LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
School of Industrial Engineering and Management
Supply chain and operations management

MASTER’S THESIS

Data and Inventory Management in Spare Part Business: Developing Operations in the Case Company

Examiner: Professor Janne Huiskonen
Instructor: Ari Muhojoki

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Johanna Rantanen

ABSTRACT

Author: Johanna Rantanen

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After sales business is an effective way to create profit and increase customer satisfaction in manufacturing companies. Despite this, some special business characteristics that are linked to these functions, make it exceptionally challenging in its own way. This Master's Thesis examines the current situation of the data and inventory management in the case company regarding possibilities and challenges related to the consolidation of current business operations.

The research examines process steps, procedures, data requirements, data mining practices and data storage management of spare part sales process, whereas the part focusing on inventory management is reviewing the current stock value and examining current practices and operational principles. There are two global after sales units which supply spare parts and issues reviewed in this study are examined from both units' perspective. The analysis is focused on the operations of that unit where functions would be centralized by default, if change decisions are carried out.

It was discovered that both data and inventory management include clear shortcomings, which result from lack of internal instructions and established processes as well as lack of cooperation with other stakeholders related to product's lifecycle. The main product of data management was a guideline for consolidating the functions, tailored for the company's needs. Additionally, potentially scrapped spare part were listed and a proposal of inventory management instructions was drafted. If the suggested spare part materials will be scrapped, stock value will decrease 46 percent. A guideline which was reviewed and commented in this thesis was chosen as the basis of the inventory management instructions.

TIIVISTELMÄ

Tekijä: Johanna Rantanen

Työn nimi: Tiedon- ja varastonhallinta varaosaliiketoiminnassa: Operaatioiden kehittäminen asiakasyrityksessä

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Jälkimarkkinointiliiketoiminta on tehokas tapa saada aikaan tuottoa ja kasvattaa asiakastyytyväisyyttä valmistavassa teollisuudessa. Tästä huolimatta nämä toiminnot pitävät sisällään myös erilaisia haasteellisia liiketoiminnan erityispiirteitä. Tämä diplomityö tarkastelee tämänhetkisen tiedon- ja varastonhallinnan tilannetta asiakasyrityksessä silmälläpitäen mahdolliseen nykyisten liiketoimintojen yhdistämiseen liittyviä mahdollisuuksia ja haasteita.

Työ tutkii varaosamyyntiprosessin työvaiheita, toimintatapoja, tietotarpeita, tiedonhankintakäytäntöjä ja tiedonhallintaa, kun taas varastonhallinnassa keskitytään varastonarvon tarkasteluun ja tutkitaan varastonhallinnan nykyisiä käytäntöjä ja toimintaperiaatteita. Varaosapalveluita tarjoaa tällä hetkellä kaksi globaalia jälkimarkkinointipalveluyksikköä ja työ tarkasteleekin ylläkuvattuja asioita näiden molempien näkökulmasta. Sen sijaan analyysissa keskitytään sen yksikön toimintoihin, johon toiminta oletusarvoisesti keskitettäisiin, jos muutoksiin päädytään.

Tutkimuksessa havaittiin, että sekä tiedon- että varastonhallinnassa on selkeitä puutteita, jotka ovat seurausta sisäisten ohjeistuksien ja prosessien puutteesta ja heikosta yhteistyöstä muiden tuotteen elinkaareen liittyvien osapuolten kanssa. Datahallintaan liittyvä päätuotos oli yrityksen tarpeisiin suunniteltu ohjeistus toimintojen keskittämisen varalle. Lisäksi työn tuloksena syntyi esitys romutettavista varastomateriaaleista ja ehdotus selkeämmistä pelisäännöistä varastonhallintaan. Jos ehdotetut varastomateriaalit romutetaan, varastonarvo laskee 46 prosenttia. Varastonhallinnan ohjeistuksen pohjaksi kelpuutettiin puolestaan keskeneräinen varastonhallinnan ohje, jonka sisältöä kommentointiin ja täydennettiin tässä työssä.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

LIST OF ABBREVIATIONS

BOL = Business Online

BOM = Bill of Materials

BU = Business Unit

ERP = Enterprise Resource Planning System

ETO = Engineer-to-Order

GSU = Global Supply Unit

IT1 = "Item Type 1", one kind of machine type that the case company produces. Larger, more expensive and structurally more complicated compared to Item Type 2 (IT2) -machines. Engineer to Order (ETO) is typical in production.

IT2 = "Item Type 2", one kind of machine type that the case company produces. Smaller, low-priced and structurally simpler compared to IT1-machines. Serial production among standard models is usual, but also ETO production exists.

KPI = Key Performance Indicator

OMS = Order Management Services

OTD = On Time Delivery

PG = Product Group

PLM = Product Lifecycle Management

R&D = Research and Development

RFQ = Request for Quotation

SKU = Stock Keeping Unit

1 INTRODUCTION

The purpose of this thesis is to study the current spare part processes in the case company. The spare part business goal is to enhance current internal business processes and the quality of customer service. Based on the company's strategical alignments, recent business changes and prospects, the presumption is that the best way to achieve this goal is through a consolidation of the spare part processes, which are currently divided into two units. Hence, this thesis examines the current spare part processes from two aspects, which are also seen to play a highly critical role in terms of a successful execution of the consolidation: inventory and data management. The beginning of this chapter is provides background information for the theoretical part of the thesis. The objectives, research questions, limitations and definitions of the thesis are explained thereafter. Finally, the structure of the thesis is presented.

1.1 Background

Technological innovation and falling barriers to trade and investment are crucial factors that have led to the modern-day market globalization. In order to survive in the international competition, companies must adjust to a new international operational environment and transform the ways to do business. International business offers various ways for companies to enhance their operations. Strategical decisions concerning where and how to execute different processes of the value chain require careful debating and outlining of the overall picture. Globalization enables the dispersal of activities in order to achieve cost-minimization or quality-maximization. For example, access to lower labor costs, better technical expertise or lower production input costs can be driving factors for business changes in industrial companies. (Wild et al. 2010, p. 34-36)

Meanwhile as the world globalizes further, the importance of the aftermarket business also grows. As a consequence of decreased demand, intensified competition and reduced profit margins, companies began to provide value services already in the early 1990's (Cohen et al. 2006, p. 129). Customer satisfaction becomes highly important for companies when world-wide competition increases (Botter & Fortuin 2000, p. 656). Providing after sales services has become vital in order to survive and prosper in different industries, because it generates long-lasting customer loyalty. Although companies are conscious of the importance of after-sales, they still find it hard to manage and naturally, only effectively produced services can create a profit. (Cohen et al. 2006, p. 130) An optimal relation between customer service level and cost-effectiveness is hard to find and it is also often risky to draw a conclusion based on the customer surveys, since the received answers can vary based on respondent in the company. Companies fall often into under-servicing or over-servicing, once the overall cost-efficiency is missing. (Konijnendijk 1991, p. 139)

Well-managed information management has an important role in complex environments, such as after-sales business (Häkkinen & Hilmola 2008, p. 94). Enormous technological breakthroughs and business dependence on IT in conjunction with globalization, mergers and acquisitions, sets growth requirements for data management (Marsh 2004, p. 107). The problem is not the lack of data, but rather a question about accessibility for the right persons and a consistent recording format (Haug & Arlbjorn 2011, p. 289). Data is often trapped into the local data silos, instead of efficient data distribution (Vayghan et al. 2007, p. 682). Once data related to different steps of the lifecycle is properly collected and distributed, it can produce valuable information through the lifecycle (Li et al. 2015, p. 667).

Within the field of after sales business one major challenge is undoubtedly related to the spare part management, especially spare part inventory. The target of inventory management is to reach a sufficient level of inventory for a minimum cost (Huiskonen 2001, p. 126). Slow and sporadic demand combined with a large service network comprising of a large variety of parts creates the basic problem for spare part inventories (Dekker et al. 2013, p. 537; Huiskonen 2011, p. 125; Jalil et al. 2011, p. 442). Neither the production plant nor the suppliers are traditionally able to support spare parts for the whole lifecycle (Fortuin & Martin 1999, p. 954). One easy way for the companies to avoid this uncertainty is to keep oversized inventories. Stock-outs can cause costly downtimes for the customer and the company image can be at stake if it is not able to provide functional spare part logistics. (Huiskonen 2011, p. 125; Fortuin & Martin 1999, p. 968)

This thesis is conducted for an after sales service department of a multinational company, which is a large operator in an industrial sector of its own. This after sales department produces services related to spare and capital part sales as well as field and warranty services for Item Type 1 (IT1) and Item Type 2 (IT2) -machines. Compared to IT1-machines, IT2-machines are smaller, low-priced and structurally simpler. Also serial production of standard models among them is more usual. This thesis focuses on internal spare part sales operations of IT2-machines. It examines opportunities and challenges of inventory and data management ahead of potential internal operations change.

1.2 Problem Discussion

Because of the recent changes in production, strategical alignments and general characteristics of the business, there has risen a need to rethink and analyze how the provided spare part services related to IT2-products should be conducted in a more effective way. Currently, the spare part business related to IT2-machines is divided between two Global Supply Units (GSUs), Finland and Sweden, and the business is approximately of the same size in both units. In addition to IT2-business, both GSUs also produce spare part services for IT1-machines. The framework of this study is described in the Figure 1 and is further explained in the following paragraphs.

The initial assumption of this thesis is that the best way to achieve the desired effectiveness is through the consolidation of current spare part processes. This way, internal processes can be conducted in a more effective way, especially in terms of the removal of overlapping inventory, a lightened organizational structure and better customer service. At the moment, roughly 15 percent of all stocked items are stored in both units and this number will grow in the future because of a more uniform design of new products. Also the quality of customer service will be improved through the consolidation, especially in terms of uniformity and internal flexibility. Today, although customers are mainly same, both units execute their customer service processes via local instructions, instead of common practices. Furthermore, in terms of the number of employees, both IT2-units are quite small, and thus the flexibility in unexpected situations is limited. Hence, via a centralized customer service, uniform customer service as well its flexibility in everyday work can be achieved. The significance of customer service quality is highlighted in the company's after sales strategy.

BACKROUND	Strategical factors • White collar productivity • Net working capital down • Strong focus on customer satisfaction	Other factors • Product transfer in production (Sweden => Finland, Poland) • Business position as a minor party in both units • Low marginal profit requires centralization
TARGET	• Improve customer service quality (especially uniform quality and internal flexibility) • Improve effectiveness of internal processes • Increase focus of the spare part business related to IT2-products	
ACTUALIZATION	• Inventory value down • Enhancement of the inventory policy • Consolidation of the operations and the processes	
CASE STUDY	• Examination of the current inventory management - Analysis considering inventory value vs. necessity - To find better ways to manage the inventory policy • Examination of data management risks related to consolidation of operations - To define requirements that are needed to fullfil in order to execute consolidation successfully	

Figure 1. *Case study framework*

A recent locational change of the production transferred the major part of IT2-production from Sweden to Finland and Poland. Locations of the GSUs originate from the idea that each production plant should possess their own support unit. Over the time, there has been, among other things, production shutdowns, product transfers and new production plant establishments, and thus this initial idea of local service units has faced changes and adjusted to circumstances. Still, GSUs support mainly their local plants, but they also support products that are produced in other locations. However, local service unit eases everyday operations, since many used IT-systems are local. Currently, global support units are located in Sweden, Finland, Italy and Switzerland. Therefore, the studied consolidation possibility concerning spare part activities is focused to transfer activities from Sweden to Finland. Poland does not have a support unit of its own.

Strategically, the consolidation is assumed to offer better possibilities to realize the spare part vision in the future, if all spare part operations are centralized in Finland. Overlapping inventory and personnel costs caused by two units create unnecessary expenses. Additionally, when an already rather small business is divided between two separated units, it cannot achieve a considerable position in neither of the units. Once all activities are focused into one unit, the significance of the business increases. This far, spare part services of IT2-products have had a role of a minor party in both units, because IT1-products cover a major part of the business, and thus IT2-products can be seen as a lower-priority business.

In this thesis, the consolidation of operations is examined in the aspect of the challenges and risks related to data management. Fundamentally, the process functions of the IT2 spare part business are quite simple, and thus one could think that they would function more automatically. Though, because of the inadequate data quality, many simple everyday functions can turn out as unnecessarily challenging cases. Among other things, locality, dispersion and fragmentation of data cause problems. Therefore, the business relies on the strong expertise of certain persons who are basically an indispensable backbone for the daily work operations.

Another significant and basically separated improvement opportunity is to take more notice to the present inventory management and inventory control policies. Strategical alignments of the case company, more accurately the target related to the decrease of net working capital, strives to pay more attention to this sector. The inventory value of the IT2-products is quite considerable compared to the revenue in both units, Finland and Sweden. Inventory value is naturally high in after sales because of the nature of this business field, but in this case, it is believed that there is room for improvement. Here, inventory control is seen tricky and hard to manage, and thus the actions have been more focused to guarantee parts availability and customer satisfaction. Hence, the inventory value control has had a minor role.

In this thesis, the aforementioned aspects constitute an opportunity to investigate the current inventory management and its control policies, describe these processes and evaluate them. Based on this analysis, possible development propositions will be given. The documentation of the overall picture of the current processes is lacking, and thus this thesis tries to describe then more precisely. Currently Sweden and Finland have approximately similarly sized inventories. If a consolidation is made without any inspection considering inventory management, the value and the physical size of the inventory will double. It is presumed, that the current spare part inventories cannot be united into one warehouse as such, because of the lack of capacity. Thus, the realization of the consolidation is basically depending on the possibility to evaluate the current inventories of the both units.

In a way, the case study is outlined into two studied topics in order to facilitate understanding: inventory and data management. Still, from the company's point of view, these two study subjects are still strongly connected to each other. Actually, the high inventory value of IT2-products was realized while starting to contemplate a possibility to consolidate the IT2-operations into one unit. Effective inventory management is seen to play a significant role for the consolidation of operations. Therefore, an initial assumption is that the consolidation will not even be realized, if actions based on the examination of inventory management are not conducted first. This idea is illustrated in the Figure 2.

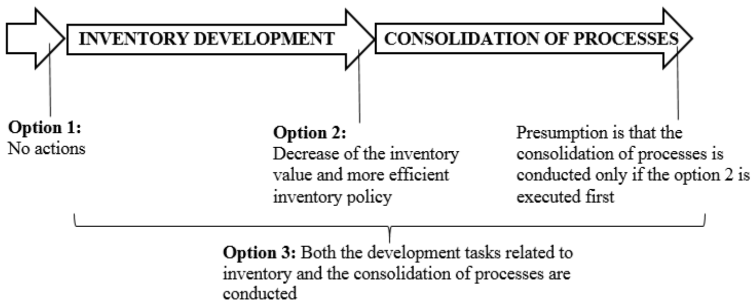

Figure 2. *Options for actions*

1.3 Research Questions and Objectives

As was stated in problem discussion, the research problem of the thesis is divided into two research topics, which are presented below:

- Data management challenges related to consolidation of operations (1)
- Inventory management and its control policies (2)

The research problem can be visualized by breaking it down to the following four research questions. The number inside of the parenthesis expresses which subject the research question concerns.

RQ1: How is data related to the spare parts process currently managed and what are the flaws? (1)

RQ2: How should the results (**RQ1**) be taken into consideration in order ensure the successful consolidation of operations from the data management aspect? (1)

RQ3: How can the present situation of the inventory and the inventory management be described? (2)

RQ4: What kind of changes in the inventory control policy can result in decreased inventory value in both the short and long term? (2)

This study aims to produce material that will support in management decision-making. The objective is to provide a deeper understanding of the studied topics by creating a better picture of the current situation and finding new ideas and possibilities as well as challenges related to the planned efficiency targets. The study is examining the situation in both units, Finland and Sweden, but since the target is to centralize operations to Finland, the focus is stronger on the Finnish operations. The situation in the Swedish unit will be covered in areas relevant to the study. Consequently, the study produces a supportive pre-material for strategical decision-making that can lead to a possible development project. It does not cover operational project management.

1.4 The Scope of the Thesis

The scope of the thesis is limited to handle after sales services, more precisely spare part operations related to IT2-products in a multinational company. In addition to IT2-products, the Business Unit (BU) develops, produces and supports also IT1-products, but in order to keep the case study compact enough, these have been left out of the study. Still, IT1-products are mentioned in some contexts in this thesis. In these cases, IT1-products are still not in the main role, but they are included in order to provide an understanding of the overall picture or to be used in comparison with IT2-products.

1.5 Thesis Structure

This thesis consists of eight chapters and the structure of them is described in the Figure 3. First, the introduction chapter presents the research topic. Thereafter, the second chapter covers the theoretical background used in this thesis. The research methods are presented in chapter three. The required background information of the case company, which the reader needs to understand, is introduced in chapter four. Because of the two separated research areas, the case study itself is divided into two chapters: one examines the data management and the other the inventory management. In the seventh chapter, the findings of the literature and case study are discussed and recommendations are given. Finally, the conclusions of the study are complied.

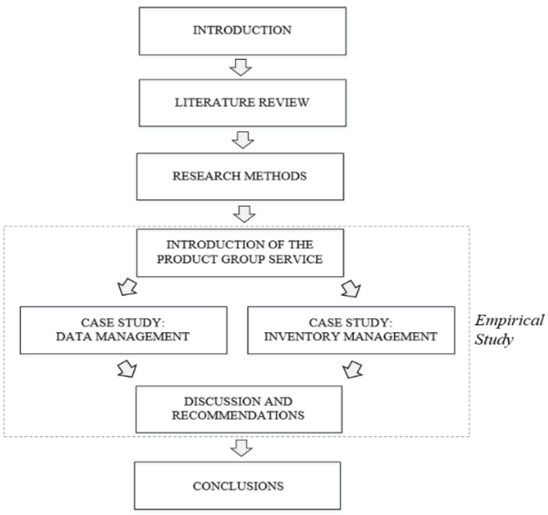

Figure 3. *Thesis structure framework*

2 LITERATURE REVIEW

This chapter presents the literature review of the study and it is combines literature concerning the both theoretical fields included in this thesis: data management and inventory management. The case study itself relates to the spare parts operations, and thus the special characteristics of after-sales business function here as a connecting link between these two theoretical fields. Hence, the special characteristics of the after sales business is basically the connective top theme which the other themes have been built around and which they strive to consider. Additionally, the importance of the customer service management is traditionally emphasized in the after sales business and the strategical alignments of the case company do not make an exception here. Therefore, the customer service management creates the third minor aspect of the literature review. The different aspects and their mutual connections are described in the Figure 4.

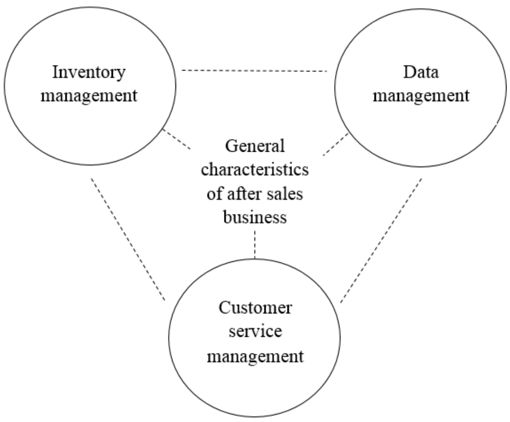

Figure 4. *Literature framework*

In addition to the previously described theoretical framework of this study, the final sub-chapter of this literature review presents the support tools that are utilized in order to help while perceiving, categorizing, classifying and analyzing the data management part of this thesis. The tools used in the inventory management are presented among the other inventory management literature, because they are experienced to be more strongly connected to the main topic itself. The tools presented in the separate sub-chapter are seen as more general tools, which are in this context linked to the data theme.

After sales business can be seen as an effective way to create revenue, profit and competitive advantage in manufacturing companies (Cohen et al. 2006, p. 129-130; Gaiardelli et al. 2007, p. 698). After sales service means a value-added activity that appears after a product itself has been delivered to a customer (Cohen & Lee 1990, p. 55). After sales service business gives manufacturing companies an additional way to do business, improve market competitiveness and maintain customer relationships. Simultaneously, companies gain valuable information concerning customer preferences and behavior. Good service is also seen as a way to strengthen up customer loyalty. Within manufacturing companies, improving the competitiveness of after sales is seen as the most essential focus area. (Gaiardelli et al. 2007, p. 698)

Although after sales business is often vital for companies, producing these services can be a costly and risky business (Spengler & Schröter 2003, p. 8). Availability of components, fast deliveries and good communications can be seen as quality factors that enhance service quality (Cohen 1990, p. 56). In order to keep up with competitors, companies need to offer more complex and custom-build products for customers (Cohen 1990, p. 55) and take an advantage from technological progress (Spengler & Schröter 2003, p. 8). Product customization has a strong impact, especially to the number of spare parts. From a perspective of a spare part business, product customization should be done as far as possible using the present item assortment. (Suomala 2002, p. 65)

Still, it has been observed that extended investments in service business in manufacturing companies do not correlate with higher returns. The competition within the industry of machine and equipment manufacturing is tough. This can be seen in increased price pressure and a need of more advanced communications systems. Companies try to compensate decreased product margins by extending their business to after sales services in order to increase revenue and profits. Although companies invest in after sales business, there are often still something lacking in the implementation. A successful implementation requires various changes in the organizational structure, including the establishment of a service organization and process, a definition of the value proposition, a strategy and service culture and the initiation of marketing relationship. (Gebauer 2005, p. 14-15; 25-26).

2.1 Data Management

The terms data, information and knowledge are easily used as synonyms in the everyday life. Briefly defined, data is traditionally considered to be alphanumeric and it is documented and stored either in digital or paper form. Information can be seen as what data becomes, when people have processed it by interpreting and contextualizing. Information can be more valuable and ambiguous compared to data. Knowledge is information within individuals' minds that can be used to create new innovations. In practise, it is still hard to determine strict boundaries between these three, when one form transforms into the other. (Bernard & Tichkiewitch 2008, p. 6-7)

Data management can be divided into master data, transactional data and historical data (Haug & Arlbjorn 2011, p. 289). Master data is a fundamental type of business data regarding the company's transactions, including customer, supplier and product data. Basic characteristics of master data is that it is created once and re-used several times. (Knolmayer & Röthlin 2006, p. 362) As for transactional data, it describes events in a company, including data related to orders, invoices, storage records and deliveries (Haug & Arlbjorn 2011, p. 289). There are not any standardised definition for product data, but especially once it is a question of the Product Lifecycle Management (PLM), it can be understood to cover all product related information. It is needed by different internal and external organizational functions, including after sales, in order to finish their duties in the process. Various stakeholders create, change, transfer, store and convert product data during the product lifecycle. (Kropsu-Vehkaperä & Haapasalo 2011, p. 61-62)

Undocumented tacit knowledge is hard to transfer, because it arises over time and it is based on deeper learning instead of routines and it is normally transferred only through close work cooperation and workplace learning (Bloodgood & Salisbury 2001, p. 58; Viitala & Jylhä 2006, p. 291-292). If people who possess a large capacity of tacit knowledge leave a company or their work capacity somehow weakens, it can cause deterioration of customer service and other processes. Thus it is crucial in every process, action and task to draw a line and identify what kind of knowledge should be documented and what is sufficient in a tacit form. (Viitala & Jylhä 2006, p. 345-347)

General Data Challenges

Operational efficiency and integrated information systems are essential issues for modern companies (Häkkinen & Hilmola 2008, p. 73). Companies can achieve considerable core competence and enhance performance by advanced data and information management (Smith & McKeen 2008, p. 68; Kropsu-Vehkaperä & Haapasalo 2011, p. 70; Haug & Arlbjorn 2011, p. 288). High-quality data complies with processes and policies of the company and it propagates its meaning and value throughout the company. Data should be able to integrate from multiple domains to support various business functions. (Vayghan et al. 2007, p. 671) Especially in global companies, data consistency has an essential role while dealing with stakeholders. Functionally managed data facilitates also globalization, acquisitions, business transformations and company reorganizations. (Smith & McKeen 2008, p. 69)

Today, the information technology has an all-pervasive role in everyday business and data is used almost in all company activities (Haug & Arlbjorn 2011, p. 288; Marsh 2005, p. 105). It is a critical transformation initiative for every company to be able to use data as an asset (Vayghan et al. 2007, p. 672). Still, the risks of dirty data are much more visible and have more significant consequences than in the past (Marsh 2005, p. 105). Data quality problems can be seen occurring from modern technological solutions that enable companies to collect enormous amounts of data. Increased volume of data increases complexity of managing data, and thus the risk of poor data and data problems increases. (Haug & Arlbjorn 2011, p. 289) Hence, data quality problems are based on organizational and process issues, instead of the lack of technology (Silvola et al. 2011, p. 160).

There has been a belief in the past that once data has been recorded, it stays unchanged and therefore it does not require any further actions. It is even normal in business life that the presence of dirty data is somehow accepted as a part of normal business processes. (Marsh 2005, p. 107) Haug & Arlbjorn (2011, p. 296) have identified five factors, which if lacking, set barriers to the overall data quality. These factors are:

- Delegation of responsibilities for maintenance of master data
- Rewarding of ensured valid master data
- Master data control routines
- Employee competencies
- User-friendliness of software that are used in managing master data

Historically, the data quality has been experienced as a desirable, but still simultaneously as a relatively low priority nuisance and companies are still not giving the needed attention to the data challenges (Marsh 2005, p. 106). Managers are not normally aware of all available knowledge recourses in the processes domain and the possibilities it contains (Bloodgood & Salisbury 2001, p. 66). It is also normal that there is no awareness of how and where data problems and poor data exists (Marsh 2005, p. 108).

Accuracy, integrity, consistency, validity, accessibility, compliance, up-to-dateness and completeness of data are in a critical role once a company is willing to reach its strategical goals (Marsh 2005, p. 107). One big challenge is to keep all the created data in standardized form since there are several ways to capture the same data (Vayghan et al. 2007, p. 671; Kropsu-Vehkaperä & Haapasalo 2011, p. 61).

In large, heterogeneous and dispersed companies, emerging data quality problems are often a result of locally managed data and the use of several IT-systems that are customized to the needs and of the local operators. This results in inconsistent data management, where all units store, process and manage their individual data subsets based on their own business policies and processes. (Silvola et al. 2011 p. 160; Vayghan et al. 2007, p. 670; Knolmayer & Röthlin 2006, p. 362) Links between these applications are often unreliable and expensive to implement (Silvola et al. 2011, p. 160). Local data silos also trap data into local applications and processes instead of in efficient, on demand based data distribution (Vayghan et al. 2007, p. 682).

Figure 5 describes data quality activity levels. Most of the companies stay on the passive or reactive level most part of the time. Once a data problem occurs, companies move temporarily to a reactive or active level and try to fix a problem. Once the problem is solved, they return back on the lower level to wait for new problems to appear. (Silvola et al. 2011, p. 158)

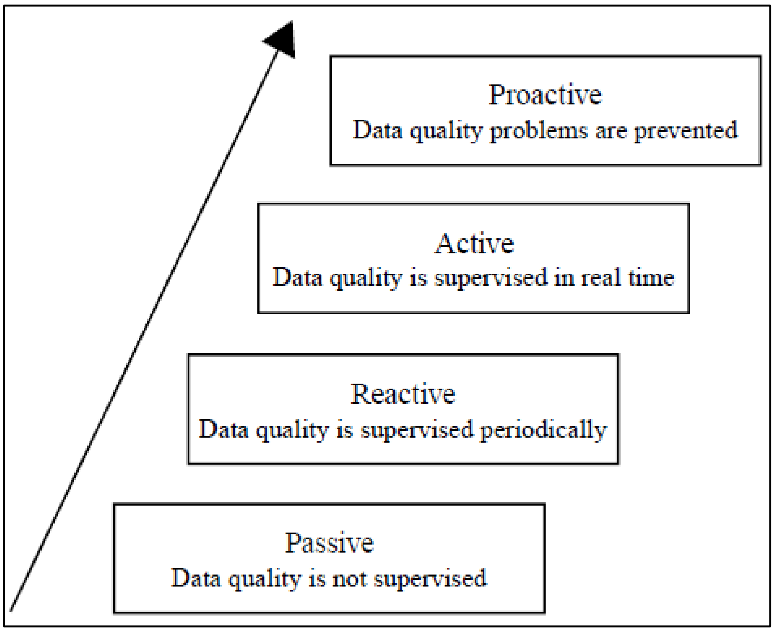

Figure 5. *Data quality activity levels (Silvola 2011, p. 158)*

Product Data Lifecycle Management

In order to answer to the challenges of the market competition, companies should also be able to meet customer needs throughout whole product lifecycle without increased costs, delayed deliveries or decreased quality (Kiritsis et al. 2003, p. 189). Diverse stakeholders create, change, transfer, store and convert product data during the product lifecycle. The Product Lifecycle Management (PLM) describes the way how companies can manage their products and achieve advanced product data management throughout a product lifecycle. (Kropsu-Vehkaperä & Haapasalo 2011, p. 61-62) Once the product lifecycle evolves, the information content grows in terms of its complexity and scope. Complexity of product data is related to the growing number of parties, who are authorising and using it, whereas the scope of product data expands eventually to cover all aspects of the product life cycle. (Rachuri et al. 2007, p. 792)

Different stakeholder groups need specific kinds of product data in order to execute processes (Kropsu-Vehkaperä & Haapasalo 2011, p. 61). In spare part business, customized products cause increased workload, especially in purchasing and sales, when it is a question of some rarely used item (Suomala 2002, p. 64). High product variation emphasizes the significance of stakeholder specific general product data. In order to ensure that operations are carried out in a predictable manner without personalized solutions by personnel, companies should invest in stakeholder specific general product data. (Kropsu-Vehkaperä & Haapasalo 2011, p. 70) However, companies find it challenging because of problems to transfer created data between the different life cycle phases of the product lifecycle (Kiritsis et al. 2003, p. 189). Different steps in the production chain are not linked and connected effectively, and thus generating, transmitting and storing of data is lacking. It can be possible that all useful data is not even stored or then manufacturers cannot use that afterwards or do not even know that it exists. All different steps would create a lot of valuable information for other parties of PLM, if the data would only be collected, stored and transmitted in a reasonable way. (Li et al. 2015, p. 667)

PLM should be a company-wide process and different stakeholders, including after sales should be included. However, it is important to remember that product data requirements of stakeholders vary in different companies because of the variable sub-division structure. (Kropsu-Vehkaperä & Haapasalo 2011, p. 69-70) The definition of stakeholder specific data content presented by Kropsu-Vehkaperä and Haapasalo (2011, p. 69-70) is described below:

- Structural illustration (includes stakeholder specified subsets that are based on general product structure)
- Product master data (consist of a core product data, including item code, item description, lifecycle status and product definitions)
- Other general data (contains different kind of instructions and work guidelines; to define how a product should be sold, produced and maintained)

In complex environments, such as after-sales business, effective information management can be a key factor in order to stay competitive (Häkkinen & Hilmola 2008, p. 94). Because of the heterogeneous nature of the after sales business, specific kinds of product data is needed in order to conduct the after sales process steps, and thus stakeholder specific data plays a highly important role. Commonly after sales services are weakly defined and they also have the most room for efficiency improvement. (Kropsu-Vehkaperä & Haapasalo 2011, p. 69) Nevertheless, Kropsu-Vehkaperä & Haapasalo (2011, p. 63) states that there are basically not earlier studies concerning the content of product data, which is required for order delivery processes.

Data Quality Impacts

Poor data quality impacts on employee job satisfaction, customer satisfaction, customer loyalty, performance and profitability (Haug & Arlbjorn 2011, p. 294; Marsh 2005, p. 106). It affects the customer services ability to reply to customers and it can also cause increase in stock levels (Marsh 2005, p. 106). If there are some shortages considering quality of data, users' Enterprise Resource Planning System (ERP) skills or communication between different organizational levels during an ERP implementation, it will rapidly affect both work of individuals and external customer service (Häkkinen & Hilmola 2008, p. 95). Additional data verification and poor decisions based on defective data are costs that are caused by poor data quality (Smith & McKeen 2008, p. 68). Operational costs increase as well while correcting and detecting data errors. Hence, poor data can be seen as a costly problem in companies. (Haug & Arlbjorn 2011, p. 294; Smith & McKeen 2008, p. 68)

Those employees who work close with the customer interface can easily feel that they are in a tricky situation between deteriorated internal business processes and tightening customer requirements. Employees who work further from the customer interface and people at a higher organizational level did not experience the situation as equally pessimistic. (Häkkinen & Hilmola 2008, p. 95) Well-managed and accurate master data reduces customer frustration while dealing with the company (Smith & McKeen 2008, p. 69).

Towards Advanced Data Management

Successful data management is an all-time ongoing preventative process (Marsh 2005, p. 110). Changes are required at process, organization, governance as well as cultural stage (Vayghan et al. 2007, p. 670). Improvement of data quality does not only mean data correcting, it requires in-depth actions, assessments, strong commitment and behavioural change through the data lifecycle, including the cleaning-up of data, processes and information systems (Marsh 2005, p. 106; Silvola et al. 2011, p. 160-161). Internal tools, processes and structures are needed to be applied so that they foster a consistent commitment towards data quality management (Knolmayer & Röthlin 2006, p. 370).

The data quality management requires a holistic, collaborative, integrated and cross-functional approach (Marsh 2005, p. 106; Smith & McKeen 2008, p. 70). Data collector, custodian and user are not necessarily the same person and their understanding of issues can considerably vary. In order to create high-quality data, it is important to increase the cross-functional knowledge of these process members about other work processes around their own immediate work tasks. These three process members should work together in order to identify and solve existing problems. (Lee & Strong 2003, p. 33) In order to achieve an efficient product data sharing process through the product lifecycle, different tasks of stakeholders and their specific product data should be understood (Kropsu-Vehkaperä & Haapasalo

2011, p. 70; Kiritsis et al. 2003, p. 198; Lee & Strong 2003, p. 33). The ultimate target of the company data architecture program is to liberate local stored and managed data and make it available for wider use within the limits of all relevant policies and rules (Vayghan et al. 2007, p. 682).

It is important that products and services are designed from a holistic point of view, thereby producing added value and benefit for all participants (Markeset & Kumar 2003, p. 390). In order to achieve maximum benefit through sharing and exchanging information in PLM, all different information systems should be horizontally integrated (Rachuri et al. 2007, p. 790). The matching of IT systems is essential when managing this knowledge (Bloodgood & Salisbury 2001, p. 67). To make this possible, the language of information should be expressive and informative enough but at the same time be computable and presentable as well (Rachuri et al. 2007, p. 798). It should be made certain that all critical data has its verified data source (Vayghan et al. 2007, p. 670).

Visualization of data into correct form for different parties can be challenging because the size and diversity (Li et al. 2015, p. 682). In order to manage to implement one master data, the whole company needs to be ready to move towards more transparent processes. Companies have normally problems with master data ownership in their operations and to create common data models that can be used by the whole company. (Silvola et al. 2011, p. 160) Security risks arise when data is widely shared (Li et al. 2015, p. 682).

Once there are existing problems in information systems, lower organizational levels should not overlook them. Problems and their sources should be identified and understood in order to avoid problems, escalation and affect to company performance. (Häkkinen & Hilmola 2008, p. 94) In everyday business life, it is still normal that data management actions are focused on immediate data crisis, instead of systematic long-term maintenance (Marsh 2005, p. 111). Once a company puts an effort to the product support, especially the support design and strategy, it can bring enormous profits and revenue for the company (Markeset & Kumar 2003, p.

376). Once the big data is utilized correctly, the advantage is that it can help to create more personified, accurate, high-quality and service for the customers (Li et al. 2015, p. 677-678). Data quality management starts from a corporate level commitment and it is a long-term initiative going from top to down of the business (Marsh 2005, p. 106-107).

2.2 Inventory Management

Generally, inventory costs and service level can be seen as the primary operating characteristics of the inventory systems (Dekker et al. 1996, p. 70). The primary aim of any inventory management system is to reach a sufficient service level with minimum administrative and inventory costs (Huiskonen 2011, p. 126). Actions regarding the material policy have normally an effect to the inventory. The inventory turnover parameter (see formula below) evaluates the efficiency of stocked material usage. (Sakki 2014, p. 55)

$$\text{Inventory turnover} = \frac{\text{yearly consumption}}{\text{average value of inventory}}$$

Here, it is recommend that the pricing principle for both the inventory and the consumption value is the same. If not, it is needed to make certain that at least the pricing principles of two different inventories are the same while comparing them with each other. The average value of inventory can be challenging to evaluate afterwards, and thus it is common to use the present value of the inventory. Another perhaps more illustrative parameter (see formula below) is called days of supply. (Sakki 2014, p. 56)

$$\text{Days of supply} = \frac{\text{365 days}}{\text{inventory turnover}}$$

When comparing inventory values between companies, the most practical parameter to calculate may be the inventory to sales ratio of total revenue, which is calculated in the following way by Sakki (2014, p. 56):

$$\text{Inventory to sales} = \frac{\text{value of inventory}}{\text{total revenue}}$$

ABC-analysis according to the Pareto-principle has maintained its popularity among practitioners and it is maybe the most commonly used classification scheme, since it is practical and easy to use. It can directly control effort and choose enough control parameters without the requirement of a material-specific analysis. ABC-analysis can be applied for various situations, especially when materials are quite similar and differences mainly emerge in terms of demand and item price. (Huiskonen 2001, p. 126) The Pareto-rule is also called as 20/80-rule and it can be applied for variable research subjects. It is based on the statement that for example 80 percent of the cumulative revenue is created by 20 percent of the products. Of course, this distribution is only approximate and it is also essential to understand that research time period must be long enough, for example one year. When it is a question of spare parts, the research time period is recommended to be longer than one year. (Sakki 2014, p. 63)

ABC-analysis is used for the actualization of the Pareto-rule. ABC-analysis categorizes different products into groups according to cumulative sale, for example. The objective of ABC-analysis is to create a better picture of how the inventory policy should be developed and how existing recourses should be focused. ABC-analysis helps to see detailed information while comparing different groups with each other. Hence, the increase of the supply chain efficiency is strongly based on the application of ABC-analysis. There is not any specific standard for categorizing, but Sakki (2014, p. 63) is conducted it as follows:

- A-products include 50 percent of cumulative sales
- B-products include following 30 percent of cumulative sales
- C-products include following 18 percent of cumulative sales
- D-products include last two percent of cumulative sales
- E-products are those ones, which did not have any demand

In order to make the right decisions concerning the inventory, it is essential to know the real total cost of the holding inventory. Understanding the costs can also help to getting approval for initiatives related to inventory management, which could be easily rejected otherwise. Adding the noncapital costs in the analysis, the true value changes substantially. The total cost of holding inventory includes both the total inventory noncapital carrying costs and the inventory capital charge. First mentioned are sum of the costs originating from warehousing, obsolescence, pilferage, damage, insurance, taxes and administration, whereas the required inventory capital can be seen as the opportunity cost of investing in an asses in relation to the expected return on assets of similar risk. In turn, low demand, obsolescence and price reductions cause the major risk of holding inventory. The noncapital carrying cost are often excluded from the analysis, since their estimation is experienced to be too challenging. (Timme 2003, p. 30-32) According to Richardson (1995, p. 96), the total cost of holding inventory is between 25 to 55 percent of the average annual inventory value. Table 1 shows the estimated carrying expenses as a percent of the inventory value (Richardson 1995, p. 96).

Table 1. *Estimated total cost of holding inventory*

1 Inventory at cost (average annual inventory)	
2a Cost of money	6 % to 12 %
2b Taxes	2 to 6 %
2c Insurance	1 % to 3 %
2d Warehouse expense	2 % to 5 %
2e Physical handling costs	2 % to 5 %
2f Clerical & inventory control	3 % to 6 %
2g Obsolescence	6 % to 12 %
2h Deterioration & Pilferage	3 % to 6 %
2a - 2h, Total	
Grand Total (1 + 2)	

In order to understand the existing costs in different stages of supply chain and their influence to the product profitability, the costs should be targeted on the basis of a causing activity. This way, the unprofitable products is easy to identify. (Sakki 2014, p. 33) In addition to warehousing costs, Sakki (2014, p. 46) counts in costs of incoming process and outgoing process. Incoming process consist of purchasing, inspection of incoming goods, goods reception, shelving, transport and administrative costs of the purchasing. Warehousing contains inventory costs, storage costs obsolescence costs. The outgoing process includes order handling, picking, packing, dispatching and administrative costs of sales and marketing. Each of these costs has its own cost driver, which is defined by the factor that has an influence to costs incurred. Typical expense for stocking space in relation to the inventory value is annually between 10 and 15 percent. The inventory capital charge is normally approximately from six to ten percent of the value of invested capital. (Sakki 2014, p. 43; 46)

Once products become more complex and technological advanced, it creates challenges for spare part management through the increased number of supported spare parts and the growth of inventory levels (Cohen & Lee 1990, p. 56). Unlike in a manufacturing supply chain, demand is hard or impossible to predict in after sales business. In spare part business, the number of stock keeping units is 15 to 20 times higher compared to a manufacturing unit and inventory turns only one to four times in a year. (Cohen et al. 2006, p. 132) Stock-outs can cause significant financial losses that are depending on downtime (Huiskonen 2011, p. 125). The company image may be at stake when it is a question of functional spare part logistics (Fortuin & Martin 1999, p. 968).

Problem occurs once a spare part that a customer demands is no longer in inventory. In this case, a spare part would have to be purchased or even manufactured individually and in every situation, it might even not be possible. Although there would not be any governmental requirement for a company to supply spare parts to customer, a company can still resort to some kind of unprofitable goodwill alternative in order to keep the customer happy. (Leifker et al. 2012, p. 285-286)

Over the time, the production starts to focus on the new product generations, which may not include the same parts as the former generations. Hence, all capacity in production will be focused on the new products and the production of spare parts for old products will not be profitable. This kind of economics of scale way of thinking that can be achieved in the production phase cannot be reached in after sales business. (Spengler & Schröter 2003, p. 8) Neither external vendors are not necessarily able to support all the parts for the whole life cycle of the product (Fortuin & Martin 1999, p. 954; Spengler & Schröter 2003, p. 8). It is undesirable to keep stocks for one user's special purposes (Huiskonen 2001, p. 131).

In spare part business the main problem arises from slow moving parts (Fortuin & Martin 1999, p. 963). Demand of spare parts is traditionally lumpy, intermittent and hard to forecast (Dekker et al. 2013, p. 537; Huiskonen 2011, p. 125; Jalil et al. 2011, p. 442). The service network can be often large and contain a high number of separate parts (Jalil et al. 2011, p. 442). Spare parts services can cover thousands of spare parts and to invest in these parts without any certainty of demand is a risky business. By means of unnecessary large safety stocks, this substantial level of uncertainty is often responded. (Dekker et al. 2013, p. 538) Furthermore, to keep the all spare parts susceptible to breaking in stock is a very unpractical solution, especially when parts are more expensive (Fortuin & Martin 1999, p. 963). Spare part logistics is a constant struggle to find a balance between inventory holding costs and the risk of stock-out and obsolescence (Dekker et al. 2013, p. 536). One solution to avoid the increase of stock level is to harmonize components (Cohen & Lee 1990, p. 56). Standardization of parts will lead to a smaller categorization and more pronounced demand of individual parts (Fortuin & Martin 1999, p. 964).

The spare part demand is hard to forecast if only historical data is at one's disposal (Dekker et al. 2013, p. 536). Hence, one-dimensional ABC-analysis is not anymore sufficient while variance of control characteristics increases. In practice, spare parts inventory management has traditionally applied general inventory management principles. Spare part inventory management is often seem as a specific case of general inventory management. In this connection, it is normally identified by some of its special characteristic, like very low demand volumes. (Huiskonen 2011, p. 125-126) Traditional statistical models for inventory control, including demand forecasting model are less applicable in spare part inventories, because the demand is often very low and lumpy (Fortuin & Martin 1999, p. 954).

Different kind of mathematical models traditionally strive to find the most optimal alternative between service level and inventory investment, whereas different kind of classification systems are trying to improve consideration techniques of administrative efficiency. Many sophisticated models are difficult to understand and to apply by practitioners. Basically, these models are either too strongly based on strict assumptions or more general versions of them are too complex to practical use. Prominent mathematical models do not still erase the fact that there are still various administrative decisions needed to be done, including choice of control parameters, purchase decisions and control policies for different kind of items. (Huiskonen 2001, p. 126) Via classification, companies can show that all service parts are not equally important and that items that are used in many different machines are more crucial compared to others (Fortuin & Martin 1999, p. 966). More attention should be focused on specific control characteristics of spare part business. Control practices are normally reaching only the local inventories, instead of seeing the supply chain as a whole. (Huiskonen 2011, p. 125)

According to the study results of Bacchetti & Saccani (2012, p. 724; 730) most of previous studies have used multi-criteria classification techniques, whereas companies favor mainly value or volume of demand and the use of ABC-analysis. Though, one-dimensional ABC-analysis is not sufficient anymore when variance of control characteristics increases (Huiskonen 2001, p. 126). Bacchetti & Saccani (2012, p. 724) have collected main spare parts classification techniques identified in past literature, including part value, criticality, supply uncertainty, demand volume, demand value, part specificity, demand variability, part reliability and product life cycle phase.

However, according to Huiskonen (2001, p. 129) the most relevant control characteristics of after sales business are criticality, specificity, demand and value. Criticality is a very crucial factor since the downtime costs of a machine can be significant for a customer. Though, it is still hard to define exact downtime costs in practice and normally it is not even necessary to do so. For practical use, it is recommended to define a couple distinctive categories for criticality, which are based for example on tolerance of failure. Specificity refers to the division between standard and more specific tailored parts. Here, specificity can vary in terms of both the number of customers as well as the number of other potential suppliers. Volume and predictability are aspects of demand pattern. In spare part business, large assortment of parts with low and irregular demand combined with high criticality and high price lead normally to a significant increase of stock while providing for unpredictable situations. As for predictability of demand is connected to failure rates, whereas high value of individual items makes stocking a non-attractive choice, and thus other kind of solutions are sought, including more effective cooperation of the supply chain parties. Generally, a high value of parts makes it more desirable to keep parts backward in the supply chain. (Huiskonen 2001, p. 129-130)

According to Dekker et al. (1996, p. 70; 74-76), spare parts should be divided into critical and non-critical parts and the criticality is determined by the equipment in which it is installed. Hence, same spare part can be both critical and non-critical. Though, this kind of inventory policy can be hard to conduct in more practical circumstances because its complexity. (Dekker et al. 1996, p. 74-76) Also Botter & Fortuin (2000, p. 662-663) valuation of the component criticality is hard a task to do and it normally requires subjective judgements. They suggest to divide parts into two groups based on functionality: a broken functional part will cause failure for the whole system, whereas cosmetic parts do not cause that (Botter & Fortuin 2000, p. 663-664).

Installed base data tells about the extent of installed base that triggers demand, and thus, it brings another kind of aspect that supports historical demand aspect. Installed base data includes information regarding size, age and location of equipment. (Dekker et al. 2013, p. 536-537) Though, manufacturers know unfortunately seldom the number of products that are still in operation (Leifker et al. 2012, p. 285). Dekker et al. (2013, p. 544-545) find that the use of installed base information together with historic demand creates economic benefits, especially in inventory and obsolescence costs for a company. Installed base information is especially useful, once it is a question of expensive slow-moving parts (Dekker et al. 2013, p. 545; Jalil 2011, p. 454). Furthermore, installed base information helps to understand geographical distribution of customers, and thus it helps to create a more effective inventory network (Jalil 2011, p. 455).

In a case example of Dekker et al. (2013, p. 541), installed base data covers machine level information of every machine type. Here, installed base data is linked together with relevant Bill of Materials (BOM) data. Installed base can include high number of varied machine types, which means low level of product standardization, which makes things more complex. Faultless and up-to-date installed base information is hard to obtain because of old, large and distributed installed base, autonomous changes of product configurations, diverse customers and machines and complex organizational structure. Especially data concerning older installed base is often scattered in legacy systems. It is also possible that the use of installed base information is focused only on newer products. Though, it can be an expensive and demanding task for a company to stay on track of installed base information, and thus it should be carefully considered if it is worthwhile. (Dekker et al. 2013, p. 541-544)

The decisions considering when to order are closely related to the question of how much to order. In spare parts inventory control, it is unpractical to adopt only one (re)ordering policy for parts, because of large diversity of characteristics of spare parts management. There are different kind control methods for order decision. In cases, where the parts themselves have a low value, but reordering afterwards is expensive because parts are needed to manufacture separately, and thus set-up costs are extensive. Here, demand forecast is needed to do once for the whole life cycle of the technical systems requiring this part and high safety margins are used to lessen the probability of stock out. In order to gain the greatest benefit here, orders and forecasts should be issued together with information of installed base. (Fortuin & Martin 1999, p. 959-961)

Spare parts with a very little probability that they will be required at all are so called risk parts. These parts are very essential for functionality of the machine and simultaneously their availability afterwards is very hard. Post-orders can be very expensive or have too long a delivery time, for instance. Overinvestment in risk parts are not wise, and thus it would be more important to evaluate how long the last technical systems that may need these parts will be functioning. The needed investments for these parts should be balanced against the consequences of non-availability. In these cases, the initial order should normally contain one or two parts. If reorder is needed, it should not contain more than one item at a time. (Fortuin & Martin 1999, p. 961)

Expensive and rarely ordered parts should be stocked at higher echelon levels compared to inexpensive and high usage products. One way to achieve a benefit is that spare parts that are needed by several actors that are located quite close to each other, would only be stocked in one location. Once items of two demand of two different units are joined together, so called pooling effect will decrease size of safety stock, compared to situation where separated unit would have their own safety stocks. (Fortuin & Martin 1999, p. 964) This above-described stock pooling improves service level simultaneously with decrease of inventory. Every part should not be stocked in every location. (Cohen & Lee 1990, 65) Also Huiskonen (2001, p. 131-132) recognizes benefits of inventory pooling, especially when items are both expensive and highly critical.

While evaluating stocking decisions of spare parts, consumption in units is more important than consumption in money. Nevertheless, item price is an important factor too while considering where and how many items should be stocked. Hence, they should be both taken into account in spare part logistics as very important factors. The criticality of an item should define need for stock-keeping, whereas the amount and location of stocked items should be based on usage in units and price. (Botter & Fortuin 2000, p. 655; 673)

Decisions, concerning which spare parts should be kept as stocked items, should be based on a categorization that is designed to be suitable for the purpose. All criteria that are proposed in the literature are not relevant in all situations, and thus the criteria should be a subset of these characteristics, selected case by case. (Fortuin & Martin 1999, p. 959). In different kind of control situations, there can be found that several criteria and combining them into one classification system would produce huge amount of different item classes, which would be impossible to manage (Huiskonen 2001, p. 130). As it turns out in the case study of Botter and Fortuin (2000, p. 673), it is important for companies to keep used techniques simple and practical enough for every day work especially, if there are large assortments of service parts. Used methods need to be accommodated to local knowledge (Botter & Fortuin 2000, p. 663). Attention should be focused on parts that really matter for the business and others should be controlled by a simple rule (Fortuin & Martin 1999, p. 968). Managers do not feel comfortable if they do not completely understand what the results of computational inventory models are based on, and thus different kind of rules of thumbs are very popular in managerial practice. Control and coordination in inter-organizational systems should be rather based on soft means instead of hard formal systems. (Huiskonen 2001, p. 127; 132-133)

Cooperation between the customer, the supplier and potential other parties as well as open information sharing has a critical role in strategic inter-company supply chain planning. It is important to have a clear definition of what levels of services are to be offered and is there segmentation or prioritizing among customers. After all, the effectively managed logistics system needs also to have clearly defined control and coordinator mechanisms, including decisions concerning inventory control principles and performance measurement indicators that support the set goals. (Huiskonen 2001, p. 127-128)

Because of the trickiness of spare part logistics, spare parts managers invest in better agreements with suppliers and increase cooperation and set up new kind of agreements with competitors and colleagues (Fortuin & Martin 1999, p. 968). Huiskonen (2001, p. 131) proposes that companies with special parts should search a reliable supplier, who can fabricate these parts by having technical drawings and right tools available. Parts standardization is also recommended, if possible. Once parts are more standardized, but expensive and have low criticality, it is practical to keep parts in supplier's stock. In the case where parts are critical as well as expensive, possibility of stock pooling could be an option. (Huiskonen 2001, p. 132)

2.3 Customer Service Management

The importance of service and customer satisfaction has undeniably a key role in business (Rust & Zahorik 1993, p. 193-195). According to Narver and Slater (1990, p. 32), market orientation can be seen as an important determinant of profitability in business. The most important element of achieving revenue growth and profitability is driven by customer loyalty, which is again based on customer satisfaction (Heskett et al. 1994, p. 164-165).

The customer satisfaction can be achieved with the help of well-managed and designed service concept that produces value for the customer. A successful service concept is managed by employee productivity and loyalty, which is a result from employee satisfaction. (Heskett 1994, p. 166) Employee satisfaction can be seen as the most important factor for the customer satisfaction and it is the key to build close customer relationships, and thus employee-oriented thinking is vital for management in order to ensure employee satisfaction (Heskett et al. 1994, p. 168-169; Kantsperger & Kunz 2005, p. 147). Hence, quality of customer service is highly related to the relations between management, employees and customers. Basically, everything originates from management level; their attitudes, interests and orientations and these appear in the employee satisfaction and loyalty, and that way in the customer satisfaction. (Kantsperger & Kunz 2005, p. 147-148) Therefore, management should support the front line workers in their everyday work and ensure pleasant working conditions and provide sufficient training for them (Kantsperger & Kunz 2005, p. 148). The strategical decision-making authority in the value proposition and marketing strategies should be handled and conducted at the lower level in management instead of high involvement of senior management. Once the responsible managers are closer to the performing level, the more they are able to understand about the complex needs of service business and its customers. (Neu & Brown 2005, p. 15)

Service ability is defined as an ability to act in a way that fulfills the customer expectations. Customers' needs and expectations vary and their perception of service ability can differ from the beliefs of the company, and thus it is highly important to have the right perception of the customer. (Sakki 2014, p. 58) According to Sabath (1978, p. 26), companies actually set service levels unnecessary high compared to how any customer would set them. Instead of speed of delivery, customers can prefer quality, reliability, availability or price, for instance. Thus, the service ability level should be measured via customer satisfaction surveys and customer feedback. (Sakki 2014, p. 58)

It is also important to have a critical point of view when implementing customer requirements considering service. Customers can likely name factors that they appreciate in service, but the exact definition of requirement is often missing. Thus, companies can easily execute requirements too precisely and expensively. For example, 24-hour delivery and 48-hour delivery can be both considered as fast deliveries, but the first-mentioned can cause much bigger expenses for a company. Hence, service levels should also be compared to the expenses that it causes in order to avoid over-performance. (Konijnendijk 1991, p. 141) Rust & Zahorik (1993, p. 211) point out that it is not guaranteed that those companies who already have a good customer orientation will improve it via directing more money into it. The only exceptions to this are specific, acknowledged weaknesses that are still remaining in operations.

Companies and associations buy because of organizational needs rather than personal consumption. Customers in organizational markets are more price-conscious and risks are normally higher than in consumer markets. (Viitala & Jylhä 2006, p. 89) The buying behaviour of organizations can be seen as more systematic and foreseeable and is based on different kinds of calculations (Bergström & Leppänen 2006, p. 126).

Although purchaser carries out the final purchase, there are many background forces including users, experts and managers affecting (Bergström & Leppänen 2006, p. 126). Decisions need approval of various actors and the financial responsible is normally a different person than the end-user of the product. Market networks are stronger and traditional buyer-seller roles are vaguer because one party can be both seller and buyer depending on the situation. (Viitala & Jylhä 2006, p. 88)

In organizational buying, the selling party faces challenges related specially to the customer satisfaction management and the building and development of customer relationship. The challenges are a result from the various actors who are affecting the buying decision. Also the decision-makers may vary according to situation. (Viitala & Jylhä 2006, p. 89) It is common that organizational purchasing is seen as a totally separate action compared to individual customers. In spite of its rational nature, it is important to still remember that there is still people behind all the decisions, and thus activities are regulated by personality factors as well. (Bergström & Leppänen 2006, p. 127)

2.4 Utilized Support Tools

While outlining the process data flows and piecing together data needs and requirements of different stakeholders in the case company, a SIPOC chart is used as a modelling tool. The SIPOC chart is a process mapping tool that illustrates different functions regarding to supplier, input, output and customer in a process. The picture above illustrates an example of how the SIPOC chart should be done. The SIPOC process begins with a definition of the process and is followed by a description of the process key steps that are described at the bottom of the SIPOC chart. Thereafter, main outputs and inputs of the process are listed and suppliers and customers for every input and output are identified. Figure 6 below illustrates the SIPOC chart. (Brook 2014, p. 25)

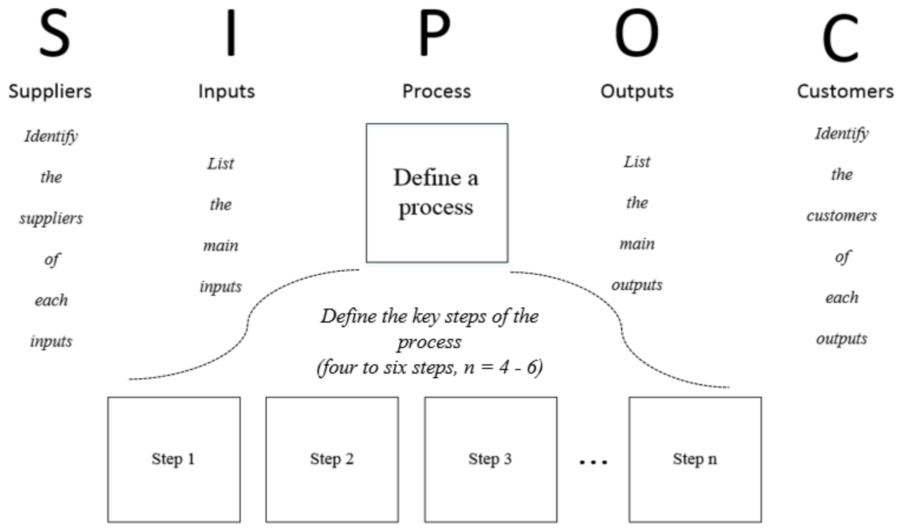

Figure 6. *SIPOC-chart (Brook 2014, p. 25)*

The fishbone diagram i.e. cause and effect diagram is used while identifying root causes. Additionally, it can be used in the analyze phase for structuring thoughts and issues. In the analyze phase, examined issues have normally several specific areas of investigation. The fishbone diagram helps to document each separated area of investigation by a different branch. (Brook 2014, p. 109) The fishbone diagram is illustrated in the Figure 7.

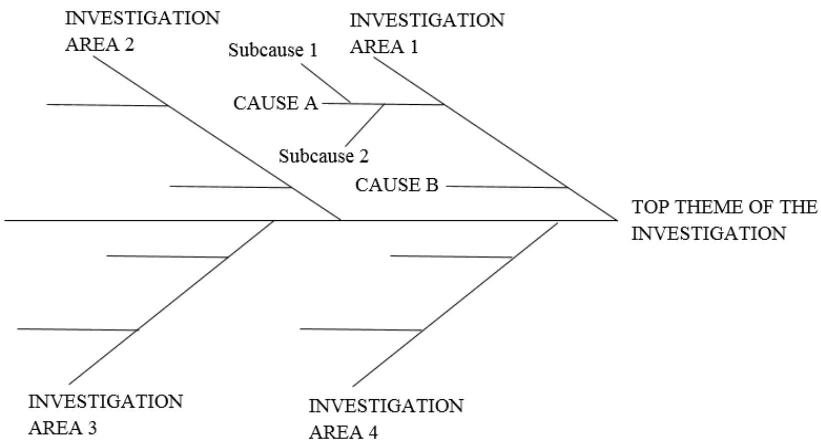

Figure 7. *Fishbone diagram (Brook 2014, p. 109)*

3 RESEARCH METHODS

This chapter describes the research methods that were used in order to conduct this thesis. First, the research approach is presented and it is followed by the research strategy. Finally, the data collection and data analysis are presented.

3.1 Research Approach

This study originates from a real-life problem faced by the case company, and therefore it is an empirical study (Kangasharju & Majapuro 2005, p. 14). Empirical studies can be based on either a deductive approach or an inductive approach. This thesis used a deductive approach, and thus the conclusions of the empirical study are based on existing literature that creates a theoretical foundation for the thesis. (Kangasharju & Majapuro 2005, p. 14; Saunders 2009, p. 41)

This study used both qualitative and quantitative data, and thus it is a multi-method research (Metsämuuronen 2008 p. 60). Qualitative research is defined as a non-numeric description of data and an analysis related to it. It can range from formalistic questionnaires to a more free-form in-depth interviews. Qualitative data can also include company’s internal material, such as already existing instructions and policy documents. (Saunders 2009, p. 480) Qualitative methods are useful especially when a study is interested in more detailed facts of events instead of their general distribution. Qualitative methods are more focused on events that cannot genuinely be demonstrated in an experimental environment. (Metsämuuronen 2008, p. 14) Quantitative data refers to numeric or other kind of quantified data that normally conveys very little meaning for most of the people before processing and analysing (Saunders 2009, p. 414).

According to Metsämuuronen (2008, p. 59), many methodology guides warn of excessively strong dichotomy between qualitative and quantitative research methods. Actually, the used approach should be determined by the needs of the research problem or the research aim itself. All resources of the research should be conducted in such a matter so that the most truthful outcome will be achieved.

Different kind of approaches are likely to give a richer general impression of the whole research subject, and thus it is recommended to exploit overlapping approaches. Still, since there are quite big differences between qualitative and quantitative research methods, it is recommend to use one method as a main method. In turn another method functions as a supportive role. (Metsämuuronen 2008, p. 59-60) Here, the qualitative method has a main role, whereas quantitative data acts as a supportive method.

3.2 Research Strategy

A research strategy describes the logic of how the empirical data has been collected and analyzed. This study was conducted as a case study, because it is an empirical research that examines a real-life topic and a contemporary phenomenon related to it in a case where boundaries between context and phenomenon are not totally evident. This study was also conducted in the field of business, where a case study is a suitable research strategy. (Yin 2003, p. 1; 13) Furthermore, this thesis combines quantitative and qualitative data, including simultaneous use of interviews, documentary analysis and observations, which fits well into the nature of a case study (Yin 2003, p. 14-15; Saunders 2009, p. 146). According to Saunders (2009, p. 146), the use of multiple sources confirms for a researcher that different sources of data are telling the same story.

3.3 Data Collection

Data collection defines how the empirical data of study has been gathered after the research strategy has been decided. In this sub-chapter, both the theoretical background of the data collection, concerning both primary and secondary data and their practical implementation of this study, will be presented. In this study, the primary data was mainly collected through internal semi-structured and more informal interviews, which both are functional for qualitative research. Interviews are a good way to collect reliable and valid data that is relevant to the research objectives and questions of a study. (Saunders 2009, p. 320-321) According to Saunders (2009, p. 323), a researcher can use more than one type of interviews and the most important thing is that chosen interview types should be consistent to with the research purposes. Here, the interviews were aimed to provide a deeper understanding of processes and used practices and procedures related to the spare part business, and thus interviews were kept quite informal. Semi-structured interviews were used especially when the scheduled time was more limited or when the researcher's initial understanding of the topic was still narrow. The more the researcher's understanding increased, the more specific were both interview themes and asked questions. These interviews were informal and unstructured, because the target was that the researcher truly understands and gets a clear picture of the studied issues.

In total, there have been 21 interviewees, who work with various tasks in different parts of the organization. Most of the interviewees work in these two supply units that study straightly concerns, but there are also people from product group level and from overhead units. The titles of the interviewees vary, including global products manager, business development manager, product manager, spare parts manager, warehouse manager, sales engineer, development engineer, motor technician, etc. Some of the people have been interviewed several times due to their considerable position and critical and large know-how in relation to this study.

The researcher of this study has earlier worked in another of these units that the study was all about and she also spent quite much time in the unit during the thesis work. According to Saunders (2009, p. 291), the participant observer can already be part of some specific community or organization which the research covers and this method is totally functional in the business research field. Hence, the participant observation is another primary data source of this case study, even though the minor one in conjunction with interviews. Here, the researcher has also adopted a role of an observer as participant. The advantage of this role is that the researcher can be totally focused on conducting the research. Also all additional pressures related to concealing are not disturbing the research itself. One disadvantage can be that the researcher cannot truly experience emotional involvement. (Saunders 2009, p. 294)

Secondary data covers both, utilized raw data and finished summaries. It is common that companies collect and store essential data in order to support and develop their own operations. (Saunders 2009, p. 256) In this thesis, the secondary data appears in various forms of written material. Utilized data originates from organization's databases, reports, websites and minutes of meetings are used as well as individual emails and one recently conducted master thesis. Consequently, all used secondary data of this thesis was obtained inside the company. Here, the secondary data is utilized together with primary data sources and according to Saunders (2009, p. 258), this is the most usual mode of operation for secondary data. The use of secondary data also saves resources and also enables the use of much larger data sets compared to a situation where all data is needed to be collected (Saunders 2009, p. 268). These two were definitely the contributing factors, for why the secondary data sources were exploited in this thesis.

3.4 Data Analysis

In this thesis, the data analysis has been conducted as an interactive process with the data collection process, as Saunders (2009, p. 505) states that it should. The right tools that are used for data analysis have an influence for analysis success and they should be determined by the objectives and possibilities (Saunders 2009, p. 490-491). Hence, the tools used in this thesis were selected so that they would be suitable for this thesis and the case company's purposes. The selected tools were found from the literature and, within the tools which are commonly used in everyday operations of the case company. Saunders (2009, p. 428-429) also notices that in quantitative analysis, it should be carefully considered that statistical techniques used meet their ends. Misrepresentation can be caused by using wrong kinds of mediums. Here, the foregoing required careful consideration while deciding which the most suitable presentation form for inventory values would be. The real values could not be shown in the final version of the thesis, because these values were classified, but then again real values help a reader to perceive things better. Eventually, it was decided to express the real values via factor *f*.

4 INTRODUCTION OF THE PRODUCT GROUP SERVICE

This chapter forms the first empirical part of the study. The Product Group (PG) is presented first and it is followed by the essential concepts and terms relative to this study. Thus, the aim is to provide adequate background information to the reader that is needed while reading the empirical part of this study. This thesis is conducted for a multinational industrial company that is a notable actor in several technological fields of its own.

The case company is divided into four different divisions which are again divided into their own BUs. Under every BU, there is again a separation into PGs. This thesis is written for one specific PG, which is specialized in service business. PG Service is responsible for the after sales services of machines that are produced by the four other Product Groups. Consequently, the operations of all other product groups are focused on Research and Development (R&D) and production. One of these is specialized in IT2-products, while the other three are producing IT1-products. This thesis is strictly focused on operations related to the IT2-products of Product Group Service. The organizational structure is illustrated in the Figure 8.

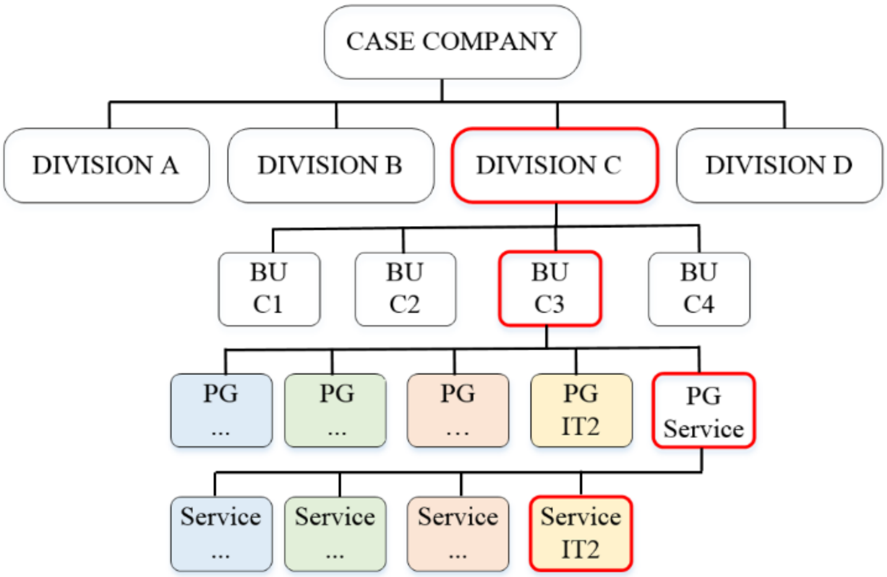

Figure 8. *Organizational chart of the case company*

4.1 Structure of Product Group

The PG Service is responsible for lifecycle services for machines produced in the BU. It has adopted a two-echelon operations model that is generally known as a front-end and back-end model. Therefore, the PG Service consists of both global as well as local technical support operators. The basic idea of this model is that an end-customer is taken care of by a local service sales unit that is focused and specialized in understanding and delivering the end-customer's specific needs. Thus, the local service sales units are the primary interface that an end-customer sees and due to this it is called a front-end.

Global Service Units (GSUs) are the so called back-end sales and they do business only internally with the front-end. The back-end is more strongly linked to the production and the R&D. Although the front-end operators constitute the clientele of the back-end, spare parts are still often delivered straight to the external end-customer address. Consequently, the front-end units take care of their local end-customers, whereas back-end deals with local front-end sales units worldwide. Figure 9 illustrates this structure. This study is focused on operations and functions of GSUs.

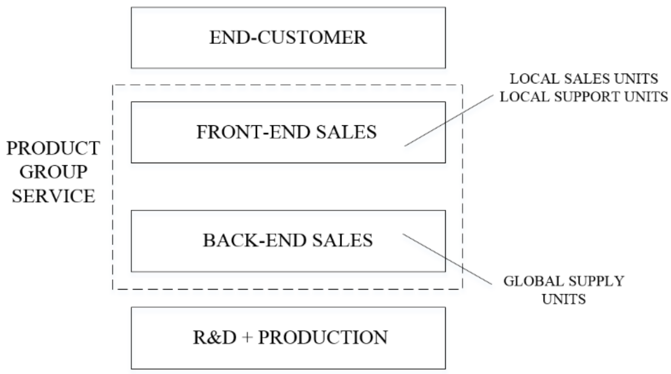

Figure 9. *Structure of the PG Service*

There are four different GSUs, which are located in Finland, Sweden, Italy and Switzerland, but only Finland and Sweden produce after sales services related to IT2-products. In addition to spare part sales, GSUs also produce services related to capital spares, field service and warranty. As it was stated already earlier, this study concerns only spare part services of IT2-products.

4.2 Product Group Strategy

The vision of PG Service is based on the fact that service is seen as the key differentiator in the customer's eyes when choosing a supplier. This means that customers choose to buy products of the case company because of the quality of service, and not the other way around. Hence, the mission of PG Service is to understand their customers better than any other competitor. Product Group Service helps customers to achieve their goals via driven service of customer's known and unknown needs and expectations and thus fulfilling the service experience.

The value proposition of the spare part business is to provide a full scope of easily available genuine spare parts for customers with critical operations. Spare parts are provided with the right price and delivered at the right time in order to minimize any production downtime. In order to differentiate the company from its competitors, specific criterions i.e. differentiators have been defined.

Firstly, the company knows which parts statistically fail, how the lifecycle of components has been designed and how critical each one of the parts is. The company has adopted a proactive approach: availability of recommended tailor-made spare part packages for each individual motor and generator is guaranteed. It is recommended that customers keep these spare part packages on site, and thus possible motor downtime can be minimized. Next differentiator is that the company knows exactly which components are used in each individual motor and generator. This way, correctness and authenticity of the spare parts can be guaranteed. The third differentiator is the ability to provide all required spare parts. The competitors of the company can only provide a specific spare parts and thus, it is possible that the customers have to shop around in several places. In this case, they will take a risk regarding component correctness. Lastly, the Business Online (BOL) eases the way of doing business and the most common parts are provided directly from stock with short delivery times. However, for critical devices it is a better option to have parts on site.

4.3 Product Lifecycle

The purpose of a product lifecycle is to define technical product maintenance and product information management. In the end of production, a product lifecycle map reveals how long a particular product will be supported by the company. This support service period is divided into four different time periods, which differ from each other in terms of product availability. These four periods are illustrated in the Figure 10:

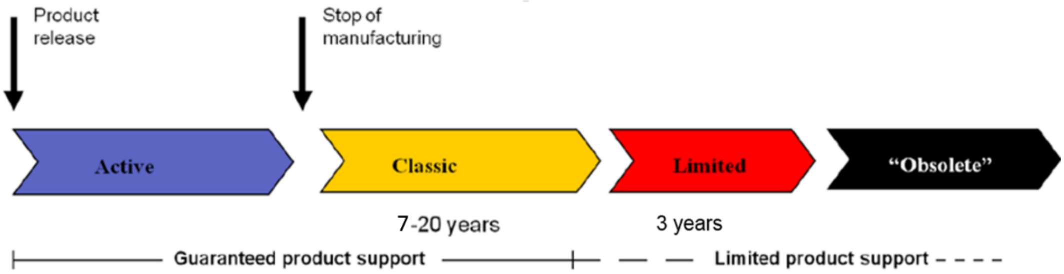

Figure 10. *Support service periods*

During the active period the products are actively produced, marketed and sold. Full service support is available for the products in this period. Once production stops, the products will move on to the classic period. The products still have full service support available. Limited support period means simply that service support is limited and the availability of all parts cannot be guaranteed. Once the limited period of the product support has begun, customers are recommended to replace their products with a new superior product type that is in the active phase. Obsolete product types are no longer in volume production and service support is normally not available. Customers are strongly recommended to replace their obsolete product types with a new superior product type in the active phase.

The length of these separate time periods are normally strongly connected to the size of the machine. The support period of the smallest models lasts normally ten years, among middle-sizes machines the same period is fifteen years, and the largest motors have twenty-year-support. There are slight differences between the GSUs in Finland and Sweden, regarding how the support period is calculated. The relation between machine size and support period can be seen in the Figure 11. Also the alternative support period calculation methods Y and X are illustrated.

	Life-cycle of machine after the active period i.e. after manufacture has ended (year)																								
Shaft height	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
56-132 (method Y)	C	C	C	C	C	C	C	L	L	L	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
56-132 (method X)	C	C	C	C	C	C	C	C	C	C	L	L	L	O	O	O	O	O	O	O	O	O	O	O	O
160-250 (method Y)	C	C	C	C	C	C	C	C	C	C	C	C	L	L	L	O	O	O	O	O	O	O	O	O	O
160-250 (method X)	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	L	L	L	O	O	O	O	O	O	O
280-450 (method Y)*	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	L	L	L	O	O	O	O	O
280-450 (method X)	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	L	L	L	O	O

* = Not in use   C = Classic   L = Limited   O = Obsolete

Figure 11. *Support period calculation methods*

The guaranteed availability of lifecycle services for a certain product can be seen in the product lifecycle map. The spare part catalogues define, which spare parts are offered for each supported product. The type of catalogue varies depending on which GSU-unit is responsible of producing its lifecycle services. Thus, different IT2-products have different types of catalogues depending on product model, responsible unit and year of manufacture. In general, the case company supports all different parts of machines with the exception of a few larger inner assemblies of the machine that can be seen as separate independent entities in this context.

4.4 Spare Part Types

IT2 spare parts can be divided into two groups: machine spare parts and accessories. Once a new supported machine type is introduced, the list of required spare parts is compiled. At the GSU Finland, this is done in the form of a spare part catalogue, whereas in Sweden an equivalent Excel-file is used. These catalogues include only machine parts, not accessories. In addition to the aforementioned, the GSU Sweden also sell complete spare part packages. The GSU Finland is not doing it, because they have more custom produced machines to support and the spare part packages are easier to design and sell, once it is a question of serial produced machines.

The physical size and complexity of the machine has a main role regarding the amount of different spare parts for a specific machine. The more complex and larger a machine is, the more spare parts it consists of. In smaller machines there are not so many small individual parts, because separate parts are already originally produced in bigger assemblies. Spare parts can be divided into machine spare parts and accessories which both consist of sub-categories. These sub-categories are presented in the Figure 12.

1 MOTOR PARTS

- **1.1 Bearings, Bearing Housings and Related Parts**
  - 1.1.1 Bearings
  - 1.1.2 End Shield
  - 1.1.3 Inner Bearing Cover
  - 1.1.4 Outer Bearing Cover
  - 1.1.5 Shaft Seals
  - 1.1.6 Valve Discs
  - 1.1.7 Other Bearing Parts
- **1.2 Cooling Parts**
  - 1.2.1 Fans
  - 1.2.2 Fan Covers
  - 1.2.3 Other Fan Parts
- **1.3 Terminal Parts**
  - 1.3.2 Connection Parts
  - 1.3.2 Terminal Box Frame
  - 1.3.3 Terminal Box Cover
  - 1.3.4 Terminal Board
  - 1.3.5 Other Terminal Parts
- **1.4 Other Mechanical Motor Parts**

2 ACCESSORIES

- **2.1 Heating Elements**
- **2.2 Parts for Cable Entry**
  - 2.2.1 Cable Gland
  - 2.2.2 Gland Plate
  - 2.2.3 Cable Sealing End Unit
  - 2.2.4 Other Parts for Cable Entry
- **2.3 Screws and Nuts**
- **2.4 Sensors**
  - 2.4.1 Temperature Sensors
  - 2.4.2 Vibration Sensors
- **2.5 Other Accessories**

Figure 12. *Spare part categorization*

Spare parts are divided into two categories, listed items and unlisted items. This division is based on material status in BOL in the following manner:

- Listed items can be found and ordered from the BOL system with up-to-date prices and supply information by a customer. A part of the listed items is physically stocked and the rest are purchased from a supplier based on customer order.

- Unlisted items, in all its simplicity, cover all possible other items that are not listed items. Unlisted items always require a Request for Quotation (RFQ) from the customer. They are handled individually by a sales engineer, and thus price and supply information can vary. The order of the unlisted item is always based on a quotation drafted by a sales engineer.

Both units have their own Lotus Notes procurement database that include all case specific supplier orders related to the quotations of unlisted items.

4.5 Systems and Applications Used

There are many different systems and applications that are needed while executing the spare part process related to IT2-products in the case company, and therefore they are also widely referred later in this study. In order to get a deeper understanding of the issues discussed, a basic knowledge of the systems and applications is important for the reader. Hence, the most important systems and applications that are relative to this study are defined below. These definitions are written from the perspective of PG Service.

- Business Online (BOL) is a web-based front-end application i.e. a customer interface system. It is a customer visible online platform, whose functions are based on the use of Order Management Services (OMS) system as a backbone. All required data that is needed in BOL functions, including material, customer and price data is stored in OMS. BOL has recently been implemented in all GSUs within the recent years. The objective has been to simplify processing of quotations and orders. Through BOL, the back-end activities can be brought closer to the customers.

- Lotus Notes is a globally used platform that contains mainly local applications, including email and various databases. It was decided recently that the company will give up the system.

- SAP is an Enterprise Resource Planning tool (ERP) that is used globally all over the company’s units, but every country is using its locally customized SAP system. SAP includes information related to the basic processes of the company, including data related to products, customers and orders, and therefore also different steps of the spare part process are handled at least partly in the SAP system. Additionally, SAP is used widely as a database, where various data can be checked. SAP acts as a master data system for the units. Local SAP systems vary from each other in terms of type and amount of made system configurations, whose purpose is to facilitate how everyday processes in the company are conducted.

- ServIS is an installed base management tool that is intended for the global tracking of the installed product base. The ideal goal has been to include all installed base information of the BU, including machine spare parts under one worldwide tool. Spare part lists can be found from the ServIS by a serial number basis. GSUs are responsible for uploading serial number specific spare part lists into the system.

4.6 Spare Part Process Introduction

The purpose of this subchapter is to present the basic spare part process before the deeper examination of the business in the following chapters. The aim of the spare part services is to produce high-quality customer service, spare part deliveries and technical expertise to the customers. As it was stated in the beginning of this thesis, dispatch operations have been delimited outside of the scope, since a review of them is not seen to give any additional value for the purpose of this thesis. Hence, the spare part process consists of sales, order handling and purchasing, which are also called as office processes, since they are physically executed at the GSU offices, whereas the dispatching is executed in the warehouse. Additionally, product support has also a vital role in spare parts sales. Figure 13 below illustrates these different sub-processes.

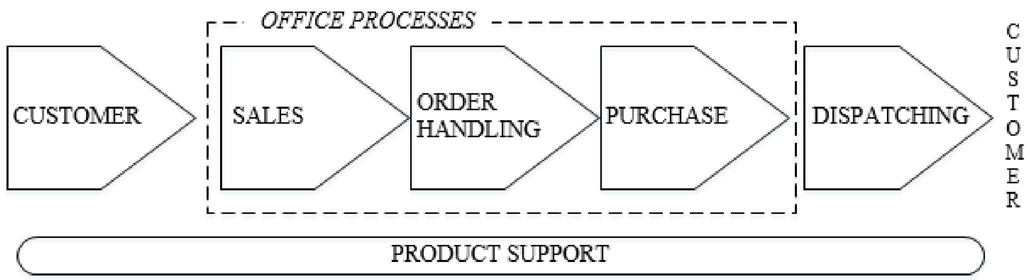

Figure 13. *Sub-processes of the spare part process*

The purpose of the sales process is to reply to the RFQs that are sent by customers. As it was stated, all global support services of the IT2-machines are centralized in

Finland and in Sweden, The general division of the support responsibility between these two GSUs is conducted so, that the GSU Finland is responsible for cast iron machines, whereas the GSU Sweden takes care of the aluminum machines. In regard to technical or structural basis, these two do not have major differences, only the production material is different. Table 2 below describes how the received RFQs differ in terms of country of production.

Table 2. *RFQs by the country of production*

GSU FINLAND	GSU SWEDEN
Finland (60 %)	Sweden (50 %)
Poland (20 %)	Poland (36,8 %)
Spain (10 %)	Spain (3 %)
Germany (5 %)	Italy (0,5 %)
China (3 %)	China (3 %)
Italy (2 %)	Romania (5 %)
	Turkey (1,5 %)
	Denmark (0,2 %)

The RFQs can include either spare part inquiries or technical support questions. Depending on the needed spare part, customers either order a spare part independently or send a RFQ to the GSU. At GSU Finland, virtually all customer orders and RFQs are received via BOL. At GSU Sweden, all customer orders are basically received via BOL, but RFQs are still received partly via email. However, at the GSU Sweden the number of RFQs received via BOL has steadily increased and in the latter half of year 2015 approximately over 70 percent of all IT2 RFQs were received via BOL. In addition to spare parts sales, the both GSU also gives technical support related to spare parts to the customers. These questions are also sent as RFQs via BOL. All other possible inquiries are forwarded to other departments.

There are approximately 350 RFQs replied monthly in Finland, whereas in Sweden 270. The target is to handle all received RFQs within the next 24 hours. In Finland, this target is achieved approximately in 70 percent of all cases, whereas the same number in Sweden is almost 100 percent. Challenges are caused by long supplier response times, quality of data and the variability of workload and recourses. There are two full-time sales engineers at GSU Finland, although it is estimated that the workload should be able to handle by 1,5 employers. Still, because of the complex work tasks and high turnover risk of part-time employers, it has been decided to have two fulltime sales engineers. GSU Sweden has only one sales engineer.

Order handling is responsible for the order approval in BOL. Currently, both units receive on average 330 orders monthly, but the number fluctuates. Customers can make an order independently or base it on a quotation received from a sales engineer. Order handling checks the orders and makes sure that required material data of ordered spare parts can be found from SAP. Once a BOL-order is approved, a sales order is automatically created in SAP on basis of the BOL-order. All IT2 spare part orders are received via BOL. GSU Finland has two common order handlers for IT1- and IT2-products. Roughly 40 percent of their total worktime is taken by IT2-products. GSU Sweden has one fulltime order handler for IT2-products. The customer promise is that all stocked spare parts, where the order is received in BOL before the noon, will be sent on the same day. At GSU Finland, approximately 95 percent of all IT2 order rows include stocked items, whereas roughly 50 percent of all IT1 order rows are stocked items. Hence, the IT1 spare parts are more often purchased individually from the supplier. The IT2 spare parts are much widely stocked, although the IT2-machines are simpler and less expensive, and thus generally less critical machines compared to the IT1-machines.

GSU Finland has two purchasers who both buy spare parts related to IT1- and IT2-products. The distribution of work is carried out so, that one purchaser buys all non-stocked items, while the other takes care of the stocked items. In Sweden, there are only one common purchaser for both product types and IT2-products constitutes approximately only 25 percent of the purchaser’s workload. Procurement initiatives of stocked items are based on storage levels and re-order points. Procurement initiatives of non-stocked items are created by individual customer orders. The GSU Finland has its own supplier agreements, which are regularly updated by the purchasers, whereas the GSU Sweden has common supplier agreements with production.

Quality and performance of operations are mainly analyzed via On Time Delivery percentage (OTD) and customer complaints. Traditionally, there has been only one common OTD meter for both IT2- and IT1-deliveries. At GSU Finland, the common meter has been 98,7 percent during the last year, whereas OTD percent only for IT2-deliveries has been 99,5. At GSU Sweden, the common meter has been approximately 94 percent. The own OTD meter for IT2-deliveries is a rather new indicator in the GSU Sweden, and thus there are not yet reliable results available. It is still known that compared to IT1-deliveries, OTD has been constantly more stable and higher among IT2-products. The excellent OTD-percent of IT2-products can at least partly be explained by the high percent of stocked items and the regularity and simplicity of products. The customer complaints are handled individually case by case and any compilation is not made.

Product control is handled by a product specialist whose basic duties are to create, maintain, update, replace and remove an item in SAP and other systems that are used, mainly OMS and BOL. The product specialists also make decisions considering inventory policies of individual products: they are in charge of taking new spare parts into the warehouse as well as doing decisions considering possible scrapping of stocked parts.

Both units have their own product specialist for IT2-products. They both have long experience of working with IT2-products. A product specialist in the Swedish unit has worked 25 years among IT2-products, whereas a product specialist in the Finnish unit has approximately 20 years of experience. Long experience helps product specialists to support the parties that are working in the spare part process related to IT2-products, if needed. Additionally, they take care of different kinds of general issues and administrative tasks related to IT2 and their opinion in issues related to IT2-products is usually highly valued. Neither of them are not working full time as product specialist, but they also have other responsibilities.

5 DATA MANAGEMENT STUDY RESULTS

In this chapter the different process steps of the spare part process are described from the data management aspect. The product control is studied first and it is followed by the spare part process steps in chronological order. The results of the study are based on interviews with different parties of the spare part process. This chapter is written collectively considering the both GSUs. The emphasis of this chapter focuses on the processes of the GSU Finland and it has been completed with differences and specialties in comparison with the GSU Sweden. The basic process steps are quite similar in both GSUs, and thus separated processing would only make the structure of this thesis harder to read.

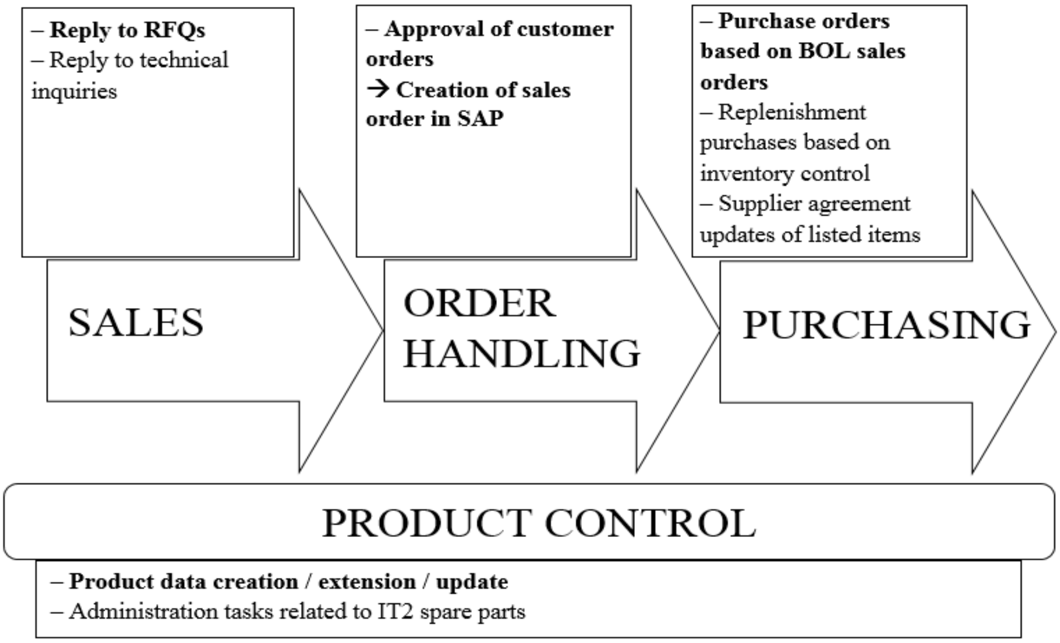

Figure 14. *Summary of process tasks*

The basic tasks of every process step are presented in the previous subchapter 4.5 and the summary of the tasks related to the every step can be found from Figure 14. Now, when the basic tasks of each process step are sorted out, it is time to find out:

1. What kind of procedures are used in order to conduct the different process tasks?
2. What kind of information is needed for a successful execution of them?
3. How is the needed information stored?
4. What kind of difficulties does the different process steps and procedures include?

The clientele of the GSUs is made up of the internal front-end units, which sell spare parts and modification parts for the end-customers' machines that have been bought earlier from the case company. Because the case company has produced the machines itself, it should have all the records considering the information of these machines, and thus it should also be able to say, which spare parts and modification parts are the right ones to use. Consequently, it is presumed here that the execution of the IT2 spare part process should not require any particular technical expertise, but all needed information should be stored in an accessible data form. The only exception is seen in the tasks of the product specialists, which are more general and administrative compared to other work tasks in the spare part process, and thus they have to have a good general overview and deeper understanding of the machines.

In this chapter, the bolded process tasks of Figure 14 are examined with help of the SIPOC-chart that was presented in the literature chapter. Other tasks are described more briefly, only in a text form. The separation is based on the preliminary assessment of the criticality of the different tasks.

5.1 Product Control

At GSU Finland, the product specialist receives information of a new machine and its spare part lists from the R&D department in the form of a spare part catalogue. This catalogue includes the list of spare parts that the new machine includes. The product specialist reviews the list and gives possible editing comments as feedback. Generally, the spare part catalogue may give a good picture of the basic spare parts of the machine, but occasionally catalogues contain some incorrect spare parts and module codes of larger assemblies. A template of a new catalogue is traditionally copied from an old catalogue, and thus flaws sometimes appear.

The product specialist of the GSU Sweden also receives the information of new machine from the R&D, but as a difference compared to Finland, the product specialist creates the spare part listing independently based on the Bill of Materials (BOM) and the technical drawings of the machine. Basically, the creation of the spare part listing should be an assignment of the R&D, but in some point they have had difficulties to find a qualified person to do it, and thus the product specialist has taken over. Over the time it has become established practice. The GSU Sweden uses a specific spreadsheet as spare part catalogue. From this spreadsheet, it is possible to check what spare parts belongs to a certain machine based on the machine code that is filled into a certain cell.

The product specialist of the GSU Finland does not always receive information of each new supported machine. There is often insufficient information particularly with the machines that are produced in some other location than the local production plant. Once the production network of supported machines has gone more global, it has become harder for the product specialist to keep up with the new products. The global communication process is not working completely smoothly and information gaps occur.

In the beginning of the support period, the most important step is to take care of the creation of new spare part codes. This process is illustrated in the Figure 15 as SIPOC-chart, from the GSU Finland's view. The spare part codes are needed for everyday operations in SAP as well as by customers in BOL. Same spare parts can be used in several machine types, and thus some spare part codes of new machines do not require any actions, because they are already supported. At the GSU Finland, same material codes are used with the R&D and the production, and thus the material codes are normally created in SAP by other users already. Therefore, the GSU Finland can normally expand the existing material data to their own SAP-plant while creating the material codes.

At GSU Finland, the SAP system is integrated with the OMS system. Therefore, it is basically enough to create all codes in SAP, since all items that are created in SAP, should automatically move from SAP to BOL via OMS during system updates. Still, the codes are not extended to OMS, without a specific command from the product specialist. This is done via a separate SAP transaction. In practice, the product specialist often still needs to do changes manually in OMS. The critical thing here is the product data ownership in OMS. Generally, according to the OMS logic, the product owner is the party, who has first created a spare part material code in OMS. In many cases in the spare part business, spare part material is also used as a customized part by central warehouse, and thus the spare part material code is already created in OMS by the production plant. The production plants do not use OMS by themselves, but the central warehouses do not have a license to own any material codes, and therefore the factories open codes for their use.

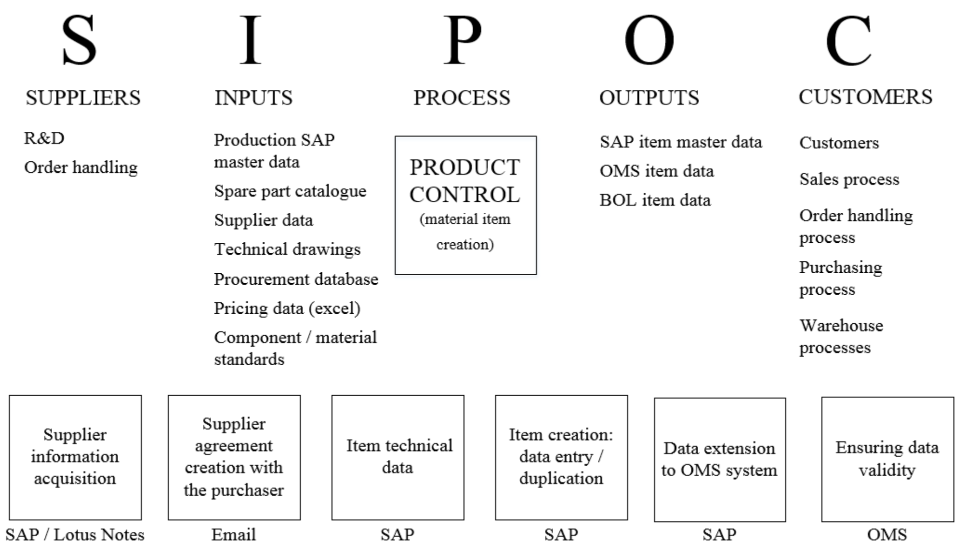

Figure 15. *SIPOC chart: product control*

When the GSU is not the product owner of a material code in OMS, all product data that is intended to update in BOL by sending it from SAP via OMS to BOL, does not turn up in BOL at all. The party who is not a data owner is unable to change certain specific OMS data fields, including material name, technical specifications and a permission to publish and sell the material in BOL. If this data needs to be changed or created by someone else than the product owner, it is needed to send a single request of each offending material code to the PG Content Team, which has the right to do changes into this restricted data. Any user is able to appoint itself to be a supplier of a spare part. Once the user has agreed to be the supplier, the user can define availability and price information.

Once the factory is creating a material code for the need of the central warehouse in OMS, it is not interested in the same kind of material information, as the spare part business would be. For example, in the spare part business material description and technical specifications have a strong importance for customers, since OMS data is shown to customers via BOL. OMS is an old system, which was originally designed for more local use, and thus it is not practical in global use.

Contrary to the GSU Finland, the GSU Sweden uses its own rewritten material codes. Basically, these codes look the same as the material codes of the R&D and production, but the end of the code is changed. The GSU Sweden replaces the end of the original code by its own specific sign. Still, if the general code is used more widely than by the Swedish production plant of the IT2-machines, the general codes are used instead of the modified ones. Among other things, these general codes include for example bolts, nuts and washers. Because the GSU Sweden has its own personal codes, it does not suffer from the difficulties caused by the product data ownership, since it is always creating its own material codes from the very beginning. For instance, problems related the data transfer from OMS to BOL do not cause any harm once one has data ownership. The labelling logic of the GSU Sweden codes works as follows:

- When the factory code ends with a number, the support unit replaces “–“ with “R“ (eg. 3GZV223039-3 = 3GZV223039R3)
- When the factory code ends with a letter, the support unit replaces “–“ and puts “1“ behind the code (eg. 3GZV314053-B = 3GZV314053B1)

At GSU Sweden, the SAP system is not integrated with the OMS system, and thus material codes needed to be opened separately in both systems by the product specialist. On one hand, this naturally increases workload since everything has to be done twice, but on the other hand it is more certain that all data is in correct form in all needed systems. Although the above-described code modification rule is quite simple, there are still some problems for the customers to remember it, and thus they need to be reminded of this rule.

A new spare part material code requires both technical data and supplier data. The technical data describes mainly general issues, classifications and technical characteristics of material. The basic data is basically the same as the production uses, and thus it can be duplicated as such from the production master data. At the

GSU Finland, if updates for material codes need to be done afterwards, they are normally related to supplier information. Technical data stays basically unchanged the whole lifecycle of a part. At the GSU Sweden, the technical data is not changed, but additional information is often added afterwards to assist customers better.

The GSU Finland is located physically relatively far away from the production plant, and thus it cannot be assumed that suppliers are willing to do business with the same delivery terms as with the production plant. Therefore, the supplier contact information can normally be checked from the production SAP-plant, but more accurate supplier data, including delivery time, batch size and price is inquired separately from a supplier. Although a supplier contact information normally comes from the production, there is not any guarantee that the same supplier is willing or even capable to support the parts during their after sales period. Therefore, the production and the after sales do not have common supplier agreements.

At GSU Finland, the product specialist acquires relevant supplier contact information and the purchaser handles the operational contact. If a potential supplier contact is unable or unwilling to fulfil the request, the purchaser turns back to the product specialist who tries to find out another potential supplier contact. Primarily, the GSU Finland uses the same supplier as the production does. In order to find a supplier for a spare part, the product specialist can check possible earlier or secondary supplier information for the spare part. If the supplier contact cannot be found via the production purchase data, the product specialist uses his personal experience of potential suppliers.

Since the GSU Sweden is located very close to the Swedish machine factory, the internal purchase department of the machine factory is responsible of the supplier agreements in active phase machines, and thus the GSU Sweden has not needed to have its own supplier agreements. In recent years, these supplier agreements have also been updated to officially cover the spare part deliveries over the whole support period. The supplier contracts are normally valid until further notice, and thus the GSU Sweden has no need to perform any specific updates. However, if a supplier becomes unable to supply certain spare parts, the product specialist checks for possible other suppliers that the machine factory has used in past. If this does not give any results, a product specialist uses personal experience and tries to find out a new potential supplier contact among the suppliers who have traditionally delivered equivalent spare parts. Searching for a supplier contact from the internet is the last option.

Once the production location of machines changes, also the support responsibility can be transferred with it. These kind of changes happen normally when the production of the present machine generation is transferred to another production plant, and thus the support service of the previous models is transferred along. Communicating and the data transfer should be handled in coordination between the global representatives of the PG Service and the R&D. Especially in the GSU Finland's point of view, communicating about these changes has been quite weak and received data has been insufficient in the past. Once it is a question of transferred products, the primary used contact information varies in both units case by case between a supplier contact information given by the current or previous production plant.

Due to unclarity issues, the both product specialists keep mainly contact with the local production plant. Once it is a question of problems with spare parts, whose responsibility has been transferred globally, the product specialist of the GSU Finland contacts still mainly with the local production plant, whereas the product specialist of the GSU Sweden consults the contact persons of the original unit. At GSU Finland, contact information of global productions unit are partly defective, while the GSU Sweden does not have corresponding problem. At the GSU Sweden, the main problems related to the supporting of the machines produced outside of the local production plant concern unidentified serial numbers, while the product specialist can normally solve all other problems. At the GSU Finland, the access to the original BOMs of the transferred products is sometimes experienced as hard. Also changes in BOM are likely after the production transfer, which causes problems for the after sales business because information of these changes is lacking. Now, when the IT2-production has transferred from Sweden to Finland, the product specialist of the GSU Sweden has kept more frequently contact with the production plant in Finland too. The product specialist of GSU Sweden is an expert with BOL and OMS system, and thus the Finnish product specialist needs his help with material code problems related to these systems.

The task of the product specialists is also take care of administrative tasks related to the IT2 spare parts. In the data management point of view at the GSU Finland, this means collecting and gathering data that cannot be found from other data sources in form of so called technical releases that are meant mainly for back-up material of the sales engineers and training. At the GSU Sweden, these kind of databases is not maintained, since all required information is found from other data sources. Furthermore, at the GSU Finland, another sales engineer has also created some additional instructions that are located on a network drive. These instructions originate from a personal wish to record some essential points that are needed in sales, but cannot be found elsewhere. However, these instructions are not a complete instructions for IT2 spare part sales process, but rather guidance on specific subject areas and to specific cases.

5.2 Sales

The purpose of the sales process is to reply to RFQs that are sent by customers. The RFQs can include either spare part inquiries or technical support questions. The process starts with the reception of a RFQ in BOL. If it is about a pure spare part inquiry, the first thing is to identify the spare part, which the customer refers to. The most important contents of the RFQ are serial number, machine type code, possible variant codes and a description of spare part or alternatively a material code. All machines do not have a serial number. Especially, the age and size of the machine, the level of customizing as well as production plant have an impact to the existence of material code. Once the machine has a serial number, spare parts are much easier to quote. If only the basic machine type code is available, only the standard spare part can be quoted. The machine type code does not tell anything about possible changes in the machine structure. Hence, the sales engineers try primarily find out the serial number. The sales process is described in the Figure 16.

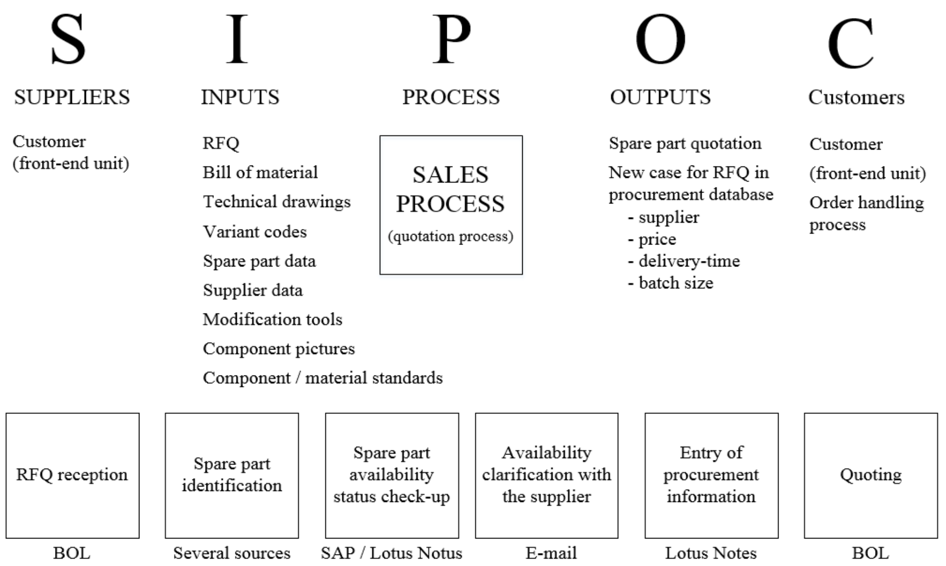

Figure 16. *SIPOC chart: sales process*

Especially various modifications make the quoting process more difficult and complex. Modification work can be done either for unfinished machines, undelivered but finished machines or already delivered machines by the customers themselves. First, the modification can be done by the production plant, which means that the customer has already originally ordered a custom-made machine, and thus it is engineered based on the order (ETO). In this case, the changed structure caused by the modification work is already mentioned in the original BOM. The Finnish production plant has traditionally produced a lot of these custom produced machines, the Swedish production unit less. Therefore, especially the GSU Finland has a lot of custom machines to support.

Secondly, the central warehouses of the case company sell modified versions of the standard machines to customers. Consequently, the central warehouses stock the standard machines and modification parts and sell these machines to customers with desired modifications. Done modifications are expressed through variant codes, which can be checked from the rating plate of the machine. At the GSU Finland, the variant codes cause some difficulties to the quoting process, because the variant codes are in some cases not connected to the original serial number of the machine clearly enough. Problems occur especially with the older machines. The variant codes of machines that are produced within recent years can be checked easily via original serial number from ServIS. The variant codes do not tell the exact material code of modification part, but only the type of done modification work and the exact material code needs to be searched from another database. At the GSU Finland, this clarification process is experienced as needlessly complex. The GSU Sweden does not recognize this kind of problems. According to the GSU Sweden, basically all variant code information can be found from OMS and it has been transferred also to ServIS. Once the correct variant code is found, the technical details can be checked through technical drawings that can be found via variant code from ServIS.

Finally, once customers want to change or enhance some feature of a current machine, it is a question of a modification work. At the GSU Finland, roughly every third RFQ is related to a need of modification parts, whereas at GSU Sweden number is lower. At the GSU Finland, the suitability of a modification part can be checked via a configuration tool in SAP, and this way the suitable part can be identified and quoted to the customer. The problem is that the configurator does not give a clear answer to what parts should be used in the modification work, instead it just shows the new modified structure without highlighting the parts that has been changed compared to the original BOM. The main component to be changed is normally easy to identify, but the additional parts are trickier. These situations can be solved by either comparing the original BOM to the BOM that the configurator has given or by verifying the other parts via the variant code descriptions and technical drawings. As it was stated in the previous paragraph, all possible modification work is expressed via the variant codes. The GSU Sweden does not use any configurator tool, but all these cases are solved by using variant code based modification instructions.

When there are problems to identify, which spare part is needed by a customer, the case is primary clarified by discussing with a customer in BOL. At the GSU Finland, if this clarification does not make progress, the customer is advised to consult the spare part catalogue. The sales engineer can also ask for a picture of the needed spare part from the customer, or alternatively show photos or simplified technical pictures of potential spare parts to the customer. In turn, once the sales engineer of the GSU Sweden has problems to identify desired spare part, the picture of the machine rating plate and broken component are primarily asked from the customer. If this is not making any progress, help is asked from the product specialist. According to the both GSUs, a technical expertise of customers is quite low, and thus customers also inquire spare parts, which could be found straightly from BOL by themselves. For the same reason, customers do not always understand what kind of information is important to declare while compiling the RFQ.

As it was already stated, the correct spare part is searched either by a serial number or machine type code. Needed product data includes mainly spare part lists BOMs, a technical drawings of machines, variant codes, material standards, component standards and component photos. In both GSUs, the documentation is divided into various databases and the right database is mainly determined by year and country of manufacture. The Appendix 1 describes information sources used by sales engineers at the GSU Finland, whereas the Appendix 2 describes corresponding information sources of the GSU Sweden. As it can be seen from the both appendices, there are several information sources used in both GSUs and information searching can be very complex. Ease of use and coverage of information vary as per database. As it can be seen some sources are used much more than others.

The reason, why the data is documented in various forms in the various databases is based on for its dissimilar history. Basically, the machines that are always manufactured in the same country and supported this far invariably by one domestic support unit, have commonly the best data quality for the use of after sales. The case company has many systems that are, at least primarily, only in domestic use, and thus for practical reasons, it is easier when after sales is located in the same country where the machine has manufactured. The biggest problems occur when the production unit has changed once or several times during the support lifecycle of a machine. The less there has been preliminary actions before the change of the support unit, the more difficult the quotation process is after implementation. The reason, why obtainable documentation is often inadequate after the change of supply unit, is that the needs of spare part business have not been understood well enough before the change. A reason for this can be that the significance of spare part business is not totally understood in other functions of company and the quantity and quality of information is not sufficient.

Once the needed item has been identified and the item is not a listed item, the sales engineer checks if there is a valid offer from a supplier for the item in the specific procurement database. This procurement information database is located in Lotus Notes and basic purchase information of unlisted spare parts, including supplier information, price and delivery-time is stored in it. Both GSUs are using their own local procurement database in Lotus Notes. If the item does not exist in the procurement database or existing case is expired, the sales engineer enquires the availability from a supplier. Once the sales engineer has received required data of a spare part, a new case for this RFQ is opened in procurement database.

Difficulties caused by inadequate data during the quotation process can cause retardation for the quoting process. Retardation can be caused especially by difficulties to identify needed item or to find the suitable supplier. In some cases, poor quality or lack of documentation has led to a situation where only the most standardized parts of machines have been able to be quoted. At the GSU Finland, the product specialist takes part in the quoting process regarding requests and clearances that are particularly challenging. These cases are normally related to RFQs concerning certain IT2-products which spare part responsibility have been transferred to the GSU Finland recently. There has been something lacking in data and information transfer during the responsibility change. As it has been stated earlier, without having adequate data, it is impossible to quote, and thus the product specialist has been solving these cases. In Sweden, the product specialist does not take part in the quoting process.

In addition to the recorded data sources, both units also have contact persons in the production plants. The closest contact person for the sales engineers is the product specialist of the own unit. The sales engineers of the GSU Finland use mainly the local production plant as information source but in some cases also the Chinese production plant is used as information source. The contact information to other production plants is lacking, even if better contact information to for example Poland would be beneficial. In turn, the problem with the production unit in China is that some data that the GSU Finland would need to use are categorized as classified files, and thus the Chinese production plan declines to share them.

As it was stated, the Finnish production plant is able to help the GSU Finland in most cases. There are two contact channels to use: technical inquiries should be asked from the after sales department of the production via the after sales mail box, whereas the pre order –base in Lotus Notes is meant for purchase inquiries. In reality, the sales engineers rarely use the after sales mail box, because the same answer can be received much quicker via the pre order –base, which is mainly meant for spare part purchases. Anyhow, both of these are common contact channels and the messages are forwarded to the right person.

The GSU Sweden on the other hand, does not have the corresponding problems with the information channels outside of Sweden. Unlike the GSU Finland, the GSU Sweden inquires the original production plant about issues related to the transferred production, whereas the GSU Finland mainly contacts the local production plant. The most common problems that the GSU Sweden inquiries about are related to unidentified serial numbers.

Among the real RFQs, there are also request that are only asking about some technical expertise. In the case of a technical question, the RFQ itself is rejected for further actions, but the RFQ still remains in BOL and the customer can find the answer from a specific text field of the rejected RFQ. At the both GSUs, the data needed for technical questions is basically the same as the data used while quoting.

5.3 Order Handling

The task of order handling is to work on the interface of SAP and BOL. The SAP master data correctness of each BOL customer order row needs to be checked and verified before the sales order can be created in SAP on the basis of the BOL order. First of all, the request material code needs to exist in SAP. Secondly, the SAP material data needs to contain all necessary information for an order. Once the item is not created or the existing data is partial or false, the missing information can be found from the procurement database in Lotus Notes updated by the sales engineers. Order handling process is illustrated in the Figure 17.

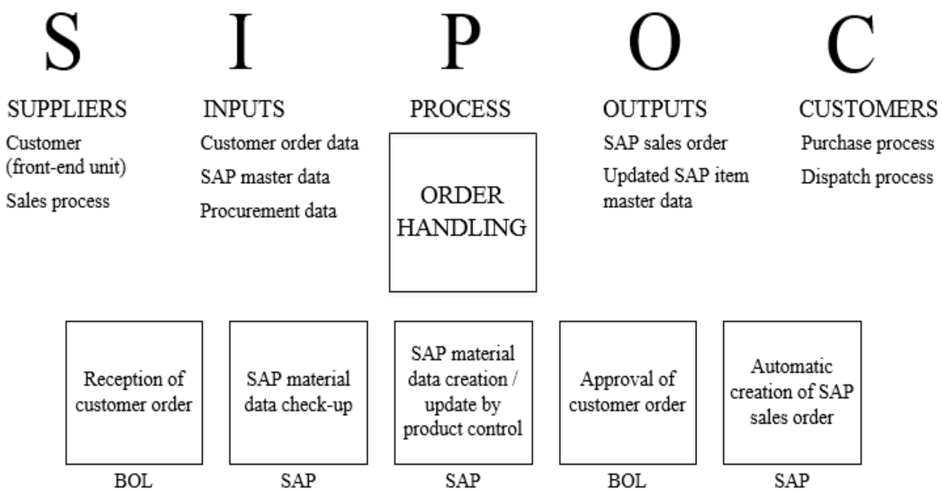

Figure 17. *SIPOC chart: order handling*

At the GSU Finland, the order handler cannot generally do changes independently in the SAP master data, and thus another order handler has got rights to do changes in the SAP master data. At the GSU Sweden, the product specialist makes the SAP material data changes already in advance, while the sales engineer compiles the order specific information in procurement database in Lotus. Therefore, the data changes in at the order handling step are rarely required.

As it was earlier stated, all spare parts that customers can order without related quotation are listed items and can be found from the SAP. The SAP material data for these materials should always be updated and reliable, and thus order handlers can approve these orders rows without need for editing. Consequently, once all order data is in order in SAP, a processing of the order row is a quick action. Once there are some updates to be done for the SAP-data, the processing takes a little bit longer time. In order to automatize order handling process, there is a development project in progress.

5.4 Purchasing

As it was described earlier, the purchase tasks are divided into two different kind of purchasing: purchases into the stock and purchases based on a customer order. At GSU Finland, the purchasing is also responsible for regular updates of the supplier agreements of listed items. Basically, all specified data that purchasers need in order to execute their part in the process is related to supplier data, including supplier contact information, price, batch size and delivery time. The purchasing process itself is quite operative and based mainly on a case-specific, transactional data. The purchasing process is described in the Figure 18.

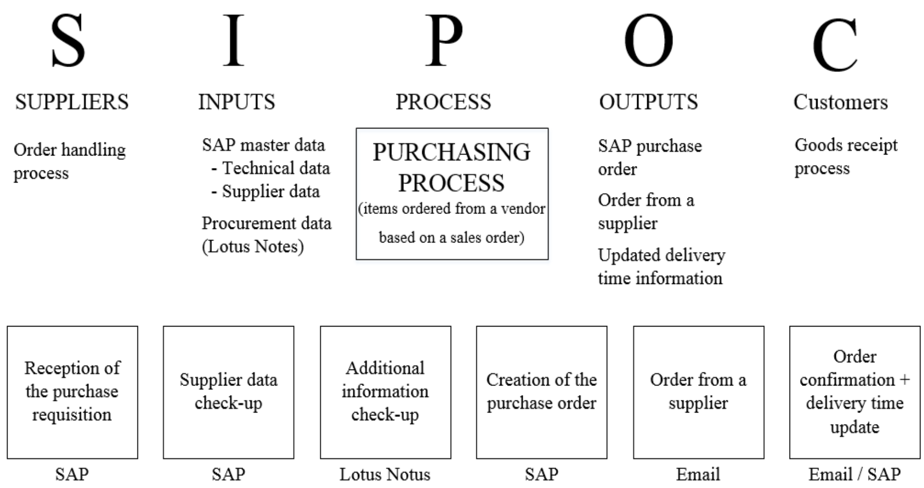

Figure 18. *SIPOC chart: purchasing process*

When it is about the purchases based on customer order, the purchase process starts from a procurement initiative. The purchases of the listed items do not require any additional data, since everything can be found from the SAP material master data. Once it is a question of the purchases of unlisted items, the SAP material data should be already updated by the previous steps of the process. Still, at both GSUs, every quotation that is concerning an unlisted item possesses its own case-specific data file in Lotus Notes procurement database. Thus, the procurement database functions as an informational backup for purchase operations.

When it is question of purchases of stocked items, all needed data should be found from the SAP system. Stocked items are always listed items, and therefore their SAP data should include up-to-date supplier data. Hence, a purchase event of a stocked material does not require any additional data apart from SAP material data. At the GSU Finland, there has been set a re-order-point for all stocked spare parts in SAP, which informs the optimal time for a re-order based on SAP history data. Also optimal order quantity is calculated with specific EOQ-formula based on SAP history data. Here, annual holding costs per unit are estimated to be twenty percent of purchase price of item yearly. At the GSU Sweden, the batch order size calculations are based mainly on demand and minimum batch size offered by the supplier.

The GSU Finland does not have common supplier agreements with the production. Thus, the GSU Finland is responsible for supplier agreement’s update of the listed items. This is normally done once in a year by the purchasers. Once it is time to update, the purchaser contacts primarily the previous supplier and asks for an updated offer. If a supplier is unwilling or unable to deliver a spare part anymore, a purchaser asks a new potential supplier contact for a spare part from a product specialist. The product specialist finds out potential suppliers mainly via purchase history of production. At GSU Sweden, the purchase department of the factory is responsible for the maintaining of supplier agreements and thus, the after sales unit is not basically responsible for them updating them. If spare part is not anymore in active phase and an old supplier has become unable to supply, the GSU Sweden takes responsibility of acquiring the new supplier. In this case, the distribution of work functions in the same way at GSU Sweden as it described to work at GSU Finland: the product specialist seeks a potential supplier contact and then the purchaser handles the operational contacting.

5.5 Other Remarks

Here are collected various points that have arisen during the interviews and which have importance from data aspect in terms of the consolidation of the current spare part processes. These comments have been collected from the interviews that have been conducted among the GSU Finland. The interviews were based on the experience that has accumulated in the everyday work. First of all, it is highly important that the distribution of support responsibilities between the units is unambiguous and completely clear for everyone who is working in the spare part process. Lately, there have been situations where a customer cannot be served directly and a RFQ has been juggled between two units when there has been confusion which unit should handle the case. According to the GSU Finland, the more complex, global and larger the network of supported machines has become, the more there are cases where the support responsibility is unclear. Additionally, also adequate data and tools are required to be at disposal of the responsible unit and employees should familiarize with the new parts early enough before.

Secondly, once the consolidation of processes is considered and there are differences in the code naming logic between the current units, some sort of unification of the logic may be in order. When a current spare part code has to be replaced with a new one, it is important to make sure that the BOL substitution is fully automatic. The automatic replacement and informing the change will ensure that customers will easily find the needed spare parts from BOL also in the future and confusions can be avoided. The IT2 spare part codes are used also by other actors outside of the GSUs. These actors can be for instance local sellers and end-customers and they are located in several countries worldwide. In order to manage BOL substitution properly, all users should inactivate the old material code. Firstly, the party who is conducting the change is required to be at least the data owner of old code in OMS. Thereafter, the changes cannot be done via SAP, but changes in OMS are required. At the GSU Finland, it has been the decision in principle that all required changes considering BOL data can be done via SAP, and thus the employees at the GSU Finland do not have basically any experience of OMS system. If the IT2 spare part business is handled as a whole by the GSU Finland in the future, it should be carefully thought beforehand what kind of considerations are needed to be done before any concrete actions. Currently, there are great suspicions and unawareness related to the functional code substitution. There has been difficulties with the larger OMS data changes in the past.

6 INVENTORY MANAGEMENT STUDY RESULTS

This chapter examines the current inventory policy of the case company. The inventory policy is based on different kinds of decisions and control mechanisms, regarding what materials should be kept in stock, when a reorder is performed, how the delivery batch size is decided and at what point the material is scrapped. Since the analysis part of this thesis is focused only to the GSU Finland, this chapter examines the inventory management of the GSU Finland more thoroughly. Still, in order to perceive the applicability of the case study analysis to the GSU Sweden, the basics of the inventory management of the GSU Sweden are presented here and they are compared with GSU Finland. The existing inventory management instructions are presented first and they are compared with actual process execution. Then, the current stocking decision principles are looked through as their own subchapter. Finally, the current inventory values of the both GSUs are presented.

The listed item selection of the both GSUs includes both stocked and non-stocked spare parts in BOL. The both GSUs also have their own separated stock for the spare part materials instead of a shared stock with the production plant. As it has been stated, the GSU Finland is located relatively far away from the local production plant of the IT2-machines, and thus they do not have a shared warehouse with the production. In turn, the spare parts of the GSU Sweden are physically stocked in the same warehouse as the production’s stock, although the stock values are separated.

6.1 Inventory Management Instructions

At the GSU Finland, the inventory policy procedures are the same for the IT1 and IT2 spare parts. At the GSU Sweden, the IT1 spare parts have their own specific purchasers and planning department taking care of the inventory, but the IT2 spare parts and the non-stocked IT1 spare parts are handled internally at the GSU. Neither of the GSUs have complete instructions for the current inventory management, although some rules and practices are clearly existing underneath the everyday procedures. The GSU Finland has even an incomplete instruction concerning the

GSU's inventory policies drawn up by the development department of the GSU. Nevertheless, these instructions have not yet been finished or published. Generally, there has been a low interest towards the inventory and the compilation of these instructions is basically the result of one development engineer's personal interest towards inventory management. One positive thing to note is that these instructions are still followed in terms of the safety stock, the reorder point and the batch size calculation.

To gather deeper information of the inventory management of the GSU Sweden has proven to be more challenging. In Sweden, the information management is also ruled by logistical parameters, but written instructions are missing. At the GSU Sweden, the safety stock, the reorder point and the batch size have been set into SAP and they are managed by demand-based logistical parameters, but more detailed information is missing. Since the case study analysis is focused on the GSU Finland and the GSU Sweden does not have any instructions regarding it, this subchapter focuses from now on introducing these incomplete instructions of the GSU Finland and simultaneously compares their content to the execution in practical.

At the GSU Finland, the target of the inventory management instructions is to optimize and balance the inventory costs and the customer service level. The inventory level is defined by the stocking decisions, the safety stock values and the order batch size. The safety stock parameter in SAP defines when a new purchase initiative is created. In order to set the safety stock at an optimal level, the specific safety stock Excel tool was created. The implementation of this EOQ tool started during the summer 2014, but its effects have emerged gradually. The safety stock tool divides the spare parts into the three classes based on their demand: very weak demand, weak demand and great demand.

In order to keep the used practices simple enough, the reorder point is not defined separately, but it is included in the safety stock value. Consequently, the upper limit of the safety stock is also the reorder point. To set up a separate reorder point in

SAP is possible, but it makes controlling the SAP parameters much more difficult and the GSU Finland does not currently have sufficient know-how to manage it.

The safety stock tool is updated monthly or whenever necessary and all data is imported automatically from SAP. The safety stock tool does not automatically make any changes to the safety stock values in SAP, but it indicates which safety stock values depart from the calculated optimal value in SAP. The changes are necessarily not done every time the values differ from each other, since in some cases this could give too much weight for one single divergent sales event. If the changes would happen every time when the values differs from each other, it could lead to a situation where the safety stock values would be changed all the time back and forth. Hence, the changes are supposed to control material-specifically case-by-case, and therefore the manually-managed stock level update system has been a deliberate choice.

Parts with very weak demand are those which have between zero to one order annually. According to the instructions, the safety stocks of these spare parts should be lowered to zero. These parts are planned to be sold out and then changed to non-stocked parts. Secondly, for the weak demand spare parts, the safety stock is calculated to be a median of the lead time demand. The weak demand parts have from two to five parts sales during a year. The lead time demand is evaluated by the history data regarding the demand over the equal long time periods as the lead time. This calculation method takes only those time periods that have had demand into account, if the demand has been zero, the time period is not included. Consequently, if the demand of these time periods has been 5, 0, 0, 3, 0, 4, the safety stock is calculated to be the median of the numbers 3, 5, 4, since zero demand time periods are delimited outside, and therefore it is four.

Lastly, the safety stock for great demand spare parts is calculated by the Excel-function NORM.INV which calculates the inverse of the normal cumulative distribution. The values p, μ and σ are set into this equation, NORM.INV(p, μ, σ). The value p defines the desired probability that there will not be a stock out during the lead time. At the GSU Finland, this value is generally set so that it is unlikely that the stock will be sold out. The greatest single factor that influences is the item value. The cheaper the item is, the higher the desired probability is. The value μ is the average demand during the lead time, whereas the value σ is the standard deviation of the demand during the lead time.

This far, the safety stock calculation has worked well with the help of this tool. Figure 19 describes the OTD percent of stocked IT2 spare part materials. As it can be seen, the OTD has been excellent lately. Of course, there can also be other reasons, which have an influence on it. Still, it can be said that the influence of safety stock calculation tool has at least not been negative.

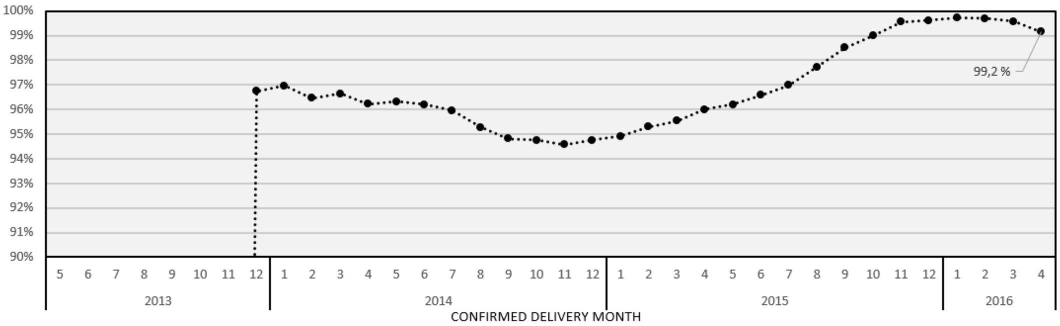

Figure 19. *OTD percent of order rows, 12 month moving average*

The batch order size is defined by the purchaser, who is using the economic order quantity (EOQ) –tool. The purchaser has a specific Excel-tool for the EOQ-calculation, and thus only the case-specific values needs to be set. At the GSU Finland, there are not any official definition of how the stocking costs are calculated. While the purchaser calculates the EOQ, the stocking costs are estimated to be 20 percent of spare part purchase yearly. This number is based on general assumptions of what these costs could be, not the realized costs.

According to the inventory management instructions, a certain spare part is taken into stock, if the annually demand is six orders or more. Once the spare part demand is non-existent, the safety stock is lowered to zero. Once in a month, a product specialist checks with the help of the safety stock tool, if there are some spare parts that should be taken into stock or if any safety stock should be lowered to zero.

The instructions state that possible scrapping decisions are done once a year for materials which have not had demand in five years. All materials are looked through separately and scrapped if there are not any good arguments for why the stocking should be continued. In practise, in terms of the spare parts scrapping procedures, the both GSUs basically only scrap the spare parts that are already obsolete. In other words, all machines that contain the part are already in the obsolete stage of the life cycle. At the GSU Sweden, there is a “last chance to buy” opportunity for the customers before the remaining stock is scrapped. Here, the parts are on discount and there is no possibility to buy them afterwards. At the GSU Sweden, the scrapping is done more regularly, whereas at the GSU Finland, the scrapping of spare parts has only happened once, when one large product family was moved into the obsolete phase.

The inventory management instructions also define the distribution of liabilities in the inventory management. According to the instructions, the safety stock updates and the stocking decisions should be done by the product specialist and the purchaser. The scrapping decisions are done by the product specialist, whereas the development department is responsible for maintaining the safety stock tool and the inventory management instructions.

At the GSU Finland, different items are controlled via the specific information field in BOL that tells the customer which availability class spare part belongs to: parts supplied from stock, parts ordered from a vendor based on a sales order or sold until the stock ends -parts. Also those spare parts that the GSU knows to be impossible to supply are categorized into their own category in BOL, in order to avoid unnecessary RFQs related to these parts. This data is sent to BOL from SAP via OMS, and thus it can be utilized also in everyday operations in SAP. The GSU Sweden does not have a corresponding practice, because as it was stated already earlier their SAP system is not connected to OMS, and thus the data cannot be sent from SAP to BOL, and thus the information cannot be utilized in the same way.

6.2 Stocking Decisions

This chapter describes how the stocking decisions are done in practice at the both GSUs. The earlier described inventory management instructions of the GSU Finland describe some stocking principles, which are at least partly conducted in practice as well. Still, there are several practical reasons, which lead to the stocking.

In practice at the GSU Finland, the stocking decision of the spare parts supplied from the stock are based on the reasons listed below:

- General spare parts of new supported machines
- At least six sale events during past year
- A desire to keep equivalent parts available in stock for different machines in the same product family
- It is discovered by the product specialist or the purchaser that the spare part is quite frequently sold
- Minimum batch size is higher than customer orders
- A possibility to buy the parts from the production plant in the end of production phase
- The support responsibility of machines has been transferred → The stock is (partly) bought by the GSU

Whereas at the GSU Sweden, the stocking decision is based on:

- General spare parts of new supported machines
- At least four sales event during past year
- A desire to keep equivalent parts available in stock for different machines in the same product family
- Spare parts from which the support responsibility has been transferred to the GSU
- The support responsibility of machines has been transferred → The stock is (partly) bought by the GSU

The major part of the stocking decisions is done in the beginning of the machine support lifecycle. The requests concerning spare parts can start in a very early point in the lifecycle, sometimes already before the customer has even received the machine. The product specialist is informed about a new machine that needs the support by the local R&D department. At this stage, both product specialists take the most of the general parts straight into the warehouse. Alternatively, it can be decided that stocking will be started when the first customer order has been received. Some specific parts are traditionally in higher demand than others: other parts exist in several different machines and others only in one design.

The stocking decisions are mainly done based on the equivalent parts demand and the criticality of the spare parts. Still, there are not any rigorous decision models, but all decisions are done on a case-by-case basis. Parts such as plastic fans, fan covers, bearings, shaft seals, terminal boards, connection parts, terminal boxes, terminal covers and occasionally also end shields, outer bearing covers, inner bearing covers and valve discs are normally taken into stock at the GSU Finland. Whereas at the GSU Sweden the general parts include mainly terminal boxes, terminal boards, terminal box covers, end-shields, bearings, bearing covers, sealings, plastic fans, fan covers and stator feet.

Individual spare parts can be connected to the BOM of one or several machine types. Still, information tracking possibilities regarding how many different machine types a spare part is connected to and how many of these machines have been produced in a certain year are difficult to use. For example, at the GSU Finland, a spare part can be seen from the spare part lists and BOMs. Basically, machine types that a certain spare part is connected to can be searched from the ERP-system of the production plant. The problem is that the search results do not always give machines types straightly, but only module level codes, which connections to the machine types needs to be checked separately. An estimation of spare part frequency can be gained via the spare part purchase history data of the production plant. It is also possible to search for the list concerning separate machine sales in which certain spare parts are connected. Furthermore, technical drawings and the type mark database in Lotus Notes gives further technical information about the spare parts and how they are connected to certain machines. By means of personal expertise and the technical information gained via technical drawings and the type mark database, the product specialist can draw a conclusion regarding which kind of machines a certain spare part is linked to. Hence, installed base information is basically searchable, but it is in a very unpractical form regarding the needs of the after sales user. These methods work only for machines produced by the local production plant, since the GSU Finland cannot use the SAP-systems of other production plants. Moreover, the Finnish production plant started to use SAP as ERP-system in 2009, and older data that is not transferred to SAP is needed to be searched via the EMIS-system.

If a new machine contains a spare part that is already kept in stock, no action is taken. Lately, the guidelines for decisions concerning stocked items have become stricter, since total amount of supported parts has increased and the number of supported machines has grown and supported assortment has become more global. Earlier, the support services of the IT2 spare parts were managed in a more scattered and local fashion compared to the current two GSUs. At the both GSUs, once one spare part is decided to be stocked, it is usual to stock also the correspondent spare parts suitable for other size versions of the machine model. Based on experience, that this kind of procedure keeps the whole assortment more consistent. This practice also works the other way around: same kind of products are kept in stock although all of them would not have demand.

The spare part can also be taken into stock in the latter stage, mainly based on the demand of the spare part. As it was mentioned in the spare part inventory instructions, spare parts can be taken into stock if there has been at least six sale events annually at the GSU Finland. Basically, this is operational practice, but it is not executed so precisely. The development department and the purchaser give the suggestions for new stocked materials. The development department base these suggestions on the six sales annually –rule, whereas the suggestions of the purchaser are more strongly based on gut feeling. Product specialist, who changes them to stocked parts, still always makes the final decision.

At GSU Sweden, an account manager who runs through a list of inventory values and products four times in a year holds the inventory control. The list is looked through and the product specialist takes actions. Though, because of the lack of time, the actions based on the list are only done twice in a year. The list holds information about spare parts sales volume: which products sell well and which do not. Those products that have had four or more sales events yearly will be taken into stock. This practice has been used for a very long time at the GSU Sweden.

At the GSU Finland, the stocking decision can also be based on an individual customer order, when the minimum supplier batch size is larger than the request of the customer. In these situations, the extra parts are sometimes taken into stock with the hope that they will be sold to other customers later. The GSU Sweden does not have a corresponding practice: in order to buy parts, the customer has to accept the minimum batch size that supplier is willing to deliver.

Too large batch sizes can also be a problem already in the beginning of the support period and forces the GSU to keep unnecessary big batches in stock. Furthermore, the GSU Finland often acquires bigger batches than necessary when doing business with the production plants since the production plants are often unwilling to deliver individual spare parts or smaller batches to the GSU. For the production plants larger deliveries are preferred since they then can deliver less frequently. Additionally, it has been experienced that supplies from the production often have flaws related to delivery correctness, adequate packing markings and invoicing. In the past the GSU Sweden has had a very close cooperation with the local production plant and they have stocked up certain products in suitable batch sizes from the production stock on a regular basis. Recently, this cooperation has naturally decreased due to the transfer of production to a new location. Still, the GSU Sweden has not had the same kind of problems with delivery correctness as their Finnish counterpart.

Problems related to the availability of spare parts are normally caused by supplier problems; a spare part cannot be produced anymore, the minimum batch size for an order is too large or the prize is too high. Once a spare part is not actively used by the production anymore, its total consumption in the case company is strongly reduced, and thus it is not profitable for the supplier to supply it anymore. If there is not any special agreement with the supplier regarding the after sales period, it can in some cases be extremely hard to find the part for a reasonable price once the use in production has stopped. Therefore, the safest option is in many cases to keep the spare parts stocked. As it was stated already earlier, the GSU Finland has it own supplier agreements, while their Swedish counterpart have had common supplier agreements with the production during the recent years. These agreements state that the supplier needs to be able to serve the GSU ten years after the production has stopped. Based on the interview, it seems that the GSU Sweden has had less availability problems compared to the GSU Finland. Regardless of the common supplier agreements, the GSU Sweden has relatively high stock values, which can be explained by the fact that the agreements have not been valid so long and even the classic stage of the support period lasts at least ten years.

In the end of the active phase, the production plant is often willing to sell or give the remaining stocked items to the GSUs. In these cases the opportunity to buy is often seen as a fairly inexpensive and easy way to acquire needed spare parts. However, all acquired items increase the value of the stock and therefore tie up capital. Additionally, unnecessary Stock Keeping Units (SKUs) take up the warehouse area.

6.3 Current Inventory Value

In this thesis, the current inventory is studied with the help of the sales data covering a time period of 22 months. The sales data has been compared to the stock value data. The sales orders show all realized sales events of the stocked materials during this time period. The inventory value data of the GSU Finland is based on average stock values during the same time period as the sales data. The inventory data is analyzed with the help of the ABC-analysis and the Pareto principle, as well as the inventory turnover ratio, which were all presented in the literature review. The examined time period of both units is from November 2013 to August 2015. The spare part kits sold by the GSU Sweden are limited outside of the analysis, but the spare parts they include are added in.

At the GSU Finland, there are currently over 1400 stocked IT2-material codes (SKUs). The total inventory value is approximately 25 900 *f*. At the GSU Sweden there are 1878 SKUs of IT2-materials. The inventory value is approximately 33 700 *f* . The inventory value is high compared to the annual revenue at the both GSUs. During the reviewed time period, the GSU Finland has had 78 percent direct sales from the stock in monetary sense, whereas the corresponding percentage at the GSU Sweden has been 67. The inventory to sales ratio of the both GSUs can be seen in calculated below, after this paragraph. Here, the both values i.e. sales and inventory are expressed in purchase prices. The inventory to sales ratio of the GSU Finland is 1,4, whereas the inventory to sales ratio of the GSU Sweden is 2,6. Hence, the annual sales from the stock are less than the average stock value at the both GSUs. As it was stated already earlier, compared to the IT1 spare parts, the IT2 spare parts are widely stocked. Once the sales of the stocked items are examined with the sales price, the inventory value is more tolerable. Due to data sensitivity the issue concerning sales price will not be discussed further.

$$Inventory\ to\ sales\ ratio, GSU\ Finland\ (purchase\ price) = \frac{25\ 900\ f}{18\ 200\ f} = 1{,}4$$

$$Inventory\ to\ sales\ ratio, GSU\ Sweden\ (purchase\ price) = \frac{33\ 700\ f}{13\ 050\ f} = 2{,}6$$

Since the IT2 spare parts are low-priced products, the aim has been to create a relatively automated sales process, and through this avoid the extra workload in the spare part process, caused by the handling of the individual sales orders. The workload of office processes decreases, once most of the orders can be delivered straight from stock. This naturally requires a relatively high inventory value.

Although the aim is to keep the sales process highly automated and the requirement of a high stock value is accepted, there is still a wish to get a better control over the selection of stocked materials. The stock value should consist of those spare parts, which really have a demand and the stocking of unnecessary spare parts should be avoided.

The sales data of the GSU Finland is presented in the form of an ABC-analysis in the Table 3, whereas the GSU Sweden is presented in the Table 4. The ABC-analysis is compiled according to the annual sales based on purchase price. It is the case company's wish to use particularly purchase prices, since the pricing principles have changed during the examined time period in both GSUs. The sale prices are delimited outside of this study.

Table 3. *ABC-analysis, GSU Finland*

CATEGORY (BASED ON PURCHASE PRICE)	YEARLY SALES (PURCHASE PRICE ƒ)	% OF TOTAL	SKUs	% OF TOTAL	INVENTORY VALUE (ƒ)	% OF TOTAL	INVENTORY TURNOVER	WEEKS OF SUPPLY	TOTAL AMOUNT OF SO ROWS	% OF TOTAL	ORDER ROW AMOUNT / SKU
A-category (up to 50 % of sales)	9 137	50 %	51	4 %	3 121	12 %	2,9	18	1048	16 %	21
B-category (up to 80 % sales)	5 518	30 %	136	10 %	4 393	17 %	1,3	41	2291	34 %	17
C-category (up to 98 % of sales)	3 281	18 %	383	27 %	8 195	32 %	0,4	130	2221	33 %	6
D-category (up to 100 % sales)	276	2 %	341	24 %	2 375	9 %	0,1	448	1151	17 %	3
E-category (no sales)	-	0 %	482	35 %	7 821	30 %	0,0	-	5	0 %	0
Total	**18 212**	**100 %**	**1393**	**100 %**	**25 905**	**100 %**	**0,7**	**74**	**6716**	**100 %**	**5**

Table 4. *ABC-analysis, GSU Sweden*

CATEGORY (BASED ON PURCHASE PRICE)	YEARLY SALES (PURCHASE PRICE ƒ)	% OF TOTAL	SKUs	% OF TOTAL	INVENTORY VALUE (ƒ)	% OF TOTAL	INVENTORY TURNOVER	WEEKS OF SUPPLY	TOTAL AMOUNT OF SO ROWS	% OF TOTAL	ORDER ROW AMOUNT / SKU
A-category (up to 50 % of sales)	6 569	50 %	23	1 %	3 325	10 %	2,0	26	632	7 %	27
B-category (up to 80 % sales)	3 943	30 %	131	7 %	5 477	16 %	0,7	72	2778	32 %	21
C-category (up to 98 % of sales)	2 364	18 %	423	23 %	7 912	23 %	0,3	174	3897	44 %	9
D-category (up to 100 % sales)	197	2 %	433	23 %	2 136	6 %	0,1	564	1501	17 %	3
E-category (no sales)	-	0 %	868	46 %	14 825	44 %	0	-	0	0 %	0
Total	**13 073**	**1**	**1 878**	**1**	**33 675**	**1**	**0,39**	**837**	**8 808**	**1**	**5**

In the Table 3 it can be seen that fifty percent of all sales in monetary at the GSU Finland can be covered by twelve percent of the stock value, whereas eighty percent of all sales in capital are covered by 29 percent of the stock value. There are in total 1393 SKUs and 14 percent of these i.e. 187 SKUs make 80 percent the sales. Almost 60 percent of all stocked SKUs belong to the last two percent of sales or no sales categories. Still, C and D-categories include about fifty percent of all sales events although these sales make only 20 percent of the total in monetary sense. On other hand, C- and D-categories include a little bit over fifty percent of all SKUs, whereas A- and B-categories include only 14 percent of them. 35 percent of all SKUs were not sold at all.

At it can be seen from the Table 4, at the GSU Sweden, fifty percent of sales in capital can be covered by ten percent stock value, whereas 80 percent of sales in capital can be covered by 26 percent of the inventory value. In total, there are 1878 SKUs and eight percent of these i.e. 154 SKUs make 80 percent of total sales. Over two thirds of the SKUs belong to the last two percent of sales or no sales categories. At the GSU Sweden, C- and D-categories include over 46 percent of sales events. As it was discovered while examining the data of the GSU Finland, the major part of the SKUS at the GSU Sweden also has very low or non-existent demand. C- and D-categories include 46 percent of all SKUs, whereas A- and B-categories include only eight percent of them. 46 percent of all spare parts were not sold at all.

Since the C- and D-categories include a relatively high number of sales orders at the both GSUs, the number of spare parts that have a certain amount of sales orders during one year will be further examined. These results can be seen in the Table 5 and the Table 6. Although the IT2 spare parts are low-cost products are in general, they still have large variety in price. As it can be seen in these Tables 5 and 6, the C- and D-categories include both weakly selling spare parts as well as better selling very low-cost materials. At the GSU Finland, 31 percent of the D-category materials and 13 percent of the C-category materials have less than one sales event during a year, which means that during the examined data period (22 months), there have been only one sales event. Correspondingly, 58 percent of the D-category have in average less than two sales events during a year, whereas in the C-category 40 percent have this many sales events. In turn, at the GSU Sweden (see Table 6), 34 percent of the D-category materials and 13 percent of the C-category materials have annually less than one sales event. Correspondingly, 59 percent of the D-category materials have in average less than two sales events during a year, whereas in the C-category, 35 percent have this much sales events.

Table 5. *Sales events in C- and D-category, GSU Finland*

Number of Sales Events During a One Year	Number of Different Materials in C-category	Number of Different Materials in D-category
Less than 1	51 (13 %)	107 (31 %)
1 - 2	102 (27 %)	93 (27 %)
2 - 5	111 (29 %)	78 (23 %)
5 - 10	62 (16 %)	36 (11 %)
Over 10	57 (15 %)	27 (8 %)

Table 6. *Sales events in C- and D-category, GSU Sweden*

Number of Order Rows During a One Year	Number of Different Materials C-category	Number of Different Materials D-category
Less than 1	55 (13 %)	149 (34 %)
1 - 2	95 (22 %)	108 (25 %)
2 - 5	114 (27 %)	98 (23 %)
5 - 10	59 (14 %)	46 (11 %)
Over 10	100 (24 %)	32 (7 %)

The previously presented ABC-analysis observes also the inventory turnover ratios of the different ABC-categories. At the both GSUs, these values were quite low. At the GSU Finland, the inventory turns one time or more only in the A- and B-categories, whereas at the GSU Sweden this happens only in the A-category. Therefore, in addition to the ABC-analysis, the inventory value is also examined based on the inventory turnover rate. The turnover rates are divided into five categories and are presented in the Tables 7 and 8.

Table 7. *Inventory turnover, GSU Finland*

Inventory turnover	Stock Value (*f*)	SKUs	Yearly sales (purchase price *f*)	Orders yearly	A products	B products	C products	D products	E products
0	7 910	483	0	10	0	0	0	7	476
0 - 0,5	9 534	433	1 557	1 351	0	9	157	267	0
0,5 - 1	2 078	171	1 471	978	0	16	105	50	0
1 - 2	3 178	176	4 492	1 931	8	65	88	15	0
2 - 5	3 111	118	9 518	2 246	40	45	26	7	0
over 5	184	13	1 175	204	3	1	7	2	0
Total	**25 994**	**1 394**	**18 212**	**6 721**					

Table 8. *Inventory turnover, GSU Sweden*

Inventory turnover	Stock Value (ƒ)	SKUs	Yearly sales (purchase price ƒ)	Orders yearly	A products	B products	C products	D products	E products
0	14 825	868	-	0	0	0	0	0	868
0 - 0,5	13 683	526	1 474	1 657	1	17	181	327	0
0,5 - 1	1 955	163	1 332	1 309	0	26	86	51	0
1 - 2	1 667	136	2 302	2 045	5	35	72	24	0
2 - 5	1 001	109	2 833	1 881	8	27	53	21	0
over 5	544	76	5 131	1 915	9	26	31	10	0
Total	**33 675**	**1 878**	**13 073**	**8 808**					

At the GSU Finland, roughly 80 percent of all SKUs, the inventory turns less than once in a year. Simultaneously, these materials create only 20 percent of total sales. Still, those materials, whose inventory turnover is annually less than one, create over 30 percent of all sales events. On another hand, these materials whose turnover ratio is annually over zero but less than one cover 43 percent of all SKUs, and hence there are not so many sales events per SKU compared to other materials. In turn, at the GSU Sweden, 83 percent off all SKUs, the inventory turns less than one time in a year. Still, these materials form only a little bit over 21 percent of the total sales and their sales events cover almost 34 percent of all sales events. On the other hand, these materials cover almost 37 percent of all SKUs, whereas all other sales i.e. over 66 percent are covered by 17 percent of SKUs.

6.4 Inventory Holding Costs

The considerations related to the stocking decisions are quite different depending on whether it is a question of the stocking of new spare parts or the scrapping of already stocked parts. Beforehand, neither of the GSUs had any specific estimation of how much the stocking costs per component were, nor any rule for how it should be calculated. Once the spare part is already in stock, the original invested capital cannot be returned unless someone buys the part. Therefore, the savings that are achieved through scrapping are mainly coming from the decrease of inventory space costs and the general inventory maintenance and management costs.

Both GSUs buy the stocking services from the internal logistics operator of the case company, which charges the GSUs according to the required space and equipment as well as personnel costs. The GSU Finland is sharing the warehouse premises with the local IT1 production plant, while the GSU Sweden is sharing the warehouse premises with the larger number of different actors. In Finland, the warehouse was originally founded for the needs of the local production unit and the GSU has started to use it on the side, whereas the Swedish warehouse is a regional central warehouse. The Finnish stocking space charges are purely based on the used floor area, while the GSU Sweden is charged by the number of storage bins in use. Since the Finnish warehouse does not charge by storage bins in use, and the used warehouse premises include both pallet bins and smaller storage bins, the thesis does not define any specific price for individual storage bin.

Currently, the GSU Finland is annually paying approximately 8 400 *f* in total for the IT1 and IT2 spare parts stocking. During the thesis process, it has been evaluated with the warehouse personnel that IT2 spare parts take at least 75 percent of the area, and therefore 6 300 *f* of this total amount should be allocated to IT2 spare parts stocking annually. At the GSU Sweden the IT2 stocking space costs are charged separately from IT1 spare parts. Annual IT2 spare part space costs are 5 950 *f* in Sweden. Though, it is known that the stocking expenses of the GSU Sweden will be at least 12 percent higher in the coming years.

In relation to the average stock value, the stocking expenses are annually approximately 24 percent of the stock value at the GSU Finland, whereas at the GSU Sweden, the same proportion is 18 percent. Once the stock expenses of the GSU Sweden increase, they will annually be approximately 20 percent of the warehouse value. These are calculated below:

$$Annual\ Stocking\ Costs, GSU\ Finland = \frac{6300\ f}{25\ 900\ f} = 0{,}24$$

$$Annual\ Stocking\ Costs, GSU\ Sweden = \frac{5950\ f}{33\ 700\ f} = 0{,}18$$

As it was stated earlier, in addition to the savings in the stocking space, the spare part scrapping will also bring savings in inventory service costs. The inventory service costs cover the costs caused by annual stocktaking. At the both GSUs, all stocked IT2 spare parts are taken stock once a year and the stocktaking is managed through a procedure where a few SKUs are handled each day. Here, these costs are estimated by the information gained from the GSU Finland, since the analysis part of this thesis is focusing to the GSU Finland.

At the GSU Finland, there is one material advisor handling the stocktaking process of the whole warehouse. According to the material advisor, 70 percent of the total worktime is taken by the IT1 and IT2 spare parts. Still, the time consumption between these two is hard to estimate, since the material advisor does not pay attention to it during the everyday work: they are just all spare parts. Here, these expenses are split by the amount of the IT1 and IT2 SKUs. According to stock data, over 80 percent of all SKUs of the GSU Finland are IT2 spare parts and the annual average expense of the warehouse employee, including the material advisor is 2 450 *f*. Since 70 percent of the total worktime of material advisor is taken by the after sales parts and again 80 percent of this is allocated to the IT2 spare parts, the estimated expense of the stocktaking costs is annually approximately 1 400 *f*. In relation to the average stock value of the IT2 spare parts, the inventory service costs are annually approximately 5 percent of total stock value. According to the utilized inventory data, the GSU Finland has 1393 IT2 SKUs. Consequently, stocktaking expense of individual SKU is approximately 1 *f*.

Other possible cost cuts that can be achieved by the scrapping are related to the physical moving and handling of the spare parts. The lower stock value and the way that the smaller amount of stocked items can be seen to decrease the total workload of the forklift drivers, but the difference in workload is so small and occasional, that any specific numbers of savings will not be presented here. Additionally, the decreased number of stocked items can also be seen to ease the work of the office personnel, who constantly deal with the stocked spare parts data and control the stock value. This benefit concerns especially the product specialists, the purchasers and the development personnel and the accounting personnel. These savings are also very hard to estimate, and thus limited outside. Although the financial savings are hard to estimate, at least it lightens the everyday work of the affected personnel.

Of course, once a spare part is scrapped, also the possibility to make the money will be lost for good. Neither purchase price nor other incurred costs cannot be recovered. Additionally, the spare parts need to be collected and delivered forward to be scrapped. Also the scrapping itself will naturally cause expenses. However, the expenses are most likely lower, if the scrapping decisions and actions are executed in are larger batches. On another hand, if spare parts are not scrapped, they will continue to cause stocking expenses in the future.

In addition to previously mentioned stocking expenses, once it is a question of decisions concerning the initiation to stock a spare part, there is also the capital charge of the spare part that is needed to take into account. Once the capital is used to spare part stocking, it naturally binds capital into the stock, and consequently takes it away from other possible investments. On the basis of the literature (Richardson 1995, p. 94-95 & Timme 2003, p. 30-37) and the estimation of the business controller of the GSU Finland, it has been decided that a reasonable profit loss value is annually 10 percent of the purchase price of the spare part.

Before the stocking initiation is done, also the risk of obsolescence should be considered as well. According to Richardson (1995, p. 96) purchase price and the risk cost of the risk of the obsolescence is estimated to be from six to 12 percent. Since the risk of the obsolescence is emphasized in the after sales, it is estimated to be in this context 12 percent.

Contrary to the case company, Richardson (1995, p. 96) estimated stock insurance costs to be one to three percent of the stock value, while the stock insurance costs in the case company are only 0,03 percent of the stock value since the centralized and global insurance policy. Since the almost non-existent value, the insurance costs were delimited outside of these calculations.

Consequently, the inventory holding costs are estimated to be the total sum of these factors summarized below:

- Annual stocking costs 24 percent
- Inventory service costs 5 percent
- Profit loss value 10 percent
- Risk of obsolescence 12 percent
- (Insurance costs 0,03 percent)

51 percent of annual average inventory value at the GSU Finland

The total inventory holding costs of 51 percent, are relatively high, compared to Richardson's (1995, p. 96) estimation that stocking costs should be between 25 to 55 percent of the average annual inventory value.

According to Sakki (2004, p. 46), addition to the stock holding costs, the incoming and outgoing flows of goods are connected into the total inventory costs as well. It has been noticed here that outgoing process is totally depending on the number of the received sales orders, regardless whether a spare part is stocked or not. Consequently, while estimating expenses caused by stocking, the outgoing expenses are not counted in.

However, the incoming process is depending on the amount of single purchase events. Thus, the more actively sold spare parts are stocked, the less any incoming process has workload. Figure 20 strives to describe this composition. Beforehand, the inbound logistics costs are estimated to be four percent of a spare part purchase price at GSU Finland. As it can be seen from Figure 20, easiness of identification and good availability are the key factors. The listed and stocked spare parts are very quick to handle, since they are identified already beforehand and they can be sold straight from stock. A little bit more time-consuming are those parts which are identified beforehand and the supplier is known, but the spare part is needed to be purchased separately. The hardest ones are unlisted items, which require always the RFQ drafted by sales engineer. Unlisted items require a variable amount of sales engineer's worktime depending on how long it will take to identify the spare part and acquire a supplier contact. In order to speed up the process further, there has been an initiative that all stocked spare parts could go through the process without separate acceptance.

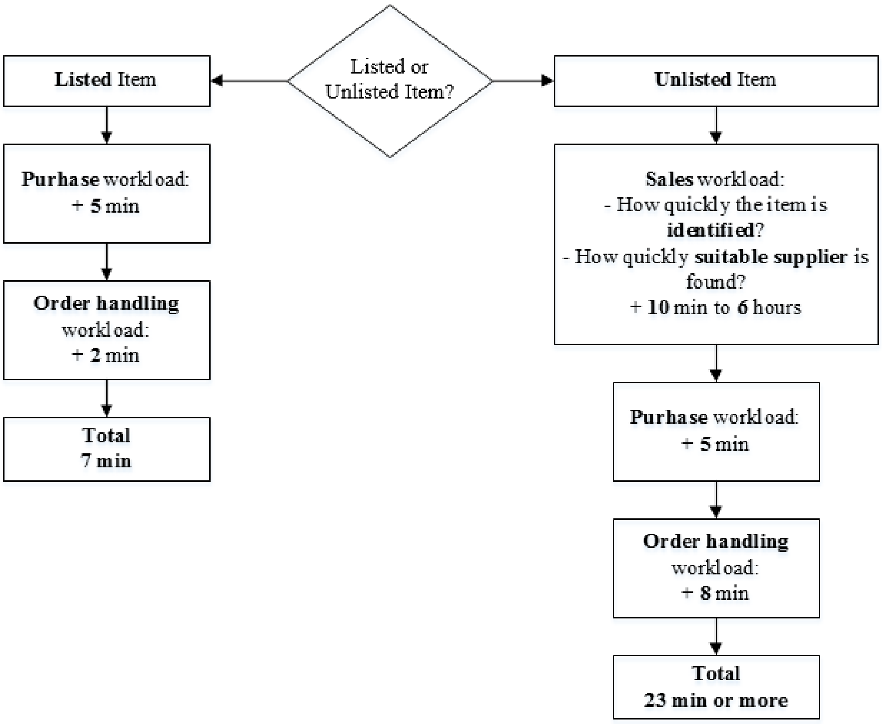

Figure 20. *Time consumption in incoming process*

6.5 Criticality and Captivity of the Spare Parts

The literature review brought out, the spare parts criticality can be used as classification criteria while making decisions about spare part stocking (Bacchetti & Saccani 2012, p. 724; Botter & Fortuin 2000, p. 663-664; Dekker et al. 1996, p. 74-76; Huiskonen 2001, p. 129). The following question trees (see the Figures 20 and 21) are used by the case company while evaluating criticality and captivity of a certain spare part.

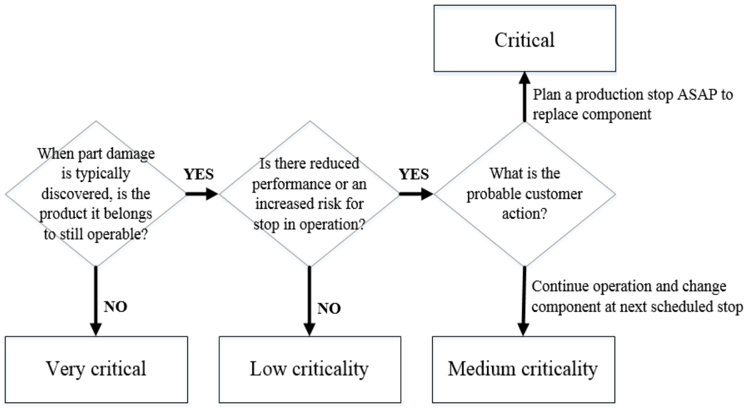

Figure 21. *Spare parts criticality chart*

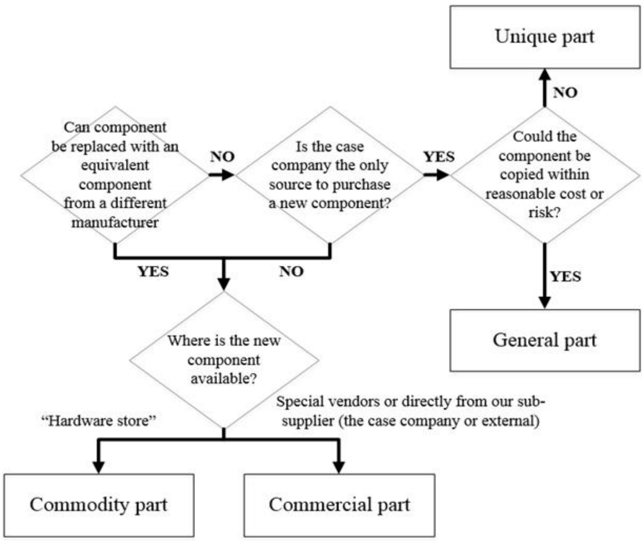

Figure 22. *Spare parts captivity chart*

In the sub-chapter 4.4., the spare parts are classified according to the spare part type. Here, these formed spare part categories are set on the matrix Figure 23 based on the results of the questions trees. As it can be seen from the Figure 23, Inner Bearing Covers, Outer Bearing Covers, End-Shields, Terminal Box Frames, Terminal Box Covers and Valve Discs are the most critical spare part categories. The critical thing here is the availability of the castings and the casting models afterwards. The castings are raw versions of the parts, which will get their final form through the machining. Also size of machine, end-use application and level of customizing are affecting factors while it is question of criticality.

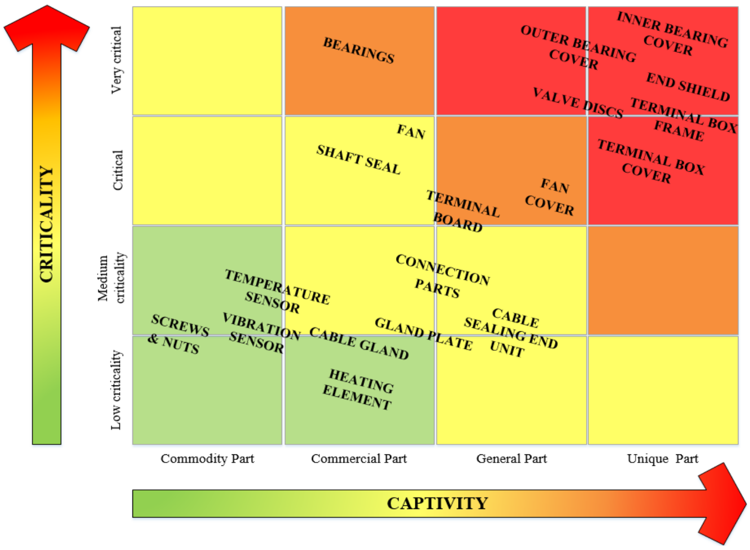

Figure 23. *Spare part types in terms to criticality and captivity*

6.6 Closer Look at the GSU Finland

As it was stated already earlier, this study generally examine both GSUs inventory policies and stock values, but the deeper examination focuses on the inventory management at the GSU Finland, since the in-depth examination of the both GSUs would make this study unnecessary long. It has been experienced that it is better to focus all efforts to studying one unit, instead of a more superficial inspection of the both units. Moreover, the results of this analysis regarding the GSU Finland can be applied to the GSU Sweden as well. This sub-chapter provides a closer look at the stock values of the GSU Finland and the discussion chapter of this study continues with the GSU Finland.

Since the spare part data does not tell more accurately about spare part type or character, it was decided to start the analysis through the spare part categorization. Thus, all spare parts were classified according to their type into the main categories and sub categories, which were presented in subchapter 4.4. Figure 24 illustrates the ABC-categorization and spare parts types according to the stock value.

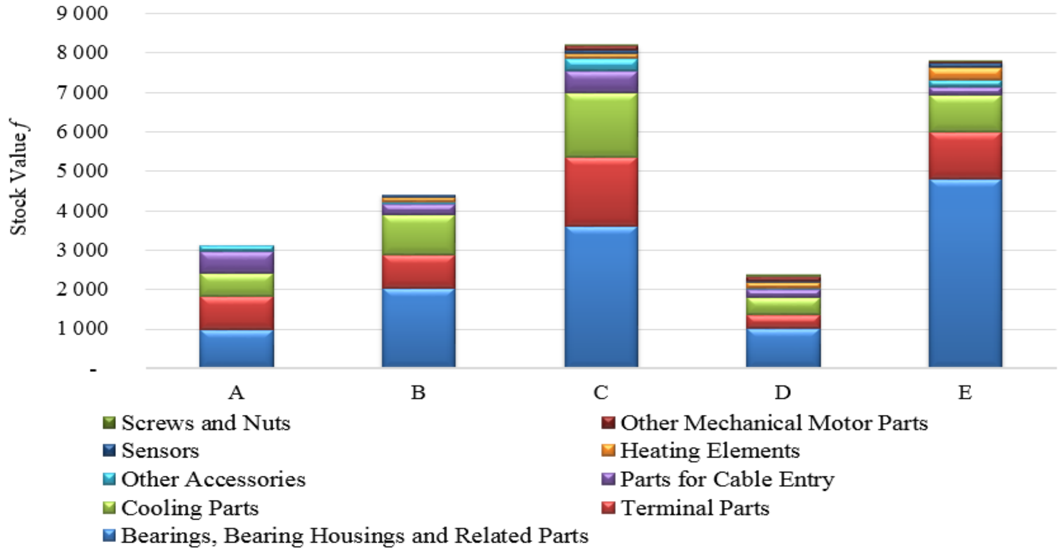

Figure 25. *ABC-categorization and spare part types*

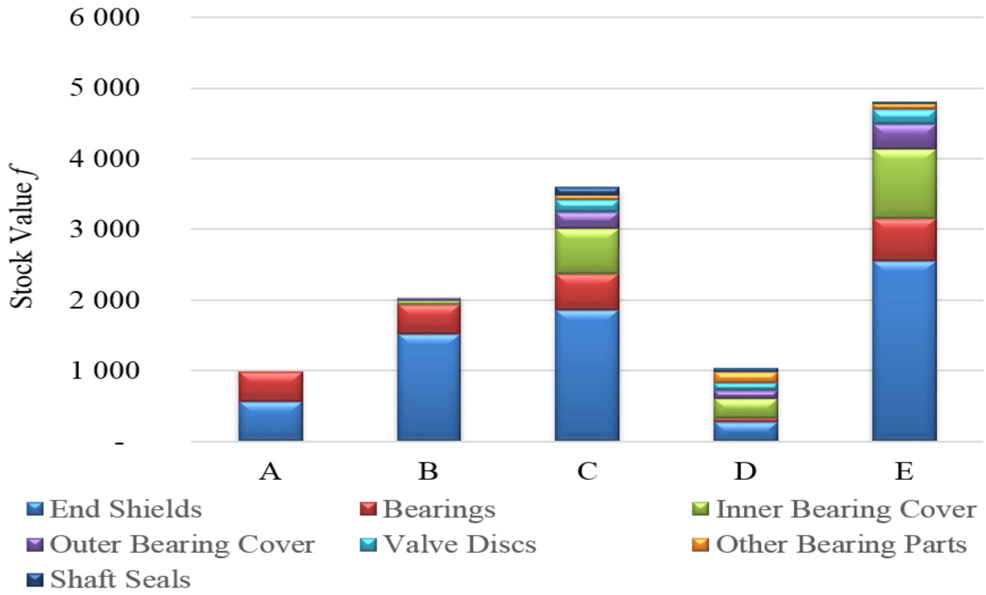

Figure 24. *ABC-categorization & subcategories of Bearing, Bearing Housings and Related Parts*

As it can be seen the from Figure 24, the group called Bearings, Bearing Housings and Related Parts create absolutely the biggest singular group, and thus these parts were taken into more accurate inspection regarding the sub-categories of this group. Figure 25 illustrates these sub-categories. As it clearly can be seen from the figure, end shields create the biggest group, while bearings themselves and inner bearing covers are the second biggest groups.

Since the classification of spare parts criticality was presented in Figure 23, it was decided to link this aspect together with the ABC-categorization showed in the Figure 24. The result of this can be seen in Figure 26. As it can be seen, the major part of the current stock value is either highly critical or very critical parts, and thus criticality is already taken into account while doing the stocking decisions. Anyhow, in the E-category roughly 60 percent materials are classified as highly critical spare parts, but these have not had any demand during the research period.

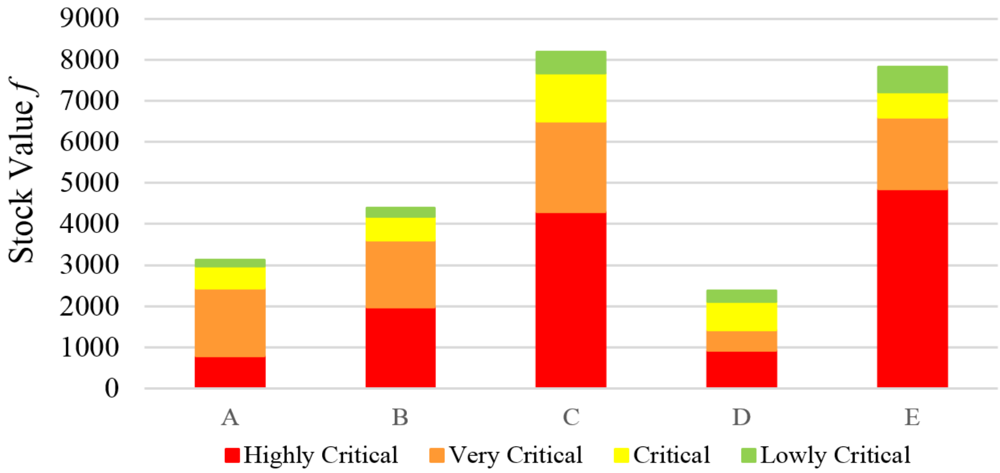

Figure 26. *ABC-analysis according to the criticality (stock value)*

In addition to the spare part type classification, also the analysis concerning the reasons why different spare parts are started to stock in the first point was conducted. Since it would be interesting to know, why the stocked assortment corresponds so weakly to the actual demand i.e. why wrong choices in stocking are done, this examination involved only stocked parts i.e. E-category parts that were not sold. Figure 27 presents these reasons.

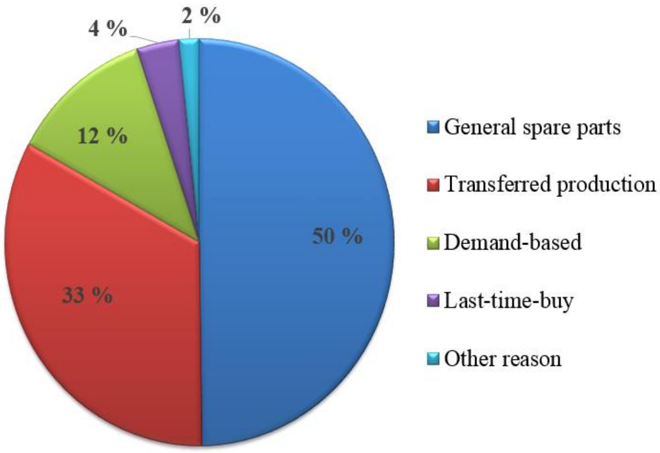

Figure 27. *Initial reasons for stocking non-sold items*

The Figure 28 describes the lifecycle phase of machines for which the stocked parts are related to. Furthermore, the figure illustrates how many parts have existent supplier contact. The absolute major part of stock value in the A-, B-, C- and D-categories is coming from materials that are in the active phase and have a relevant supplier contract. In the E-category, roughly 50 percent of the stock value comprises materials which are in the classic phase and do not have an existent supplier contract, whereas the stock value of A- and B-categories consist almost totally of materials, which have existent supplier contact. These materials are mainly in active phase.

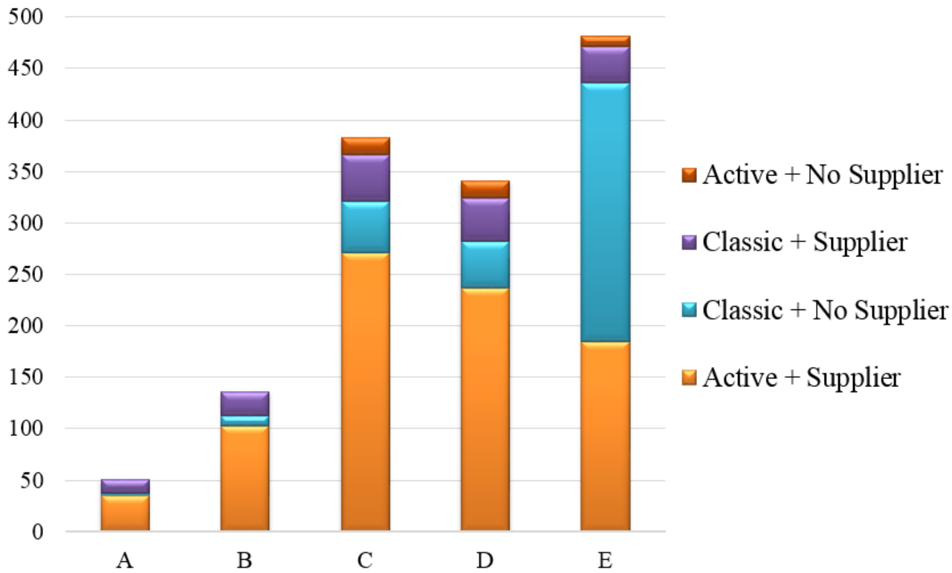

Figure 28. *Lifecycle phase and supplier information (according SKUs)*

7 DISCUSSION AND RECOMMENDATIONS

The results of the previous two empirical case study chapters are analyzed in this chapter and recommendations are given. The inventory management and data management are both divided into two sub-chapters.

7.1 Data Management Challenges

As it was found in the chapter of the empirical study, different work tasks of the spare part process require very different kind of data, and thus very different numbers of used data sources as well. According to the results, the sales engineers and the product specialist use a lot of different kinds of data sources, including both internal and external data sources, whereas the order handlers and purchasers generally only use internal sources. Especially the product specialist role as a back-up of other parties is very strong in both GSUs. The sales engineers produce information for internal use, for other parties of the spare part process. The product specialists produce material for both internal and external i.e. customer's use. The process tasks of the order handling and purchase are clearly more operational and do not include so much information searching. The Figure 29 describes the used information sources by a certain party of the spare part process.

Required information of a specific IT2 process step originates from...	SALES	ORDER HANDLING	PURCHASE	PRODUCT CONTROL
SUPPLIERS	F S		F S	
CUSTOMERS	F S	F S		
INTERNALLY ADMINISTERED	F S	F S	F S	F
EHTERNALLY ADMINISTERED	F S			F S
IT2 PRODUCT SPECIALIST	F S	F S	F S	F
OTHER PERSONNEL OF THE GSU	F S	F S	F S	
PERSONNEL OF THE OTHER UNITS	F S		F S	F S

SALES	ORDER HANDLING	PURCHASE	PRODUCT CONTROL	...and employees of a certain IT2 process step produce data for...
F S		F S	F S	DATA FOR INTERNAL USE
			F S	DATA FOR EXTERNAL i.e. CUSTOMERS' USE

F = GSU FINLAND
S = GSU SWEDEN

Figure 29. *Information sources used*

Quoting process

The sales engineers are the ones who are constantly sorting out various RFQs in the customer interface. The quoting process is conducted in two steps. First, the spare part in question needs to be identified. Secondly a suitable supplier offering needs to be acquired. Problems within these two steps can cause a significant retardation of the process lead-time. Nevertheless, especially the identification step of the process consists of several data sources. The supplier contact is perhaps easier to identify. If there are no earlier purchases conducted by the GSU, the sales engineers can check if any purchases have been conducted by the production unit. If neither of these makes any progress, the personal knowledge of potential suppliers producing corresponding products or the product specialist's expertise can be used.

According to the results, the data management problems seem to be bigger at the GSU Finland, whereas the GSU Sweden does not recognize any actual problems in their spare part process. The basic attitude towards problems can naturally be different, and thus one unit can see things as problems, whereas another unit accepts them as a part of everyday work. Still, the differences were so considerable that they cannot only be a result of different attitudes. One explanatory reason can be that the GSU Finland is responsible for more customized machines compared to the GSU Sweden, since the Finnish production plant has traditionally produced highly modified machines. According to study results, the GSU Finland experiences difficulties especially with the customized machines. In some cases, it is extremely challenging to get accurate information of any given machine, and thus the quoted parts are concluded at the GSU office. The problem is that the information is not easily searchable and accessible, and hence the problems are more in processes and process design. The statement of Silvola (2011, p. 160), that the data problems are particularly occurring from organizational and process issues and rarely from the lack of technology is also true for the case company. Li et al. (2015, p. 667) note that sometimes companies do not even know that some useful data exists and this could also be a problem in the case company. On the basis of the researcher's own observations, due to the great size and complex structure of the case company, the needed data can be very hard to find. In order to get it, one has to find the exactly right person. Once the changes are planned, many decisions are done at higher management levels. In order to fully understand the employee needs related to the changes, more decisions should be done at the lower level in management, close to the performing level and the customer. (Neu & Brown 2005, p. 15)

Based on the results gained from the empirical study of the GSU Finland, the most frustrating aspect of the work tasks of the sales engineers is caused by the uncertainty of quoted spare parts. There are situations where the absolute certainty of needed spare parts is not achieved. As it was stated in the previous paragraph, especially modified machines are occasionally challenging. Also Suomala (2002, p. 64) finds that customized products cause increased workload, especially if they are rarely used. The GSU Sweden does not recognize this kind of problems with modified machines. Basically, the data search is conducted the same way at the GSU Sweden as well, but it seems that the data quality is somehow better. Additionally, since the machines that are supported by the GSU Sweden have more standardized structure, they possibly have somewhat more standardized modifications.

At the GSU Finland, it was estimated that approximately every third RFQ is related to the customers' wishes to modify the machine independently, whereas at the GSU Sweden the amount is smaller. This can partly be explained by the technical information showed in BOL to customers. The GSU Sweden has more accurate spare part technical data shown to customers in BOL. This data includes the alternative parts that can be used as modification parts replacing the original part of the machine, and thus the customers can order these independently via BOL. The GSU Finland does not have the same amount of corresponding information, and therefore the customers need to contact sales more often, in order to find the right parts, since they do not have enough accurate instructions in BOL.

Neither of the GSUs have complete instructions for the IT2 sales process execution. The application of different data sources is also undocumented, although the amount of different data sources is extensive. At the GSU Finland, they have recently tried to collect the instructions regarding the quoting process into one location. Still, these instructions do not cover nearly everything, since the whole IT2 quoting process is so fragmented. Another issue that tells about the complexity of the IT2 spare part process is the training for the work tasks of the sales engineer. The training for these work tasks takes a long time and mastering them takes even years. Because of the long orientation process, the unit has decided to have two full-time sales engineers, although the total workload has been estimated to be only for 1,5 employers. The employee turnover has experienced to be high among the part-time employees and the unit does not have resources to constant training. Also Smith & McKeen (2008, p. 68) have found that Additional data verification and poor decisions based on defective data are costly problems for companies. At the GSU Sweden, they have not experienced any need for these kinds of specific instructions.

Product Control

The significance of data in the product specialists' duties should not be understated either. Although they are not mainly in touch with the customer, they are still the ones who create and maintain different kind of data, especially spare part data that is also seen by customers in BOL. The spare part data is basic master data that is also used by all parties in the spare part process. The product specialists of the GSU Finland mentioned that there are often incorrect or missing information in the spare part lists that are sent by the R&D. The product specialists correct the faults they discover for the R&D, but there is always a risk that everything is not found. At the GSU Sweden, the product specialist complies these lists independently, although it should not be his work task. In both GSUs, the product specialists is an important back-up for the sales engineers, and thus the product specialist is that party who should clarify unclear issues as a last resort. Hence, the product specialist utilizes the same data sources as the sales engineers do.

One of the main tasks of the product specialist is to create and maintain spare part material codes. At the GSU Finland, the data management issues are the most difficult whenever the GSU is not the owner. All data is not uploaded to BOL without separate requests from the PG content team. The GSU Sweden has customized their spare part codes in order to avoid the previously mentioned problems with the codes. However, the GSU Sweden is facing problems time after time with the customized codes, since the logic is hard to remember by the customers even though they are constantly reminded of it.

At the both GSUs, the role of the product specialist as a supporter in the different process steps is significant and it is possible that a part of the problems with lacking data escapes from everyone's attention, since they are handled quietly with the help of the product specialist. As Viitala & Jylhä (2006, p. 345-347) stated, it is very risky to keep large amounts of data in tacit form, since if these persons is prevented from working, it can easily cause deterioration of customer service and other processes. Thus the line between tacit and documented knowledge should be strictly defined. In the case company, the management is perhaps too dependent on these people's ability to work. It would be more important to pay more notice to situations where different parties, especially sales engineers need help from the product specialist. The data problems should be brought up more emphatically while discussing with the management. Still, as it was stated by Marsh (2005, p. 107), the employers can view some parts of bad data quality as unavoidable and accept its presence. March (2005, p. 107) also states that it is normal that the management might not understand how much problems poor data really causes the processes and this can be a problem in the case company as well. The benefits that could be achieved through good data quality is not fully understood by managers (Bloodgood & Salisbury 2001, p. 66).

In addition to pure data problems, the product specialist of the GSU Finland has also mentioned that nowadays when the whole picture is very global, it is challenging to keep up with the machine selection that should be supported. The R&D department should inform the GSU, whenever there are new models to support, but especially with the global products, this does not happen every time. The limits of the support responsibilities between the units are not easy to distinguish in day-to-day work. This problem disturbs mainly sales engineers while quoting.

Utilized Data Sources

Vayghan (2007, p. 670) states that in large heterogeneous and dispersed companies, bad data quality is a result of locally managed data and locally customized IT-systems. At the case company, the reason for why the data management is very fragmented and information is divided into various data sources is at least partially the result of a more globalized support base of machines. Basically, if the GSUs would support only the local plants like in the past, the amount of different kind of information bases would be fewer. As stated by Smith & McKeen (2008, p. 69), functionally managed data eases the globalization and process reorganizing. At the case company, some IT-systems and information management practices have not been planned for global use. Thus, once the support operations of the GSUs have started to cover also global machines, there has not been a way or even a will to merge together the transferred data and the already existent data into the same form into the same system. Because of this, the transferred machines have had their own separated databases.

Secondly, the great number of different databases is also a result of diversity in the information system. There are plenty of local and global systems and applications and at least within the framework of this thesis, no specific logic for why this large variety of systems would be needed was found. For example both units have had SAP as ERP-system since 2009. Before this both units used local ERP-systems. Once the system changed, the old data was not transferred into the new system. In Sweden the data was transferred into the business intelligence –system called QlikView. While in Finland, the old data can still be viewed through the old ERP-system but parts of the data have been transferred into archive files that can be viewed via Microsoft Access. New systems and applications are not naturally a bad thing, but the total picture and user friendliness should always be considered. Especially in after sales business, even decades old data is often needed. Once the amount of systems increases, many simple things can become more complex and hard. Instead of acquiring new systems, one should pay notice to how the total picture of the data management looks like and how manageable the network of different systems is for the end user.

Also different kind of modification work increases the amount of needed data sources, since they create exceptions from standard machine structures and increase the spare part selection. As it was stated previously, the modification work can be done as early as it is included in the original BOM or alternatively for the finished standard machines according to the customers' wishes in which case the modification work can be viewed via the variant code. These variant codes tell only what kind of modification work that has been done, not the used component codes, which are depending on the type and size of the machine. Every separate change gets its own variant code that gives information about the specific modification. The precise material code of a certain machine can be checked from the modification instructions.

The variety of different kind of data sources can also partly be a result from the fact that the data is not managed consistently and logically even at the local level. Based on the study results, similar data can be stored in different systems instead of managing all existing data more logically. For example, at the GSU Finland the sales engineer and the product specialist maintain both maintain instructions, especially regarding the quoting step of the spare part process. However, these instructions are stored separately in different locations: in Lotus Notes and in the local network drive. It seems to be, when data is created, attention is not paid to comprehensive data management and mastering all data as one package, but the main thing is rather that the data is just existing.

The different steps of the product lifecycle create a lot of useful information to use for other parties, if the data is just collected, stored and transmitted in a reasonable way (Li et al. 2015). Since the spare part process is located in the end of the lifecycle, it is very dependent on the data used by others. The statement of Rachuri (2007) that once the product lifecycle evolves, the information content grows in terms of complexity and scope, clearly causes problems for the case company. In general, the case company is eager to produce after sales services to the customers, but the problem might be that the complexity and especially the data needs are not completely understood. It seems to be that the needs of the spare part business are thought of afterwards and that the spare part business needs to adjust to prevailing conditions. As a result of this, especially the data management of the spare part business is fragmented in the case company. According to Li et al. (2015), different steps of the lifecycle should be connected effectively enough and this is something that the management also should understand in the case company. Figure 29 strives to outline the reasons for the data problems.

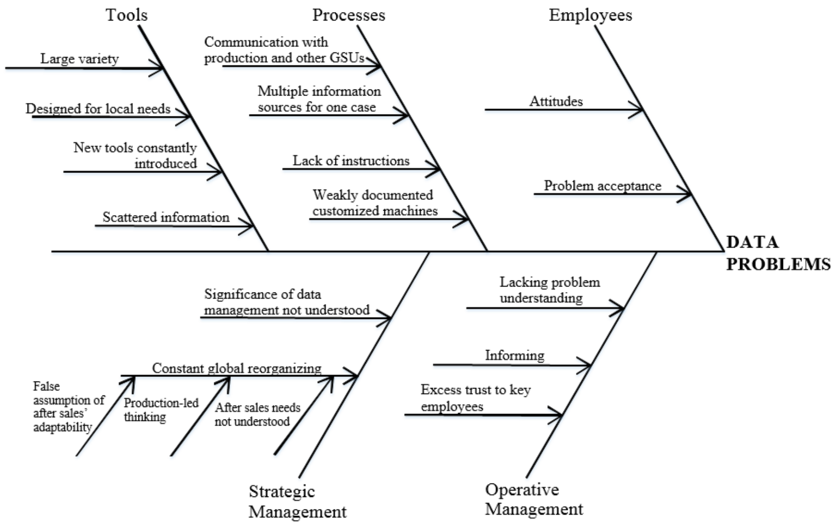

Figure 30. *Fishbone chart regarding data problems*

7.2 Data Management Recommendations

If the spare part operations of the GSU Sweden will be transferred to Finland, it is very likely that there will not be any point to do any large improvements to the data management, since the successful data management requires more holistic view that encompasses all operations through the whole company (Vayghan 2007, p. 670). Since the spare part process is a function that operates in the end of product lifecycle, its data quality is highly dependent on the parties of the product life cycle.

Hence, the substantial actions are not even reasonable to conduct before the case company is ready to these actions on larger scale and ready to see these issues more comprehensively. Still, as it has been discovered during the study, there are parties who are in a more critical role in terms of data. The importance of their involvement is vital in order to conduct the consolidation of processes successfully. The following issues should be taken into consideration:

1. Ensure continuation of the existent customer service level

According to the study results, the data management in general is well managed at the GSU Sweden. The spare parts identification does not basically cause any problems and the technical information showed to customers in BOL enables them to act more independently without related RFQ. Compared to the GSU Finland, the spare part process of the GSU Sweden seems to have very few problems. If the spare part processes are centralized to Finland in the future, it is important that these processes are adapted totally and successfully and the achieved customer service level can be kept. This naturally requires careful preparation.

2. Understanding the extent of the transfer project

The consolidation project would be the largest change that has happened for IT2 spare parts this far, and thus it is important to embrace it as such. The amount of monthly RFQs at the GSU Sweden is approximately 270, whereas the same number at the GSU Finland is about 350. This means that the consolidation would implicate that the amount of RFQs would increase monthly by approximately over 75 percent, and therefore the workload in sales will especially increase. It is also important to notice that this increase would consist of the cases that are unfamiliar to the GSU Finland beforehand. The major impact on the success is depending on the preparation to transfer: how well the receiving unit is informed and oriented in advance about the transfer and how much required data it has received for the spare part process execution. Consequently, if the preliminary work of the transfer project fails, the extent of the consequences is totally in a different scale compared to before. It is critical to be ready to put enough effort and resources into the transfer project.

3. Overall understanding of the data requirements

In this study, the different tasks of the spare part process and their data requirements were identified. Based on the study results, the availability of correct data plays a particularly critical role when it is a question of the tasks carried out by the sales engineer. The processing time of an individual case is basically depending on two factors: the spare part identification and the spare part supply. Here, the access to right information has a key role. This study strived to compile such an extensive list of the data sources used by the sales engineers at the both GSUs as possible. Still, it needs to be remembered that there are very likely some hidden data sources which were not revealed during the thesis work. Additionally, it has been revealed that the same information can be searched via different data sources and different users can prefer different information channels. Consequently, before any information sources are transferred, it should be examined more precisely which data sources are really needed and what information could be found via already existing data sources. Because of this, the sales engineers and the product specialists' involvement and cooperation during the transfer project are important. It is highly critical that all needed data sources are available, even if acquiring them would require extra resources. The data source lists compiled during this study is a good starting point for the survey.

4. Uniform material code policy

Currently, the GSUs have dissimilar material code logic: the GSU Finland uses the same codes as the production plants do, whereas the GSU Sweden modifies them to their own naming convention. Once it is a question of centralizing all operations to the GSU Finland, it is likely and even recommended that the code logic will be harmonized. So far the GSU Finland has used the same material code logic with production in terms of the both IT1 and IT2 spare part codes and the unit is unfamiliar with the idea of modified codes. Data consistency has a critical role in strategic data management (Marsh 2005, p. 107) and one of the biggest challenges particularly is to keep all the created data in a standardized form since there are several ways to capture the same data (Kropsu-Vehkaperä & Haapasalo 2011, p. 61). Thus, the idea of uniform material code logic through the company contributes to effective data management. Hence, the idea that the spare part business starts to use the production codes with the current Swedish spare parts seems more likely. In order to avoid confusion among the customers and secure the customer service level, the code replacement is required to be conducted completely smoothly. It is important to inform the customers about the change, but even more important is to ensure an automatic code replacement. If these actions fail, the customer service will suffer and the amount of office work will increase. According to interviews, the GSU Finland does not have the required know-how to conduct this kind of change.

5. Automatized order handling process for stocked items

Currently, all IT2 customer orders need to be checked through by the order handling before they can be accepted. Still, for those spare parts that are sold straight from the stock, any check-up should not be needed, since the master data is supposed to be faultless. At the GSU Finland, 95 percent of all order rows are sold straight from stock, and thus acceptance procedure is valid only for routine-like actions, which do not require any concrete check-up at all. At the GSU Sweden, the amount of sales from stock is at the same level as in Finland. If all operations will be centralized to the GSU Finland, it is highly critical to get this process automatized in order to avoid an unnecessary workload increase in order handling.

6. Informing and orientating

Insufficient data and informing about the change, have caused situations where only the most standardized spare parts or none at all can be quoted. As it was stated by Heskett et al. (1994, p. 168-169), the customer satisfaction and quality service is occurring from employee satisfaction, and thus the management should strive for employee-oriented thinking, support these front line workers, ensure pleasant working conditions and provide sufficient training for them (Kantsperger & Kunz 2005, p. 148). Since the customer satisfaction is highly valued at the PG Service, these kinds of issues are important to consider by the management level. There has earlier been a problem for the GSU Finland, that once operations are transferred, the information related to operations execution has not transferred at the same time.

These problems have concerned both the general communication of the transfer, of the control and the data that is needed for quoting. It is very critical that the GSU Finland will have access to all required data sources that are needed while quoting and that all parties of the process are completely informed about when and what will happen. In this thesis, the needed information sources are listed as extensively as it has been possible. Still, it is important to continue this survey, since there is always a probability that something was forgotten and not mentioned.

7. Support after the implementation

Despite how well the spare part transfer would be prepared beforehand, there will always be something that has not been taken into consideration enough. It should be ensured that the product specialist has enough time to work as sales support. Also the former GSU is critical to have as a support contact. Additionally, all used contact information of the production plants and other possible parties should be transferred as well. The GSU Sweden supports also machines that are produced by production plants that are unfamiliar to the GSU Finland.

7.3 Short-Term Inventory Actions

As it was stated already earlier, this discussion part of the study focuses only on the examination of the inventory management of the GSU Finland, and subchapter 6.6 already took a closer look at it. According to the study results, the problem does not seem to be in the inventory policies related to the safety stock, reorder point or the batch sizes that are calculated with the EOQ-calculator. The annual inventory turnover in the A-category is 2,9 and in the B-category 1,3, which are completely normal values in the spare part business according to Cohen et al. (2006, p. 132). It has to be also noticed that the safety stock tool only has been used since summer 2014 and the case study data spans from November 2013 to August 2015. Thus, if the data was newer, the influence of this safety stock tool could probably be seen clearer. Since these previously mentioned issues are not seen as a root cause of the problem, the recommendation is that the use of the safety stock tool should continue unchanged.

It is a good thing that the current inventory management practices take the spare parts demand into account, and consequently the safety-stocks of the materials with very small or non-existent demand are lowered to zero, and thus the supplement orders are prevented. Of course, this does not help with the already purchased spare parts, which will stay in the stock until someone buys them or they are scrapped. Based on the study results, the main problem is more about what items are kept in stock and how the stocking decisions of new items are done. In order to prevent high inventory value, the stocking decisions done in the first place should be stricter. Then again, stocking is a way to prevent uncertainty caused by weak availability afterwards. Additionally, one affecting problem is naturally unnecessary big batch sizes that are a result from the too large minimum batch size requirements of the suppliers. Therefore, the recommendations discussed in this chapter are more focused on stocking decisions of different SKUs and general issues of the inventory management.

As it was found from the study results, the both units have a very low average inventory turnover rate and the major part of the revenue is coming from a very small part of the SKUs. 39 percent of the inventory value is created by the last two percent of sales and unsold SKUs. As it was stated by Dekker et al. (2013, p. 538) companies often respond to great uncertainty by means of unnecessary large stocks and this can be seen to happen in the case company as well. The annual stocking costs are approximately 24 percent of the average stock value at the GSU Finland, and thus they are much higher compared to Richardson’s (1995, p. 68) evaluation in the literature, which was two to five percent. However, the estimated total inventory holding costs were 51 percent at the GSU Finland, which was also quite high, but still in the limits that Richardson (1995, p. 68) told to be between 25 and 55 percent. Hence, if the GSU Finland has stocked an item four years, its stocking has already caused almost the same cost as its original purchase price. If all inventory holding costs i.e. 51 percent, are included, the stocking will cost the same as the original purchase price was in only two years.

Since the stocking costs calculation at the GSU Finland is not based on any exact costs that are caused by some exact material, but rather on a visual evaluation of the used stocking space. Therefore, it would be unnecessary to use time for scrapping individual spare parts from the stock, if it does not have any influence on the total stocking costs, because the total change to stock space would not be so radical. This way, it would seem to be more reasonable in the case company to focus on the inventory possibilities that can be achieved through the consolidation of operations into one unit.

As it was found in the study results, the both GSUs have great reduction potential in the inventory value, and therefore the target at the starting point could be to get the current stocking space of the GSU Finland to be sufficient for all IT2 parts that are currently stocked in two separate locations. As stated by Fortuin & Martin (1999, p. 963), keeping everything that can be possibly break in the stock is not a reasonable option. According to Dekker (2013, p. 538) spare parts services can cover thousands of spare parts and to invest in these parts without any certainty of demand is a risky business. On the basis of the study results, the problem in the case company is exactly this and as it can be seen from the Figure 24. Only a very small portion (12 percent) of total stock covers first 50 percent of sales from stock, whereas 29 percent of stock value covers already 80 percent of total sales.

According to many authors (including Bacchetti & Saccani 2012, p. 724; Botter & Fortuin 2000, p. 673; Dekker et al. 1996, p. 74-76; Huiskonen 2001, p. 129), the criticality of a spare part is a significant factor while examining the inventory policy and control. Botter & Fortuin (2000 p. 673) even state that criticality of an item should define the need for stock-keeping. Dekker et al. (1996, p. 74-76) admit that the more complicated criticality assessment principles are the harder they are to apply in practical circumstances. Botter & Fortuin (2000, p. 662-663) add that the assessment of the component criticality requires often the subjective judgements. As it was seen in the Figures 21 and 22, the case company has conducted question trees, which evaluate criticality and captivity of spare parts particularly subjectively. The results of the spare parts criticality assessment based on these question trees are seen in the matrix Figure 23, whereas the Figure 26 describes results of the ABC-analysis according to single spare part criticality assessment and stock value. While examining the Figure 26, it can be seen that the stock is already now containing lot of parts, which were categorized as the most critical ones. However, the demand of these parts is very low. Additionally, the GSU is not responsible for the downtime costs (mentioned by Huiskonen 2011, p. 125) nor it does not have any governmental requirement (mentioned by Leifker et al. 2012, p. 285-286) to supply spare parts to the customers, since the warranty period is not included in the spare part services. Hence, the image losses mentioned by Fortuin & Martin (1999, p. 968) are basically the only possible caused expenses.

Since the case company is not officially responsible of being able to supply spare parts to customers and it is not getting any real penalties for possible downtime, the criticality factor may not be the most functional one for the case company's spare parts classification criteria. Additionally, the GSUs are back-end units, which are not in contact with the end-customer, but only the front-end unit. Thus, the end-units do not really know anything about how critical situation the end-customer is having.

The initial target of this thesis was to find both immediate actions and actions that will have more long-term influence. The basis of the study results, the recommended immediate action is to scrap SKUs that have non-existent or very minimal demand. Based on the study results, the scrapping decisions are situated in C-, D-, and E-categories in ABC-analysis and have two sales event or less annually. As it can be seen from the Figure 28, there are a lot materials in C-, D- and E-categories which are still in active phase, but demand is low or non-existent. Thus, the case company should not be so worried of scrapping these items, since the lifecycle phase does not evidently guarantee the demand. It is recommended that followed spare parts are scrapped:

- All non-sold items i.e. E-group (482 SKUs)
  - → Stock value reduction 7 800 *f*

- Those items from the C- and D-categories, which have less than two sales events annually and have a known supplier contact (260 SKUs)
  - → Stock value reduction 4 000 *f*

→ Total stock value reduction 11 800 *f* (46 percent reduction compared to the original value)

→ Total reduction in SKUs 742 SKUs (53 percent reduction compared to the original amount of SKUs)

Additional remarks related to scrapping:

- Since the examined data period ends by the end of August 2015, possible newer sales of the potential scrapped items should be verified first. If sales events exist, the scrapping should be reconsidered.
- If some items are desired to be kept in stock despite of the scrapping recommendation, these reasons should be written in the specific material memo –field in SAP. Also the year of obsolescence should be announced in the same context.

It is expected to be a better option to focus on the SKUs that can be scrapped completely. It is not considered worthwhile to use resources to collect an estimated amount of SKU items away from stock bin and scrap them. According to the study results, the stock basically includes a lot of incorrect materials and unnecessarily big batches of the right ones. The stricter inventory management procedures enable using of stocking space for right materials. However, since there is no way to evaluate the actual savings in stocking space, it is generally assumed in the thesis that the stock value change is directly proportional to the savings in stocking space. However, it can be said that for example End-Shields, of which roughly 60 percent of E-category items are composed of, are relatively large components.

Since the annual revenue of stocked materials at the GSU Sweden is only 72 percent of the corresponding number of the GSU Finland and since the GSU Sweden is only supporting machines with the small and medium shaft height, there should be enough saved stock space to keep both stocks within the current premises of the

GSU Finland. If the recommendations of this study are followed, the number of SKUs would decrease with 53 percent and the inventory value with 46 percent. According to the study results, it should not be an over demanding target to strive to fit the SKUs of both GSUs into the same stocking space where the current materials of the GSU Finland are located. Hence, if the average inventory value of the whole IT2 business that currently is divided between the two GSUs would be at the same level as the current inventory value of the GSU Finland in the future and the annual revenue of IT2-products sold from the stock would correspond to the current revenue of the GSU Finland and Sweden, the inventory to sales ratio would be 0,8, whereas it is currently 1,4 at the GSU Finland and 2,6 at the GSU Sweden. Also stocking costs and the total inventory holding costs would lower compared to revenue. Consequently, the value of yearly sales from stock would be higher than the average inventory value. This new value for the inventory to sales ratio is calculated below.

$$\text{"The new"}\ inventory\ to\ sales\ ratio\ (purchase\ price) = \frac{25\,900\ f}{31\,250\ f} = 0{,}8$$

The spare part materials that have been retired from the stock in the proposal have annually had 142 sales events during the reviewed time period in total. One purchase order is estimated to take approximately five minutes (see Figure 20), and thus the increase in annual workload is 710 minutes i.e. 11,8 hours. However, the growth is still much less than one purchase order per day. In order to avoid increased workload caused by the scrapped materials, it is required to plan beforehand how to act with these materials in the future. Before any material is scrapped, it should be solved how to react in the future if a customer requests the part. As it was found earlier, the GSU Finland classifies spare parts into different kind of categories through which customers can get more information about the spare part status, including stocked item, delivery time item, sold until the stock ends item etc. Also information regarding if some spare parts are unavailable is provided. In order to avoid an increase in sales engineer’s workload, all scrapped items should be classified to be either non-stocked listed items or alternatively no longer available spare parts.

Once the items are scrapped, it is important to provide the last-time-buy chance to the customers. The problem here is that the customers of the GSU are the front-end units, which means that the GSU cannot deliver the message straight to the end-customers. Because of this, the importance of this factor should particularly be emphasized to the front-end units, since the scrapping concerns lots of different kinds of items.

7.4 Inventory Management Long-Term Possibilities

The proposed long-term activity is to have stricter stocking policy in the future. The inventory management should be defined through common instructions. According to Fortuin & Martin (1999, p. 968) the attention in the inventory management should be focused on parts that really matter for the business, whereas other parts should be controlled by a simple rule. Huiskonen (2001, p. 132-133) states also that managers do not feel comfortable if they do not completely understand what the results of computational inventory models are based on, and thus different kind of rules of thumbs are very popular in managerial practice. On the basis of these statements and basic knowledge about the company's preferences, it is decided to strive to make simple rules to the inventory management of the case company. First of all, the study results revealed that it has been hard for the employees to figure out whether they should be more focused on ensuring the availability of spare parts or contribute the low stock value. Consequently, the inventory management of the spare part business needs to have a crystal clear alignment towards the long-term strategic objectives of the inventory management. The management should be committed and secure that these alignments will stay unchanged in the long run. In the spare part business, the support periods are long and the selection of spare parts broad, and thus constant changes in strategic alignments do not produce any favourable results.

Basically, the incomplete inventory instructions constitute a good base for the new inventory policy and as it was stated already in the study results, the same principles are at least partly followed at the GSU Finland already now. The instructions need to be completed and everyone involved should be informed of them. Also the GSU should be committed to follow them. Perhaps the most important issue regarding these instructions is the need of a clear division of responsibilities, which according to study results currently causes problems since many people are executing overlapping responsibilities without any unambiguous instructions or clear control mechanisms.

Currently, there is no clear and unambiguous division of responsibilities. Some of actions, including the decisions of material stocking are originating from several reasons that are affected by several persons. However, the product specialist is the only party who can really decide the stocking. In order to master the inventory management better in the future, all decisions and changes related to the inventory management should be based on predetermined rules that are mastered by a certain party. These rules need to be recorded in the inventory management instructions and possible changes require reasonable explanation. If there are some situations where for example material stocking needs to be started, but the instructions related to stocking are not met, the stocking is needed to be justified. The purpose of this kind of procedure is to get clear basic principles for the stocking.

During the thesis work, it has been heard many times that there are problematic materials whose stocking is based on for instance the availability problems. Still, the scope of this problem is hard to perceive, since these materials are not marked in a special way. Once there are clear divisions of responsibilities, unambiguous rules and all stocked exception materials are flagged, the real situation of the inventory management can be seen better. Once it is really perceived in the case company, which spare parts have problems related to supplier contact, it is easier to consider options. It could be a potential development idea to focus to get a special supplier contact for problematic materials like Huiskonen (2001, p. 131) suggested, who can produce these parts by having technical drawings and right tools available.

As it discovered in the Figure 27, roughly half of those SKUs, which were not sold at all during the examined time period of this study, were decided to take into the stock already in the beginning of the lifecycle. Also quite notable share of these SKUs was transferred production. Because of these results, it would be recommend that stocking decisions would be always based on verified demand, also when the support responsibility is transferred from one unit to another. In this thesis it is suggested that the material stocking is mainly started if the demand of past year has been at least six sales events or the demand of past half year at least four sales events. The product specialist is the party who is responsible of these decisions. If the stocking is decided to start and these reasons are not met, the justification is given by typing the case-specific explanation in the material memo -field in SAP. Moreover, the ordered batch size is required to be reasonable and calculated by the EOQ-tool. The purchasing department is responsible for the right batch size. If the ordered batch size differs from optimal, the reason for a different batch size is typed in the material memo -field in SAP.

As it is already documented into the incomplete instructions of the inventory management, the scrapping decisions should be done once in a year, the decisions should be based on low or non-existent demand and actions against these instructions are only allowed with good arguments. Currently, the draft instructions state that a SKU should be scrapped if there has not been any demand during the past five years. As the basis of this study, it has been evaluated that sufficient non-demand period for scrapping is two years. As the draft instructions already state, the person responsible of scrapping is the product specialist. According to interviews, although these potential SKUs for scrapping are evaluated once in a year, no scrapping actions are done so far. In order to have functional and believable inventory management, the documented procedures need to be followed.

The positive development of stock value is recorded as the responsibility of the product specialist and it is constantly followed by the inventory to sales ratio as Key Performance Indicator (KPI) that is based on the average inventory value and the revenue, which are both calculated by purchase price. The purpose of these improvements in the inventory management procedures is to pay more attention to stocking decisions and understand the influence of stocking different parts.

Currently, the average stock value is more than the sales from the stock annually. Also the stocking costs are high and only the stock space cost is 24 percent of average stock value annually. If all inventory holding costs are included, the same number is 51 percent. This means that two-year stocking period creates an equal cost as the original purchase price has been.

However, many challenges of the current inventory management are actually occurring from the factors outside of the GSU. On the basis of the study results, especially weak supplier agreements set challenges for support services. Problems are resulting from unavailability of spare parts and too big minimum batch sizes. Since the support periods are long and the assortment of different spare part materials broad, in order to respond to customer requirements and keep the stock level low, the spare part business should find more flexible ways to act. The GSU Sweden has been involved in the supplier agreements of the local production plant. According to these agreements, the supplier should be able to supply the spare parts to the GSU next ten years after production has stopped. On the basis of the study results, the GSU Sweden has less supplier problems as the GSU Finland does. The common supplier agreements would possibly make the spare part business position easier, since it is not needed to be prepared to unavailability situations with unnecessary high stock levels. Probably no changes are happening if the GSU is not promoting its position itself. Since the strategic target of the BU is to decrease the value of net working capital, it should be understood at upper management level of the case company how challenging the lower stock level is to achieve in the spare part business because its special nature. Huiskonen (2001, p. 129-130) suggests more effective cooperation of the supply chain parties as an alternative option for that high stock value. According to Fortuin & Martin (1999, p. 968), spare part managers invest in better agreements with suppliers and increase cooperation and set up new kind of agreements with competitors and colleagues because of the trickiness of spare part logistics. These kind of solutions should be striven to find at the case company as well.

According to Cohen & Lee (1990, p. 56) and Fortuin & Martin (1999, p. 964) one possible way to decrease the stock level is to adopt spare part standardization, which is also discovered in the case company and even utilized at some level. However, the benefits cannot be seen in the spare part business at least yet. Still, the problem in the spare part business is the length of the support phase periods that can last even twenty years, and thus the possible improvements impact very slowly over time.

Dekker et al. (2013, p. 544-545) find that by using installed base data together with historic demand data creates economic benefits, especially savings in inventory and obsolescence costs and it is especially useful with slow-moving and expensive. Based on study results, using the installed base data in spare part categorization together with historic demand data could be very functional for case company's purposes. During the inventory management examination, it was understood by the researcher, how difficult it actually is to gain information about the installed base of certain spare part in the case company. Depending on the case, the installed base data is searched from several locations, including SAP-system, Lotus Notes databases and spare part catalogues. Since the data is not designed for the use of the spare part business, it is challenging to filter it to an easily analyzable form. The machine sales volumes are not available either. Furthermore, according the product specialist, the data includes also defects which can usually be interpreted by means of experiential knowledge of the product specialist.

Leifker et al. (2012, p. 285) states that manufacturers know unfortunately seldom the number of products that are still in operation and this holds true also in the case study. Basically, the spare parts of a certain machine can quite practically be viewed via serial number or machine type code, but this search cannot be executed the other way around. Hence, if one wants to gain information about the installed base of certain spare part, this is basically needed to done via technical drawings. From the research point of view, this situation makes the inventory management highly depending on certain employees' know-how and expertise and gaining specific information of certain spare part is difficult and slow for even them.

Also Dekker et al. (2013, p. 541-544) find that old, large and distributed installed base, autonomous changes of product configurations, diverse customers and machines and complex organizational structure make installed base information difficult to exploit and these are all factors that can be linked to the case study example as well. Also the point that older installed base is often scattered in legacy systems holds true in the case company as well. The SAP-system has been used since 2009 and before that the case company had a lot of local ERP-systems. Though, Dekker et al. (2013, p. 541-544) states that if the installed base data is not available from the whole support lifecycle, it can be used only information searches considering newer machines. Dekker (2013, p. 541-544) still notices that it should be carefully considered if the use of the installed base data is worthwhile, expensive and demanding task for a company to stay on track of installed base information.

In the ideal situation, one could get more information about the spare part by one search, including data related to machine type, year of manufacture, annual sales volume. Basically, all this data should be recorded and be somehow searchable from systems already now. The only problem is probably that the data structure in the system is not designed for searches executed this way. The Figure 31 presents an illustrative example of ideal installed base –tool that would be practical for case company's purposes.

TYPE THE SPARE PART MATERIAL HERE

	Machine Type	Machine Type A	Machine Type B	Machine Type C	Machine Type D	Machine Type E
	Production Country	FI	FI	FI	PO	CH
	No of items	2	2	2	2	2
PRODUCED MACHINES PER YEAR	**2016**	505	0	0	443	776
	2015	203	0	0	321	654
	2014	345	0	0	478	0
	2013	543	0	654	0	0
	2012	555	0	786	0	0
	2011	234	19	983	0	0
	2010	444	45	876	0	0
	2009	587	27	0	0	0
	2008	501	59	0	0	0
	TOTAL	**3917**	**150**	**3299**	**1242**	**1430**

Figure 31. *Illustrative example of installed base -tool*

8 CONCLUSIONS

This chapter begins with the presentation of the key findings of this thesis and is followed by an assessment of the study limitations. Finally, the possibilities for further research that have arisen from this study are provided.

8.1 Key Findings of the Study

According to the studied results of the data management, the spare part process is very strongly depending on the data that is produced by the preceding parties of the machine lifecycle. Concerning the data needs, the sales process and the work tasks of the product specialist are the most critical steps, while the other parties use mainly internally produced data. Since the sales engineers are working as the front-line customer service persons, the bad data quality or availability problems can easily impact the customer service level. Instead the product specialists are more back-office based, and thus the lacking data does not cause so easily immediate harm as there often is more time to clarify the case.

The selection of utilized data sources is quite broad and fragmented at the both GSUs. Additionally, the spare part process is depending on the expertise and know-how of the product specialist at the both GSUs. This far there have not been problems with it, but still the fact that the whole process is relying on these few persons is quite a risk. Different kinds of data or information gaps are the main reasons why the help of the product specialist is needed. At the GSU Finland, the data management problems cause mainly frustration, delayed customer service and uncertainty about the validity of quoted parts. On the other hand, at the GSU Sweden, basically no such problems are recognized. One explaining factor can be that in Finland there are more customized machines supported, so the amount of deviating cases is probably higher. Additionally, attitudes and how things are experienced can make a difference in this kind of comparison. However, the large amount of different data sources used did not have such a great influence on the process execution at the GSU Sweden as it had at the GSU Finland.

In its totality, before the significance of consistent data management and the after sales functions' dependency of data created in earlier lifecycle phases, is truly understood at the higher management level, it is not reasonable to execute any major changes in the data management. Achieving a consistent data management will require general approach and actions. After sales business is highly depending on the data used by other parties and is thus unable to do required improvements independently. Still, based on the results of the study, the recommendations considering the prospective consolidation of the current operations were given and they can be seen in the sub-chapter 7.2. According to the results, the data management is currently better mastered at the GSU Sweden, and thus it creates pressure on the GSU Finland to adopt and implement the operations successfully in order to secure the achieved customer service level. The critical factor here is to fully understand the extent of this change compared to corresponding ones conducted in the past. The former changes have been either smaller or less all-encompassing projects, and thus these operations have been implemented without much effort put into pre-planning.

In the inventory management, the problem seems to be occurring from the large assortment of non-sold or weakly sold stocked items at the both GSUs. Additionally, at least at the GSU Finland, the basic principles of the inventory management are experienced as unstructured and there is no clear distribution of responsibilities. Basically, the general atmosphere has not been very interested of possibilities and the cost savings that could be achieved through an effective inventory management. However, the general strategical alignments in the case company have started to pay more attention to the inventory value. Still, these alignments are not fully clear for the employees at the performing level.

According to the study results, the policies related to the reorder point, the safety stock and the batch sizes are already handled well at the GSU Finland and changes in this field are not needed. Since the stock costs are based on visual estimations, small changes in needed stocking space do not have influence on the stocking costs. Since the stock consist of a lot of slow-moving and non-moving spare parts, there would seem to be room for even greater changes. The proposed short-term action of this study is to scrap all E-category spare part materials and those C- and D-category materials, which have less than two sales events annually and an existent supplier contact. These actions would decrease the current stock value with 46 percent and the amount of SKUs with 53 percent. If the case company decides to consolidate the IT2-operations into one unit, it should not be a far-fetched target to strive to fit all materials into the same stocking space where the spare parts of the GSU Finland currently have been located. Additionally, this would mean that the presently high stocking costs would go down quite radically, since they would be shared by bigger revenue. Although it could easily be supposed that the criticality, which was highlighted as an important stocking criteria by literature as well, should be a relevant criteria for stocking, does not seem to be functional in this case example. According to the study results, the absolute major part of stock value is already now coming from critical materials. Based on the study results, the decisions should be based more purely on spare part demand.

While considering different options regarding the inventory management of IT2 spare parts, it is also important to remember that a relatively much smaller range of SKUs is adequate to manage the spare part support services of the IT1-machines. Consequently, relatively much larger portion of IT1 spare parts are bought individually case-by-case, although IT1-machines are on average much larger and more expensive, and thus more critical from the customer’s point of view. Since the IT2-machines are less expensive, it is more likely that once the machine breaks down, the customer is more inclined to invest in a new machine. Newer technology enables better efficiency of machines, which again brings savings in the operating costs. Hence, if the price of a new machine were low, it would seem likely that the customer would choose a straight new machine instead of repairing the old one more often. Or at least, if the required spare parts were unavailable, this would probably not cause that much harm. Then again, since the IT2-machines are relatively cheap and the procurement of certain spare parts is sometimes disproportionately difficult and expensive, it could be an option to offer the customer a completely new machine with a price discount, if the requested spare part is unnecessarily hard to supply. However, dissimilar stocking principles between IT1 and IT2 are questioning the need for the existing large scope of IT2 inventory.

Still, the key for improvements in the inventory management undoubtedly lies in the need of clear and documented processes and an unambiguous distribution of responsibilities. First of all, the long-term strategic alignments of the inventory management must be defined and their compliance committed to. Additionally, the KPIs for the evaluation of achieved objectives must be defined as well. Moreover, the supplier agreements especially at the GSU Finland have been revealed to be at least partly inadequate. This has caused the increased need for stocking materials. In the future, it is important to focus on the cooperation between the production and after sales in order to ensure availability and reasonable batch sizes of spare parts. Basically, the production is the first party who is in contact with the supplier in regards of new materials. In order to ensure availability after the active production period, it is important to secure availability for the whole lifecycle at once. Once the negotiation of availability is conducted at the first point of the whole lifecycle, the possibility to gain profitable agreements is probably higher. Of course, the closer the cooperation with supplier agreements require actions, particularly from the after sales side.

After all, the study results reveal that the large range of different spare part materials causes problems in both the data and inventory management. According to Huiskonen (2001, p. 132) and Fortuin & Martin (1999, p. 964), it is recommended to strive for parts standardization when it is possible, in order to achieve an effectively controlled spare part inventory management. Fortuin & Martin (1999, p. 964) also add that the standardization makes the demand of individual parts more pronounced. In the case company's situation, the standardization would basically help with both the data and inventory problems, since the large range of spare parts makes effectively handled business operations unmanageable. At the case company, the recent trend has been to manage support operations more centralized, which means that individual operators are responsible for a wider and more global range of spare parts than ever before. Therefore, the standardization has an important role in terms of controlling the scope of various spare parts.

Moreover, the strategical issues of the spare part business should fit better into the reality of the business. If existent data, supplier agreements and functional cooperation through the lifecycle are lacking, the spare part services cannot do miracles, at least without large investments into the stock. After sales is the party in the end of the product lifecycle and it is strongly depending on actions done by previous parties of the product lifecycle. As it was stated by Cohen et al. (2006, p. 129), the after sales services are treated as a mere afterthought by top management worldwide and the same occurrence is noticeable in the case company as well.

8.2 Limitations of the Study

One major limitation of this study was that both GSUs could not by examined to the same extent. From the perspective of the researcher, this could mainly have had a negative influence to the data management part of the study, which was conducted as a qualitative study through the conducted interviews. In order to acquire and compile all significant points that are needed to be considered while planning and executing the consolidation, the researcher needs to have a fully comprehensive understanding of the processes and functions of the both units. The researcher has worked at the GSU Finland in the past, and thus the understanding of the operations happening there was naturally stronger already in the beginning of this study. During the thesis process, the researcher was based at the GSU Finland office and had the opportunity to interview all parties of the spare part process there. The interviews conducted at the GSU Sweden were kept more low-profile in order to avoid unnecessary worries that could have been raised via the interviews, and thus all interviews were conducted with the spare parts manager and product specialist who acquired needed information from other process parties. However, the interviewer did not mention the possible consolidation during the interviews with neither of the GSUs.

Another restrictive issue during the execution of this thesis was the quite broad research area, which even included literature from two different disciplines: data and inventory management. The connective factor behind these two topics was the prospective project related to the consolidation of the current operations. The case company was willing to conduct a study that would be examining those subjects that were experienced as the most challenging and critical concerning the consolidation. Due to the study area of the thesis was broader than normal, it naturally had some sort of influence on the depth of the research, since the time was limited. However, the conclusions were provided and the thesis worker is satisfied with the result. On the other hand, it would still be interesting to get on a deeper level of these subjects, since both of them include many opportunities for development.

8.3 Possibilities for Further Research

From the basis of this study, the data management revealed to be quite scattered and incoherent even at the PG Service level in the case company. Since there are problems with the data management already at a lower level in the case company, it would be interesting to conduct further research about the data management at a larger scale as well. An examination at the BU or at division level could help in order to understand and perceive data problems better. Furthermore, the consistent data management requires more top to down approach and the initial actions at the higher company levels.

Another interesting research topic could be found from the field of inventory management. As it was found during the study, spare part inventory management is quite tricky to conduct since one has to consider both the service level and the cost-efficiency. The case company is far from the only company that is struggling with these issues. Hence, it would be interesting to conduct corresponding research in other companies operating in the same business field, compare the results and adopt the best practices for wider use.

Also the internal structure of the PG Service and its relations to the end-customers have been revealed as quite tricky in their own way. Furthermore, the information is not actively shared inside of the PG Service either. As it was noticed, the back-end unit does not really get any information concerning the end-customer, and thus it is difficult to know for example the true criticality of parts and customer preferences. Despite weak end-customer knowledge of the back-end, it is still the party which has to make the call on which parts to stock in an already difficult inventory management of the spare part business. Heskett (1994, p. 166) states that company needs a well-managed and designed service concept in order to achieve customer satisfaction. According to Sakki (2014, p. 58), customers' perception of the service ability can differ from the beliefs of the company, whereas Sabath (1978, p. 26) states that companies can hold service levels even unnecessary high. The exact definition of customer requirement is important to understand, since companies can easily execute requirements too precisely and expensively (Konijnendijk 1991, p. 141). Because of these considerations collected from the literature, in order to avoid unnecessary costs of the spare part business, it is highly recommended to get acquainted with customer requirements, especially because the strategical alignments of the PG Service highlight the significance of the customer satisfaction. Even if there are some customer feedback actively collected or market research conducted, it does not at least seem to reach the back-end units. Perhaps even the overall function of the PG Service and its current structure should be examined more closely and reassessed.

REFERENCES

Bacchetti, A. & Saccani, N. (2012) Spare parts classification and demand forecasting for stock control: Investigating the gap between research and practice. Omega Vol. 40, pp. 722–737.

Bergström, S. & Leppänen A. 2007. Yrityksen asiakasmarkkinointi. Helsinki. Edita. 463 p.

Bernard, A. & Tichkiewitch, S. 2008. Methods and Tools for Effective Knowledge Lifecycle-Management. Berlin. Springer-Verlag. 586 p.

Bloodgood, J. & Salisbury. D. 2001. Understanding the influence of organizational change strategies on information technology and knowledge management strategies. Decision Support Systems. Vol. 31, Issue 1, pp. 55-69.

Botter, R. & Fortuin, L. 2000. Stocking strategy for service parts - a case study. International Journal of Operations & Production Management. Vol. 20, No. 6, pp. 656-674.

Brook, Q. 2014. Lean Six Sigma and Minitab - The Complete Toolbox Guide for Business Improvement. United Kingdom. Opex Resources Ltd.

Cohen, M., Agrawal, N. & Agrawal, V. 2006. Winning in the Aftermarket. Harvard Business Review. Harvard Business School Publishing Corporation. Vol. 84, No. 5, pp. 129-138.

Cohen, M. & Lee, H. 1990. Out of Touch with Customer Needs? Spare Parts and After Sales Service. Sloan Management Review. Vol. 31, No. 2 (Winter 1990), pp. 55-66.

Dekker, R., Pince, C., Zuidwijk, R. & Jalil, M. 2013. On the use of installed base information for spare parts logistics: A review of ideas and industry practice. International Journal of Production Economics. Vol. 143, pp. 536-545.

Dekker, R., Kleijn, M. & de Rooij P. 1998. A spare parts stocking policy based on equipment criticality. International Journal of Production Economics. Vol. 56-57, pp. 69-77.

Fortuin, L. & Martin, H. 1999. Control of service parts. International Journal of Operations & Production Management. Vol. 19, No. 9, pp. 950-971.

Gaiardelli, P., Saccani, N. & Songini, L. 2007. Performance measurement of the after-sales service network - Evidence from the automotive industry. Computers in Industry. Vol. 58, No. 7, pp. 698-708.

Gebauer, H., Fleisch, E. & Friedli, T. 2005. Overcoming the Service Paradox in Manufacturing Companies. European Management Journal. Vol. 23, No. 1, p. 14-26.

Haug, A. & Arlbjorn, J. 2011. Barriers to master data quality. Journal of Enterprise Information Management. Vol. 24, No. 3, pp. 288-303.

Heskett, J., Jones, T., Loveman, G., Sasser, W. & Schlesinger, L. 1994. Putting the Service-Profit Chain to Work. Harvard Business Review. Vol. 72, No. 2, pp. 164-174.

Huiskonen, J. 2001. Maintenance spare parts logistics: Special characteristics and strategic choices. International Journal of Production Economics. Vol. 71, pp. 125-133.

Häkkinen, L. & Hilmola, O-P. 2008. ERP evaluation during the shakedown phase: lessons from an after-sales division. Information Systems Journal. Vol. 18, No. 1, pp. 73-100.

Jalil, M., Zuidwijk, R., Fleischmann, M. & Nunen, J. 2011. Spare parts logistics and installed base information. Journal of the Operational Research Society. Vol. 62, p. 442-457.

Kangasharju, H. & Majapuro, M. 2005. Tutkimusraportin kirjoittaminen. Helsingin kauppakorkeakoulun julkaisuja. Helsinki. HeSe print. 125 p.

Kantsperger, R. & Kunz, W. 2005. Managing overall service quality in customer care centers: Empirical findings of a multi-perspective approach. International Journal of Service Industry Management. Vol. 16, No. 2, pp. 135-151.

Kiritsis, D., Bufardi, A. & Xirouchakis, P. 2003. Research issues on product lifecycle management and information tracking using smart embedded systems. Advanced Engineering Informatics. Vol. 17, No. 3-4, pp. 189-202.

Knolmayer, G. & Röthlin, M. 2006. Quality of Material Master Data and Its Effect on the Usefulness of Distributed ERP Systems. Conference: Advances in Conceptual Modeling – Theory and Practice. Lecture Notes in Computer Science. Berlin. Springer-Verlag. Vol. 4231, pp. 362-371.

Konijnendijk, P. 1991. Setting customer levels: an overall cost-approach. International Journal of Production Economics. Vol. 23, No. 1-3, pp. 139-146.

Kropsu-Vehkaperä, H. & Haapasalo, H. 2011. Defining Product Data Views for Different Stakeholders. Journal of Computer Information Systems. Vol. 52, Issue 2, pp. 61-72.

Leifker, N., Jones, P. & Lowe, T. 2012. A Continuous-Time Examination of End-of-Life Parts Acquisition With Limited Customer Information. The Engineering Economist. Vol. 57, No. 4, pp. 284-300.

Lee, Y. & Strong, D. 2003. Knowing-Why About Data Processes and Data Quality. Journal of Management Information Systems. Vol. 20, Issue 3, pp. 13-39.

Li, J., Tao, F., Cheng, Y. & Zhao, L. 2015. Big Data in Product Lifecycle Management. International Journal of Advanced Manufacturing Technology. Vol. 81, Issue 1-4, pp. 667-684.

Markeset, T. & Kumar, U. 2003. Design and development of product support and maintenance concepts for industrial systems. Journal of Quality in Maintenance Engineering. Vol. 9, No. 4, pp. 376-392.

Marsh, R. 2005. Drowning in dirty data? It's time to sink or swim: A four-stage methodology for total data quality management. Journal of Database Marketing & Customer Strategy Management. Vol. 12, No. 2, pp. 105-112.

Metsämuuronen, J. 2008. Laadullisen tutkimuksen perusteet. Gummerus kirjapaino Oy. Jyväskylä. 74 p.

Narver, J. & Slater, S. 1990. The Effect of a Market Orientation on Business Profitability. Journal of Marketing. Vol. 54, pp. 20-35.

Neu, W. & Brown, S. 2005. Forming Successful Business-to-Business Services in Goods-Dominant Firms. Journal of Service Research. Vol. 8, No. 1, pp. 3-17.

Rachuri, S., Subrahmanian, E., Bouras, A., Fenves, S., Foufou, S. & Sriram R. 2007. Information sharing and exchange in the context of product lifecycle management: Role of standards. Computer-Aided Design. Vol. 40, No. 7, pp. 789-800.

Richardson, H. 1995. Control Your Costs – Then Cut Them. Transportation & Distribution. Vol. 36, No. 12, p. 94-96.

Rust, R. & Zahorik, A. 1993. Customer Satisfaction, Customer Retention, and Market Share. Journal of Retailing. Vol. 69. No. 2. pp. 193 – 215.

Sabath, R. 1978. How Much Service Do Customers Really Want? Business Horizons. Vol. 21, Issue 2, pp. 26-32.

Sakki, J. 2014. Tilaus-toimitusketjun hallinta: Digitalisoitumisen haasteet. Vantaa. Jouni Sakki Oy. 161 p.

Saunders, M., Lewis, P. & Thornhill, A. 2009. Research methods for business students. Essex. Prentice Hall. 614 p.

Silvola, R., Jaaskelainen O., Kropsu-Vehkapera, H. & Haapasalo, H. 2011. Managing one master data – challenges and preconditions. Industrial Management & Data Systems. Vol. 111, No. 1, p. 146-162.

Smith, H. & McKeen, J. 2008. Master Data Management: Salvation Or Snake Oil? Communications of the Association for Information Systems. Vol. 23, pp. 63-72.

Spengler, T. & Schröter, M. 2003. Strategic Management of Spare Parts in Closed-Loop Supply Chains - A System Dynamics Approach. Interfaces. Vol. 33, No. 6, pp. 7-17.

Suomala, P. Sievänen, M. & Paranko, J. 2002. The effects of customization on spare part business: A case study in the metal industry. International Journal of Production Economics. Vol. 79, pp. 57-66

Timme, S. 2003. The Real Cost of Holding. Supply Chain Management Review. Vol. 7, No. 4, pp. 30-37.

Vayghan, J., Garfinkle, S., Walenta, C., Healy, D. & Valentin, Z. 2007. The internal information transformation of IBM. IBM Systems Journal. Vol. 46, No. 4, p. 669-683.

Viitala, R. & Jylhä, E. 2006. Liiketoimintaosaaminen: Menestyvän yritystoiminnan perusta. Edita. Helsinki. 399 p.

Wild, J. Wild, K. & Han, J. 2010. International Business: The Challenges of Globalization. 5th ed. Pearson Education. New Jersey. 507 p.

Yin, R. 2003. Case Study Research: Design and Methods. 3rd ed. Sage Publications. Thousand Oaks. 181 p.

APPENDICES

Appendix 1. Data Sources Used, GSU Finland

Source of information	Usage (% of received RFQs)	Document type	Manufactured by	Year of manufacture
SAP, GSU Sweden (ERP-System)	85 %	- Sales order data - Purchase order data - Item data - Technical data	Finland & Poland	2009 and newer
SAP, Production plant Sweden (ERP-system)	85 %	- BOMs - Material configurator - Machine sales data	Finland & Poland	2009 and newer
BOL (Customer Interface)	35 %	- Component photos - BOMs	Finland, Sweden, Spain & Germany	1995 and newer
Lotus Notes (Platform, several application databases)	80 %	- Technical drawings - Component standards - Material standards - HATI, Purchase database (case spesific data) - Pre order support (Vaasa) - Technical releases - Article numbers	Finland, Poland, Sweden, Spain, Germany & China	1995 and newer
Emis (ERP-system)	40 %	- BOMs - Purchase Order archives	Finland	2004 - 2009
ServIS (Global Installed Base Management)	20 %	- Checking of added variant modification codes that are done by central stock - Product code available if a serial number is known	Poland, Spain & China	Varies according to production history of machine
ElApp (Database with browser front-end)	5 %	- Product code available for a serial number	Poland	2010 and newer
VnP (Database with browser front-end)	25 %	- Modification instructions	Finland, Poland, Sweden, Spain & China	2002 and newer
Microsoft Access, EMIS archives (Database in network drive)	15 %	- BOMs	Finland	1996 - 2004
Microsoft Access, Dynamo-books archives (Database in network drive)	5 %	- BOMs	Finland	60's - 1996
Excel Spreadsheet files in network drive	5 %	- Bill of materials (standard structure)	Spain & Germany	80's - 2013
Internal Online Library (Intranet)	25 %	- Motor products catalogues - Avaibility of modification variants - Main dimensional drawings of machine - Spare part catalogues -files	All	1995 and newer
Dynamo-books and folders	5 %	- Technical data and product code - Technical drawnings	Finland	60's - 1996

Appendix 2. Data Sources Used, GSU Sweden

Source of information	**Usage (% of received RFQs)**	**Document type**	**Manufactured by**	**Year of manufacture**
SAP, Production plant Sweden (ERP-system)	50 %	- BOMs - Supplier information - Product data information	Sweden Poland	2009 and newer
SAP, GSU Sweden (ERP-System)	25 %	- Spare part data - Sales order data - Purchase order data	Sweden Poland	2009 and newer
SAP, Production plant Spain (ERP-system)	20 %	- BOMs	Spain	- 2013
BOL (Customer Interface)	100 %	- BOMs - Component photos - Item data - Item technical data - Replacing materials	All	1995 and newer
Lotus notes (Platform, several application databases)	90 %	- Techninal drawings - Modification instructions - Purchase database (All)	Sweden Poland Spain	Early 90's and up
ServIS (Global Installed Base Management)	75 %	- BOMs - Variant codes	All	90's - today
QlikView (Analyse & reporting system)	25 %	- Sales data archieve - Bill of materials - Master data	Sweden	90's - 2009
Download Center (Repository)	5 - 10 %	- Spare Part Lists	All	All
OMS (Order Management Services)	2 - 5 %	- All items - Content Data - Prices	All	All
Books	3 - 5 %	- Spare Part lists	Sweden	60's, 70's & 80's