

Maria Yakovleva

# Managing Last Time Buy components

Helsinki Metropolia University of Applied Sciences

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<p>Component obsolescence is a topic that became important because of the need for innovation and frequent technological changes. The significance of the topic varies across industries and types of products. Companies that are producing long-life high-cost industrial products are especially vulnerable to component discontinuation. Separate components of such products often have shorter lifecycles. Lifecycle mismatch is leading to additional risks and costs. For this reason, companies need a well-organized End of Life (EOL) management of obsolescent components. Author's own interest in the topic is driven by participation in the project related to EOL management at the case company.</p> <p>The aim of the case company project was to create SCM EOL Concept. The thesis is based on the information from the Concept as well as interviews with company representatives, own observations of the author and literature review. The thesis is focused on EOL Last Time Buy (LTB) as one of the component obsolescence management strategies. The objectives of the research were to compare the difference between normal purchasing and EOL management in the case company as well as identify the reasons of EOL process inefficiency and additional risks. Another goal was to find the ways to minimize the risks and increase the efficiency of EOL process. One more aim of the project was to find out how to increase the financial performance of the case company and similar organizations through a better EOL management.</p> <p>Many differences between the normal purchasing and EOL management were found during the research. These differences are mainly resulting from the uniqueness of EOL cases, unavailability of components and the low purchasing volume. The differences are leading to additional risks and are making EOL process less efficient than the normal purchasing process. Furthermore, EOL process is inevitable in technology related industries. Since it is not possible to completely avoid EOL management, EOL process shall be optimized in order to increase its efficiency and improve financial performance. In addition to process optimization, well-organized risk monitoring strategy can minimize EOL-specific risks. The results of the study are applicable to companies operating in similar industries.</p>	
Keywords	EOL LTB management, product lifecycle, obsolescence management, supply chain management, inbound execution, warehousing, outbound execution

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## Terms and abbreviations

**EOL component** (End of Life component) - component that is at the end of its lifecycle. The original supplier will no longer be producing the component and might limit or end the support (EOL Concept 2017).

**BB** (Bridge Buy) - a type of Last Time Buy (LTB) where a certain number of parts is purchased in order to cover demand for a limited period before the product redesign is ready and replacement takes place (EOL Concept 2017).

**Broker** - a person who buys and sells goods or assets for others (Oxford dictionary 2017). In EOL case at Company X (EOL Concept 2017), broker is a company that buys EOL components from original suppliers and sells them to the other companies for the higher price.

**Classic purchasing** - a replenishment method. Company makes replenishment decisions itself, sends a purchase order to the supplier and owns the material in the warehouse (Procurement Concept 2017).

**E-commerce tools** - tools that enable a firm or individual to conduct business over an electronic network (Investopedia 2017).

**EDI** (Electronic Data Interchange) - computer-to-computer exchange of business documents in a standard electronic format between business partners (EDI Basics 2017).

**EMS** (Electronic Manufacturing Services) - companies that manufacture products for original equipment manufacturers. Company X is an original manufacturer that outsources some of its manufacturing operations to EMSs (EOL Concept 2017).

**EOL Coordinator** at Company X is a person that ensures alignment, cooperation and smooth EOL material flow between suppliers, EOL warehouse, factories and EMSs (EOL Concept 2017).

**ERP** (Enterprise Resource Planning system) – a system by which a company manages and integrates the important parts of its business such as planning, purchasing, inventory, sales, marketing, finance and human resources (Investopedia 2017).

**ESD** (Electrostatic discharge) - swift discharge of electric current between two objects with different charges and different numbers of electrons (Technopedia 2017). EOL component handling at Company X is done in ESD protected area in order to avoid ESD damage (Company X 2017).

**F&C** - Finance and Control

**Inbound execution** - the process of delivering goods from suppliers to central warehouse (Procurement Concept 2017).

**Lead time** - the length of time taken to obtain or supply the requirement from the time a need is ascertained to the time the need is satisfied (Lysons & Farrington 2012:318).

**Lifecycle mismatch** - a difference between the lifecycle of a component and a product (Bradley & Guerrero 2008).

**LOD** (Last order date) - the last date when a company can order EOL components. LOD is defined by the supplier (EOL Concept 2017).

**LSP** (Logistics Service Provider) - a third party that provides logistics services to a company (Company X 2017).

**MOQ** - Minimum Order Quantity of a purchase order

**MPQ** - Minimum Packing Quantity

**NCNR** - Non-cancellable and non-returnable purchase order

**Normal purchasing** - a term used to define the purchasing of usual components at Company X. In contrast with EOL components, usual components are not at the end of their lifecycle (Company X 2017).

**Outbound execution** - the process of selling and delivering the materials from a central warehouse to plants and EMSs at Company X (EOL Concept 2017).

**P2P** (Plant-to-plant) is a delivery from warehouse or plant that belongs to a company to a plant that also belongs to the company (Company X 2017).

**PDN** (Product Discontinuation Notice) is a starting point of EOL process (Company X 2017).

**PGI** (Post Goods Issue in SAP) is pressed when materials leave the warehouse in order to reduce the stock by the goods issue quantity and make value changes in accounting (EOL Concept 2017).

**PO** - Purchase Order

**RFID** - Radio-frequency identification

**SAP** - enterprise resource planning software produced by SAP corporation (SAP 2017).

**SB** (Supplemental Buy) - an additional EOL component purchase made after LTB (EOL Concept 2017).

**SCM** - Supply Chain Management

**SCS (or VMI)** - Supplier Managed Consignment Stock (or Vendor-managed inventory) is a method in which inventory replacement decisions are centralised with upstream manufacturers or distributors (Lysons & Farrington 2012:351).

**STO** (Stock Transfer Order) - is a delivery from a warehouse or a plant that belongs to the company to a plant that does not belong to the company (Company X 2017).

**TCE** - Technical Component Engineer

**WMS** (Warehouse Management System) - a software application that supports daily operations of a warehouse (Business Dictionary 2017).



## 1 Introduction

Kumar and Saranga (2010: 170) write about the absolute necessity of technological innovation as a strategy needed for survival. Innovation is seen as a factor that is increasing the performance of companies. Ince et al. (2016: 2) agree that innovation is vital and that it is one of the most important strategies for achieving competitive advantage and maintaining market share. Due to an innovative approach, technology develops very fast and product lifecycles decrease. Obsolescence is one of the outcomes of fast technological innovation. Component obsolescence issue became very important over the past 10 years for many industries, especially for those that are facing many technological changes. In some industries, such as electronics industry, components usually have a shorter lifecycle than the products these components consist of (Bartels et al. 2012: 33). The lifecycle mismatch is resulting in a need for the component end of life management that will secure product availability.

Component obsolescence is occurring more frequently nowadays and is causing financial losses for many equipment manufacturers (Shen & Willems 2014: 522). The examples of products that are facing very frequent component changes are mobile phones, cameras and computers. However, the issue is particularly significant in the case of the long life industrial products that are composed of regularly upgrading parts. Such products as ships, telecommunications infrastructure and medical equipment are changing to new technologies more slowly because their development is complex, costly and takes more time. These products are more vulnerable to component discontinuations because, in contrast with mobile phones and computers, they are originally designed to work for many years (Josais et al. 2009). Long life industrial products cannot be redesigned as fast as the smaller products. They have to be partly redesigned or have to secure the old component availability for the whole product lifecycle. This results in additional supply chain risks, challenges and inefficiency.

Smart supply chain management can provide a competitive advantage through an improved cost and value of the products. This means that companies can either decrease the cost of their product, increase the value of their product or they can achieve both goals at the same time as it is shown in Figure 1 (Christopher 2016).

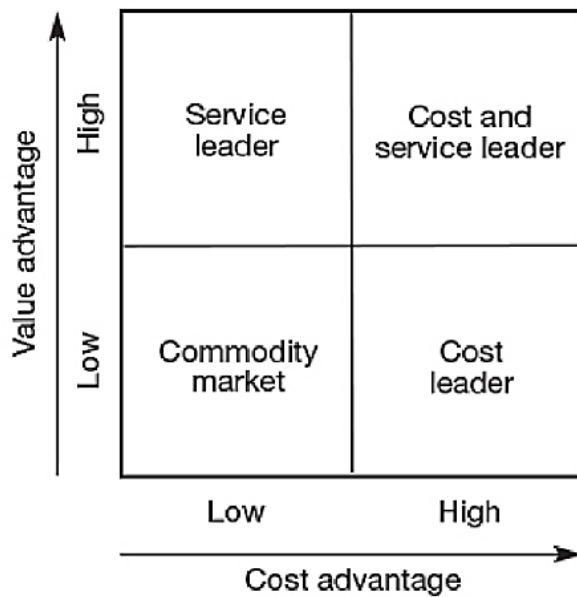


Figure 1. Logistics and competitive advantage (Christopher 2016)

Even though different approaches to improve the supply chain performance exist, component obsolescence is one of the weak spots in supply chain management. The increased importance of component end of life management was a recent discovery of the author, who was working as a summer trainee in the case company. After the completion of the traineeship, author was involved in the EOL related project in the company. The result of the project is confidential and cannot be presented to the public. However, upon the completion of the project the author identified a need to investigate the difference between the normal and end of life processes and find out more about the supply chain efficiency as well as its weak spots and their influence on cost and value of components. Real name of the company is changed to Company X in this thesis.

### 1.1 Case company

Company X is a big multinational company with many suppliers and factories located abroad. Case company has its partners and offices in more than 100 countries. Company X is an industrial organisation that purchases goods and services for production and is a primary manufacturer of technological equipment for many different industries and public sectors. The company is mainly manufacturing long life industrial information technology equipment. It has 20% market share for many of its product and service types and more than 40% market share for some of its products (Company X 2017).

The project was focused on the analysis of End of Life (EOL) Last Time Buy (LTB) of Company X components that are used in complex relatively expensive products with a long lifecycle. EOL LTB is a rather unique process for the company. LTB purchasing has a low volume in comparison with the normal purchasing. This is resulting in a rare involvement of certain employees in the EOL process and difficulties with the understanding of responsibilities. The process also has some additional challenges related to cost and time in comparison with the normal purchasing.

## 1.2 Objectives and scope

The target of the project completed by the author at Company X was to create SCM EOL Concept in order to solve the information-sharing issue. The concept combines all the important subjects of EOL management at Company X from the point of view of EOL Coordinator and the parties working in a close cooperation with EOL Coordinator. The purpose of the document is to introduce Company X EOL management process with its roles and responsibilities and the most important issues and make the employees, who are working in the areas related to the EOL operations, familiar with the process. One more reason for the concept to exist is that, according to the rules of the company, all business relevant processes have to be documented (Company X 2017).

The target of the thesis was to compare EOL LTB management process with the normal purchasing, warehousing and outbound execution. The results of the comparison were used to identify the risks and challenges of EOL process and evaluate their effect on the efficiency and financial performance of the company. The ways to minimize EOL component cost were identified. Some of these risks and challenges are applicable to the other companies and might be useful for the evaluation of their performance.

The main research questions were:

1. What are the main differences between normal purchasing at Company X and EOL LTB management?
2. What are the reasons of the additional risks and process inefficiency in EOL cases at Company X? How can Company X and similar companies minimize the risks and increase efficiency?
3. Is there any way to minimize EOL component cost and improve financial performance of the company?

### 1.3 Methodology

The author was working as a project worker from the end of 2016 until March 2017 in a close cooperation with Company X representatives who are directly involved in EOL process. Qualitative research method was used to collect the information required for the completion of the project and creation of EOL Concept. Some of the information was distributed in a form of official company guidelines as well as unofficial instructions. However, most of the information was gathered through an interview with EOL Coordinator, who is the key person responsible for the LTB execution and all the processes following the LTB. To increase the understanding of the process, practical interview methods were implemented. For example, EOL warehouse was shown and all the related issues such as storage guidelines, quality control, scrapping, inventory counting, warehouse layout and packing methods were explained. In addition, some of the LTB planning examples were presented in a form of email conversations and demand calculations in various company tools. Roles and responsibilities and the functions of the tools were clearly explained. The purpose of this information sharing creation of the SCM EOL Concept, which is now used at Company X.

Data gathered for the concept, company documents and personal observations of the author are the main sources of information for the evaluation presented in Chapter 4. Normal purchasing concept was used as an example for SCM EOL Concept creation. Similar topics are discussed in both documents and this fact enabled the comparison. As a result, purchasing planning, inbound execution, warehousing and outbound execution of normal purchasing and EOL management are compared in Chapter 4. Company information is supported by other secondary data sources such as books and articles. One of the challenges of secondary data research was the limited information about component end of life and obsolescence management.

### 1.4 Limitations

EOL process is described very generally due to the large variety of the topics included. This is the limitation of SCM EOL Concept as a method of information sharing improvement. Reader of the concept may understand the main issues of EOL process and find out some important aspects to pay attention to. However, if the reader needs to get a more detailed information about, for example, SAP purchase order placement process, then the one will need to ask EOL Coordinator for the further information. This

is resulting in a variety of topics included in Chapter 4 and a rather general comparison of the main issues.

Limitation of the comparison between the normal purchasing process and the EOL process is that the process is only partly discussed and the big picture cannot be clearly shown and evaluated. The process can be analysed only partly due to the limit of company information and the scope of the project. Also, due to the confidentiality issue, no numerical data is provided to support the research. The extent of inefficiency, consequences of the risks and the influence of EOL process on the company financial performance is only presented in the qualitative form. Competitive advantage of the normal purchasing is also not evaluated numerically. Finally, the process is evaluated from a point of view of one company and one industry. Some issues may be applicable for the other companies. However, the analysis and results cannot be fully applicable to the other companies and industries.

### 1.5 Research structure

The research structure is based on the suggested model of Colin Fisher (2010: 295). Introduction chapter explains the focus of the research, its importance as well as its purpose, scope and limitations. It defines the main research questions and describes the case company. Introduction chapter also includes research methodology and explains the ways to gather the information. Theory related to the research is described and analysed in the following chapters. Theory concerning the supply chain tendencies and product lifecycle management is included. The issues discussed in these chapters are important for the practical part of the study. The results of the case company research are following the theoretical part. The results and the analysis include the reference to the theory discussed in the previous chapters. Research conclusion and the further research recommendations are provided at the end.

## 2 Supply chain management tendencies

Lysons and Farrington (2012: 16) introduce purchasing as a “significant contributor to corporate efficiency”. This chapter is focused on the supply chain management strategy of large international information technology companies with extensive supply chains and big volumes of production. Some of the solutions used to increase the efficiency in the supply chain are presented. These issues are relevant to the comparison of the normal purchasing process and the EOL management.

### 2.1 Centralized inventory

The research is focused on a centralized inventory structure. One of the strategies for the companies is to forecast plant demand and deliver the goods from the suppliers to plants via the central warehouse (Figure 2). Advantages of such purchasing strategy are the increased efficiency of inventory management and transportation as well as decreased administrative cost. Central warehouse is a demand consolidation point with the improved demand visibility and material availability (Hub Global Concept 2014). Material delivery is organized so that the demand from each plant is combined in the central warehouse and is sent to suppliers. Suppliers deliver components that are close to lead time to the central warehouse. Plants then order the components from the warehouse inventory.

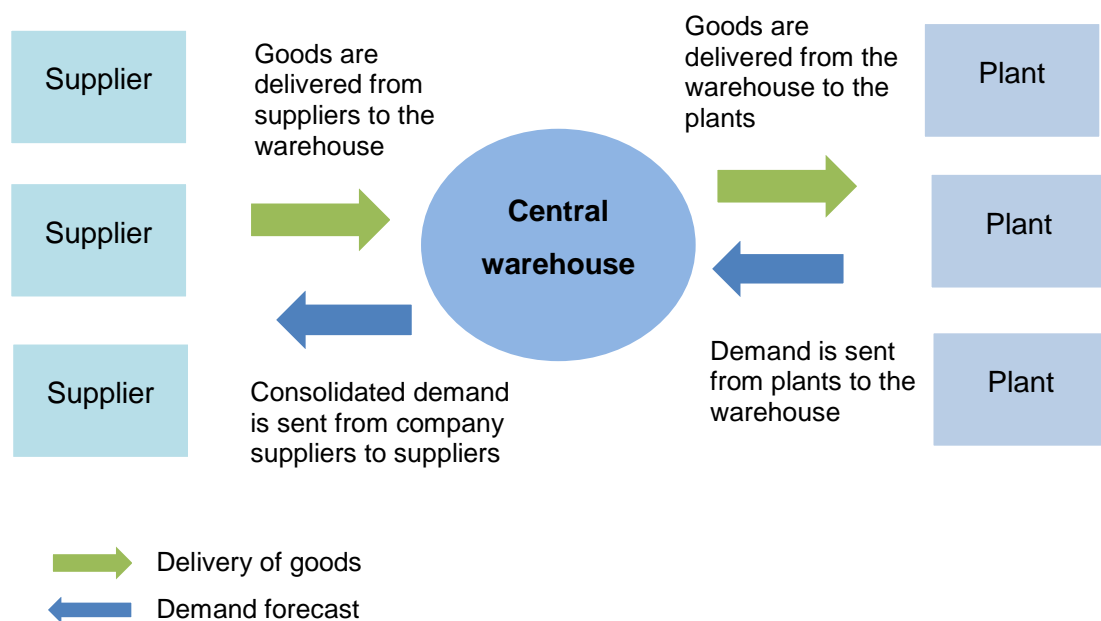


Figure 2. Central warehouse structure (Company X 2017)

Component cost is increasing because of the complexity of products and the variety of components. Inventory cost reduction is one of the main concerns in supply chain management. Stock centralization is the way to reduce inventory cost (Kutanoglu & Lohiya 2007: 666). This model has a number of other benefits such as the flexibility in demand forecasting and a better control over inventory. Excess inventory ordered for some plants may be shipped to a plant that has a risk of stock-out. One of the disadvantages of stock centralization is the increase in the transportation cost since the goods have to travel to the central warehouse before being delivered to the plants. However, this fact often does not exceed the benefits of decreased inventory cost (Company X 2017).

## 2.2 Vendor-managed inventory

There are many other strategies to lower the cost of inventory. They vary depending on the type of a product. Vendor-managed inventory method is one of the strategies applicable to the case company and the research. Vendor-managed inventory (VMI) is used to deliver inventory automatically from suppliers to the warehouse (Lysons & Farrington 2012: 351). Stock levels are discussed with suppliers in advance. Suppliers check the real-time inventory of a customer and deliver the components at the right moment. VMI can significantly decrease lead time and inventory level of the customer as well as improve the delivery timing (Zachariassen et al. 2014: 845). VMI can have a positive impact on the communication between supplier and a customer and significantly reduce the costs of their operations. Elvader et al. (2007: 783) also point out the opportunity of increased inventory turnover, reduced risk of stock out and better control over customer demand.

The main goal of VMI is to improve the supply chain efficiency and demand management. According to Darwish and Odah (2010: 473), VMI is one of the most effective supply integration strategies and a good source of competitive advantage. This approach, however, only works with the reliable suppliers. One of the risks of this replenishment method is that the supplier gets access to such information as inventory levels, demand fluctuations as well as some other sensitive information. VMI may also not bring enough benefits if a customer has a high demand uncertainty, low demand or a high level of demand seasonality (Sari 2007: 536).

### 2.3 Information systems

Moreover, one of the factors that influence efficiency of supply chain management is the ability of a company to communicate with suppliers faster and with fewer errors. This is usually achieved through enterprise resource planning (ERP) systems. Such systems also offer a better approach for placing orders, receiving goods and paying invoices. Electronic data interchange (EDI) between a company and its suppliers also helps to reduce transaction costs and increase the speed of operations. Advantages of EDI are the substitution of the paper documents with the electronic ones, reduction of lead times because of the real time working environment between buyers and suppliers, reduction of inventory cost and the integration of different functions such as purchasing and finance (Lysons & Farrington 2012: 187). On the other hand, common systems require big investments and usually exist only between a company and part of its suppliers (Mena et al. 2014).

Many variations of information exchange between the company and its external partners exist. They vary depending on the importance of the partnership and the resource availability. In some cases the information about the order is sent by email and suppliers enter it to their system manually. In the other cases, a supplier might have an online access to customer's ERP to check the real-time inventory levels (Elvader et al. 2007: 791). Figure 3 shows the variety of options of getting the information about the customer inventory levels in case of VMI. Most of them, except the visual control, are using different kinds of IT system integrations.

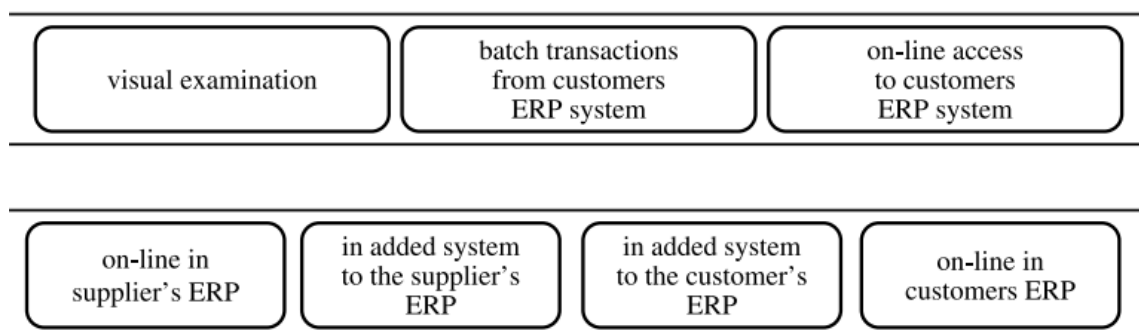


Figure 3. Supplier inventory control options (Elvader et al. 2007: 791)



## 2.4 Warehouse technologies

Warehouse is a functional element of the supply chain. Its performance is significantly influencing the performance of the whole company. Warehouse management systems (WMSs) are often not providing real-time information and rely on the manual inputs of warehouse personnel. Therefore, the information may not always be accurate. Big warehouses with a large turnover improve their operations by investing in different technologies. As an example, radio-frequency identification (RFID) technology is improving inventory management inside the warehouse (Kok et al. 2008: 521). One of the most valuable advantages of RFID is its ability to provide the information about the exact location and quantity of goods and eliminate the need for inventory audits. RFID improves the visibility of stock, makes the automated inventory counting possible and increases the accuracy of information.

Order-picking is another case where the technology can be used to improve the process. There are different paper-less picking methods such as barcode handheld, RFID handheld, voice picking and pick-to-light system (Battini et al. 2015: 488). RFID handlers, for example, have a function of selecting an appropriate handling equipment, identifying the location of materials and creating the shortest picking route. These functions can significantly reduce the time and effort spent on picking as well as minimize the errors (Poon et al. 2009: 8278). RFID can be also used to improve goods reception. The quantity of the received goods can be automatically added to the warehouse system and the availability of storage space can be identified. This also reduces the inventory management time and cost (Wamba & Chatfield 2011: 695).

RFID technology is only implemented in the large warehouses because of its relatively high cost. Before installing RFID technology, companies need to perform a careful evaluation of the expected return on investment. They also need to identify how the data collected by RFID will be shared with the other company systems such as ERP. There are also concerns about the performance of RFID technology and its reliability. Some authors argue that the information gathered by RFID may not be 100% accurate and may lead to supply chain disruptions (Lim et al. 2013: 409).

## 2.5 Supply chain partners

Outsourcing some of the operations, for example, warehouse management, transportation and production is also one of the strategies that many companies are using nowadays. Some of the main reasons for outsourcing are the reduction of operational cost, improvement of company focus, accessing world-class capabilities and resources and improving the service level (Weele 2009: 122). Despite the benefits of outsourcing, some problems such as overdependence, reduced flexibility, lack of control, poor communication and the risk of information leakage may occur. These issues may lead to the loss of competitive advantage (Lysons & Farrington 2012: 389). Therefore, many success factors have to be evaluated before engaging in any outsourcing relationships.

Finally, companies are aiming to establish long-term supplier relationships that would lead to the improved service quality and delivery, operational support and product quality and would benefit both parties (Börekçi et al. 2014: 808). By establishing long-term strategic relationships with suppliers, companies are decreasing costs and gaining a competitive advantage. Apart from the cost, quality is a very important aspect of the component purchasing process. By buying components from reliable suppliers, transporting and storing the components properly, companies are reducing the risk of delays and production losses resulted from the reduced quality of the final product (Weele 2009: 92). Suppliers are constantly evaluated and in the case of the quality failure supplier contracts are discontinued.

### 3 Product lifecycle management

Previous chapter introduced the methods of increasing supply chain efficiency. This chapter will focus on one of the efficiency challenges – short product lifecycle.

#### 3.1 Component and product lifecycle stages

According to Sandborn and Myers (2008: 96), each type of technology has a lifecycle that starts with the creation and introduction of the product and ends when the product becomes unavailable. Component lifecycle management is important because the revenue of companies depends on sales of their products, composed of these components. There are four stages of product lifecycles from the sales point of view: product introduction, growth, maturity and decline. Decline is eventually followed by the withdrawal of the product (Stark 2015: 18). EOL management of components and products is done on the component withdrawal stage.

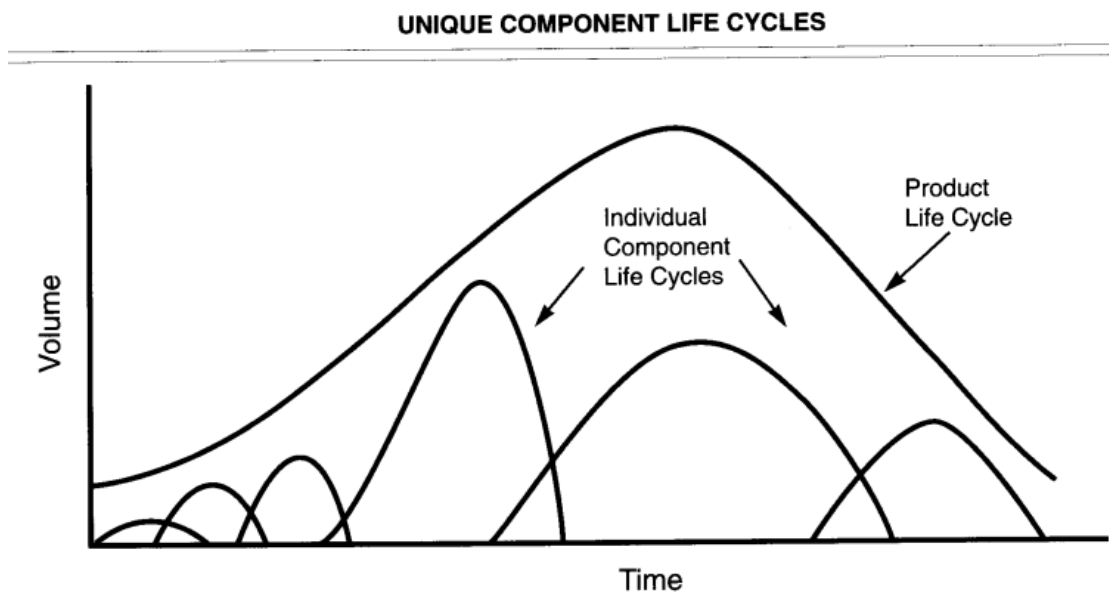


Figure 4. Component lifecycles and product lifecycle (Handfield & Pannesi 1994: 20)

Products are influenced by such factors as new technologies, market demand, competition and country regulations. That is why their lifecycles are changing and usually are not endless. Products that are influenced by technological advances have a very short lifecycle (Stark 2015: 18). Moreover, the products have a complex structure and the lifecycles of their components can be shorter, as it is shown in Figure 4. The figure relates to both issues when the components are becoming old and should be changed

to the new ones and when the components are at the end of their lifecycle and should be substituted. To sum up, lifecycle of products and components is not endless and the individual components that are built into the products might have shorter lifecycles. This fact is bringing some efficiency challenges and operational risks to the companies.

### 3.2 Component obsolescence problem

Obsolescence is a loss of original manufacturers or suppliers of items or the decrease in availability of raw materials. Obsolescence management includes checking the availability of components, forecasting the end of their lifecycle and finding the approaches to solving the component end of life issues (Sandborn & Myers 2008: 90). According to Bartels et al. (2012), there are three main reasons for a component to become obsolescent. The first one is the consequence of a technological development, the second one is the disappearance of a manufacturer from the market, and the third possible reason is a decision of a manufacturer to stop production due to economic reasons.

Lifecycle mismatch is the term used to define the differences between the lifecycle of a component and a product. According to Bradley and Guerrero (2008: 497), the mismatch is more severe in the case of capital-intensive equipment because they usually have a longer lifecycle and it is harder to redesign them. The authors also say that sometimes a design of a new product is an origin of the introduction of new parts and at the same time sometimes, the new parts are influencing a new product design. The result is, however, the same - the old parts become obsolescent.

Finding another supplier is often the least costly obsolescence management solution. The option of part substitution by another supplier might be excluded if the component was designed for the company or has a unique form or functionality (Bradley & Guerrero 2008: 498). The other most common ways to solve the obsolescence of a component is to make a lifetime buy, that is also called a last time buy (LTB), or redesign the component and possibly some part of the product. Some of the other options are the bridge buy (BB) that is followed by the redesign or a production line closure (Shen & Willems, 2014: 522).

Kumar & Saranga (2010: 171) name the same strategies of LTB, redesign or the combination of those. LTB is the last chance to buy a component for the whole lifecycle

of a product. Redesign means changing the component and the product where this component is used. The combination of LTB and redesign is the process when a component is bought for a certain time until the redesign takes place. The authors agree with Jennings and Terpenney (2015: 430) and present an example of a timeline (Figure 5) showing that in some cases, LTB is becoming more expensive than product redesign after 5 years. Since the cost of a purchased component is increasing each year, there is a point when the redesign is becoming more cost-efficient.

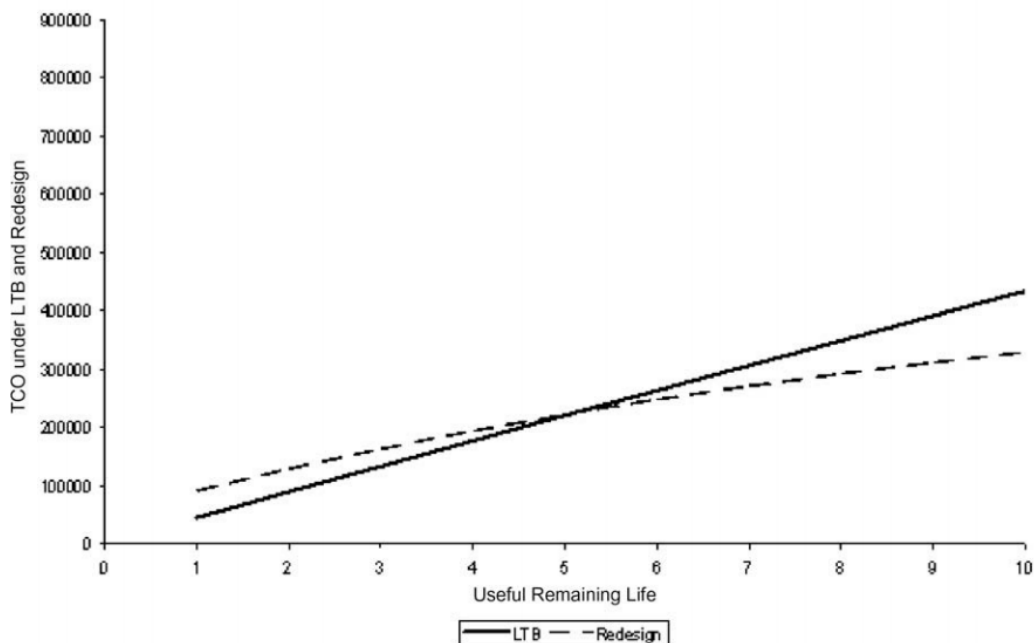


Figure 5. LTB versus Redesign (Kumar & Saranga 2010: 174)

Usually, companies have a reactive strategy towards part obsolescence meaning that they start searching for possible solutions when they get a notice about component production discontinuation. Sandborn et al. (2011: 393), however, state that another lifecycle management strategy is to forecast the time when parts might become not available in advance. Proactive obsolescence forecasting can be done for the key components by creating different algorithms using historical data and data mining. Sandborn and Myers (2008: 92) write that the obsolescence is rather unpredictable and that the majority of the firms are using the reactive approach to solving this issue even though the obsolescence management cost could be decreased through the proactive approach.

### 3.3 Managing Last Time Buy

Since the case company research was focused on LTB, this subsection will provide an overview of some of the main LTB issues discussed in the literature. LTB is often the unfavourable option for a company because it requires a complex forecasting that will minimize the risk of stock out and at the same time avoid the excess inventory (Kruger, 2013: 27). Demand forecast becomes more challenging if the LTB is made to secure the demand for several years. It cannot be identified whether there is a decline or rise in demand and LTB always carries many costs and risks.

LTB may be a costly solution in comparison with the normal purchasing. Feng et al. (2007) divide these costs to 4 categories (Figure 6): procurement cost, inventory cost, disposition cost and penalty cost. Procurement cost is the cost that a company pays for purchasing components taking into the account the available stock, forecasted demand, budget constraints and aftermarket availability. Inventory cost is a cost that a company pays for storing the components as well as the loss of inventory because of the mistakes or a drop in demand. Disposition cost is the one that is paid for disposal and resale of excess inventory. Finally, there is a penalty cost that the company is paying in case of inventory shortage. This cost results from the unavailability of components or high-cost purchasing from alternative sources.

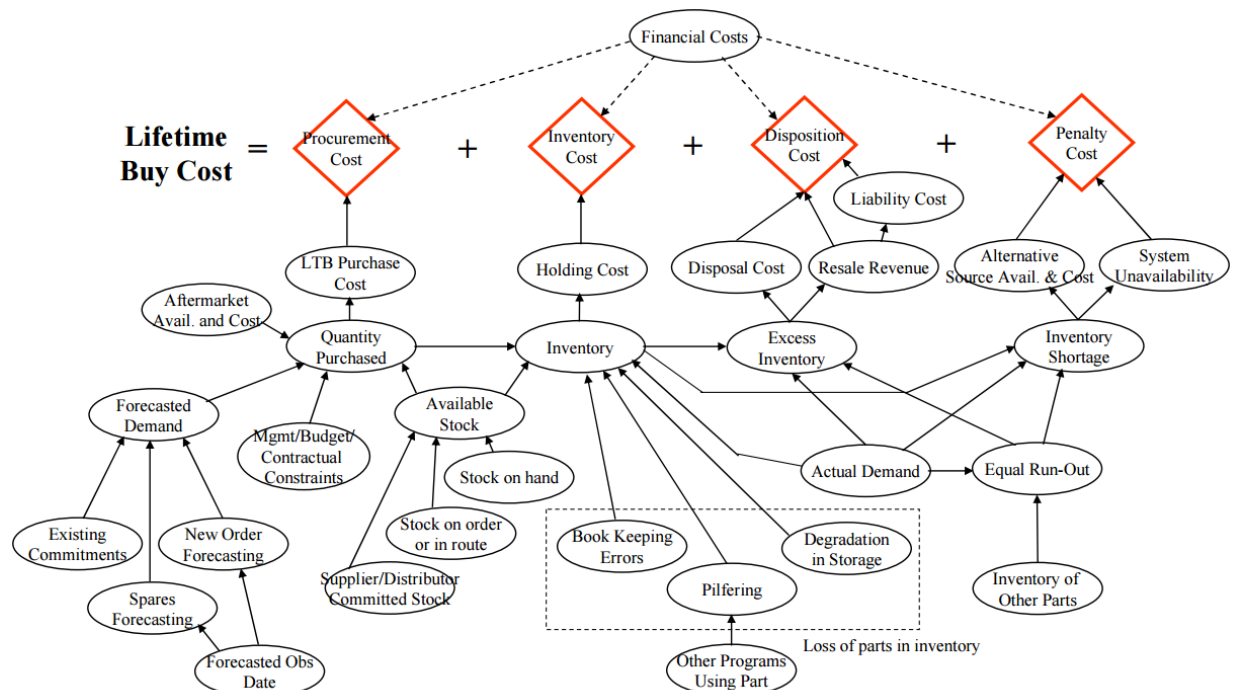


Figure 6. Cost factors affecting electronic part lifetime buys (Feng et al. 2007)

Feng et al. (2007) name two major lifetime buy problems: a difficulty to forecast demand and a difficulty to determine the purchasing quantity. The lifetime purchase is often made for a very long time. In addition, even after the end of the product lifecycle a part might have a repair demand. This issue is adding a new challenge to demand forecasting. Jennings and Terpenney (2015: 430) mention some other problems associated with the lifetime buy. One of these issues is the risk of inventory damage inside the warehouse. They propose that one of the solutions to decrease the risk of stock out of the components with the strict storage requirements is to buy a bigger lifetime buy quantity. However, some companies including Company X (2017) are, on the other hand, ordering less than the calculated demand in order to decrease the inventory cost and the risk of scrapping. The authors are also pointing out the difficulties related to the size of the lifetime buy orders. Order quantities might be much bigger than the usual orders. There is a transportation risk as well as the risk that the supplier will not be able to complete the order.

Jennings and Terpenney (2015: 430) write that the inventory cost is one of the highest costs of a lifetime buy. Figure 7 presents the changing cost of a part with the initial price of 100 dollars. The graph shows that the net present cost combined with the holding cost might increase the total cost of this component to 300 dollars in 6 years and 450 dollars in 10 years. They state, however, that the lifetime buys for more than 5 years are not as often. Instead of placing a LTB for the long product lifecycle, companies are often choosing a strategy of a BB followed by redesign.

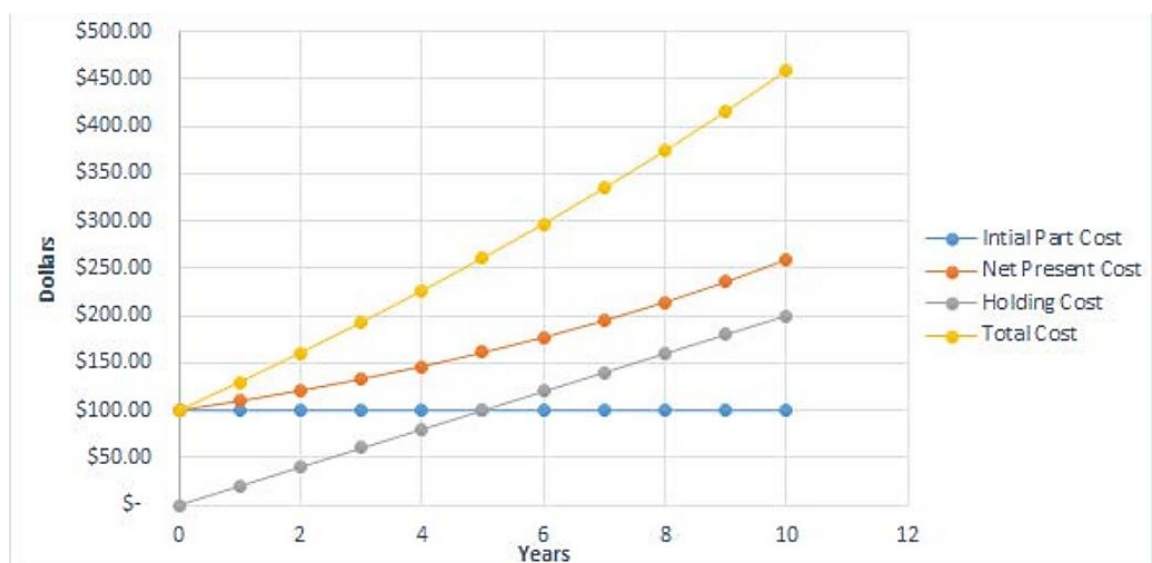


Figure 7. The cost of lifetime buy (Jennings & Terpenney 2015: 430)

Van Jaarsveld and Dekker (2011: 424) agree that one of the issues of a LTB is the inventory that is not being used for many years. Dead stock ties up the capital and increases the cost of warehouse operations. Moreover, if the demand drops, inventory might need to be scrapped. Increased inventory cost also decreases profit margin of the product. As it is shown in Table 1, if 2 out of 7 components are at the end of their lifecycle, the profit margin might decrease from 30% to 4.6%. It means that the profit received from the sale of a product that has obsolescent parts is much lower. Firms, however, accept the profit decrease to avoid the loss of company reputation. The loss of customers, might result in a bigger financial impact for the company.

Table 1. Profit margin example (Jennings & Terpenney 2015: 430)

	<b>Case 1</b>	<b>Case 2 (2 lifetime buy components)</b>
Component cost (7 components)	100	100
	100	100
	100	100
	100	100
	100	100
	100	<b>193</b> (3rd year of lifetime buy)
	100	<b>261</b> (5th year of lifetime buy)
Total cost	700	954
Selling cost	1000	1000
Profit margin	<b>30%</b>	<b>4,6%</b>

Finally, Jennings and Terpenney (2015: 433) mention the existence of counterfeiters. They might try to sell illegal or low-quality products to companies that cannot find the components from reliable suppliers. This option has to be avoided because companies cannot afford taking a risk of purchasing low quality illegal components because of the reputation issue. As an example, Company X (2017) has long-term relations with reliable brokers and, in case of stock-out, aims to buy components only from them.

To sum up, component obsolescence is occurring more frequently nowadays. Some companies are trying to predict it but most of the organizations are using reactive approach. There are many methods to solve part discontinuation issues. LTB is one of the most common approaches. Companies try to avoid LTB because of the costs associated with it. Increased costs have an influence on the profit margin of a final product.



## 4 Data analysis and results

This chapter starts with an overview of EOL process at Company X. It then continues with the comparison between EOL LTB process and normal purchasing at the case company. Such topics related to both processes as purchase planning, inbound delivery from suppliers, warehousing and outbound delivery to the manufacturing plants are covered in the chapter. The risks and challenges of EOL process are discussed and the influence on the supply chain efficiency and the financial performance of the company is evaluated. The comparison is based on the project in which the author was involved. Creation of SCM EOL Concept of Company X was the outcome of the project. Most of the information for the comparison between EOL management and normal purchasing is taken from the created document and the other company documents. SCM EOL Concept itself is confidential because it contains sensitive company-related information as well as information about the other companies – LSP of Company X.

### 4.1 EOL management

The main activity of EOL Supply Chain Management (SCM) at Company X is to coordinate central EOL inventory of components and other EOL products and execute EOL inbound and outbound operations. The target is to ensure a central visibility of EOL inventory and material availability for company factories and its outsourced factories called Electronic Manufacturing Services (EMSs). In addition to securing delivery capability of company products, affected by component discontinuation, to the customers, the aim is to minimize the costs and risks of EOL inventory (EOL Concept 2017).

This thesis is focused on EOL LTB. EOL LTB process can be summarized in the following way (EOL Concept 2017):

1. Global demand of all affected stakeholders is collected
2. Demand is combined at EOL and transmitted into investment approvals
3. Supplier receives a consolidated demand forecast of EOL components close to Last Order Date (LOD)
4. EOL components are ordered as LTB order
5. Supplier delivers material to EOL warehouse and gets the payment
6. Components are stored in EOL warehouse
7. Factories send replenishment orders to pull components from EOL inventory
8. Components are delivered to factories and invoices are processed
9. If necessary, components are returned to the supplier via EOL

LTB is the last order a company will ever place to a supplier for a specific part. In comparison with usual orders, LTB is non-cancellable and non-returnable (NCNR). After LTB order is placed, the component is no longer available to order. Supplier will build the products for all end users that made a LTB, ship the materials until the last delivery date and shut down production lines after that.

It is also important to highlight the role of EOL Coordinator in EOL LTB process at Company X. In the case of the normal purchasing, where the inventory turnover is bigger, buyers have a smaller variety of responsibility. They are mainly involved in the inbound execution. In EOL LTB cases, EOL Coordinator has more diverse areas of responsibility such as LTB execution, inventory management and selling EOL material to factories (Figure 8).



Figure 8. Short summary of EOL Coordinator responsibilities (Company X 2017)

EOL Coordinator is working in a close cooperation with EOL Manager and is informing the one about LTB execution, inventory status, scrapping process and the other relevant issues. Some of the other interfaces of EOL Coordinator are suppliers, factories, EMS partners, EOL warehouse personnel, Finance and Control (F&C) and the owners of products created by Company X.

In comparison with the normal purchasing, EOL process has some additional risks associated with the fact that the components are not available from original suppliers anymore. In addition, since the volume of EOL purchasing is smaller than the one of the normal purchasing, the process has fewer economies of scale. Difference between two purchasing processes is analysed in the following chapters. The process is divided into 4 parts called purchase planning, inbound execution, warehousing and outbound execution. Some additional challenges and risks are mentioned after these chapters.

## 4.2 Purchase planning

Purchase planning does not usually take extra time in the normal purchasing process at Company X; contract terms are already agreed with suppliers and the best demand calculation method is identified. The process is automated as much as possible and does not require separate decision-making, demand calculations, investment approvals or data changes for each purchasing case. The reason why purchase planning is not usually time consuming is the establishment of long-term supplier relationships. Such relationships are meeting the strategic objectives of both suppliers and the company. Long-term relationships make sure the objectives and responsibilities are clear and the appropriate ways of communication exist (Lysons & Farrington 2012: 219).

EOL process is, however, unique for each case and requires more planning. The process starts with supplier's notification about production discontinuation. This notification includes the timeline of the component availability and the last date the component can be purchased and shipped. Supplier might send a notification long time in advance, for example, two years before LTB date. The company will use this time to plan the LTB. However, sometimes the decision-making period is shorter, for example, half a year or less. In this case, there is more time pressure and it is harder to complete the LTB planning before LOD (Company X 2017).

### 4.2.1 Complex decision-making

Depending on the EOL case, the process that is happening before the LTB decision is made might be time-consuming. The reason for slow decision-making is, firstly, the number of stakeholders involved in the process. Some of them are directly involved in delivering the company product to customers, some are managing EOL cases, others are responsible for managing supplier issues or financial issues and all of them need to agree on one solution. The next decision-making difficulty is the variety of the solutions. Sometimes it is easy to find a solution because the new suppliers are available or material cross-usage is possible. However, sometimes the evaluation of a better solution takes a longer time. Finally, if stakeholders decide to make a LTB, there might be such challenges as long-term demand forecasting, taking the investment risk, solving budget constraints and getting the approvals for large investments from numerous managers. Planning becomes even more complex if the discontinued part is used in more than one

company product and in more than one production site. Table 2 summarizes the EOL decision-making challenges that occur before and after LTB decision.

Table 2. Complex EOL decision-making (Company X 2017)

Parties involved in decision-making	Possible Solutions	LTB planning challenges
1. EOL Manager	1. New supplier	1. Demand planning
2. Product Owner	2. Cross-usage in the company	2. Budget constraints
3. EOL Coordinator	3. Product redesign	3. Investment risks
4. F&C	4. LTB	4. Several part users
5. The others	5. Production discontinuation	5. Investment approvals

LTB planning starts when LTB decision is made (Figure 9). The issues presented later in this subsection are concerning LTB planning. These issues should be resolved until LOD. LTB order should be placed before this date.

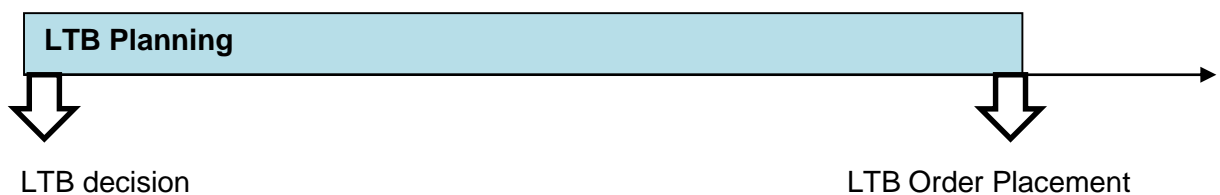


Figure 9. LTB Planning (Company X 2017)

#### 4.2.2 Demand forecasting

Forecasting accuracy depends on stability of data and the length of forecasting time. All forecasts have errors and the aim of the companies is to make future demand calculation as close to the actual demand as possible (Grant 2012: 112). Demand calculation is a challenging part of the LTB planning. It is done by analysing global demand, global inventories and open orders. Long-term demand cannot be very accurate and a risk of excess or stock-out always exists. In addition, in the case of big purchase volumes, there might be budget constraints that will affect the decision. Demand decision is usually made as late as possible before the LOD in order to increase the accuracy of calculations. This fact is adding time-pressure for the investment approval issue. Investment decision should also be approved before LOD.

In addition to the usual LTB, Bridge Buy (BB) is a type of LTB where a certain number of parts is purchased in order to cover demand for a limited period of time. After that time product redesign should be ready and replacement will take place. Since it is hard to estimate the time when the replacement is ready accurately, BB also involves a complex decision-making and carries a risk of stock-out. However, one of the advantages of BB is the possibility to use the EOL stock until the end before switching to the replacement. This reduces the risk of scrapping (EOL Concept 2017).

#### 4.2.3 Investment approvals

LTB investment approvals (Table 3) are required because product lifecycle demand can be longer than standard planning and forecasting period of 13 months that is usually visible in SAP system of Company X. Investment approval document provides a description of the case and includes LTB analysis and the other relevant information. Approvals are time-consuming in large companies. The bigger the investment value the more managers are involved in the case and have to approve the decision. If several part user organizations are involved in EOL process, investment approval is required for all of them separately. This requirement slows down the process. Table 3 gives more information about investment approvals needed for the LTB execution at Company X.

Table 3. Investment approvals (Company X 2017)

<b>Two investment approvals</b> are necessary for the LTB implementation.	
<p>EOL Manager prepares the first one.</p> <p>It is the organization unit document that approves that the unit is liable for the lifecycle investment and possible excess. It states that the unit is responsible for buying a certain amount of material, calculated by them, and later on scrapping the excess if necessary.</p>	<p>EOL Coordinator prepares the second one.</p> <p>This is an SCM approval for an actual order replacement and inbound execution. Physical inventory is owned by company SCM organization and, therefore, inventory purchasing requires an approval from SCM management.</p>

#### 4.2.4 Master data changes

Master data change is one of EOL operations that has to be done before LTB execution. As soon as a component becomes EOL, some of the master data should be changed in order to process further business transactions. All relevant parties such as EOL

warehouse, plants and EMSs should make relevant changes in their systems. In most of the cases, master data is a static data, which does not vary from one transaction to another and has to be entered only once. However, the need for changing and maintaining EOL master data adds more time required for EOL management and increases the cost of components. Some of the challenges of master data management are that it is resource intensive and not fully automated. Moreover, it may need to be manually copied to different company systems (Evans et al. 2005: 20). One of the reasons why master data management is time-consuming at Company X is that it is not automatically maintained. As an example, the following topics should be considered for ensuring EOL master data quality; these issues are manually checked from the system (EOL Concept 2017):

1. Are price, currency, payment terms and Incoterms entered correctly to SAP system?
2. Are lead times and goods reception processing time entered correctly to SAP?
3. Are invalid SAP contracts and purchasing info records removed?
4. Does each material have a correct purchasing group assignment and material requirements planning controller in SAP material master and purchasing info records?

To sum up, in comparison with the normal purchasing, LTB requires more time for planning and decision-making. Additional time is required for communication between stakeholders, demand forecasting, evaluation of the investment risks, getting the investment approvals, changing master data in company systems and the other arrangements that vary from one case to another.

#### 4.3 Inbound execution

Inbound execution is the process of delivering goods from suppliers to central warehouses. More detailed explanation of EOL inbound execution of Company X is presented in the process chart in Appendix 1. Inbound execution method of EOL material differs from the normal inbound delivery. One of the main differences is that the process is mostly coordinated by only one person representing Company X. The other parties are LSPs and supplier itself. Some of the other differences of inbound delivery and stock-out management are discussed in this subsection.

#### 4.3.1 Supplier managed consignment stock

The preferred way of delivering the stock from suppliers to central warehouses at Company X is the Supplier Managed Consignment Stock (SCS). SCS is the same process as VMI that was discussed in Chapter 2. SCS means that suppliers know the minimum and maximum inventory level requirements and they deliver the new inventory to Company X warehouse when it is necessary. Inventory stored in the warehouse is still owned by the suppliers and the ownership is only transferred to Company X after the picking is completed and materials are ready for shipping (Procurement Concept 2015).

SCS is beneficial for both parties. Main benefits for Company X are the decreased lead-time and cost savings resulting from reduced material ownership. The process is also more efficient because only one party is doing the delivery planning, inventory control and replenishment. This method is beneficial for the suppliers because they can be more flexible in their operations and they can plan the production more accurately. Therefore, SCS agreement is usually made with long-term suppliers for the products with suitable demand patterns (Procurement Concept 2015). Figure 10 explains the process in more detail.

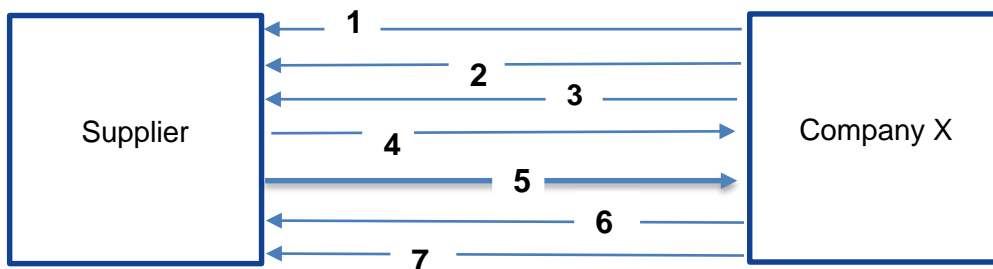


Figure 10. Supplier managed consignment stock (Procurement Concept 2015)

1. Company X provides short horizon demand visibility
2. Company X sends an information about the latest delivery date to supplier
3. Current stock and min and max levels are frequently sent
4. Supplier sends shipment information after shipping the material
5. Material arrives from supplier to consignment stock
6. Invoice is sent to supplier based on actual consumption from consignment
7. Company X pays to supplier according to agreed payment terms

### 4.3.2 Classic purchasing

Classic purchasing method is used to deliver EOL materials to the warehouse. Company X does not favour this method because of the decreased efficiency; however, it is the only option for the LTB order deliveries. In the case of classic purchasing, Company X makes the replenishment decisions itself and later on owns the material in the warehouse (Figure 11).

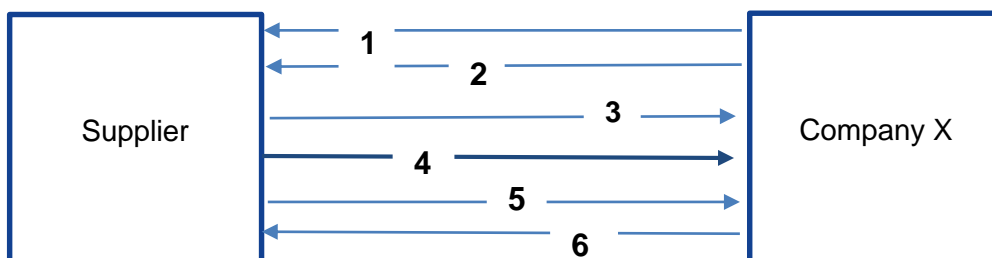


Figure 11. Classic Purchasing (Procurement Concept 2015)

1. Company X provides EOL LTB demand forecast
2. Company X sends Purchase Order (PO) to supplier
3. Supplier confirms the order and sends shipment information
4. Material arrives from supplier to EOL warehouse
5. Supplier sends the invoice based on material shipped
6. Company X pays to supplier according to agreed payment terms

As we can see from Figures 10 and 11, the difference between SCS and classic purchasing is that Company X has to decide on the replenishment time and send the PO to suppliers itself. The supplier then needs to plan the production according to the PO. PO placement, production arrangements as well as inventory ownership issue reduce the efficiency of the process. As a result, more cost saving and time-reduction benefits can be achieved in the normal purchasing process.

### 4.3.3 Stock-out management

Warehouses usually have a safety stock for the materials with an uncertain demand. Safety stock will cover shortages in case of increased demand or longer lead time. If the stock out occurs regardless of the safety stock, the cost of stock-out may include the loss of production output, cost of useless time, and cost of the stock-out management. In the worst case, stock-out might result in the loss of a customer (Lysons & Farrington 2012:



318). Even though stock-out is always associated with unfavourable costs, the issue might be solved faster and easier in most of the cases of the normal purchasing. As an example, if demand suddenly increases, material can be ordered from the original supplier and delivered directly to the plant. It is also easier to avoid stock-out because demand figures are calculated for a shorter time (Company X 2017).

In EOL cases, original suppliers are most probably not producing the material anymore after the LOD. At the same time, there is a risk that demand will exceed the supply and EOL inventory will not ensure the availability of goods for the whole product lifecycle. If the material shortage is identified and the supplier is not able to deliver more material, EOL Coordinator of Company X will look for the other places to source the material from.

Some of the options are:

1. Internal transfer of the material (cross-usage)
2. Broker purchase
3. Technical Component Engineer (TCE) replacement
4. Phase-Out (end of production)

Supplemental Buy (SB) is an additional EOL purchase after LTB. The purchase can be done from another supplier, broker, TCE or implemented as an internal transfer as it is mentioned in the list above. Stock-out management can be very costly. Brokers are, for example, selling the components for the price higher than the original one. TCE price is higher than the original component price because the new component is designed. End of production may influence the reputation of the company. If the risk of stock-out occurs, the company will usually pay the stock-out cost and ensure product delivery to the customer, even if the sale profit is not as high as it would usually be. Loss of a customer is one of the most unfavourable outcomes of EOL management (Company X 2017).

#### 4.4 Warehousing

As it was mentioned in Chapter 2, centralized inventory is one of the strategies of lowering logistics costs and reducing distribution times (Harrison & Van Hoek 2008: 121). Company X uses a centralized inventory approach. Goods are going through central warehouses in order to be delivered from suppliers to the plants and EMSs. EOL warehouse is also a central warehouse. Components arrive at Company X central warehouses from different suppliers and go through the steps shown in Figure 12. The Figure is applicable to both normal purchasing and EOL warehousing. Stages of

inventory management in the warehouse are the same for both processes but the operation methods are different. Warehouse operations and their differences in EOL management and the normal purchasing are explained in this chapter.



Figure 12. Warehouse Operations (Company X 2017)

#### 4.4.1 Goods reception and quality control

The aim of the company is to make the goods reception fast and accurate. In the normal component warehouse, RFID technology is often used to speed up the process. Pallets go through RFID gate and the purchase order is automatically compared with the information on delivery packages. Goods reception confirmation is then created in the system either automatically or manually. Even though RFID approach is fast, some of the quality issues may be missed. Therefore, fully automatic reception is usually used only with the reliable suppliers (Inventory management Concept 2014). On the other hand, EOL warehouse does not have RFID technology and the personnel is entering goods reception information to the system manually.

Only the visual quality control can be implemented at Company X central warehouses during the goods reception. The material is only tested for its functionality when it gets to the factory. Therefore, there is a risk to find out later that the material has functionality problems. This issue is usually not critical for the normal purchasing because components can be reordered. Also, they are not usually stored in the warehouse for a long time. Materials are rather leaving the warehouse as soon as they arrive there. Since the lead time between the shipment from the supplier and delivery to the factory is usually shorter than in the EOL case, quality issues can be identified and fixed faster (Company X 2017).

Functionality issue is a bigger problem for EOL components. Components usually stay in EOL warehouse for a longer time. Storage time varies from case to case and it may

exceed a year. If the issues with functionality are identified much later than the material was shipped from a supplier, there might be no chance to reorder the components. This might result in a stock out. However, according to Company X (2017), this is a rare occasion because the company has long-term relations with its suppliers and the suppliers aim to supply high-quality materials. There is more risk that a component will lose its functionality because of the long storage time. In addition, the risk of a damage during the warehousing time increases together with the increase in the storage time.

#### 4.4.2 Storage

In the normal purchasing case, the material has a short lead time. Since the material is not stored in the warehouse for a long time and is not repacked, normal warehouses do not have any special storage requirements concerning the temperature and humidity. Strict security control must be implemented to avoid the risk of vandalism and thievery. Water damage risk and the risk of fire should be prevented in any kind of company warehouses to avoid the loss of material (Company X 2017).

In the EOL case, components may have certain storage requirements concerning the temperature, moisture level, handling and packing (Jennings & Terpenney 2015: 432). Company X EOL components are sensitive to moisture and temperature. In addition, EOL components often require repacking. Warehouse personnel shall minimize product damage risk through careful monitoring of warehouse conditions and careful material handling. Table 4 gives an overview of the environmental conditions, storage space and material handling requirements in the EOL warehouse at Company X.

Table 4. Environmental conditions and storage requirements (Company X 2017)

<p><b>Temperature and humidity</b></p> <p>Stability is more important than the absolute temperature. Preferred temperature is <b>22-25 °C</b>. If it becomes less than 10 °C or more than 30 °C, the alarm will turn on.</p> <p>Low humidity of <b>RH 20-30 %</b> is recommended. If it becomes less than 10% or more than 40% RH, the automated alarm will turn on.</p>	<p><b>Fire</b></p> <p>Storage space is made of fire resistant glass.</p> <p>Fire-fighting equipment such as sprinkler system, smoke detectors and 2 separate alarm systems exist in the warehouse.</p> <p>Air conditioner engines are located in the room outside.</p>	<p><b>Water damage</b></p> <p>Ingress of condense water must be prevented.</p> <p>Shelves are located at least <b>20 cm</b> above the floor.</p>
<p><b>Theft &amp; vandalism</b></p> <p>Guarding systems and electronic surveillance exist inside of the building.</p> <p>Controlled access right is limited to material handling and service personnel.</p>	<p><b>Storage times</b></p> <p>Storage times specified by manufacturer are met.</p> <p>EOL components exceeding a time limit specified by a manufacturer are tested for solderability before use.</p>	<p><b>Packaging and handling</b></p> <p>Some components must be packaged in vacuum and dry Moisture Barrier Bags (MBB) with moisture indicator and desiccant inside.</p> <p>Electrostatic discharge (ESD) protected conditions are not needed for storage but components handling shall be done in ESD protected area.</p>

The requirements mentioned in Table 4 must be strictly followed because it is not possible or is very hard to replace the materials that are at the end of their lifecycle. The risk of fire or water damage should be prevented. The access to the warehouse must be given only to the limited number of employees. Environmental conditions have to be carefully monitored and the storage times of the components have to be taken into the account. Warehouse personnel have to complete EOL material handling training.

Finally, Company X warehouses are outsourced to Logistics Service Providers (LSP). The benefits of outsourcing were mentioned in Chapter 2. Some of the benefits for Company X are the ability to focus on the core business, reduction of labour costs and the opportunity to obtain required expertise and equipment needed for the warehouse

operations (Grant 2012: 72). Since EOL warehouse needs special conditions and careful material handling, LSP might be a source of an additional quality risk. Grant (2012: 73) mentions such disadvantages as the loss of control over outsourced operations and the risk of service failure. However, since EOL warehouse is located next to the company headquarters, frequent inspections and close cooperation are possible. As a result, the risk is minimized.

#### 4.4.3 Picking

In the normal component warehouse, picking is done with RFID handhelds. Picking order is sent to handhelds via Mobile Data Terminal (MDT). Handhelds then inform personnel about the picking location and needed quantity of items. That excludes the need of paper picking. In addition, a forklift steering system ensures optimal traffic. Storage and transportation are sometimes avoided by cross-docking method where the packages are delivered directly to the picking and shipping area (Hub Global Concept 2014).

On the other hand, EOL warehouse is much smaller. Expensive RFID technology would not be as beneficial there as it would be in a bigger Company X warehouse. Warehouse personnel uses the paper-based picking. This method is implemented by printing out the picking lists and changing the stocks manually in the system after the picking is completed (Hub Global Concept 2014). Warehouse personnel decide themselves on the picking routes and compare the required quantity with the list. Paper-based picking is an important option in case of the problems with the wireless network in big warehouses as well as an acceptable method for the small volume warehouses. There is no need for EOL warehouse to make the picking automatic, however, in comparison with the bigger Company X warehouses it can be concluded that picking is not as well-organized in EOL warehouse.

#### 4.4.4 Packing

Packing is usually not required in the normal purchasing process because the materials enter and leave the warehouse in the same packages. Ordered material amount is matching the Minimum Order Quantity (MOQ), Manufacture Packing Quantity (MPQ) requirements and the demand of the plants. There is no need to repack the material.

On the other hand, EOL material is expected to secure the material availability for the whole product lifecycle. Ordered quantity may differ during the product lifecycle and does not necessarily have to match MOQ and MPQ. Most of EOL materials transported from the warehouse to production sites require repacking in order to match the ordered quantities. In addition, moisture sensitive components have to be packed to MBB before being transferred to the storage location to make sure they are not affected by moisture. Because of the importance of EOL components, trained personnel should implement packing. Waste caused by ESD, moisture, impurities, mechanical damage and the lack of material data should be avoided (Company X 2017).

Finally, even if the material is properly packed, it is hard to prevent the risk of damage during the transportation. Transportation is done exactly in the same way as the one for the normal material except that EOL trained personnel do the packing. For security reasons, is not stated on the package that transported material is EOL. However, according to the Company X statistics (2017), transportation damage of EOL material is a rare occasion.

#### 4.5 Outbound execution

Outbound execution at Company X is the process of selling and delivering the materials from a central warehouse to plants and EMSs. EOL outbound execution process is explained in more detail in Appendix 2. Comparably to inbound execution, EOL Coordinator is playing a big role in the process and is ensuring the smooth information flow between LPS, forwarding team and internal and external factories. This chapter will provide an example of the differences between the EOL inventory sales and the normal inventory sales. It will also introduce the scrapping process.

##### 4.5.1 Outbound orders

In the case of normal purchasing, the efficiency of outbound execution as well as inbound and warehousing processes is gained by the automated solutions and standardization of the process. The use of e-commerce tools at Company X is preferred in order to make the processes as automatic as possible. As an example, PO can be automatically created by plants. Company warehouse personnel will then confirm the order. The

system in the plants will automatically compare the confirmation with the plant PO. Normal purchasing is using automatic solutions for PO creation and confirmation.

The not preferred method is when a buyer is manually typing a PO into the system, the seller is entering order confirmation into the system and the buyer is manually comparing it with the PO (Procurement Concept 2015). As an example, if EOL warehouse is selling material to EMS, the process is manual. PO is sent from EMS to EOL manually via email or EMS portal. The sales order is then manually created and confirmed and goods are shipped to the factory. The invoice is automatically created and sent. Table 5 shows the steps done from the time when the purchase order is received by EOL warehouse until the time when the shipment is done and shipment details are sent to company plant or EMS. The process is manual and is only acceptable in the case of the small volumes.

Table 5. EOL outbound delivery process summary (Company X 2017)

<b>Delivery process summary</b>
<ol style="list-style-type: none"> <li>1. EOL Coordinator receives purchase order from production site.</li> <li>2. Customer Purchase Order is submitted to SAP as a Sales Order in case of EMS sales</li> <li>3. EOL Coordinator checks availability and releases an order for delivery.</li> <li>4. Warehouse team receives the sales order and collects the material from specific product line storage type in EOL warehouse.</li> <li>5. Material is physically packed</li> <li>6. Delivery in SAP is created.</li> <li>7. Delivery is picked and packed in SAP.</li> <li>8. Post Goods Issue (PGI) is pressed.</li> <li>9. Warehouse team informs that shipment is ready to EOL Coordinator and Forwarding team.</li> <li>10. Forwarding team creates invoice and books the shipment.</li> <li>11. EOL Coordinator informs shipment details to a customer.</li> </ol>

#### 4.5.2 Excess management

Scrapping is one of the examples of the unnecessary component cost that is mainly related to EOL inventory. Scrapping useless material is not a common process for the normal inventory because the material turnover has a high rate and the demand forecast is more accurate. EOL demand forecast might not be as accurate and a need for scrapping might occur. Since storing the materials that will not be used is not cost efficient, useless materials have to be removed from the warehouse. According to Van Jaarveld and Dekker (2010: 423), scrapping obsolete inventory can reduce company yearly profits by 1%.

Scrapping is removing material from accounting and from a warehouse. Material can be both broken and unbroken. The steps of a scrapping process include the approval for material disposal, writing the material off from accounting and disposing or destroying the material physically (Figure 13).

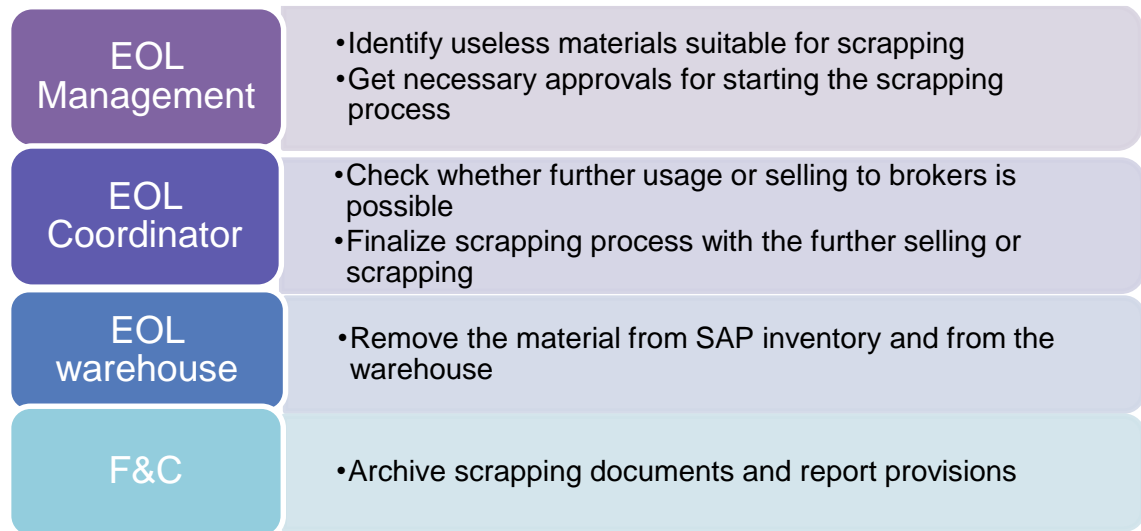


Figure 13. Scrapping process (Company X 2017)

Table 6 shows a more detailed list of responsibilities of different parties. As you can see from the number of people involved in the process, scrapping is one of the unlikely results of the EOL investment. In the EOL management process a risk that some components become useless and will have to be destroyed after going through the purchasing arrangements and inventory management always exists. If components become useless, the investment does not bring any value to the company and is instead resulting in a loss. Sometimes the scrapping cost might be reduced by selling the useless material to a broker. This option cannot cover all costs related to the EOL LTB but can slightly reduce the financial loss (Company X 2017).



Table 6. Scrapping process responsibilities (Company X 2017)

<b>EOL Management team</b>	<b>EOL Coordinator</b>	<b>F&amp;C</b>	<b>EOL warehouse personnel</b>
Evaluating and analysing the EOL inventory	Analysing the possibility of further cross-usage inside company production chain	Following up provisions together with EOL Management	Executing the scrapping steps in SAP inventory
Making proposals for starting scrapping process	Selling the approved scrap to brokers	Maintaining all accounting steps for scrapped materials	Picking and collecting the scrapped material from the stock and disposing it with the help of third party recycling company
Making scrap approval for the related material	Informing F&C about the started process		
Working together with F&C to implement provision release and other F&C related issues	Filling out scrap form for F&C and warehouse personnel		

#### 4.6 Additional supply chain risks

Supply chains are always sensitive to external risks that are associated with political, economic, environmental and social issues. Lysons and Farrington (2012: 97) write about such risks as earthquakes, strikes, computer crimes and the other issues that organizations cannot fully control. Supply chain vulnerability increases if it is spread over several countries and includes many means of transportation. There are different ways to minimize the external risks such as sourcing from different locations, having an insurance to cover losses, spreading the risk among the other stakeholders. However, the fact is that supply chains may face some additional costs associated with their vulnerability to external factors as well as internal ones.

In addition to the risks, challenges and inefficiency caused by EOL process in comparison with the supply chain management of normal components, there are some unexpected risks that the company might face in case of both purchasing options. Examples of the additional EOL risks, their impact on company operations and expected actions are shown in the table below. The magnitude of each risk is evaluated as low, medium or high according to the probability scale and the impact scale.

Table 7. EOL business impact of risks (Business Impact Analysis 2015)

Risk category	Risk	Impact scale (1-5)	Probability scale (1-3)	Risk magnitude	Actions
Network Issues	SAP is not working properly	1	1	LOW	Contacting SAP support
	Email server stops working	4	1	LOW	Contacting IT support
Transportation	Shipping company close down	3	2	MEDIUM	Re-routing the shipments
	Damage of a large shipment	3	2	MEDIUM	Identifying root cause, informing insurance company, re-ordering and re-routing goods
	Volcano eruption, hurricane	5	2	HIGH	Re-routing shipments
	Geo-political crises, strikes	4	1	LOW	Stop delivery until the situation is clear
Trade Compliance	Delivery is stopped at customs because of missing documents	3	2	MEDIUM	Delivering documents, rescheduling goods arrival
Warehouse Management	EOL cannot supply goods because of a disaster	5	1	HIGH	Implementing a critical process to cover the main business
	Shortage of key personnel	5	2	HIGH	The other personnel must be able to solve the main issues

As it is shown on Table 7, the risks with high magnitude are mainly associated with warehouse management and transportation. One of the biggest threats for EOL management is a disaster that would affect the warehouse and the EOL material stored there. Shortage of key warehouse personnel can also have a very negative impact on EOL operations. Transportation disruptions caused by environmental factors are also estimated as the ones with the high impact. Network issues and trade compliance are the other two categories presented in the table. These risks are estimated to have medium and low magnitude. The risks listed in the table are also applicable to the normal purchasing.

#### 4.7 Summary of the analysis

Table 8 summarizes the comparison between the normal purchasing and EOL LTB. The table is created by the author based on the information discussed in the previous subsections. As we can see from the table, purchasing, warehousing and selling operations of normal purchasing and LTB have many differences.

Table 8. LTB and normal purchasing differences (Company X 2017)

	<b>Normal purchasing</b>	<b>LTB</b>
<b>Uniqueness of cases</b>	Mostly not unique	All cases different
<b>Purchase planning</b>	No additional planning	Time-consuming planning
<b>Component availability from original suppliers</b>	Available	Not available after LTB
<b>Demand forecast</b>	Short and more accurate	Long and less accurate
<b>Master data changes</b>	Not required	Required
<b>Investment approvals</b>	Not required	Required
<b>Inventory turnover</b>	High	Low
<b>Replenishment</b>	SCS or VMI	Classic purchasing
<b>Goods reception</b>	Automatic	Manual
<b>Inventory ownership in the warehouse</b>	Not owned until picking	Owned
<b>Inventory level</b>	Low	High
<b>Warehouse</b>	Normal conditions	Special conditions
<b>Quality risk</b>	Low	High if warehousing time is long
<b>Picking</b>	RFID handhelds	Paper-based picking
<b>Repacking</b>	Not required	Sometimes required
<b>Storage duration</b>	Short	Long
<b>Risk of scrapping</b>	Low	Medium or high
<b>Stock-out management</b>	Ordering from original supplier	Ordering from the other sources
<b>Employees involved</b>	More employees with a narrow scope of responsibility	Less employees with a wider scope of responsibility
<b>Operations</b>	More automatic	More manual
<b>Administrative cost</b>	Lower	Higher
<b>Component cost</b>	Lower	Higher
<b>Economies of scale</b>	More	Less
<b>Product profit margin</b>	Higher	Lower

## 5 Conclusions and recommendations

EOL LTB and normal purchasing processes at Company X are similar to some extent. For example, they both have centralized inventory, they outsource transportation and warehousing to LSPs and they face a threat of unexpected supply chain risks. However, many differences between two processes also exist. Differences between purchasing, warehousing and outbound execution in the normal cases and in EOL LTB cases are summarized in Table 8. As we can see from the table, the processes differ in many ways. As an example, EOL operations are more manual and have higher administrative costs. EOL cases have fewer economies of scale and result in a lower product profit margin. They require a longer purchase planning and investment approvals and have an additional inventory holding risk and cost. The summary of Table 8 answers to the first research question about the main differences between normal purchasing and EOL LTB management at Company X.

Differences listed in Table 8 are leading to additional risks and the loss of time and capital in a case of EOL LTB. Figure 14 is based on the information from Table 8 and it shows the causes and the consequences of additional risks and process inefficiency in EOL cases. The causes, identified by the author, are the uniqueness of EOL cases, unavailability of the material and a low volume of EOL LTB orders. These factors result in many other issues listed in Figure 14 such as time-consuming purchasing planning, long-term inventory storage, manual warehouse operations and lower profit margin.



Figure 14. Causes of risks and inefficiency (Company X 2017)

The difference between two processes and reduced efficiency of EOL cases is accepted by the companies. Normal purchasing can lead to significant savings because of the large volume of materials coming from suppliers and leaving to the factories. Therefore, it is very important to optimize the process. Normal purchasing cannot be fully manual, it cannot afford time lost by repacking and long storage times of inventory. EOL is not as critically important process because of its low volume. Regardless of that, a well-organized EOL management process can be a valuable addition to the well-organized normal purchasing process. As an example, the potential EOL inventory saving can significantly improve financial results of the company.

Furthermore, as a conclusion to the question “How can Company X and similar companies minimize the risks?” it can be stated that companies can minimize risks by implementing a well-organized risk-management strategy. Organizations have to first estimate the likelihood of potential risks and the consequences of a realised risk. After that, they should see the relationship of costs and benefits of the actions taken to reduce the risks (Lysons & Farrington 2012). Overall, the sooner the risks are identified, the better solution can be found to solve the potential problems. In a case of EOL LTB the risk of stock-out is one of the most significant ones. It is especially important to accurately estimate the risk of stock-out of components used in many different products. The consequences of such risk can have a major influence on the company. Another risk could be unavailability of EOL Coordinator who has a wide area of responsibility. To avoid this risk, it is necessary to make sure that the other personnel is able to solve EOL issues. One more risk is the maintenance of environmental conditions of EOL warehouse. In order to minimize the risk Company X should ensure that LSP personnel has completed the required trainings and they are familiar with storage and handling requirements.

Another question was if the companies can increase EOL LTB efficiency. Due to the reasons listed in Figure 14, more time and financial resources are needed for LTB management compared to normal purchasing. EOL will always face diseconomies of scale because its fixed costs cannot be spread over large production volumes (Lysons & Farrington 2012: 104). The process will always have a risk of excess and stock out because of the long demand planning time. It will always be at least partly manual and not as standardized as the normal purchasing process. Moreover, because of frequent technological changes, it is hard to avoid component EOL cases. Therefore, the process has to be accepted as a less efficient and inevitable one. After all, the volume of EOL

purchasing is much lower than the normal purchasing. This means that companies may not be affected much by the EOL process inefficiency. It is much more important to eliminate the waste of time and financial resources of the normal purchasing process.

The last question was asking if there are any ways to minimize the cost of EOL components. The cost of EOL components increases due to several factors. If the LTB quantity is more than the usual order quantity, transportation cost may increase. Supplier may also propose special purchase terms for the LTB and increase the component cost (Jennings & Terpenny 2015: 433). Storing the components for many years in a warehouse may significantly increase the inventory cost. Due to a demand for the analysis, additional communication between the company and suppliers, a need for risk monitoring, inventory counting and many other factors administrative cost increases as well. The risk of stock out and excess is also adding the value to EOL components. In the case of stock out the company might be forced to buy the component for a higher price from a broker market or some other source. In the case of excess the material will be scrapped and the company will pay to implement the reverse logistics process. Sandborn and Myers (2008: 92) shortly summarize the lifetime buy cost formula presented in Figure 6. It is a sum of costs spent on the purchase of forecasted amount of components, storing the inventory for a long time, scrapping the useless inventory and finding the new parts in case of shortage as it can be seen from Figure 15.

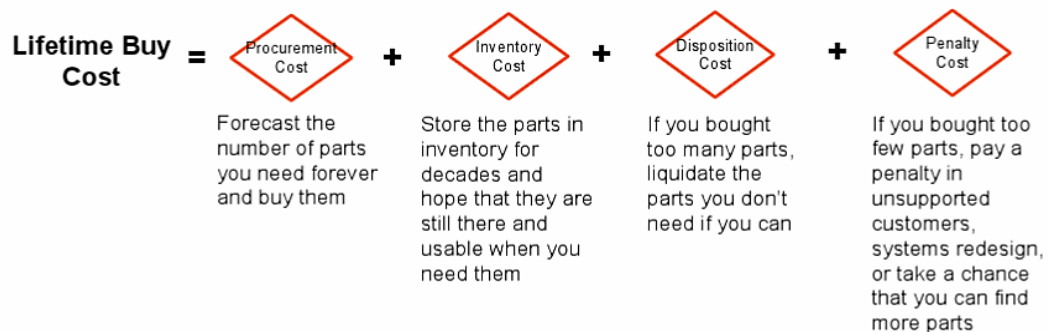


Figure 15. Lifetime Buy Cost formula (Sandborn & Myers 2008: 92)

Component cost can be decreased with more strategic procurement planning and better-organized inventory management. The fewer mistakes are done during the LTB management process and the less time and financial resources are spent to improve them, the lower is the final cost of the product. It is also important to have long-term relations with reliable brokers, TCE and the other possible suppliers of the substitute

parts. Component replacement cost can also be decreased with the flexible product design that enables a faster change for the updated components.

The results of the research are applicable to the similar IT companies that are facing technological changes and have to deal with EOL components. Especially these companies that have EOL warehouses and international scope of operations are relevant to the research. The recommendations for such companies would be to consider inevitable EOL management as one of the possible cost saving opportunities that can significantly reduce the operational costs, especially in the long run. Companies should pay attention to high inventory costs they are paying for storing EOL components. Inventory ties up the cash, needs a storage place and may become useless (Harrison & Van Hoek 2008: 76). Inventory is one of the major logistics costs in EOL that reduces the profit of the final product. Companies shall carefully consider any options to avoid inventory costs before acquiring EOL inventory. They should aim for flexible product design that would enable a faster product redesign in EOL cases. Companies should implement a proactive EOL management approach that was mentioned in Chapter 3 for the critical components used in multiple products.

In order to summarize the conclusion, the following issues were identified by the author:

1. Normal purchasing and EOL purchasing processes have many differences. The main causes of differences from EOL point of view are uniqueness of cases, low volume and unavailability of material.
2. EOL of components in IT industry is inevitable. Regardless of that, EOL management should be considered as a cost saving opportunity that can reduce operational costs of a company in the long run.
3. EOL process is not as efficient as normal purchasing. Because of the low purchasing volume, decreased efficiency can be accepted by companies. A well-organized EOL management can optimize the EOL process and can be a valuable addition to a well-organized normal purchasing process.
4. EOL management requires a careful risk monitoring. Appropriate risk management strategy can reduce EOL risks and costs associated with them.
5. Special attention shall be paid to inventory cost reduction. Cost associated with inventory is one of the main reasons of profit margin decrease of a final product.
6. It is important to establish long-term relationships with the parties involved in EOL process in order to decrease the cost of component substitution. Such parties are alternative suppliers, LSP, broker firms, TCE and the others.

As it was mentioned before, the conclusion is made based on one company and one industry. There is a space for further research of EOL management in other companies operating in similar industries and producing complex industrial products with a long lifecycle. Comparison could be also done between EOL management of long life industrial products and electronic products with a smaller lifecycle and bigger turnover. In addition, the other industries that are not connected with electronic equipment manufacturing could be included in the further research. As a result of such investigation, more issues related to EOL management could be identified.



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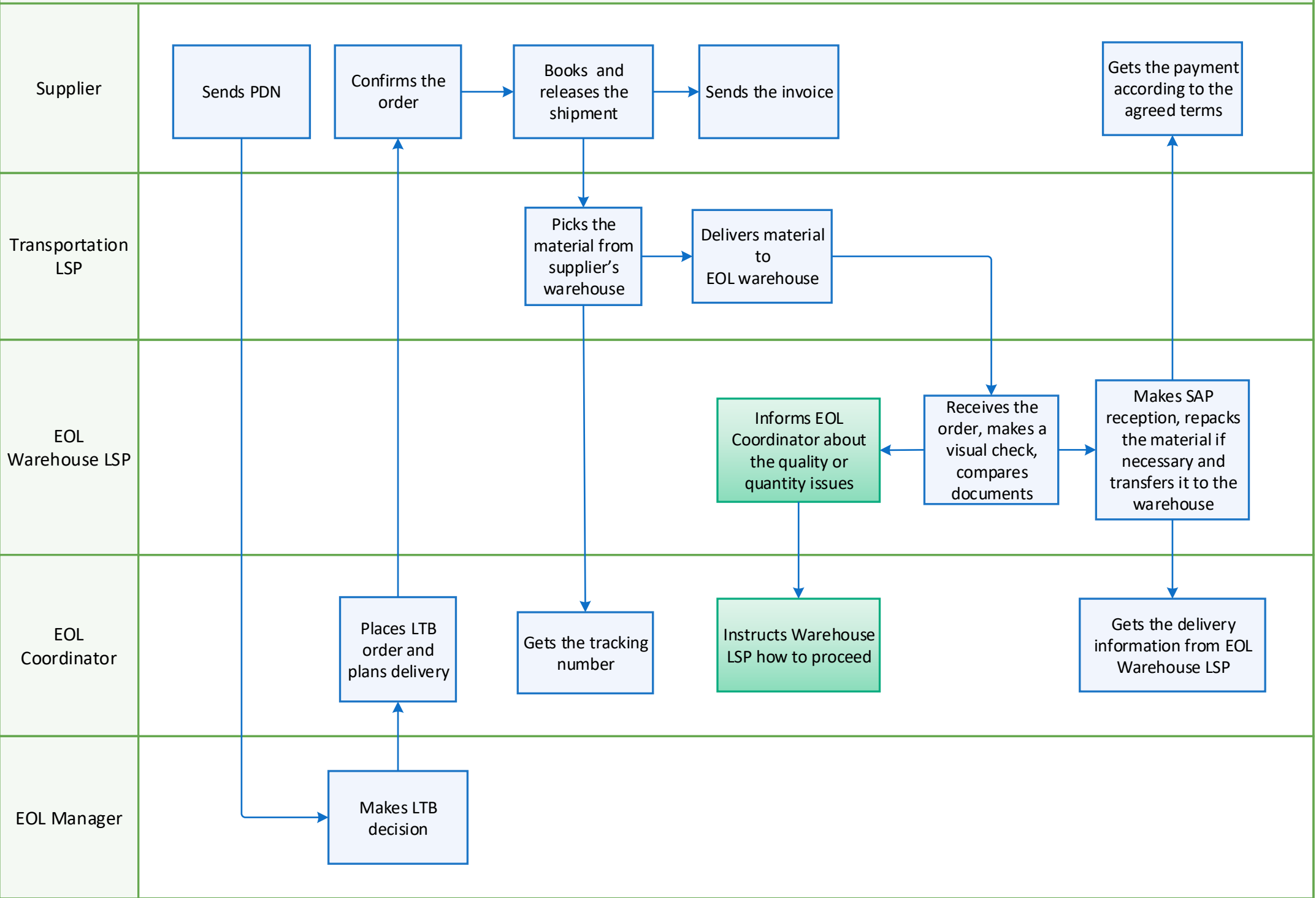
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**Inbound EOL process**



## Outbound EOL process

