point method (Ross, 2018)

In Figure 2 is illustrated the basic idea of the re-order point method, where C stands for the moment when the order arrives, optimally this is where the inventory also reaches the safety stock. B is the trigger, or the re-order point, and A stands for the value of the inventory in its highest level. Ideally the re-order point should always stop the inventory from reaching a level below the safety stock. (Ross, 2018)

2.3.4 Economic order quantity

Economic order quantity is calculating method to calculate the quantity of an order so that is in line with the consumption demand but also does not raise the inventory amounts too much. It was developed by F.W. Harris in 1915 for stock keepers. (Meuller, 2011, 105) The formula is called the Wilsons formula and it is used to calculate the minimum point of a quadratic equation. (Sakki, 2014) The formula stands:

$$EOQ = \sqrt{\frac{2AR}{P^2K}} \quad (3.)$$

The A stands for the estimated value of annual demand, K is for carrying costs, R for replenishment costs and P for unit price. Carrying costs involve all costs related to the handling of the inventory and replenishment costs involved with the costs of placing and handling the order. There are some minute variations of this formula in different materials, but in principle the output is always the same. This formula is used to determine:

- Optimized order quantities
- The timing of the order
- The total cost
- Average inventory levels

The Wilson formula is used to determine a wide array of parameters for ordering a product, but it is only because it works off assumptions for the purchased item. For the EOQ formula to be effective the demand rate of the item needs to be constant, the carrying costs and ordering costs are completely independent and the lead time is always constant. These are assumptions that do not fit every item purchased so the EOQ is in no means tool for everything. (Meuller, 2011)

2.3.5 Vendor managed inventory

Vendor managed inventory (VMI) is a partnering method for inventory management where the customer and supplier have an inter-company contract for improving supply chain efficiency. With VMI, the supplier makes the decision that make up the replenishment of items and order quantities on behalf of the buying organization. It is made reduce inventory costs of the customer, improve service levels and to create business opportunities. The vendor monitors the orders and inventory levels and makes the periodic replenishment, thus reducing the control costs of the re-ordering the product minimal for the customer. (Krajewski, 2010: 388)

There are prerequisites for VMI to work, it demands a detailed planning and very transparent information exchange between the organizations, which then again raises administrative costs and can also raise the costs of the process or the process of filling orders can turn out to be ineffective. It requires capabilities from the supplier to use the customers data efficiently to improve inventory levels. In this way, VMI also promotes high level supplier collaboration to work since ineffective implementation will make it a disadvantage. (Niranjan, Wagner & Nguyen (2012) Because of the risks involved in the trust and transparency of the operations, especially if the item in question is critical to the customers business, the items chosen for VMI are usually standard items that have steady demand and relatively short lead times (Krajewski, 2010: 388)

Kauremaa (2006: 11-14) considered that the most use for VMI is in supply chains that have bullwhip effect, distortion that travels upstream in the supply chain due to variance in orders. The VMI method reduces the bullwhip effect due to the increase in transparency and shares information of the true demand to the entire supply chain. (Kauremaa 2006: 11-14)

2.3.6 Fixed-order period systems

For the fixed-order period system, the frequency of the orders is fixed with a contract with the supplier and the order quantities only change. With the fixed-order system at times of higher demand the order sizes are the only thing that grow and vice versa, and orders are set after each set period. The main use of the fixed-order period is its lack of control required. Only thing required to manage the fixed period reviewing inventory levels to determine required order sizes. (Greasley, 2007; 75)

The other version of the fixed-order period system is the fixed-order inventory model (FOI), which is also called a min-max system in some literature. It is used to calculate the order amounts for a fixed interval. (Greasley, 2007; 75) The min-max method is used when a fixed order amount is desired for a purchased item. This required minimum and maximum inventory levels set for the items inventory. If the inventory level is between these two levels, an order is not place. The moment when the inventory level hits the minimum, fixed-order amount is placed that brings the inventory back to maximum. This is a method suitable for items with low value, where unused stock is not as expensive (Sakki, 2014; 85)

3 Classifications of items for purchasing

Because the purchaser's tasks now involve inventory management, logistics and a broader understanding of the entire production chain, the purchase function uses different calculation methods and tools to control the amounts and timing of procuring material. These tools are analytical methods like the ABC and XYZ-analysis, order point and safety stock calculating. ABC / XYZ-analysis is for prioritizing items in the inventory. Safety stock and order point calculations are for optimizing inventory values. In modern production, they are usually included in the calculation methods of information systems like, so procurement professionals necessarily do not use these tools as they are, but they are vital parts of the process involving them. (Sakki, 2014)

3.1 ABC analysis for prioritizing purchases

The ABC analysis is a widely used simple method for categorizing purchased items by different metrics, usually according to their economic value. The ABC analysis is usually in use even in companies of somewhat moderate sizes since they can have thousands of items in their inventory that require warehouse picking. (Wan Lung, 200) It is based on the mathematical Pareto 80/20 value which concludes that 80 per cent of all consequences are caused by 20% of reasons and vice versa. When applied to purchasing and material planning this would mean that 20% of items or suppliers provide 80% of all inventory value. The analysis provides purchasing with the information that which items require more control and thus guides their operative choices. (Huuhka, 2016)
The ABC in practice means dividing the items to three or more classes where:

- A-items: very important, expensive and require high control, 0-80% of annual inventory value.
- B-items: medium value, less control and have good metrics, 80-95% annual inventory value
- C-items: least important and require minimal control, 95-100% of annual inventory value. (Scholz-Reiter, B., Heger, J., Meinecke, C. & Bergmann, J. 2012)

The categorization and how they are valued can differ by the nature of the items, but the most used is their monetary inventory value. The ABC-analysis can be used in varying forms, sometimes it is enlarged to an ABCD-analysis with four categories of items, this varies by company and the amounts of items and usually how well they naturally fall into categories. According to Sakki the division can be to five categories with ABCDE, where the E-class presents the items that have no records of requirements or sales (Sakki, 2014). The item categories can easily be pictured in a graph form where the different classes are divided by their relative share of the inventory value like in Figure 3.

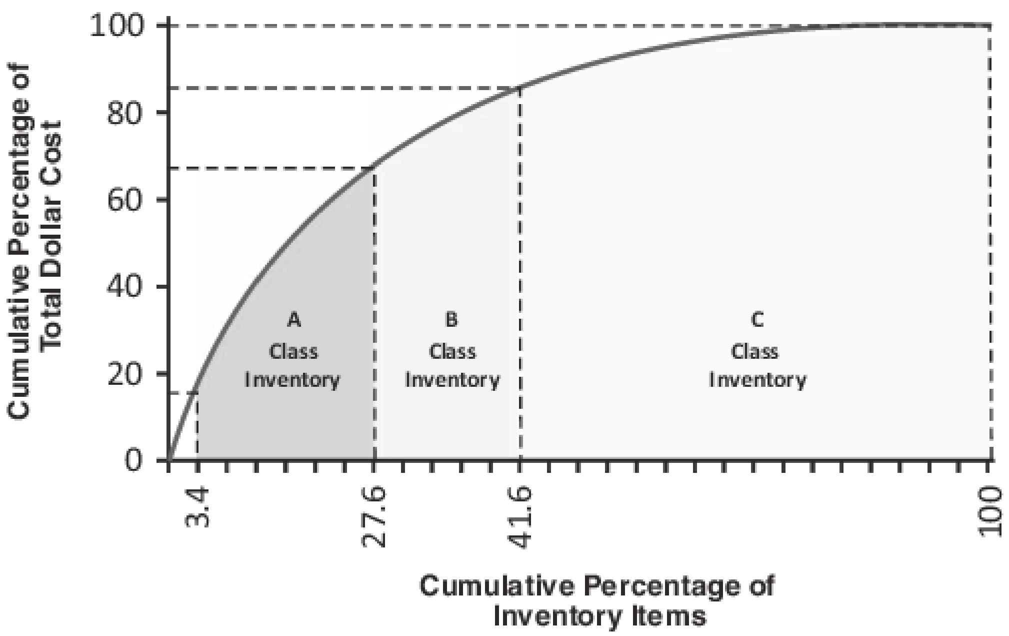

Figure 3. Diagram of ABC classification (Behesti, Grgurich, Gilbert, 2012)

According to Sakki, the basic principle of the ABC analysis, where he defined four classes, instead of three, can be boiled down the following general rules:

A- and B- classes: Purchase in a steady stream in calculated quantities. With a decent inventory turn, the buyer also has a goal of getting these on for as low price as possible.

C- and D- classes: Purchased in larger quantities that are still within limits. The control costs need to be lowered and accordingly the work efficiency is prioritized. (Sakki, 2003)

3.1.1 Guiding operations with ABC classification

While the ABC analysis is a very popular method for classifying items, there are no universal rules for choosing the optimal inventory management methods for each class. Especially guiding the B-class items purchases is difficult due to its 'middle-ground' nature. Buxey (2006: 996 – 1012) said that the biggest flaw in the literature is in the missing of optimal inventory management recommendations for ABC classes. Usually the two-bin method is recommended for C-items, but A-items have no decided best method, even though EOQ is many times mentioned. The B-class is even more difficult. It is understandable that all these methods are situational and depend on the execution of the analysis and the nature of the production. (Buxey 2006: 996-1012) The literature is still unanimous on the fact that different ABC classes require different inventory methods. The higher the class, the smarter it is to implement more precise control methods compared to cheaper items. (Hoppe 2011: 608-616)

Aswathappa and Bhat (2009) created a sample for policy guidelines that should be implemented into the material planning organizations with the ABC – analysis. It provides 13 rules for each class to guide the purchasing and sourcing of these items. The table can be examined in Figure 4. It should be noted that these policy rulings are always ambiguous and should be examined and implemented situationally. But it provides a framework on how to manage each different item class depending on its inventorial value. In their literature they provided a valid point about the ABC-method. That the distribution of value for inventory stratification is not a system or a technique, it is a fundamental management principle with universal application potential. (Aswathappa & Bhat, 2009; 477)

Table 1. ABC-class management policies (Aswathappa & Bhat, 2009)

A - items	B-items	C-Items
1. Very strict control 2. No safety stock (or very low) 3. Frequent ordering 4. Weekly control statements 5. Maximum follow-up and expediting 6. Rigorous value analysis 7. As many sources as possible 8. Accurate forecasts in MRP 9. Minimization of waste and surplus 10. Individual posting 11. Central purchasing and storage 12. Max. efforts to reduce lead time 13. Handled by senior officers	1. Moderate control 2. Low safety stocks 3. Once in 3 moths 4. Monthly control statements 5. Periodic follow-up 6. Moderate value analysis 7. Two or more reliable sources 8. Estimates based on past data 9. Quarterly review 10. Small group postings 11. Combinations purchases 12. Moderate 13. Handled by middle management	1. Loose control 2. High safety stocks 3. Bulk orders with low frequency 4. Follow-up in exceptional cases 5. Quarterly reports 6. Minimum value analysis 7. Two sources for each item 8. Rough estimates 9. Annual review 10. Group postings 11. Decentralized purchasing 12. Minimum efforts 13. Can be fully delegated

3.2 XYZ analysis

The ABC analysis is usually criticized for its simplicity and how categorizing items only by their inventory value does not provide a realistic image of the nature of the items since there many more variables that affect the material planning than their value. Therefore, it is usually complemented with the XYZ-analysis that categorizes items by their fluctuations and adds three sub-classifications similarly to the ABC classes using the Pareto principle. This is usually done to support the ABC-analysis to provide a broader and more exact image of item values. The classes can be virtually called anything, but X, Y and Z-classes are the most widely used. The three classes are separated as follows:

- X-class: Only little fluctuation in consumption, stable consumption.
- Y-class: Stronger fluctuations, harder to predict requirements, usually a trend or seasonal consumption item.
- Z-class: Irregular consumption, harder to forecast. (Hoppe, 2006)

The fluctuations of consumption are metered by the coefficient of variation of their consumption values. The coefficient of variation is the ratio of standard deviation for the average consumption over a chosen period. (Scholz-Reiter, B., Heger, J., Meinecke, C. & Bergmann, J. 2012) The way to calculate the coefficient of variation the sample mean, and the standard deviation are required, they are calculated with the following three equations:

Average mean: $\mu = \frac{\sum X}{n}$ (4.)

Standard deviation: $\sigma = \sqrt{\frac{\sum(x-\mu)^2}{n-1}}$ (5.)

Coefficient of variation: $C_v = \frac{\mu}{\sigma}$ (6.)

The standard deviation provides items with certain values ranging 0 to virtually infinity where 0 means no fluctuations at all the higher the coefficient, the higher the fluctuations for the item consumption. It should be taken to consideration that coefficient is a ratio, so it is affected by the chosen time periods and is not a stable value in that sense. (Investopedia, 2020)

The chosen period is always a critical factor when conducting the XYZ analysis, since the time period need to represent a similar period of for which the items are planned for to be used from the inventory, a year or half a year is considered the general time periods used but there are differences depending on the type of operations. When the evaluations for fluctuation between all consumable items from the inventory is done, similarly to the ABC-analysis the XYZ-classes are separated to their subclassifications by their coefficient of variation (CV). A general classification of XYZ variations are:

- X-items: coefficient of variation <0.5
- Y-items: coefficient of variation between 0.5 and 1
- Z-items: coefficient of variation > 1. (Scholz-Reiter .. 2012)

This is a typical classification for the CV of items, but like other parameters in analyses of this type, they vary between organizations depending on their nature and requirements. (Hoppe, 2006) In Figure 4, the X, Y and Z classes are represented visually.

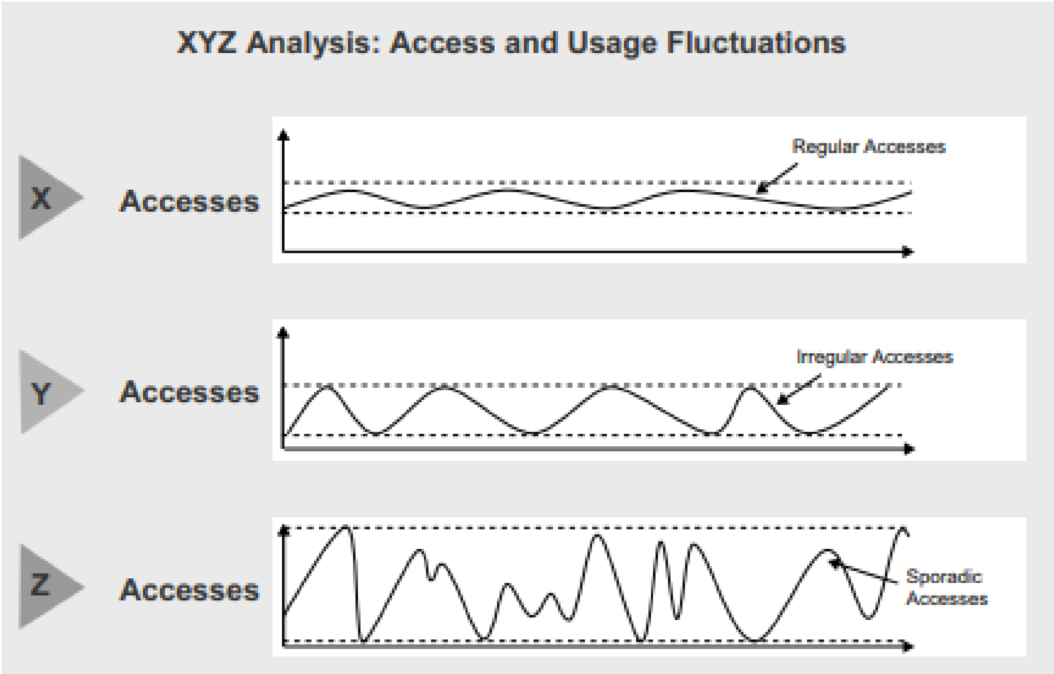

Figure 4. Visual representation of XYZ - class fluctuation (Inventops, 2015)

3.3 Combined ABC-XYZ analysis

The ABC-XYZ analysis is the combined and product of the two before mentioned analysis. By combining the ABC and XYZ-analysis together the fluctuations of consumption also are taken to account with the inventory values. (Reiner & Trcka 2004: 217−229) The ABC and XYZ-analysis matrix where each of these dimensions complement each other, where they can together provide a good view for material planning. (Sakki 2009: 96-100) This is a very standard way of operating, when analyzing German industries Reese & Geisel (1997: 147-154) found that two out of three companies use the ABC analysis and half of these have expanded it with the XYZ-analysis.

Table 2. ABC-XYZ analysis classification matrix

	A	B	C
X	AX	BX	CX
Y	AY	BY	CY
Z	AZ	BZ	CZ

It is important to classify these items on a standardized basis along standardized parameters. This is to take in account all possible changes in the demand and in the fluctuations of demand for items are noticed immediately or at least as quick as tolerably possible. According to Gudehus and Kotzab (2012: 269 - 270) the classifications should be repeated monthly, quarterly or at least annually depending on the industry and the nature of production. It was noticed that reclassification half-annually lead to better results than annual revision. (Bergman 2012: 445-451)

3.3.1 Optimization with the combined ABC-XYZ analysis

Like seen in Table 2, the ABC-XYZ -analysis leads to a matrix that has nine different item classes. For each of these fields can be implemented an own inventory management method that allows for more efficient optimization of inventory levels. (Hoppe 2008: 84) These different inventory management methods can be filled into the matrix of Table 2 for an easy visual representation.

Table 3. ABC-XYZ matrix class inventory management (Hoppe 2008: 85)

	A	B	C
X	• Expensive • Regular demand • Good forecasts	• Moderate price • Regular demand • Good forecasts	• Cheap price • Regular demand • Good forecasts
Y	• Expensive • Changing demand • Moderate forecasts	• Moderate price • Changing demand • Moderate forecasts	• Cheap price • Changing demand • Moderate forecasts
Z	• Expensive • Irregular demand • Unreliable or impossible forecasts	• Moderate price • Irregular demand • Unreliable or impossible forecasts	• Cheap price • Irregular demand • Unreliable or impossible forecasts

From Table 3 it is observable that AX items have a lot of optimization potential whereas CZ items are very difficult to gain economic use with optimizing, since they are already cheap in price and their demand is hard to predict so changing either order sizes or order dates does not really have a big impact. Traditionally A- and B items have a naturally higher optimization potential and all Y- and Z items have bigger control costs. Because CZ or even BZ items are so hard to forecast and have larger control costs the aim is to lower their work costs to as low as possible with suitable order methods. Hoppe (2008) said that CZ items should have entirely automated forecasts, so buyers do not have to spend time with these items. Because AZ items have such large fluctuations, they usually must be forecasted manually, but they do have big inventory optimization potential if they can be moved to a better class with more precise forecasting. (Hoppe 2008, 84-86)

When planning how to guide the controlling of each class. A separation can be made at least, but not limited, to two groups in the classes:

- Aim to rationalize: AX, BX and AY
- Control complexity: AY, AZ and BZ

These are critical groups in the analysis because of their inventory value and should be the control focus when decision making on based off the ABC-XYZ analysis (Pandya, 2016)

3.4 Other classification methods

While the classic ABC-analysis with running totals of currency spent on inventory is probably the most used inventory classification method. Extensions like the XYZ-analysis have been proposed in the decades this has been studied to include more criteria in the evaluation of different items inventory value. Other classification methods include the joint-criteria matrix, analytical hierarchy process (AHP) joined with multicriteria inventory classification and the fuzzy AHP, genetic algorithm for multicriteria inventory analysis or a weighted linear optimization model. These classification methods also aim to give ABC-classes to items that incorporate qualitative metrics with inventory data. The difficulty with these methods in organizations usually is in the difficulty implement them to use without extensive system building or study. (Kabir & Hasin, 2011, 1-3)

4 Systems and order process automation

In this chapter the whys and hows of automating a purchasing process is presented. It includes justifications, process requirements and system requirements for even allowing an organization to have capabilities to build an automated purchasing workflow.

4.1 Benefits and risks of automated order processing

The first question asked when thinking about automating processes is if it creates any benefits compared to traditionally working the process with an experienced workforce. This has been thoroughly studied over the last three decades. Automating the order process brings organizations:

- reduced PO cycle times, lower operating costs,
- efficient management of suppliers and item
- lower amount of faulty orders.
- more focus on value-adding work

It was found that organizations that use automated procurement systems have more employee resources to guide into supplier collaboration and strategic work, rather than operational purchasing work. (Spiegel, 2011, 62-64) Benefits of more automation in procurement that can quantified into business performance come from a rise in procurement performance with advanced systems. Automated systems have been found to capable of making supplier communication, supply chain efficiency and operational performance go up, which then again has lowered manufacturing costs with entire chain becoming more optimized and lower in mishaps and faults. It comes with a strong reliability to trust from top management and IT-resources that need to be actively involved in the planning and implementation process of new, automated systems. This takes resources and can be considered as a big entry barrier for many companies. (Sánchez-Rodríguez etc., 2019)

The risks involved with automating business processes are considered very human most of the time. Since automated systems do work much more efficiently than human employees, they cannot be considered really a bad investment only for executing processes. But system do need people to work with them, and that also brings risks, one risk being lack of training or willfulness for change. A workforce that is not trained to work with automated tools will have a high risk of bypassing the provided tools and revert to manual tools. Automated systems are not easy to use or implement and bad management can lead to low willingness for use and leave a very costly investment to a low adoption rate that raises costs even more. (KPMG, 2020) Another risk is in misunderstanding the process and its key values. Since digitizing a process does not in itself make a process more efficient, the steps that automation can help need to be understood to avoid over- or under designing a system. These always lead to more costs and risks in under utilizing a system. (Nasiri etc. 2020)

4.2 Requirements of an automated order process

In his doctorate thesis, Lauri Rantala (2016) wrote of automating the purchase order automation process in a few different manufacturing enterprise models. He was interested if automated purchase order systems would increase the inventory turns and provide more efficient inventory management to an electronics manufacturing organization. In one of the case studies attached to his thesis, he concluded that the success of an automated system improving the inventory turns lies in the safety stocks and other purchasing parameters being developed along with demand development to a more stable form and an automated systems could bring support to this. Many times, it is the efficiently optimized parameters that provide improvement. He did prove also, that automated systems can bring use. but it requires a very rigid environment in terms of the purchasing organization, parameters, item data, systems and the supplier (Rantala, 2016)

Rantala focused on the requirements for the organization to build a process that could possibly handle orders without requiring any employee contact in the process, only for checking and monitoring the orders. But the orders themselves would be sent automatically. He concluded that three things are required to make the process a possibility: classified items, classified suppliers and capable systems. The process of building an automated purchase order system can be seen in figure 5.

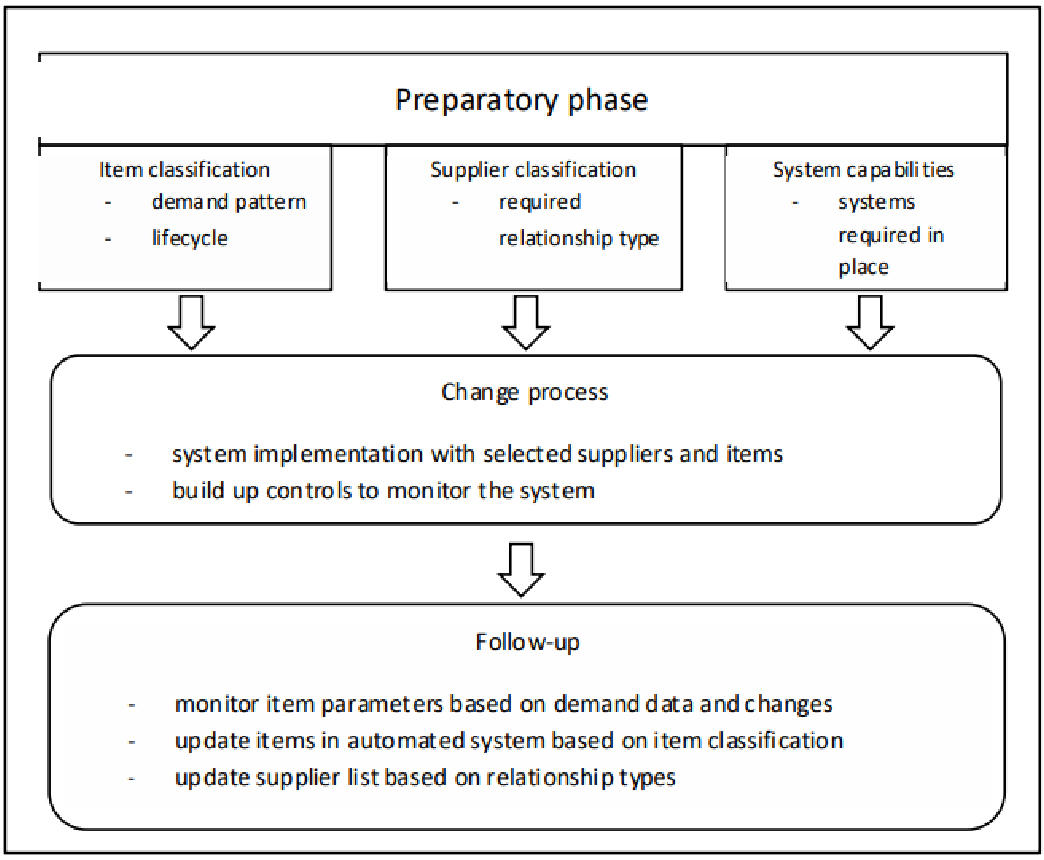

Figure 5. Purchase order automation process (Lauri Rantala, 2016)

Only items that have stable demand and patterns and long lifecycles could even be considered for automatic processes to reduce risk. The automation must be also done with suppliers that organization has a stable and trusted relationship with to ensure that all parameters and item data is trustworthy, and the process is more easily supervised when a more transparent view of the process can be held. This also requires system requirements from each side of the process to ensure that the automatically sent orders can be processed. This means that the ERP and MRP systems of each end must be gone through for capabilities in transferring data. (Rantala, 2016)

These requirements can also be found on different system supplier companies sales pitches for PO automation. OmPrompt, who offers a zero-touch procurement system that boasts an order accuracy of 99,8% and 80% order automation level, said that the perfect order requires:

- Automation
- Accurate master data
- Calmed message traffic
- Partnerships
- Lowered lead times
- Exception management
- Single point of access for auditing. (OmPrompt, 2020)

While OmPrompt also promotes a system that brings organizations great returns and efficiency into the purchasing process. Even they require levels of capability from the organization wanting to implement a system for no-touch procurement. (OmPrompt, 2020)

4.3 Enterprise resource planning

In the heart of every modern company works an enterprise resource planning system (ERP), or an enterprise system for short (ES). They are centralized systems that were initially primarily focused on integrating internal systems to support the finance, accounting, manufacturing, order entry and HR. They were meant as a tool to centralize data transfer and logging data. They did contain inventory management, but supply chain management or any external connection were not a part of early ERP's. Like mentioned, the supply chain logistics and purchasing contain massive potential for cost and inventory optimization and thus this became a large focus for ES systems also. In 2002, 30 large firms reported that supply chain management was their primary ES development focus. (Davenport, 2004)

In the bottom level, enterprise systems are for cutting costs in internal supply chain operations. This works by bringing together linking different “silos” of the business, which are represented as different modules in the system, examples for these modules or “silos” are manufacturing, inventory management, purchasing and sales. Organizations can choose the modules that are required for their processes. (Nieminen, 2016) For larger organizations, it is crucial to have an enterprise system to provide cross-department centralized information. Bringing information integration into the supply chain management will mean better visibility across different points of the chain. Davenport and Brooks (2004) reported of Reyer’s Grand Ice Cream who built a $970 million supply chain management system into their ES architecture to link its demand forecasts to production scheduling and to procurement, essentially automating and centralizing the entire chain of information flow. (Davenport, 2004)

Together with centralized information flow it is crucial that the ERP system represents the process as precisely as possible and removes the tedious nature of these processes without different departments requiring to communicate externally from the system. For example, the purchase order process from a system viewpoint would look like in figure 6.

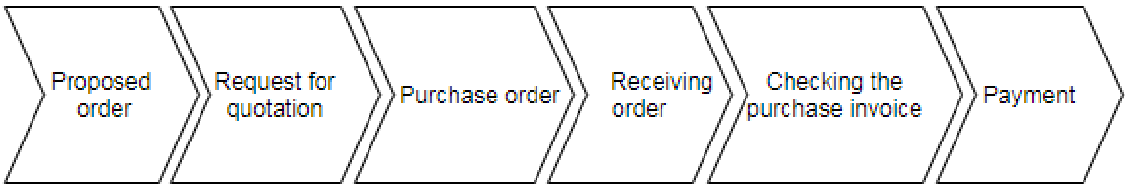

Figure 6. Purchasing process in the ERP system (Nieminen, 2016)

In the example of Figure 6, the process of the purchasing process looks like a simple one-way arrow from the viewpoint of the ERP system. While in the organizations point of viewpoint it demands input or at least monitoring from manufacturing for requirements, purchasing for ordering the items, inventory management for receiving and finance for invoicing. The process is all implemented in one ERP system and brings together all these “silos” of the business. (Nieminen, 2016)

4.4 Material Resource Planning

Sakki (2009) mentioned material resource planning (MRP) as a key tool in industrial order-processing. It is a method for forecasting the demand for material in production and It uses calculation methods to centralize all produced material and its requirements from sales forecasts, product bills-of-materials and from current inventory values. The MRP system calculates these amounts for purchasing operations to order according to JIT production methods.

Practically this sounds simple enough, but the issue with MRP is that some of the calculated demand is from actual sales orders, but some are generated from sales forecasts that again are bases on guesses. This makes fluctuation more than probable. The finished product can have several levels in its product structure that creates bottlenecks, differentiating lead times in multi-level production and changing purchase lead times. All these force recalculations for the MRP system. To conclude, MRP requires the following data for calculations:

- What is being produced (forecasts and orders)
- What is required (work hours, product structures, materials)
- What already exists (inventory values)
- When is it required (production schedule) (Sakki, 2009: 91)

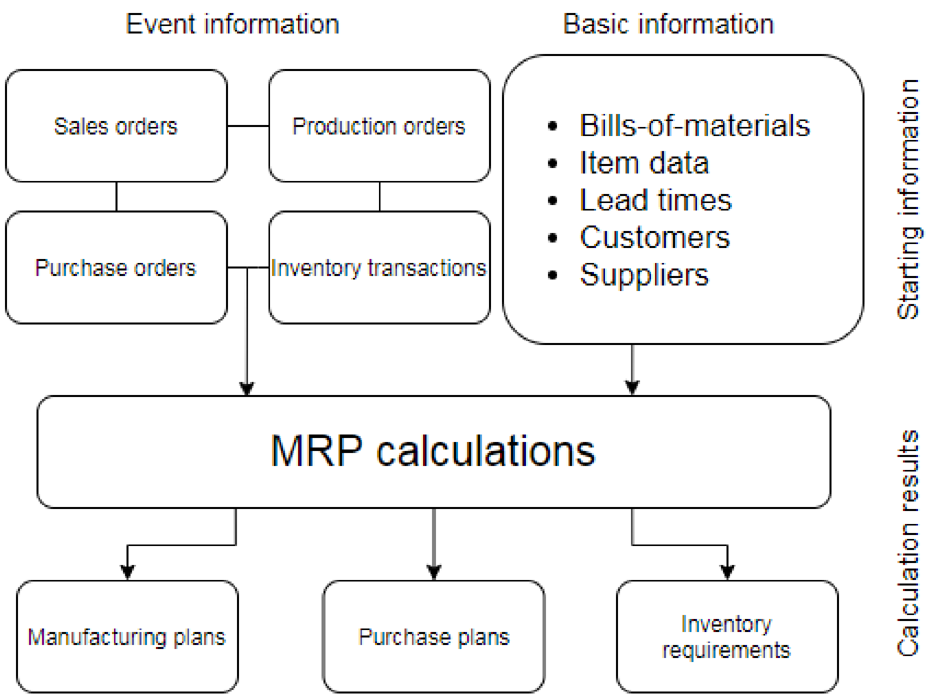

Figure 7. Material resource planning (Nieminen, 2016)

Nieminen (2016) represented MRP in one figure that has a visual representation for each of MRP's requirements, inputs and outputs. This can be seen in figure 7. According to Nieminen, on top the required base data, material planning requires the event data that changes continuously, this is what the forecasts of requirements are based on. MRP uses this information to calculate the requirements of the future and generates planned proposals for purchases, production and inventory. (Nieminen, 2016)

4.5 EDI confirmations

A common tool for automated purchase orders is an EDI (Electronic Data Interface) documents. EDI is a system where a feature is built into the ERP system directly that creates a standardized EDI 850 document that includes all the purchase order data, and the supplier responds with an EDI 855 transaction. The EDI 855 transaction requires a direct data transaction connection between the two organizations servers. When the supplier confirms the EDI 855 transaction, the connection automatically translates the order data to the ERP's format on copies the confirmed dates into the ERP PO. EDI purchase orders can be created manually or automatically from planned orders depending on the ERP process. The process can be setup for only certain vendors or a group of vendors. The EDI process requires a specialized application built integrated to the ERP system that can export and import data from the purchase orders, but also requires a transaction connection for the supplier. (Mediclick.com, 2020)

5 Current situation and the ordering process at Teleste

In this chapter the process and the identified issues of the order process at the case company are gone through. Along with it the ABC-XYZ analysis mentioned in the theory framework is introduced on top of the existing system at Teleste and how exceptions are handled and why does the case company wish for capabilities in automation and how is the need justified. For the ABC-XYZ analysis we are going to use the production data from 6 months for a handful of selected suppliers that promote a good partnership with the company. All production data is from the company's ERP system and calculated in Excel.

5.1 Procurement operations at Teleste

Teleste is an electronics manufacturer with a large product portfolio of hundreds of products including different configurations of products and products that are procured to be sold. With all the components and products, they purchase around 15 000 different items from 400 different suppliers spanning anything from lasers to gloves. This requires a lot of high-level control from the material planners and sourcing workers to ensure that everything is in place on time. Since the amount of material is so vast, everything cannot be bought to inventory to ensure lower amounts of capital tied to the warehouses. Because Teleste procures such great amounts of different items, the need to control costs of procurement and inventory to lower operational costs has been prevalent.

The purchasing team consists of 11 material planners that each control a set of suppliers and whatever purchases are required from them, the purchase orders come either straight from the MRP system integrated into the ERP or either as an inventory requirement set from production planners. Materials planners handle sending the order, controlling the dates of arrival that inventory does not over or underflow, communication with the suppliers, verifying the delivery dates into the system and taking care of the master data parameters like order quantities and safety stock levels.

All these operations produce data from the ERP system into a Power BI interface that is used to analyze the operations efficiency. This allows to see every supplier's order-to-delivery (OTD) efficiency, amounts of certain items used, purchased and their costs very efficiently. This data is used in this thesis to calculate the XYZ parameters of each item to conclude the coefficients of variability.

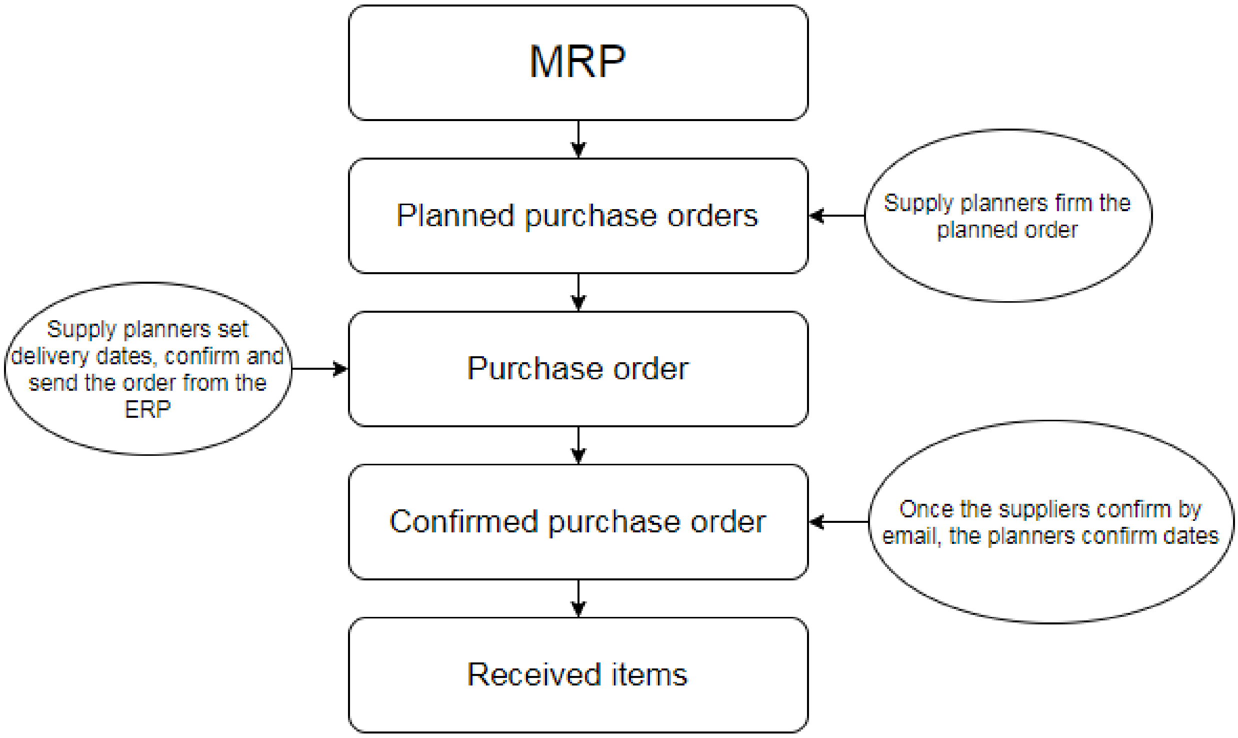

Figure 8. Purchasing process flowchart

In Figure 8 the process as seen by the supply planner is depicted. Most of the actions are done directly into the ERP system, only order confirmations must be externally viewed from emails from the suppliers. The process is centralized into the ERP, even the purchase order email is generated in the system. The receiving of the items into inventory is done by the logistics team of the company, the purchasing team only confirm that the order is ready for receiving. The amount of work required for seeing through the planned order if it completely matches the actual requirements of production varies between products and suppliers. Like mentioned in the theory framework, each product varies by demand, but mostly it could be said that the process is similar for each supplier and item line. The MRP relies completely on sales data and the purchasing parameters to generate the orders and unless told otherwise or the plans are found to be sub-optimal, the purchasers follow the planned orders provided by the system.

5.2 Purchasing parameters and ABC-classification

At Teleste, inventory and purchasing management has been taken relatively far and there are plenty of control methods and different parameters used in controlling the purchases. There are minimum order quantities for each item that are set either by the purchasing team or by the supplier to limit the purchased quantities to economic amounts. Order quantities are not calculated by Wilsons's formula. Safety stocks for each item are updated by planners each month after the forecasts are updated for finished products. The safety stocks are reported from an Excel report that calculates the quantity of four weeks of demand for each item from the average consumption per year. That averaged four weeks of consumption forecasts represents the safety stock for every item. There are also items that are not forecasted due to their nature in the production and they do not have calculated safety stocks.

Teleste has already an ABC-analysis in their use for purchasing. it very much represents the ABC-analysis of Sakki (2009) that has four classes from A to D instead of the traditional ABC. And just like in Sakkis' model it also has classifications for exceptions. These exceptions are:

- X – an item that has an issue or an exception and has separate order methods provided by a sourcing manager
- H – an either abandoned item in production or non-production related item. Purchased only on separated situations.
- E – A non-forecasted item that is purchased only when required.

Teleste made their separations for the item classification as follows:

- A-class represents 5% of items with highest inventory values of forecasted purchased items
- B-class represents 15% of items
- C -class 30%
- D-class 50%

For a management purpose, these classes are telling of the item's coverage group and order sizes. Each class has a time frame for orders to ensure that higher value items have shorter inventory turns to decrease inventory stock. A-items are ordered weeks' worth of value, B-items 2 weeks, C-items one month's consumption and D-items are ordered 3 months of consumption. The item classes represented as each item's "buyer group" that is an abbreviation that tells which are the items sourcing manager, supply planner and the ABC-class. There is also an added "+" to indicate if the item is a buffered item, and that means the safety stock is half of actual since the supplier holds a safety stock for Teleste in an VMI type fashion.

The idea with implementing this ABC-classification was not only to guide the inventory management of these items, but also aid purchasing in managing the workload for items so it would be quick to see which items require a more sensitive care due to their inventory costs. The E-class is the largest class with thousands of items in it, but it is not relevant when considering the control of items since these items are not forecasted at all for production, so they remain outside of consideration in this work. In this project the work is for the forecasted items only that are more easily managed.

The buyer groups and ABC-classes are also updated monthly through an Excel-report that calculates from the forecasts the newly reported forecasted inventory costs and proposes new classifications for items, which are then updated with an integration to Telestes ERP systems directly with the safety stocks. The Excel report demands data to be exported from several separate Excel-files and PowerBI web application to make sure that all parameters are correct for the supply planners to use in their work. The report requires forecasted consumption, safety stocks, on-hand inventory, warehouse locations and minimum order quantities for each item. The system does have an RPA (Robotic Process Automation) system designed to import the parameters automatically to the ERP, but this has also still lead to many false positives and requirements for manual adjustments. (Teleste, 2020)

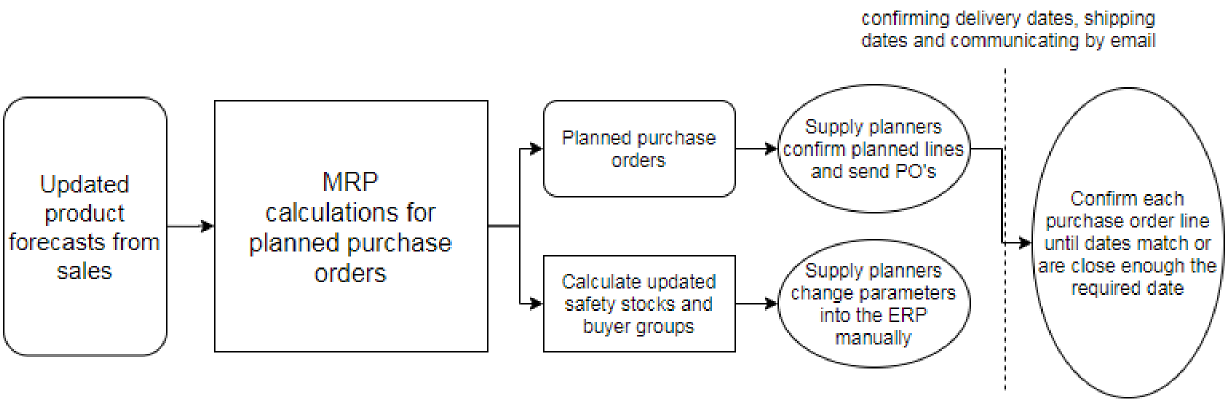

Figure 9. Forecasts to orders flowchart

In Figure 9 the process happening in the system is mapped. Here, the round steps picture an action by the purchaser and rectangles are system actions. The supply planners see a list of purchases in lines that includes amounts, the vendor and the calculated order date to match a set lead time for that item in the item’s parameters. From that list they gather a list of whatever is required at the time by the time frame of the ordering date. For some suppliers, a weeks’ worth of orders are gathered at once for an order once a week, these are suppliers that have hundreds of items and orders are set every week. Other suppliers have smaller orders that are set whenever their lines appear in the planned order list in the ERP. The orders are sent automatically through the ERP by e-mail in pdf-format as an attachment when the purchaser confirms the order after checking all the lines calculated dates.

For weekly orders this basically means setting all the lines to next week's delivery date and confirming the order. The order is confirmed through an email response by the supplier that mostly includes an attachment file in whatever format they use. Some suppliers can confirm just with a simple text response. The planners go through these emails and confirm whatever date the supplier responded with as the “confirmed delivery date” line by line.

5.3 Arisen problems, inefficiencies and desires for development

For this part of the project, the senior manager of planning provided a thorough idea of what she saw as the points of development on their current state issues. She claimed that the current state of the process is not faulty and since their team is very experienced, they know how to handle most exceptions and are very used to the systems that are now in use. But that said, Teleste has a wish to keep their processes on modern level that helps them show their customers they have a high level of operations, and that require lowering the amount of faulty orders, missing materials to provide the highest level of order-to-delivery (OTD) efficiency.

What was proposed as the guiding idea for developing the order process was bringing in automation to help purchasers focus on value adding operations, which in this case is the controlling of purchases that have delivery difficulties and taking care of purchasing parameters that would optimize the purchasing. Much of the planner’s daily work consists of reading email order confirmations and confirming them into the orders in the ERP system. This is a tedious task that for the dozens or even hundreds of purchased items daily at an electronics company takes time for each order and is a mundane task for the supply planners. Because of the differences between suppliers, the bought items, and the deviations of their consumption, this cannot be done for every time but the wish is to develop a way to find items even demand from trusted suppliers that could at least help move the focus in to more demanding orders.

This led into the current ABC-classification method and its weaknesses. At Teleste they feel that the current classification system does not have strict or robust enough implications for managing purchased items. While the classification does tell of the inventory value and ordering intervals, it does not seem to have a guiding nature for sourcing managers to find items that require care or for the suppliers to guide their way of working. Like mentioned in the theory framework, D-class items should not require the same amount of control as A-class items and this has not come true with Telestes current system. There are suppliers that with high accuracy deliver hundreds of low value items in even intervals, but still their purchasing parameters are handled with care to ensure lower inventory costs. This is good, but it is not seen as having a true impact on the bottom line and inventory costs as could be achieved with higher value items and more difficult suppliers. So the development idea here was to gain better control over the updating of the parameters to ensure that the net requirements in quantity of items the MRP calculates for purchasing are accurate and at least for items that have stable demand, it would not take any effort for control.

The existing PuMa report (Purchasing Master) that is used to calculate new safety stocks and buyer groups is seen as too heavy of a report that most planners don’t utilize properly, and a requirement would be to generate a more simple system for calculating safety stocks. Also, with the forecasts update every month and with it the parameters. There were found cases where changing of the buyer group increased the order sizes for an item and a supplier could no more anticipate the order size, causing them to have an issue fulfilling the order. To some supplier’s forecasts are send with different frequencies and they prepare for the orders accordingly, changes to order quantities can catch them off guard and cause delivery issues or at the least reporting issues even if the earlier forecasts would be enough for production.

Some planners also need to look at the production requirements of an item to check if the proposed planned purchase order is enough or does it have to be manually adjusted to fulfill the actual production requirements. Because of large deviations in demand in production, long lead times, hard to forecast parameters this is natural for some items, but is something that is desired to be at a minimal level as a task to promote trust in the parameters and remove unnecessary tasks from simple and repeating purchasing orders.

5.3.1 Desires for the developed state of the process

In a meeting with the senior manager of Teleste's planning and operations in November of 2019 the ambiguous needs how to develop their current purchasing and planning operations and what kind of end-state would be desired was mapped. The initial desire was not build a system on their own that would take care of all of their needs, but to gain understanding of their current state compared to the possibilities and find out the requirements that make the current systems possible to be upgraded into a new level and bring in more automation. The long-range goal would be to develop a system that would allow automatic purchasing and communication with suppliers that minimalizes the use of email and other channels. Teleste already had plans in place for a "no-touch purchasing system" that would allow some purchases to be done without any input from a worker. But they had not mapped the nature of their items and the requirements for such a system to be set in place. All this would in the long run bring profits by minimizing errors in human input, reducing workload from operational purchasing and make supplier communicating easier.

> *"The redesign of PuMa is not in the center of the problem. It is about finding out the possibilities in digitalization and what kind of opportunities are available for developing the operational purchasing to a more digitalized direction."*

The first issue that was wished for development is the creating a basis for a system that would make the automatization of even a small per cent of items possible, since the quantity of different purchased items is so high. This meant that the development of the ABC-classification was in a central point, since it is a method for separating the items from each other and it would be relatively easy to implement as there already is a simple version to build up from. The idea was for a system that would allow to recognize the items that have a demand profile even enough that they could be considered to have repetitive purchasing processes that rely on the correctness of the parameters and can be ordered without checking.

The current ABC-classification should be evolved into something that would guide the working of supply planners and sourcing managers in handling items. Like mentioned, the current system does not seem to influence the handling of the items. The desire was to give sourcing managers a tool of quickly mapping the demand profile of items they have responsibility over and a rule set to accommodate that. On top of that, a more advanced classification was desired to provide planners with stricter rules that would guide their working methods. This does not come only with the classification and a set of rules, like pictured in figure 6 and table 1, are required to be built to give some understandable guidelines in the control different item classes should require.

5.3.2 Aim and desire for final process

Using this information of the current processes and its difficulties, a sketch of the final process and the changes it could bring to the current system can be formed. Going through the wishes for development, the potential uses of the ABC-XYZ analysis boiled down to the following:

1. Provide sourcing managers with a managerial tool to gain information of their item portfolio in purchasing.
2. Provide supply planners with a quick view to manage the care certain items might need in purchasing and control purchasing parameters accordingly.
3. With a fast view into demand variability in items, control costs should be guided to more difficult items and lowered from ones with stabile control
4. Provide items for listing that can be included in an automated purchasing process to lower said control costs.

After the categorizing of the items have been done a basis for an automated process workflow has been provided. The aim for the automated process is to guide the expertise and resources of the purchasing team to cases that require more managing and control and thus leaving mundane and “easy” purchase orders to an automated system. This should eventually lead to lowering the amount of resources required in a procurement team, lowering costs and creating a more interesting working space for the team right now. With an automated system taking care of low volatility items and the purchasing team being available for more control over high value items, there should be more resources to optimize inventory parameters to ensure lower tied capital in the inventory. This again lowers operational costs and promotes a more lean and lossless process.

6 ABC – XYZ analysis at Teleste

In this chapter the ABC- and XYZ analyses are taken to practice for the requirements of this case. First, the process of categorizing the items and the how the first analysis are restricted. After this the ABC and XYZ analyses are combined to see what kind of quantities each class represent. In the combined analyses, production data from the 1.2.2020 through 1.8.2020 is used, this data is extracted straight from Telestes database using the Microsoft PowerBI reporting tools that use data gathered from the ERP system and the analysis in done in Excel. The ABC-XYZ analysis is planned to be extended to be used for all items in the purchasing portfolio but for chosen key suppliers it is used as a tool to take automated purchasing pipeline to development.

6.1 The process of classifying items

By classifying the items here, it can be determined how each item will be handled and how they behave in the item in terms of their demand. Finally, different handling methods and material planning methods can be assigned to each class. In this case especially there is interest in the possibilities of automatization, stricter management and more effective safety stock calculation.

Duchessi, Taiy and Levy (1988: 8-15) defined four different stages for the item classification:

1. Define proper classification criteria
2. Define the control needs for different classes
3. Pick the proper material handling method
4. Implement

For this, understanding of the nature of the items and criticality for the company must be understood. After classifying the control requirements must be defined for each class. Do all classes require the same strictness in the control and what are the optimal inventory levels? After this the methods and processes can implement properly. (Duchessi .. 1988: 8-15)

6.2 Choosing supplier and initial analysis

Rantanen (2016) wrote, when planning for automation and gaining use of the process. It requires not only classifying the items, but also a certain relationship type with the supplier that promotes a transparent process that needs solid communication from each side (Rantala, 2016). For Teleste a choice was made to use this also as an opportunity to develop supplier relations with some long-time suppliers that have a lot of purchase order traffic.

The choice of these suppliers was made by the sourcing manager responsible for supplier development and global sourcing. The PO traffic of all suppliers was listed and out of 206 suppliers six were chosen according to their amount of PO's sent in the last year, strategical importance and quality of partnership according to their responsible purchasers. These suppliers have Finland based offices to make sure they are close to home. All the ABC-XYZ analysis will be done for only the items of these suppliers to provide an estimation of items that would be capable for automation and adding additional suppliers or items will be considered in the future. The most important factor in choosing these suppliers was their high level of communication and success rate in deliveries as first confirmed. To even consider testing any automations, their overall order-to-delivery rates need to be higher than 80%.

These 6 suppliers have from 65 to 98 purchase orders sent to them annually for each, which means more than one order per week, but also all of them have agreements with Teleste for times weekly orders. The number of lines, or separate item orders, range from 318 to 645 annually and all together annually 2938 lines were ordered in the span of one year. This provides a very reasonable amount of data of purchases to analyze and the quantity of orders is already telling of some evenness in the demand profile for these suppliers' items. Among each other they share 12 per cent of all PO's of Teleste in a year. On initial empirical viewing, when the suppliers were chosen, the suppliers also have a lot of D – class and C-class items in their purchased items, meaning they have items that are ordered in large quantities with lower prices. Large quantities give more room for improving parameters like order quantities and safety stocks.

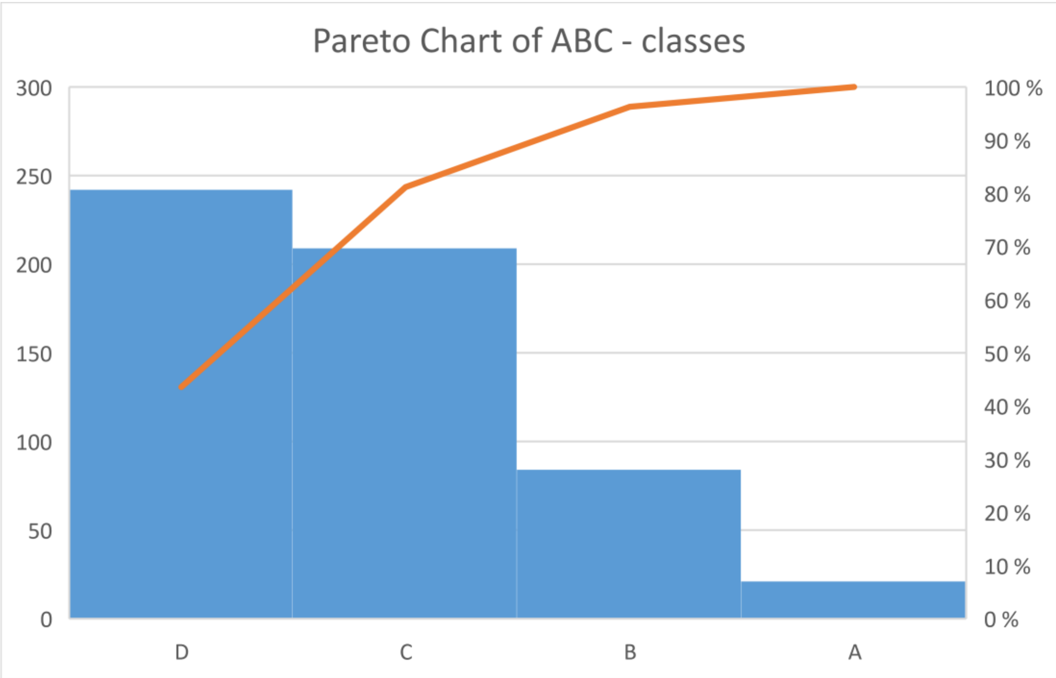

Figure 10. Pareto chart of chosen supplier items

In Figure 10 are the items of the chosen suppliers by their ABCD-classifications in a Pareto graph. This calculation consists of 556 items that were used in production in the time frame of July 2019 to August 2020, all classes that had already defined classes of X or H were removed from the calculation since regular material planning processes don't apply to those items. There were 746 items in total.

It would be expected for it to have the per cent separation of the defined classification but as each item's classes are calculated from the entire company's inventory value, so these are just the classes assigned to the items separately. But it is still notable that it does follow the earlier assigned idea that A- and B-class take much less inventory and C- and D-classes are larger in volume with these suppliers. These high-volume, low-price items are ideally the ones wanted for less control, so according to this class separations, these suppliers and their items seem very suitable for the extended XYZ-analysis.

6.3 Expanding to the XYZ analysis

Now that the supplies and items are chosen and mapped it is time to expand the ABC-analysis into an ABC-XYZ classification. At Teleste as they already have X-class for items it was chosen to change the expanded classes to 1, 2 and 3. This is done to avoid confusion and help quick identification. Numbers were chosen to provide an intuitive idea of variation of demand. This is just an expansion of Hoppes (2008) ABC-XYZ classification matrix pictured in the theory framework. (Hoppe 2008: 82) The classes that come from this calculation are pictured in Table 4.

Table 4. Expanded ABCD123 - classification table

A1	B1	C1	D1
A2	B2	C2	D2
A3	B3	C3	D3

The expected final product of this analysis is to provide a similar table that includes handling methods, rules and restrictions of each item class for planners and managers to help manage their supplier's items and decision making in how procurement could be developed. Also, these tables and calculations are to be used continuously in when the classifications should be changed. These classifications will be integrated to the ERP system to imply to suppliers quickly how are they to be managed when managing parameters and allocating time into controlling purchases. It should help purchasers control their amount of work. Finally, it serves as a tool for developing an automated purchase order process to identify the items that could be moved to that category.

6.3.1 Calculating XYZ classifications

The renamed ABCD123-classification was done in Excel using external data connections to Telestes SQL-database. The SQL-database has stored in it all purchasing and inventory related data like amounts of purchase orders, confirmation dates, inventory levels and consumption. The data was formed into a pivot table with the chosen suppliers' items filtered to a list. The columns of this pivot-table are every month's consumption for production or sales with total sum of the year's consumption. For this analysis, the consumption of August 2019 – July 2020 was used.

Table 5. Snapshot of the ABC123 -calculation table

May 2020	June 2020	July 2020	Grand Total	Average Mean	Std Dev	Coefficient of variation	XYZ-class	ABC 123
92	20		1593	145	170	1,17	3	D 3
1344	1834	4020	32084	2674	1726	0,65	2	D 2
2292	1852	1416	26598	2217	862	0,39	1	D 1
		120	392	78	44	0,56	2	D 2
758	740	732	16375	1365	483	0,35	1	D 1
1062	905	474	12344	1029	431	0,42	1	C 1
16	12		248	25	24	0,95	2	D 2
390	582	66	4902	409	269	0,66	2	D 2
44	36		514	47	23	0,49	1	D 1
88	76		1016	92	41	0,45	1	D 1
1938	1196	444	16106	1342	430	0,32	1	C 1
1734	3548	936	36396	3033	1686	0,56	2	D 2
	30		90	45	15	0,33	1	D 1
5050	4231	202	151516	12626	12230	0,97	2	C 2
	5		64	11	8	0,73	2	D 2

The choice of the time frames also carries a role in the XYZ-analysis because it is vital to understand that changing the time frames also affects the final values, the longer the time frame the more even the variations will turn out, meaning the coefficient of variation decreases (Hoppe 2006: 86). Like the initial ABC separation analysis, from this list all, items that have an ABCD-classification of E, H or X were filtered out. According to Hoppe (2008: 81-84, 338-341) the variation of demand is an apt criterion for the XYZ-analysis when the goal is improving service levels or optimizing inventory values. Hoppe (2008: 82) wrote that the goal of the XYZ analysis among others is to:

- Find valuable items that can be efficiently forecasted
- Lowering safety stocks, especially in the AX (A1 in this thesis) category
- Lowering control and inventory costs by focusing on more control to AX class and lowering the costs from the CZ class
- Enforce forecasting models

Following Hoppes theories, the variation of demand was deemed proper this analysis. For every row total sum in the calculation table there are the three calculations as a column at the end of the table that has the average mean, standard deviation and finally the coefficient of variation calculated for each item as presented in the theory framework. By Scholz-Reiters, Hegers Meineckes and Bergmanns (2012) application of the XYZ-analysis in inventory management the classifications according to the coefficient of variation the classes were separated followingly:

- X (1) = Coefficient of less than or equal to 0,5
- Y (2) = Coefficient between values 0,51 and 1
- Z (3) = Values from 1,01 and upwards

This provides a separation to classes to 1 representing even demand, 2 representing moderate swings in demand and class 3 representing difficult to forecast classification. The classes separated followingly into the ABC123 -classes:

Table 6. Quantity and percentage share of each ABCD123 -class

Quantities	A	B	C	D	Total
1	11	39	67	68	**185**
2	9	40	110	129	**288**
3	1	5	32	45	**83**
Total	**21**	**84**	**209**	**242**	556
Percentages	**A**	**B**	**C**	**D**	**Total**
1	2 %	7 %	12 %	12 %	**33 %**
2	2 %	7 %	20 %	23 %	**52 %**
3	0 %	1 %	6 %	8 %	**15 %**
Totals	**4 %**	**15 %**	**38 %**	**44 %**	

According to this separation in Table 6 we can see that 33% of all the items belong in class 1, which is telling that for these suppliers most items have very even demand and make for good test suppliers for this kind of development. Which was the first intuitive idea. It is also notable that there are still plenty of items in classes 2 and 3 which mean that especially in the moderate class 2, it is interesting to see after implementation of the classes how many could have the capability to move into class 1 with better parameters. Also, it can be noted that even though these items are from a smaller sample of items in total, the Pareto -rule highlighted by Sakki (2014) is visible in this classification in the ABC-analysis. It is vital to notice that there are none of A3 class items in this analysis, which is good for inventory management since these high value, high volatility items are difficult to forecast and inventories are hard to manage without large safety stocks, which then again are costly.

6.4 Rules for controlling new classifications

Now that the new ABC123-classifications have been calculated and shared between these key suppliers' items, to provide the suppliers and sourcing managers the tool to understand what the classifications mean, a table of rules for each classes inventory management rules needs to be made, similar to the examples of table 1., Hoppe (2008) explained the nature of each item class pictured in figure 6, rules for managing each class. Irena Nowotyska wrote of the use of XYZ -analysis as a support tool in decision making that it is appropriate to develop a system that correlates the rules of inventory management with each corresponding class that would involve the inventory levels and ways of sourcing the item. (Nowotynska, 2013) These rules and decision-making processes change within each organization so it differs according to the purchasing and inventory processes but should follow standard management methods. Like in the theory framework, the emphasis of making these inventory management policies are the correlations of a certain trait of demand against a certain kind of policy.

- High volatility in demand requires more safety stocks and control resources.
- Low volatility promotes less control and optimized inventory.
- Medium levels promote more efficient forecasting.
- Low value and low volatility in demand leans towards high inventory and low control
- High value and high volatility translate into optimized inventory and high control.

In practice this means when moving from 1 towards 3 class, the amount of required control rises, but when going from A towards D, the higher and less controlled inventory values should be used. This promotes a policy that JIT methodologies are used in the low variability to reduce waste and more buy to order and low safety stocks methods in the low variability classes. CGMA made an example of this in their study of the ABC-XYZ analysis. This is shown in Table 7.

Table 7. Example of control policies for ABC-XYZ classe**s** (CGMA, 2020)

	A	B	C
X	• Automated replenishment. • Low buffer – JIT or consignment transfers the responsibility for security of supply. • Perpetual inventory.	• Automated replenishment. • Low buffer – JIT or consignment transfers the responsibility for security of supply. • Perpetual inventory.	• Automated replenishment. • Low buffer – safety first. • Free stock or periodic estimation by inspection or weighing; low security.
Y	• Automated with manual intervention. • Low buffer – accept stock out risk. • Perpetual inventory.	• Automated with manual intervention. • Manually adjust buffer for seasonality. • Periodic count; medium security.	• Automated replenishment. • High buffer – safety first. • Free stock or periodic estimation by inspection or weighing; low security.
Z	• Buy to order. • No buffer – customer understands lead times. • Not stocked.	• Buy to order. • No buffer – customer understands lead times. • Not stocked.	• Automated replenishment. • High buffer – safety first. • Free stock or periodic estimation by inspection or weighing; low security.

The example of Table 7 cannot be followed for all cases, like mentioned, control methods are affected by company policies and the same rule applies here. Choice has been made that all groups from A to D have safety stocks even in low volatility, the E-class that was not represented in this analysis already has the items that do not hold safety stock are bought to order. Teleste’s case represents a further evolved case where there are already inventory management policies set, but the guidance of control resources needs to be guided with the classes and the task of these rules goes 2 way with the classes set right now:

1. Find out what items could be included in the automated purchasing process
2. What high and moderate value items need special attention in rationalizing

Now looking at these examples and the variables, affecting decision making on developing Teleste's matrix for the ABCD123 – analysis can be formulated. It should be later applied and expanded to the entire field of items, but in this scenario the matrix only handles the sample suppliers and items for the sake of piloting and enforcing the idea of supplier collaboration and extended item class management. The matrix of control policies for Telestes requirements is presented in appendix 1.

In the matrix of appendix 1 it can be examined that the critical changes in controls are focused on the A and C and D. Like mentioned earlier in the theory framework, the B class of an ABC- analysis can be considered as an in-between class in a sense that its requirements are not as easily recognized as the A-class and its control policies turn out to be slighter variations of the A-class (Sakki, 2008). In the ABCD variation of the analysis the B and C class are a bit similar. The focus of this matrix is particularly in the A1, A2, A3, C1, C2, D1, D2 and D3 classes with the idea presented earlier the items classified as 1 should be optimized and prepared for an automated process. The D and C classes policies are to lower control resources used in their purchasing processes and automate using higher inventories and looser parameters, meaning higher safety stocks and order quantities. the A3 and B3 classes can be considered quite separated from the other classifications in this matrix. Since they present a very low percentage of items, in this case A3 class has only 1 item, that are highly volatile in demand profile and high in inventory value. This means that they have high strategical value also, but because of their volatility they have high requirements in control resources. These are the item classes that are, with PO automation in the C and D classes, in high importance in supplier collaboration efforts to optimize their lead times and aim for rational purchase practices. The periodic checks of performance reference to supplier meeting and internal meeting with sourcing and purchasing operatives to keep up with the most strategically important items of a supplier. Such meeting can be quite time taking so it should be aimed to be maybe monthly and to focus only on A-class items to ensure high performance and raise any issues to fix.

6.4.1 Transferring items to new class

With time and changes in requirements of produced items, or more efficient purchasing operations, the nature of the items demand can change. This mean for this analysis that it should be transferred to a new item classification and the analysis must be done again. The continuous updating and following an items activity and changing the purchasing parameters continuously is very difficult. The analysis should be conducted periodically, like mentioned in the theory framework, it was researched that bi-annual analysis of the item groups is many times the most efficient manner. (Bergman 2012: 445-451)

In Teleste’s case bi-annual seems like a reasonable time frame for these analyses. Since Teleste sends forecasts of the MRP’s planned purchases for their suppliers and the order quantities are dependent of the item class an purchased item is sent, the classification can’t be changed continuously since this would make it difficult for the suppliers to prepare stock for Teleste to purchase. In practice, the time frame could be anything from monthly to annually. It is important to get the analysis to be understood in the organization and to get purchasing and sourcing staff to understand the underlying logic behind this analysis before the timeframe should or could be shortened. The shortened time between changes in class would also mean more precise tracking of demand volatility. Updating to the classes would be easy as Teleste has and interface made for Excel files that can update certain parameters in mass. The updated classes need to be copied as rows from the XYZ-analysis table to the update file and imported and all classes change. It is quite easy at this point since the item classes are together with the buyer groups as purchase parameters in the ERP.

7 Planning automation in the purchasing process

Now that the classifications are separated the items have a new extended policy in material control, which includes the automation of the "easiest" classes. This automation is no easy feat however, since there are many levels of automation. In this chapter the process of a possible automated purchase order is mapped, and a system recommendation is presented. These are mostly based on empirical observations of Telestes organization, processes and the documented restrictions. The theoretical side of moving into automated purchase orders comes from Lauri Rantala's works, since he has many extensive studies on purchase order automation in a Finnish industrial frame of reference.

7.1 Parameters and set up for automation

As established earlier, automated purchase ordering requires 3 core things: a supplier relationship, item classification and a system capability. Item classification comes with the idea that the data behind the purchased items is understood and the parameters are stable and manageable. Purchase parameters such as Minimum-order-quantities (MOQ), safety stocks and lead times are vital to be understood and settled by each party. These parameters should be maintained automatically for the C1 and D1 items that are in automation workflows.

For this Teleste has an Excel a calculator that is run every month for every item that has forecasted needs in production. This includes every item that has ABCD-classification. This calculator is set up with 12-month forecasts for each item needs in production and calculates the average of one month's requirements to be the safety stock, two weeks If there is a VMI buffer stock settled for the item. MOQs and lead times come from the supplier and are negotiated between the sourcing manager who owns the supplier relationship. In the more well managed supplier relationships, the suppliers send item data in set intervals that include changes in lead times, MOQs, availability. It is the supply planner's responsibility to update these parameters. At the time of writing this thesis, Teleste is building an integration into the ERP that will allow batch updating of purchasing parameters, which means that by uploading a csv. file thousands of fields of data can be rewritten instead of the manual updating which means that the supply planner must open each items field separately and rewrite them into the system. This batch updating of purchase parameters is very important in terms of more fluent material management in the ERP. It should and will not be used for strategically important items since these many items include exceptions and their parameters can be updated manually to ensure they are optimal. This is to ensure that they have lower inventory values and continuous availability. Continuing the idea of the ABCD123 -classifications where the body of control work is moved to the more difficult and strategically more important items.

That concludes two of the requirements: classification (and parameters) and supplier relationship that allows transparent 2-way communication and preparedness to build inter-company systems. Like mentioned, Teleste now has 6 chosen suppliers for piloting automation. System capability can be determined by the process that is planned. In Telestes case, a standardized ERP that has integration interfaces to most other used systems in the market is more than enough system capability for building an automated process. The restrictions lie more in the resources available in the wanted process automation. MRP-calculating used in managing manufacturing and planning is also a key part in capability, since it works as the trigger of the purchasing process and creates the need in production in the systems workflow.

7.2 Mapping the automated process

The most important part in automating the process for Teleste was to understand the operational purchasing team’s way of working and automating the parts that need automating. Meaning that the solution needs to be as simple as possible without building much on top of the ERP system because the costs get very high quickly with the supplier of the system and they rarely represent a long-lasting solution in their experience. The two main parts the automating an order that would normally require low amounts of control is in creating the order to match the parameters set and even more importantly the confirmation of the delivery dates from the supplier.

The first part of the process is relatively easy. Since through the item classification and an established vendor relationship, the items that are ensured to arrive as promised are known. The purchasing parameters handle the rest. Since the MRP creates the planned orders and counts their lead times for the right delivery dates and proposes the orders at that date automatically, it would be the new automations job to only set the right dated purchases together and firm them into a prepared purchase order that the supply planner only has to confirm and send to the supplier. At this point the process is still wanted to be held in human hands before the automation could be given the entire purchase workflow. That should be the next step in development that comes quite naturally when the concept is tried and tested.

The confirming of the dates into the ERP automatically is a more complex process to automate and requires some amount of interfacing with other systems since suppliers have their own methods of confirming purchase orders. The orders are sent as pdf-files by email by the ERP to the suppliers and the suppliers respond by email with different types of file formats and messages to confirm the delivery date for each item. This makes automation difficult since the source material for the dates is not the same each time for a machine to read and transfer to the system. This separates the possibility for a system into two directions: either automate the reading and transferring of the data by a system or create a pipeline where all the confirmation dates come in uniform ways. The proposal for a process most fitting for Telestes needs that also promotes supplier relationship development and provides a new interface for working would be a system where the suppliers can insert the dates themselves to the orders directly and they would be copied as confirmed to the order in the ERP system. This way the only knowledge from confirming the orders coming to the supply planners could be of the dates that could not be confirmed by the supplier or dates that don’t match the date that was proposed in the order. With a process like this the suppliers email amounts could be more focused in the orders that require control and reduced outright. For orders, that as planned, would include items that have low volatility in their demand, would go by without any control resources but for sending the order. This process is depicted in Figure 11.

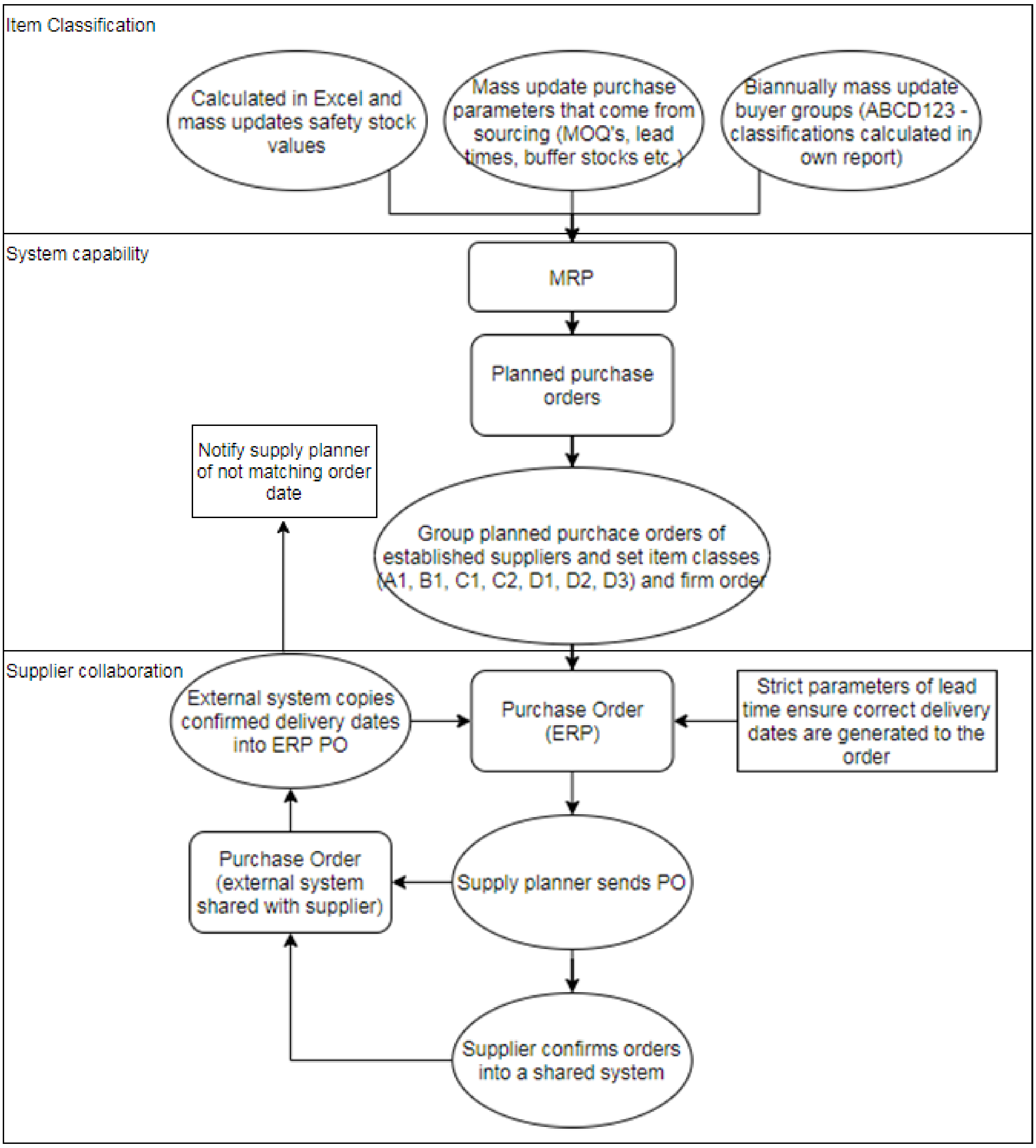

Figure 11. Workflow for automated purchase ordering

In Figure 11 the 3 parts of Rantalas graph of keys for automating purchasing orders are represented as the squares surrounding the flowchart (Rantala, 2016). Actions done are represented as circled steps, rounded rectangles are passive parts that are generated by systems. Item classification represented as the three first actions. Using externals tools from the main system (the ERP), the parameters are calculated or imported according to sourcing agreements or Teleste's policies. These parameters are the solid base that is needed for enabling the process. System capability takes up the rest of the process, it includes ERP, capability to material resource planning inside the system and the external system where purchase orders are confirmed. Supplier collaboration is the most bottom part of the process where setting up the confirmation process requires communication and shared systems with the supplier. The notable difference between this process and the one in figure 10 is the lack of emails with purchase orders changing into a system where suppliers can semi-directly through an external system confirm the order. This is to reduce unnecessary email traffic and to provide a uniform platform for confirmations.

7.3 System recommendation

In building the system capabilities for the process flow pictured in Figure 13, there is a part that Teleste does not own now and that is the external system that would allow suppliers to confirm the purchase orders. To reach the wanted process flow into a system that allows suppliers to confirm orders without sending an external message like a purchase order confirmation email. This is not a new technology and there are several established systems that are developed for the purchasing process. A common solution is the EDI (electronic data interface) document confirmation and another, more modern system is a supplier portal system.

After reviewing the EDI process and its requirements in terms of Teleste's capabilities and resources specializing the automated process with the suppliers. The EDI process requires work from both the supplier and Teleste. While this does require the supplier collaboration ideas represented in this thesis. Teleste does not want to put risk into putting pressure to supplier to change their processes too much or require infrastructure changes, because many of the supplier companies are bigger companies and Teleste is not always a key client for these larger distributors and manufacturers so to commit to building automation a solution is wanted that can be expanded safely for a larger group of suppliers not dependent on the size or the intercompany relationships. It was felt that the EDI process is not the most dynamic or feasible at this moment.

7.4 Supplier Portal

After reviewing system possibilities that could provide the proposed purchase orders. System suppliers where found that supply a system called a supplier portal. These systems are not necessarily called this, but in this thesis, they will be referred as such due to the required nature of the system. A portal for suppliers that gives them the capability to insert data into the organizations system.

One example of such a system is provided by a Finnish company called Jakamo, they refere to their system as a “supplier experience platform”. Jakamo’s system is a good example of a supplier portal system. The system is a subscription based environment, where suppliers sales organization creates an account to Jakamo that gives them the possibility to link into a target organizations account where they can handle the customers purchase orders and confirm the requested dates that are then automatically stored in the purchasing organizations account and there from through integration transferred into ERP (Jakamo.fi 2020) . This kind of system for example would provide Teleste’s necessary missing piece of building a purchase order process that would take away tedious setting of date work. There are plenty of system suppliers such as Jakamo that offer a supplier management system that provides external capability, such as Procurify or even Microsofts own Dynamics 365.

A supplier portal comes with the issue of getting suppliers on board with using a new system just for Telestes confirmations. That is where supplier collaboration comes in again, it is a difficult requirement to get suppliers to use a new system. Especially if Teleste is not a critical customer for them. This requires transparent communication with the supplier to make clear what efforts Teleste is taking to build a more efficient purchase order pipeline. Another issue that surrounds systems like a supplier portal is the return on investment, since the savings created by a system like this are mostly indirect and developing new integrated systems costs are heavy. The returns come from at first glance small things like lowering email traffic, taking away the confirmation time from purchase order processes and focusing only on exception cases and elevated confirmation data quality. Direct savings come from more focused supply planner work time and raised quality, which should lead into less required resources into procurement and purchasing in the long haul. These are difficult returns to argue for management that is responsible for allocating costs into developing new systems and processes. In Telestes case, where there are 11 supply planners doing purchasing operations, even a few per cent taken away from the workload provides quantified savings. The average amount purchase orders sent daily is 11, these orders can contain dozens of items purchased. Getting an automated workflow for "easy" orders that contain fixed order dates and delivery dates without having to worry about the confirming would free up hours of workload to develop and manage more difficult and time-consuming cases.

Creating and confirming purchase order dates and deliveries is estimated to take sometimes even 50% of a purchaser working time. The 50% includes the difficult cases too, but if an automated workflow could reduce this amount by 20%, that would already mean a weekly saving of 44 hours between the purchasing team. That already counts for thousands of dollars monthly and the proposed raise in quality and throughput time increase that earned rate with reducing fixing work and making all work faster. This requires commitment from management, operational work force and the supplier to build and believe in the efficiency of automated workflows. The process flowchart for the supplier portals confirmation process is pictured in Figure 12.

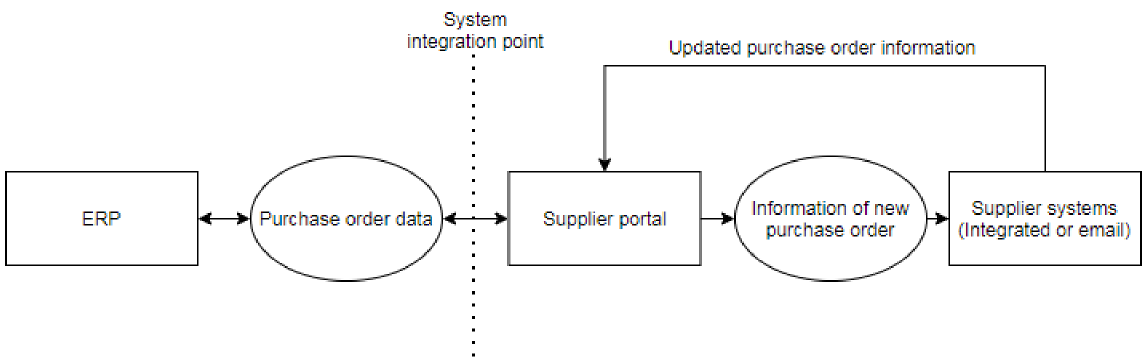

Figure 12. Supplier portal purchase order workflow

8 Managerial implications

The implication and aim of this ABCD123 -item classification system is to help managers understand the volatility of different items and specify critical items that they then can have more precise discussions with suppliers. The item classification matrix works as a road map for sourcing managers where they can make more justifiable decisions on how to set safety stocks and lead times for example for critical items. It also helps divert and manage resources on what categories and sets of items they should focus their work on. It brings information about the procurement portfolio and helps understand the place of each item in the importance hierarchy. The biannual set interval for re-analyzing the classification also creates rhythm into the operations and somewhat makes sure that there is precise information continuously.

Another use of the item classification for managers is the ability to use it in supplier collaboration development. With the matrix and the knowledge of coefficient of variation factors, the discussion about automating ordering with suppliers can be started. Sourcing managers and purchasing staff have meetings with suppliers every quarter about procurement, transport and supply performance. Now there is more precise information on the critical sourced items and have guidelines on how they should be set with parameters to have proper inventory. This requires communication with suppliers, but the item classification will help with that.

The item classification system is also a development tool in understanding the specifications of each items demand profile. This helps operations managerial team in developing systems, like an automated purchase process, to help the operations in developing to a more optimized. To concise, the item classification is for economical item management, optimizing supply and decision making in procurement management.

9 Conclusions and future works

This thesis was done as a part of a project at Teleste to create ways for enhancing the purchase order process and remove more tedious parts of operational purchasing workforces' day-to-day operations. The goal of this thesis is to present the requirements for Telestes current way of working to gain a step forward to automating their processes and developing a more efficient procurement workflow. The first research question was of finding the prerequisites for the current system to move into automation. The second question was how current analysis methods, like the ABC-analysis, could be expanded to a more usable form. The second research question handled the entire inventory management processes of Teleste and the for the first question a selected group of suppliers was chosen for studying possibilities of upgraded methods.

In the theory framework the focus is mainly on how procurement and inventory management are done and how does literature cover item classification methods, like the ABC and XYZ-analysis and their possibilities. Also automated processes and its requirements are covered in the final part of the theory framework.

For the empirical study part of the thesis, it was concluded that an expanded ABC-XYZ analysis for the chosen set of suppliers purchased items should be done to figure out the demand nature of items. Since the goal of the study was to find out of Telestes current systems would gain a more usable form, a 9-part matrix of different classification groups that include very practical ideas of the items should be handled in terms of how difficult or volatile they are in terms of demand fluctuation. The demand data used in the analysis was each item monthly demand in production or sales from 12 months. This matrix would not also provide the limitations and guidance for each item group but create a need for managing the items purchasing parameters to even allow for providing automation. The chosen group of six suppliers were determined by sourcing managers inside Teleste as possible partners for more supplier collaboration methods and provide a high number of items of critical strategical meaning for production.

From the analysis it was visible that for these six suppliers handled in the analysis, most of the items supplied belong into the C1, C2, D1 and D2 categories (67%). These are the item classes with the low volatilities in their demand patterns and lower inventory values and thus lower strategical value. This was very fitting for the aims of this thesis, since these are the items that are generally deemed to be possible to be viable for automating since their demand is predictable. When this information is combined with supplier collaboration to ensure high level of information about purchase parameters like lead times from the supplier, it is deemed possible that an automated purchasing pipeline can be set up for these items. For the more volatile and difficult items, more optimized order planning methods like optimal safety stocks and only manual ordering with is taken to use to avoid stock outs. Quarterly performance checks are necessary for items in high values, high volatility classes.

In the second part of the empirical study the requirements of an automated, or even a semi-automated, purchase process workflow is mapped. Here the, current processes parts deemed too tedious or time consuming and turned into a sketch of an automated process. A management decision dictated that the process should probably start with the idea that the entire purchase process is not handed to automatization and the first phase should include checks by a human for insurance to this is also taken into consideration.

These two parts of studying the current state of Telestes purchasing process and organization ended with mapping the critical purchase parameters that should be upheld by repeated calculations and by high levels of communication with the suppliers. These parameters are updated using data migration tools that Teleste already has built. Using these parameters and material resource planning systems in the ERP, viable purchase orders for these low volatility items are grouped with fixed order weekdays. This leaves the supply planners only job is sending the purchase order to the vendor. For the confirming of an order, a supply portal system is to be implemented into the purchase pipeline to give vendors the possibility to confirm order dates without sending email and only exceptions in order dates should be handled.

To conclude, the extended ABC-XYZ analysis provides a strategic map for not only operational purchasing, but also sourcing to map each supplier's item portfolios demand volatility and this data can be used in many ways to enhance decision making. The analysis should be repeated bi-annually. The analysis also provides a basis for finding items that should be considered to not require attention by purchasing staff, since they are continuously ordered. Teleste still has some steps in building required system capability to ensure a completely automated purchase process, but this thesis's findings should provide a proper starting point and a roadmap for understanding the requirements of such a concept.

For future studies, the implementation and choosing a correct system supplier for building a completely automated purchasing workflow should be looked at. The process workflow of this thesis represents a first step of automation in purchasing that still includes semi-automatic steps. Next cases could also include such topics as implementing machine learning tools to read purchase invoices and other documents to help ease document handling and confirmation work.

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Appendices

Appendix 1, Matrix of item class control policies for Teleste

	A	B	C	D
1	• Optimized safety stocks • Periodic checks of performance • Option for automatization • JIT supply chain for optimized value, low safety stocks	• Automated purchase orders with manual interception • JIT supply chain methods • Fixed order periods for perpetual inventory	• Automated purchase orders and confirmations • Fixed order periods for perpetual inventory	• Automated purchase orders and confirmations • Lower control resources • Fixed order periods for perpetual inventory
2	• Periodic checks of performance • JIT supply chain for optimized value • Manual control	• Basic purchasing procedures • Medium control resources • Manually adjust parameters	• Automated purchase orders and confirmations • Purchase parameters ensure lead times and dates • High safety stocks and order quantities for lower control	• Automated purchase orders and confirmations • Purchase parameters ensure lead times and dates • High safety stocks and order quantities for lower control
3	• High control of PO confirmations and lead times • Periodic checks of performance • High communication with supplier • Priority in rationalizing supply	• High control of PO confirmations and lead times • Priority in rationalizing supply	• High safety stocks and order quantities for lower control • Aim to understand supply dates for automatization possibility	• High safety stocks and order quantities for lower control • Aim to understand supply dates for automatization possibility