Lappeenranta University of Technology 14.112014

School of Industrial Engineering and Management

Department of Industrial Management

Supply Chain Management

Janne Petteri Romppanen

Global Spare Parts Supply Chain Analysis

Examiner:	Professor	Janne Huiskonen
Instructors:	Head of Supply Chain Management	Robert Jenks
	Manager - Spare Parts Operations	Mikko Ravaska
	Head of Spare Parts, EMEA	Tomi Ravattinen

ABSTRACT

Author: Romppanen Janne Petteri

Title: Global Spare Parts Supply Chain Analysis

Department: Industrial Management

Year: 2014 **Place:** Lappeenranta

Master's Thesis, Lappeenranta University of Technology

84 pages, 27 figures, 4 tables

Examiner: Professor Janne Huiskonen

Keywords: Lead time, Supply chain analysis, Service business, Spare parts, Customer satisfaction

In today's global industrial service business, markets are dynamic and finding new ways of value creation towards customers has become more and more challenging. Customer orientation is needed because of the demanding after-sales business which is both quickly changing and stochastic in nature. In after-sales business customers require fast and reliable service for their spare part needs. This thesis objective is to clarify this challenging after-sales business environment and find ways to increase customer satisfaction via balanced measurement system which will help to find possible targets to reduce order cycle times in a large metal and mineral company Outotec (Filters)' Spare Part Supply business line.

In case study, internal documents and data and numerical calculations together with qualitative interviews with different persons in key roles of Spare Part Supply organizations are used to analyze the performance of different processes from the spare parts delivery function. The chosen performance measurement tool is Balanced Scorecard which is slightly modified to suit the lead time study from customer's perspective better. Findings show that many different processes in spare parts supply are facing different kind of challenges in achieving the lead time levels wanted and that these processes' problems seem to accumulate. Findings also show that putting effort in supply side challenges and information flows visibility should give the best results.

TIIVISTELMÄ

Tekijä: Romppanen Janne Petteri

Työn nimi: Globaali Varaosien Toimitusketjun Analyysi

Osasto: Tuotantotalous

Vuosi: 2014 **Paikka:** Lappeenranta

Diplomityö, Lappeenrannan Teknillinen Yliopisto

84 sivua, 27 kuvaa, 4 taulukkoa

Tarkastaja: Professori Janne Huiskonen

Hakusanat: Toimitusajat, Toimitusketjun analysointi, Jälkimyynti, Varaosat, Asiakastyytyväisyys

Globaalin teollisuuden dynaamisilla palvelumarkkinoilla yritykset kohtaavat entistä enemmän haasteita pyrkiessään löytämään uusia asiakkaille lisäarvoa tuottavia keinoja. Asiakaslähtöisyys on tärkeää haastavassa jälkimarkkinoinnin liiketoiminnassa sen nopeasti muuttuvan ja stokastisen luonteen takia. Asiakkaat vaativat nopeaa ja luotettavaa palvelua varaosatarpeisiinsa. Tämän tutkielman tavoitteena on selvittää tämä haastava jälkimyyntimarkkinaympäristö ja löytää keinoja asiakastyytyväisyyden parantamiseen käyttämällä hyödyksi tasapainoista mittaamistyökalua, jota käyttämällä mahdollisia toimitusajan lyhentämiskohteita voidaan paikantaa ison teknologiateollisuusyrityksen varasaosaliiketoiminnasta.

Tutkielman case osiossa analysoidaan Outotec (Filtersin) varaosaliiketoimintaan kuuluvia prosesseja käyttäen hyväksi sisäisiä dokumentaatioita ja saatavilla olevaa dataa numeeristen laskelmien muodostamiseen sekä kvalitatiivisesti haastattelemalla varaosatoimintojen eri organisaatioissa ja rooleissa olevia työntekijöitä. Suorituskyvyn mittaamistyökaluna käytetään käyttötarkoitukseen muokattua Balanced Scorecardia. Löydökset osoittavat, että asiakasta tyydyttävän toimitusajallisen tason saavuttamisessa on haasteita useassa eri varaosatoimintojen prosessissa. Löydösten valossa huomataan, että suurimmat hyödyt saavutettaisiin panostamalla saatavuuden haasteisiin ja tiedonsiirron läpinäkyvyyteen sekä prosesseihin keskittymällä.

ACKNOWLEDGMENTS

Now that this thesis is finally complete, I would like to express my gratitude to all the people who made this possible. Firstly, I would like to thank my professor Janne Huiskonen at Lappeenranta University of Technology for giving me this opportunity and letting me finish this far-strained thesis. The same thanks go also to all my instructors and interviewees and my co-workers at Outotec.

Gratitude also to my fellow students and friends who have made sure that the college life was one of the best times of my life. You compensated the hard studying and made the whole time spent in university fun.

Special thanks family and especially to my son Leo, who made sure that father did not have too much spare time in his hands. It is your turn next.

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

APAC - Asia, Pacific and Australia

BA - Business Area

CRM - Customer Relationship Management

DMS - Document Management System

EDI - Electronical Data Interchance

EMEA - Europe, Middle-East and Africa

ERP - Enterprise Resource Planning

FI02 - Warehouse in Finland

FI04 - Warehouse in Netherlands

MTO - Make-To-Order

MTS - Make-To-Stock

MRP - Material Resource Planning

OECD - Organization for Economic Cooperation and Development

OTA - On Time Accuracy

OTD - On Time Delivery

PDM - Product Data Management

SC - Service Center

SCM - Supply Chain Management

SPC - Service Product Center

1. INTRODUCTION

This thesis is made for a large metal and mineral company Outotec (Filters') Spare Part Supply business line. Outotec (Filters) has long traditions in filtration and its after-sales business. But even with the Outotec (Filters') long traditions and experiences from the after-sales business, the spare part business has been growing and changing in recent years very rapidly and it has set lots of challenges towards an efficient supply chain management and especially to lead times and customer satisfaction. The object of this study is **"Global Spare Parts Supply Chain Analysis"**. The background, objective and framework of the study are presented in the next few chapters.

1.1 Background

The huge service potential of spare part business has been noticed in the case company Outotec but its exploitation is still far away from complete. Sales figures are going high but the average customer satisfaction is not following the sales trend and the customer feedback shows that the reason for mediocre customer satisfaction lies in too long lead times. Idea and objective for this thesis rose from the desire of the supply chain managers to increase customer satisfaction via shorter lead. The company has faced many challenges in meeting the customers' expectations regarding the lead times of spare parts, and wished for a thesis that would ease the way to tackle these challenges.

The industrial after-sales business is a rapidly changing and demanding environment because of the fluctuating demand of quickly needed services. Customers in service business are very time-sensitive and their purchasing behavior is increasingly demanding towards lead times. Long lead times can be very disastrous for a service provider in this very challenging after-sales business environment as some customers tend to choose their suppliers based on offered lead times. (Christopher, 1998, p. 149) This time-sensitive environment can lead

to a problem where the time to produce or acquire and deliver customer's ordered products (spare parts and services) is longer than what the customer is willing to wait for them. For a service provider such as Outotec, this problem is experienced when the customer's requested lead time is shorter than what Outotec can supply. However from Outotec's the internal back end systems this problem does not emerge as the information flow is not visible enough. In this thesis, one key point is to wake better understanding of the customers' needs in industrial after-sales business through viewing literature and reflecting it to the current processes and lead times of Outotec (Filters) so that efforts which could be made to enhance the information flows would come clear to the management, hence getting better understanding of the end-customers' real needs.

All theories used, tools created and results concluded in this thesis can act as supporting tools and findings for decision making in the company's spare part supply development projects in future. There may be already ongoing projects in Outotec which may already have similar features as this thesis so the outcomes gained from the thesis can act in either supportive or questioning roles in those projects.

1.2 Objective of the thesis and the research questions

The main purpose of the thesis is to find ways to improve customers' order fulfillment ratio by shortening the spare parts' supply lead time and to eliminate possible lead time gaps but also to be able to identify and understand the customers' needs which can also be seen as a strong asset in the company. In other words, the objective is to find the performance gaps or bottlenecks from the case company's spare part supply chain's processes and try to find ways to improve the performance or ways to remove these bottlenecks, ultimately leading to shorter lead times, better customer satisfaction and more agile spare part delivery process. The possible performance gaps can be revealed by measuring the performance of the supply chain processes with a performance measurement

tool which is based on findings from the literature review and afterwards applied in to the case company's processes. From the measurement findings and results, the current Outotec (Filters)' supply chain process' challenges can be identified and based on the literature and interviews suggestions for lead time improvements can be given for the supply chain management.

This study's purpose is not necessarily to develop any new concrete management tool but to enhance the knowledge of the reader and to recognize the problems in the current spare part supply. However the performance measurement tool can be used also in other purposes outside this thesis. For the thesis' framework development and the theory to be used, the managers gave the author almost free hands. At first the thesis was limited to contain only spare parts from two product lines but the limitations changed during the data obtaining phase because the two product lines were using different ERP-systems and the data obtained was very difficult to combine and process into manageable or analytical form. Also as the Outotec (Filters) has much longer experience in after-sales business than Outotec (Finland) the data and figures were not balanced in any manner so the chosen business line for further study was Outotec (Filters)' spare parts supply.

Any possibilities to reduce the spare parts lead time are formed by studying and analyzing the gathered data from Outotec's back end systems together by interviewing different persons acting in key roles of spare part supply organizations and analyzing the performance of spare parts delivery function's processes using a balanced measurement tool and metrics specifically created for the purpose of this thesis. Areas for performance improvement will also be studied by investigating the challenges which different organizations are facing in daily processes. Findings from this study will most likely need to be dealt in more deeply manner and in case by case before trying to implement them in practice.

This thesis' main research question is stated as:

"What are the possibilities to shorten lead times in spare parts supply?"

In order to answer the main question, few sub-questions need to be answered also:

"What are the customer needs in industrial after-sales business environment?"

"How performance gaps can be identified?"

"What is the current performance level of the case company's after-sales supply?"

"What are the main challenges in the case company's current after-sales supply?"

2. OUTOTEC OYJ

Keyword at Outotec's way of doing business is sustainability. For Outotec sustainability means helping their customers to create the smartest value from Earth's natural resources by providing leading technologies and services for the full value chain from ore to metals. Outotec is the global leader in minerals and metals processing technologies, providing its customers with technology solutions and services for entire life cycles of processes. In the last decades, Outotec has developed many breakthrough technologies for sustainable solutions. The company also provides innovative solutions for industrial water treatment, the utilization of alternative energy sources and the chemical industry. The company literally helps their customers to get "More out of ore" which is also the company's slogan. (Outotec, 2013)

Table 1. Outotec's business areas. (Outotec, 2013)

Minerals Processing	Metals,Energy & Water
Concentrators	Non-ferrous metals
Comminution	Ferrous metals and ferroalloys
Flotation	Light metals
Dewatering	Industrial water treatment
Services	Services
Operation & Maintenance	Operation & Maintenance

Outotec's sustainable technology solutions and life cycle services offering for its customers can be dived into two business areas: Minerals Processing, and Metals, Energy & Water. (Outotec, 2013) These two business areas' technology offerings are shown in table 1.

Minerals Processing solutions are designed for the mining industry. The product portfolio extends from pre-feasibility studies all the way to complete plants and life cycle services. With over a century of experience in minerals processing, Outotec can provide efficient and profitable treatment for virtually every type of

ore. For Metals, Energy and Water business area, Outotec provides sustainable solutions for metal processing, renewable energy production and industrial water treatment. (Outotec, 2013)

The net sales of Outotec corporate in year 2012 were approximately two billion Euros, of which the service sales were about one third. The net number of workers was approximately 4600 employees in 25 different locations. (Outotec, 2013)

2.1 Values

Figure 1. Outotec's values (Outotec, 2014)

Outotec's core value is committed to sustainability and all other values are enforcing factors towards to this core value. The other values, shown in figure 1,

are: building success together, aspiring for excellence and creating leading technologies for Outotec’s customers. (Outotec, 2013)

2.2 Strategy

Outotec's mission is to strive for sustainable use of Earth's natural resources. Going forward, the company intends to focus more on providing sustainable life cycle solutions, which guarantee the best return on a customer’s investment. In addition to further strengthen its technology portfolio for the entire value chain from ore to metals, Outotec targets expansion to adjacent industries such as energy industry and industrial water treatment. Furthermore, the company will further strengthen its presence in emerging markets, and improve its productivity and scalability. (Outotec, 2013)

The key elements of the strategy are the best return on a customer's investment with minimized ecological impact, strong global market presence and integrated operations, increasing value through life cycle solutions, applying core technologies in new attractive growth areas, improving cost-competitiveness and scalability and leadership in technology and innovation. (Outotec, 2013)

2.3 Outotec (Filters) Oy

The story of Outotec (Filters) Oy begins from the 1880’s when Lappeenrannan Konepaja was established. Lappeenrannan Konepaja was then acquired in 1977 by Nuutti Vartiainen who set up the filtration business and founded Larox. Eleven years later Larox was listed in Helsinki Stock Exchange. In the 20th century, Larox acquired many filtration technologies from competitors, in example Scheibler Filters Ltd UK and Outokumpu’s filtration business. In 2009 Outotec Oyj acquired Larox’s filtration business and in 2010 Larox was integrated to one of Outotec’s business units and named Outotec (Filters).

Larox develops and delivers industrial filters for separating solids from liquids and its filtration solutions are primarily used in the mining and metallurgical industries worldwide as well as in chemical processing. After the acquisition of Larox's filtration business, Outotec can now provide complete solutions covering all technologies and services for the entire value chain from ore to metal. Larox recorded sales in 2009 of EUR 150 million; the company had about 550 employees and operated in over 40 countries. (Outotec, 2013)

2.4. Common working practices

Due to several acquisitions during the past years accomplished at a relatively fast pace, many different incompatible enterprise resource planning systems exist and are still in daily use in different offices of the corporate. Because of this mix-up of used systems, Outotec pursues a goal which is named "One Outotec". "One Outotec's" goal is to adopt common working practices around the globe and mould them in to one. A part of this journey is to consolidate the different systems in to a more manageable amount and to establish common resource planning and workflow management tools. The journey towards One Outotec has started already a several years ago and is still ongoing process. Some common tools and systems have been adopted throughout Outotec but the results have been challenging. Common working practices and organizational cooperation is still rare and different organizations keep working in "silos". Measurement tools used previously have turned out to be hard to use and the new system integrations and adaptations have always many problems at the beginning.

3. CUSTOMERS' NEEDS IN INDUSTRIAL SERVICE BUSINESS ENVIRONMENT

This chapter's objective is to get a thorough understanding of the industrial business environment and the special features included in service business through customers' point of view. In-depth understanding of the environment and the service business is a necessity for obtaining competitive advantage and building a strong service culture and that way to meet customers' expectations and needs in a sustainable way.

It is widely accepted fact that in today's competitive global markets it has become more challenging for corporate to find new ways to create value to customers. Customer orientation in business is therefore an imperative because customers' demands and complexity continually increases. Customer orientation in the global competitive market can be seen as a double-edged-sword; as the customer needs tend to increase and become more complex, the pressure on reducing costs still remain or even increases. These two goals of service level improvement and cost reduction can be achieved through effective logistics and supply chain management. (Christopher, 1998, p. 1)

To be efficient in services from customer's point of view, it is important to manage customer relationships with appropriate manner. A customer oriented enterprise tries to find and identify what creates value to the customers and to deliver that value to them in an effective way. Companies which cherish their relationships with individual customers will more likely to be heading in to a path of profitability than companies which are not customer oriented. Customer satisfaction plays a major role in a healthy business relationship. Customer is satisfied when its needs and expectations are fulfilled. If customer's needs and expectations are not fulfilled then the customer will probably try to seek an alternative supplier if such is available. (Peppers and Rogers, 2004, pp. 20, 32, 38, 46) But before we are able to increase the benefits in customer relationships, it is important to turn the focus on the industrial service business and industrial service business environment first.

3.1. Customer Services

Service as a term can be seen as a very difficult to analyze thoroughly because it is more of a concept than an absolute fact. Service is something which every person experience a bit differently because every service transaction is affected by personal expectations and previous experiences. Because of its complicated nature, there are various definitions available for services.

Zeithaml and Bitner (2003, pp. 3-4) describe services in general as being intangible deeds, processes and performances. These kinds of services are for example repair and maintenance services, consulting services and training services. While these services may have intangible nature, there may be also included tangible things related to the service. These tangible things included in the intangible services can be maintenance manuals, spare part list recommendations, instruction manuals or a website, to name just few.

Grönroos (2000, pp. 46) defines services as a process consisting more or less intangible activities that normally take place in interactions between the customer and service employees and physical resources or goods or systems of the service provider which are provided as solutions to customer's problems. The meaning of these keywords must be noted and deciphered further: there are activities involved which contain interactions between the customer and supplier to meet the purpose of providing a functional solution to a problem or to fulfill customer's need.

These general service definitions fit both domestic customer service and industrial customer service. However there are differences in domestic service and industrial service and these two must be separated from each other. To get a proper understanding of the industrial services, its special features have to be attained and discussed.

3.1.1. Customer Service Elements

Customer service is usually viewed as an essential part in companies marketing strategies. Marketing strategies are often considered to be a mix of four different characteristics: *p*roduct, *p*rice, *p*romotion and *p*lace – the four Ps. Customer services impact on buyer behavior has been a popular research topic thorough the years. It is difficult to verify which elements constitute the most customer service because usually customers are not able to identify the key motivators behind their behavior and motivation. (Ballou, 2004, p. 93)

Ballou (2004, pp. 93-94) introduces three groups of elements of customer service according to cases where transactions took place between supplier and customer. These elements are *pretransaction, transaction* and *posttransactions* and are listed in the Figure 2. Pretransactions are the basis of a good customer service culture. It is all about letting the customer know what level of service can be expected right from the start. Pretransactions from the supplier side can be providing written statements of customer service policy (when the goods are going to be shipped – expected lead time), the procedure for handling returns and back orders and methods of shipping. Important part of preparing pretransaction elements properly is to establish contingency plans for situations which can affect or will affect normal service (such as labour strikes, natural disasters, vacations or sick-leaves). These plans should contribute in creating organizational structures where the customer service policies are implemented in to the core of daily work.

Transactional elements are those that directly affect the results of a delivery to the customer. Stock levels, transportation modes and order-processing procedures are examples of transactional elements which all affect directly on delivery times, order fulfillment accuracy and stock availability. (Ballou, 2004, p. 93)

Posttransactions elements are all about offering the needed services to customers for supporting the use of the delivered products in the field and also to protect the customers from defective product. These services contain also the claim-handling, complaints and product returns. All of these actions take place after the product sale but they must be planned in the pretransaction stage. (Ballou, 2004, p. 93)

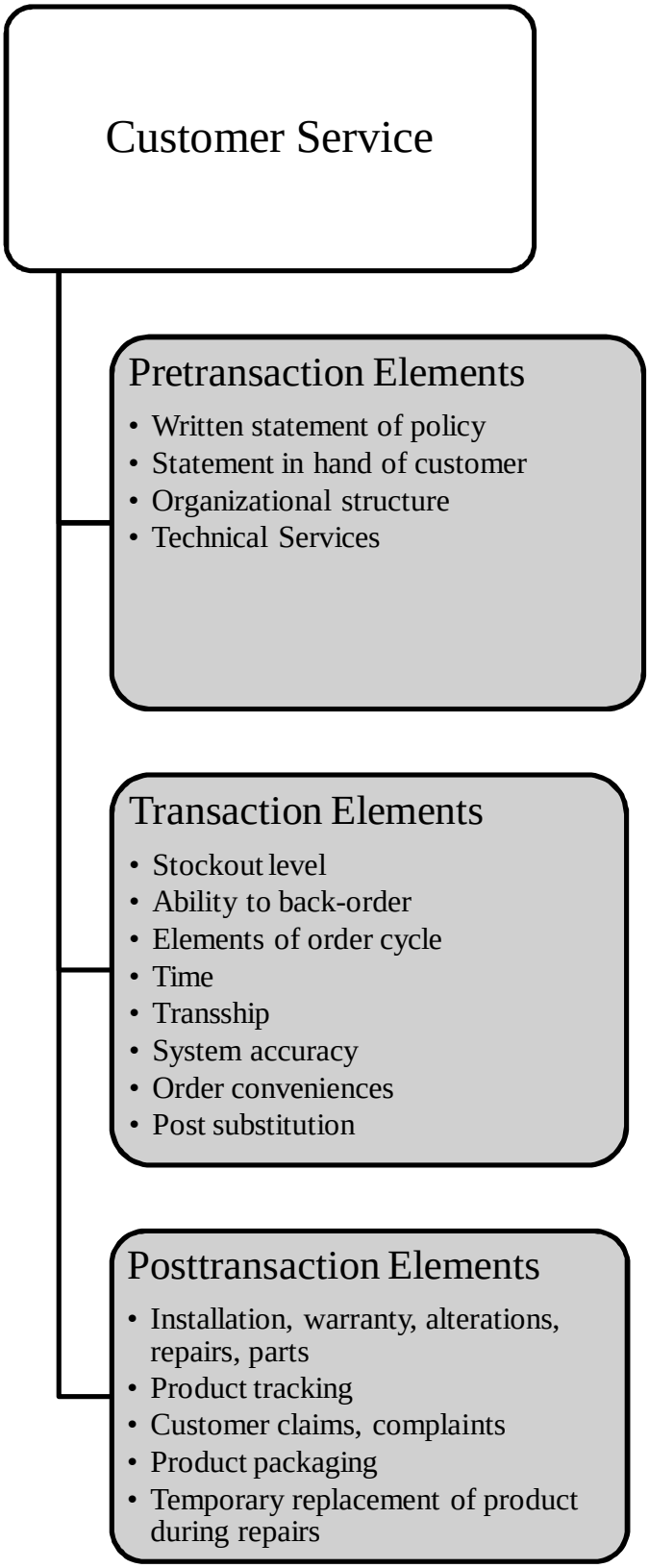


Figure 2. Elements of Customer Service (Ballou, 2004, p.94)

3.1.2 Industrial Services

Industrial customer service has many names. In addition to industrial service, it can be discussed as a Business-To-Business service or as an after-sales service. One of the simplest definitions which divide domestic service and industrial service from each other has been presented by Johansson and Olhager (2004). According to Johansson and Olhager (2004, p. 310), industrial services are a supply of after-sales services which contain tangibles such as spare parts and other consumables used for maintenance of industrial goods. Also Ballou (1999, p. 81-81) describes industrial services being a complete supply chain (from customer's order to delivery) of sales-satisfying activities such as industrial equipment service or maintenance and other technical support.

While these presented definitions consider mainly the after sale activities related to corporate core products, Axelsson and Wyntsra (2002, p. 30-31) introduce a good overviewed structure adapted from a release of Organization for Economic Cooperation and Development (OECD) for different Business-To-Business services available:

- *Facility services*: cleaning, security.
- *Financial services*: banking, insurance, finance.
- *Information and community technology services*: hardware implementation, software development and implementation.
- *Business organization services*: management and environmental consultancy, auditing, legal services.
- *Research and development and technical services*: technical maintenance, development, engineering.
- *Transportation and distribution services*: warehousing, value-added logistics, transportation.
- *Human resource development services*: training, recruitment.
- *Marketing services*: sales, reselling, advertisements.

As in the previous chapter, services were defined as activities or performances provided to satisfy customer needs, *goods* are tangible products or stable intangible assets. Kotler (2003, pp. 445-446) introduces a “Service mix” which divides the services offerings and goods into five types:

- Pure tangible goods
- Tangible goods with services
- Hybrid services
- Major service with minor goods and services
- Pure service

Today, majority of industrial companies’ service offerings are mostly tangible goods with accompanying services. The ongoing trend is however towards the hybrid services. (Brax, 2005, pp., 144)

3.2 Industrial Service Business Environment

Services are gaining more attention in industrial sector than before. Reasons for this growing importance are to: facilitate the sales of goods; lengthen customer relationships; create new growth opportunities in already matured markets; balance the effects of economic cycles with new cash-flow channels and to be able to respond to the growing customer demands. (Brax, 2005, p. 142) The potential of after-sales business is well noticed amongst the industrial companies and it is estimated to be four or five times bigger than the market for new products. In addition, the after-sales service such as spare parts may generate more than three times the turnover than the original purchase. Considering these estimations, after-sales business is no longer being seen as a necessary evil but a real source of competitive advantage and business opportunity. (Saccani N., Johanson P. and Perona M., 2007, p. 52)

Pressure on product margins, increased competition and changing customer demands have had a big impact on industrial service business in the last few

decades. Gaining competitive advantage in after-sales business requires differentiation from competitors and full understanding of customers' demands. Customers prefer total solutions to their problems over basic tangible products. This means that service companies have to create the product offering with services to create integrated solutions to customers. This kind of approach in after-sales has a positive impact to the customer loyalty, hence higher profit margins and new sell possibilities but also to speeding up innovation processes. (Ojasalo, 2009, p. 125)

While it may seem a foregone conclusion to focus in service business, many manufacturing company have failed to adopt the role of a service provider. The main reasons for these failures have been customers' dissatisfaction in the proposed service concepts and their lack of added value in the current business between the service provider and the customers. It is also hard for a manufacturing-oriented company which concentrates on selling products to change the strategy towards service-oriented business in which the focus have to be on fulfilling the customers' needs as thoroughly as possible. (Ojasalo, 2009, p. 125)

3.3 Spare Parts

As it was stated in the introduction chapter, the objective of this Master's Thesis is to study the spare parts lead times. So it is essential to go through the special features of spare parts which separate them from manufacturing parts. Also as services have been described in previous chapters, it is clear that spare parts play a major role in the industrial after-sales business.

Simply put, spare parts are "*components, assemblies and equipment that are completely interchangeable with like items installed or in use, which are used, or can be used to replace items removed during maintenance and overhaul*" (Patton, Feldmann, 1997, p. 26). Patton and Feldmann (1997) declare that there are dozens of major different attributes between the parts used for manufacturing and the

parts used for repair and maintenance but from these attributes only those which are directly affecting the lead times the most are introduced.

Firstly the environment is different which creates a challenge for the used Enterprise Resource Planning system, ERP. The Spare parts' dynamic environment is much more complex than the one of manufacturing parts'. In this environment standardized MRP-systems do not usually work in after-sales environment because of those focus is on fixed cycles with variable quantities – Spare parts MRP should originate from fixed quantities with variable cycles. This environmental based challenge can be seen as a double MRP. Double MRP means that first the repairable assets are analyzed focusing on using parts already owned. If that is not possible, then the parts need to be procured from external sources and the second MRP process is used in planning the purchase. Secondly, future demand variability is different. As manufacturing parts' demands is usually well planned and scheduled, service parts demands are more probabilistic. Because spare parts' demands are driven by random equipment failures and human interventions the after-sales business must be very flexible. No matter how educated persons are planning the demand, it is still a process of forecasting future with inevitable complications. Demand planning is usually a process which projects the historical data in to the future. One must no rely entirely on a computer based demand planning because the computer programs can't replace interactions between humans. Humans are therefore the most important asset in demand planning. This means that a company's different organizations have to communicate to each other regarding issues which can possible affect to the future demand of spare parts. (Patton, Feldmann, 1997, pp. 32-36)

One attribute affecting to lead times and demand planning adversely are the root causes of replacement; not all causes for replacements are attributable to failure. In example, according to a technician's troubleshooting, it seems most possible that a system failure was caused by a dysfunctional circuit board while the real problem was a loose connection on that same circuit board but the technician did not recognize the real root cause behind the malfunction. Technician then decides that it is easiest to replace the whole circuit board. It may be so that the circuit

board was not listed as a spare part so the lead time can be very long. To avoid such misfortunate mistakes, it is essential to train the maintenance personnel and to provide necessary equipments for proper troubleshooting. Other reasons than failure in replacements can be incompetent or overstressed operators damaging the equipment or even a willful damage towards the equipments. In sometimes it is also possible that the spare parts are replaced twice due to incorrect first repair. These all are factors which are directly affecting the demand planning and can be caused delays in lead times. (Patton, Feldmann, 1997, p. 36-37)

Third attribute directly influencing on lead times is the warehousing or stocking of spare parts and more specifically the complexity of it. Stocking spare parts is much more difficult than stocking parts for manufacturing use. Warehousing spare parts in multiple geographical locations usually mean shorter lead times, but these local warehouses are very challenging to manage efficiently. More warehouses mean increased quantities of stocked parts, higher costs and the difficulty of finding the correct part from the correct place. (Patton, Feldmann, 1997, pp. 37-38)

In addition to the variable demand of spare parts compared to the manufacturing parts, also the supply can vary. In manufacturing's MRP, the lead time for new parts is tightly established and the procurement personnel as well as other operations are scheduled for that time span. The total lead time for service spare parts start from the moment the customer realizes the need for a spare part until the moment the customer has the part in hand. As the parts purchased for manufacturing needs can be already arrived in stock, there is no urgency to use it until the tightly established time frame says so. Service parts however often need the delivery to be as soon as possible. (Patton, Feldmann, 1997, pp. 40-41)

3.4. Customer Needs

People tend to describe a product or service in several different dimensions or characteristics. These descriptions can usually be managed from three different

aspects: responsiveness (how fast was the response time), availability (how fast was the supply time or how available was the service provider) and professionalism (was the experience pleasant and how the service provider dealt with the customer). As simple as it seems, these three dimensions are a subset of all possible dimensions by which the service can be described. Hayes (1992, p. 6.) uses the term "quality dimensions" to describe these dimensions. Customers' demands and opinions about the service are based on these quality dimensions of the service provider. (Hayes, 1992, p. 6)

It is essential for a service provider to understand these general quality dimensions and further to identify all dimensions which are individual for almost each company. That way the company will know how customers define the quality of the service or product and can also develop a measure to assess these dimensions. Means for determine the quality dimensions can be as simple as a comprehensive list of these identified attributes. To be able to identify these attributes from each dimension, the service offerings and company's service in general needs to be analyzed. (Hayes, 1992, pp. 6-7)

3.5 Differentiating Customers by their Needs

In the most generic definition the term customer need refers to the reason why the customer wants to buy. In addition to the reason why, also how customer wants to buy may be as important to the company. Needs do not only concern products but also services, delivery channels, communication styles and channels, invoicing methods, and so on. So when a company wants to influence customers' behaviour in a manner that is financially beneficial for the company, it is very important to understand what the customer's needs are. In a healthy business relationship both parties are generating value to each other. The company's value is generated from the amount which the customer pays to the company for its products and services and the satisfied need generates the value to the customer. Customers categorizing in terms of needs could end up being a difficult task if there is no sub-categorizing

done. Efforts should be focused in those customers who generate the most value to the company. Also, by accepting the fact that returning customers are the most profitable one because they require less marketing effort and relationship building, after-sales service has a critical role in a company for achieving customer satisfaction and retention. (Peppers and Rogers, 2004, pp. 69, 139)

Almost every company serves multiple types of customers which can all have individual characteristics and needs. One example of this scene could be a car manufacturer which customers are both the car retailers and also the end-users who use the car but buy the car from the retailers. As a customer base, the end-user consumers do not have very much value even though some consumers could purchase a new car fairly frequently; the discrepancy in value between the most valuable end-user consumer and an average consumer is rather small. But that aside, every consumer still has their different individual characteristics and needs such as car models, colors, engines and accessories. So even though car users are not differentiated in terms of value, they are very different in terms of their needs. Also retailers have different individual needs when some need more help and investments in marketing; some may need adjustments in their supply chain management or inventory planning. Retailers display very large variation in their value and needs towards the car manufacturer (big retailers versus small car dealers). (Peppers and Rogers, 2004, p. 139)

Peppers and Rogers (2004) state that there is no single best way to differentiate customers by their needs because the most basic needs are psychological, dynamic and can differ over time. Also customers' needs are situational in nature.

The objective of chapter 3 was to enhance the reader's knowledge regarding the special features which apply in the industrial service business environment from the customers' perspective. Customer orientated approach was chosen as the main focus point in this chapter because it was noted to be the most neglected aspect in the case company's current system and has the much potential for improvement.

4. Supply Lead Time Management

In this chapter the service supply chain and lead time management possibilities are examined from performance measuring perspective. After describing the industrial services business environment, customer needs and spare parts' features, it is important to understand the key metrics behind the efficiently managed supply chain and to find possibilities to reduce the lead time in the case company.

Defining terms will help framing supply chain decision making and overall understanding. Firstly, the term *supply chain* can be defined to be more than just the physical movement of goods. According to Ayers (2001), supply chain is: "*Life cycle of processes comprising physical, information, financial, and knowledge flows whose purpose is to satisfy end-user requirements and services from multiple linked suppliers*". Further examination of the definition reveals that the mentioned *processes* cover a wide range of activities such as sourcing, manufacturing, transportation and selling physical products. *Life cycle* in this meaning contains the market life cycle and the usage life cycle. Market life cycle is the time which a particular product is on the market while the usage life cycle includes the whole time the product is useful to the customer. The three different flows mentioned in the definition are often considered to be the dimensions which form a supply chain: *physical, information and financial flow.* The ultimate goal for any supply chain is to satisfy its *end-user requirements* which usually refer to the end customer in the industrial business environment. (Ayers, 2001, pp. 4-5)

"Time is money" is probably one of the most over-used phrases in the common world, but in the world of logistics it truly goes in the heart of the matter. Time itself means costs to supply chain and inventory managers and for the customers time can be seen as lead time or response time. Time related costs in logistics are formed from the direct relationship between the length of the logistics pipeline and the inventory that is locked up in it. This is usually described as an inventory holding cost. (Christopher, 1998, p. 149)

Supply chain management or SCM can be defined into an easy looking definition: *"Design, maintenance, and operation of supply chain processes for satisfaction of end user needs"*. (Ayers, 2001, p. 7) However, SCM is a very complex issue which requires lots of effort from multiple different organizations of a single company. As Grieco and Cooper (1995) describe it: "*Supply Management is typically thought of as a coordinated effort by a company's design, quality, assurance, marketing, manufacturing, procurement and finance functions along with the supplier to improve product design, quality, cycle time, reliability and cost."*.

4.1 Time-based competition

When lead time is viewed from the customer's point, only one time is relevant: the time elapsed from order to delivery. For the supplier however, it is only a partial view of the lead time. For the supplier, also the time it takes to convert an order in to cash is as important; Time which capital is committed in the supplied products until the customer's payment is received. These lead time concepts can be defined as Order-to-delivery cycle and Cash-to-cash cycle. (Christopher, 1998, p. 157)

Order-to-delivery cycle and cash-to-cash cycle are equally important for enterprises as the time is usually valued as much as money hence there are synergies and causalities existing between these two factors; Time can be transformed in to monetary value. (Coyle, Bardi, Langley, 1996, pp. 14-15) As the cash-to-cash cycle may be as important as the order-to-delivery cycle, it will not be studied further as there is no capacity to do it in a sufficient manner regarding the framework of this Thesis. Order-to-delivery cycle on the other hand will be described further as it has direct impact to lead times.

4.1.1 The order-to-delivery cycle

The order-to-delivery cycle must be defined more closely as it is crucial for the thesis' structure. It can be seen as the time which is taken from the reception of customer's order to the delivery of the goods. Short order-to-delivery cycle is a critical factor in gaining competitive advantage in today's highly competitive service markets. However as the short lead times may seem to be the most important factor in satisfying customer's needs, it is equally important to be consistent with the lead times. This consistency can be also referred as the reliability of lead times. (Christopher, 1998, p. 158)

Ballou (2004, p. 98) explains the order cycle time as *"the elapsed time between when a customer order, purchase order, or service request is placed and when the product or service is received by the customer."* In this definition, not only the customer orders but also the service requests can be seen as a part of the order cycle time.

There are several different components or processes in order-to-delivery cycle which all consume time and which can act as a major factor in creating bottlenecks leading to variability in lead times and reliability (Christopher, 1998, p. 158). These components are shown in figure 3.

Customer places an order	**Order entry**	**Order processing**	**Order assembly**	**Transport**	**Order received**

Figure 3. Order-to-delivery cycle (Adapted from Christopher, 1998, p. 158)

All of the components shown in figures 3 and 4 consume time. If there are any bottlenecks in some or all of these steps, the overall lead time reliability can vary a lot. This overall effect is demonstrated in figure 4 where cycle times presented are fictitious and the figure only illustrates only the total time variation possibilities. Segmenting the order-to-delivery cycle in to smaller parts can help in finding the most time consuming processes and allows supply chain managers to

respond any anomalies faster. By shortening the average time consumed in all the different processes can streamline the total order-to-delivery cycle considerably.

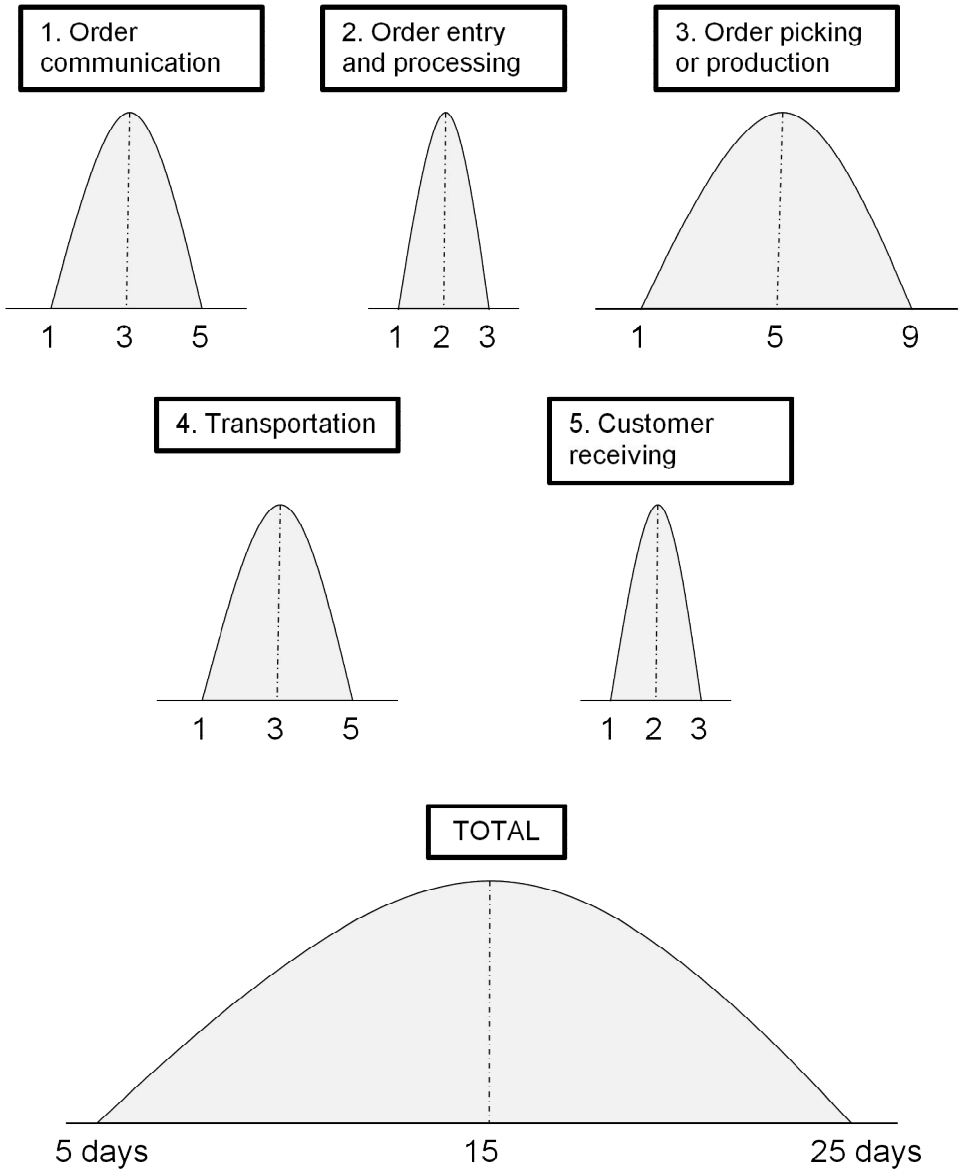


Figure 4. Order-to-delivery cycle with variability (Adapted from Christopher, 1998, p. 159)

4.2 Performance measurement

Because of supply management is a flow-oriented concept including resources across the pipeline which extends from suppliers all the way to the final customers, it is desirable to have means to measure and assess the performance of that pipeline flow. When measuring performance, companies must avoid a situation where the measurement and chosen metrics are too narrowly defined because supply chains span many functions in an organization. Too narrowly defined measurement leads distorted view of the true performance of a company. Harrison, Hau & Lee (2003) describe these narrow metrics as “one-dimensional” metrics such as inventory turns or material costs. To be efficient in these one-dimensional metrics does not mean that the rest of the supply chain is on par with the results – Supply chain is only as strong as its weakest link.

Performance can be defined as the capability of company to provide outputs with available resources in relation to the objectives set. Available resources are used to maximally satisfy owner’s needs and sufficiently satisfy other stakeholder’s needs as well. Today, the emphasis is on the profits received by the shareholders and is used to control the operations and to create economic value through the measurement. (Laitinen, 1998, pp. 279-280)

Company’s performance can be divided in to two main categories which are the external performance and internal performance. When company is being viewed from inside and the performance measurement focus area is on the processes, internal performance is addressed. Internal performance measurement is executed mainly by company itself because it has more internal information available than external viewer has. When the company is being viewed externally as a whole, it’s a case of external performance. External performance measurement can be done by many different parties. The used metrics in performance measurement are not divided solely by the internal or external viewpoints and the metrics can even be same on both sides. For example return on capital can be seen as an internal metric for one single department and external metric for the whole company. (Rantanen and Holtari, 2000, pp. 11-12)

4.2.1 Internal performance

Main elements of internal performance are productivity, performance and cost efficiency. Other important elements are quality and lead time. For performance measurement purposes, companies usually use internal information and data as the basis for formulas. Therefore companies can use the metrics they see the most fit for current purposes. This will also be the case in the empirical study where all the available information and data are acquired from the case company's back end systems and the metrics chosen and formed contribute the set strategies best. (Rantanen and Holtari, 2000, p. 12)

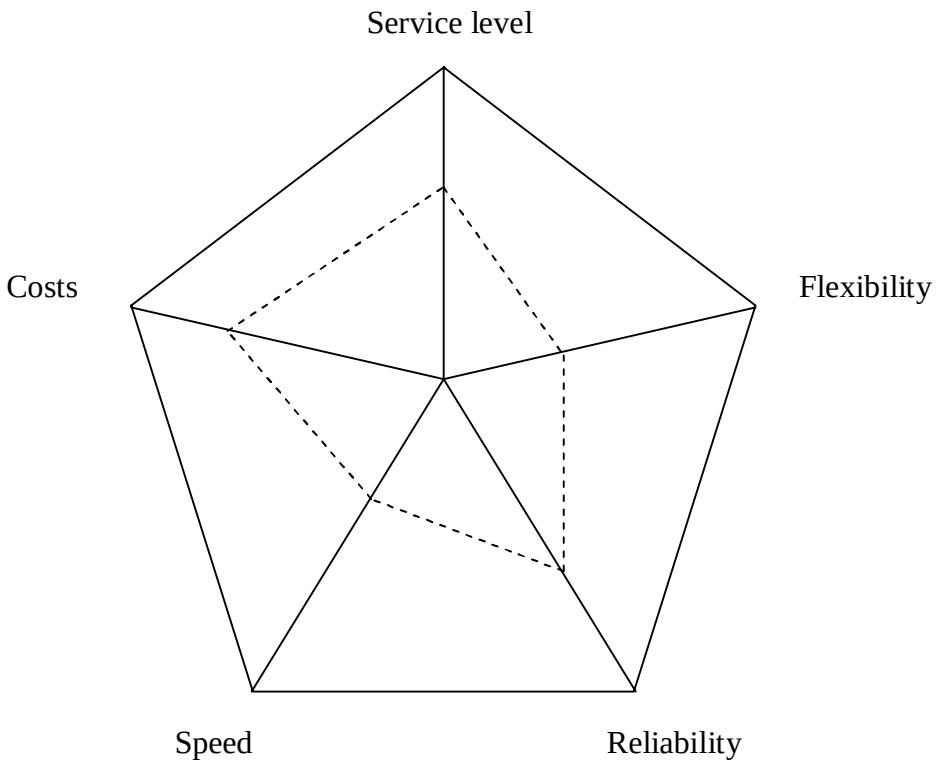


Figure 5. Elements of internal logistical measurement (Adapted from Huiskonen and Kerkkänen, 2007, p. 117)

The most important internal performance elements from logistical viewpoint are shown in figure 5 and are service level, flexibility, reliability, speed and costs. These five different dimensions of logistical performance are linked to each other so improving one can cause improvements in other areas and vice versa. For example by improving the overall lead time or speed of the supply chain, reliability and costs improve also by being able to ship goods sooner than normally and by shortening the cash-to-cash cycle time.

4.2.2 External performance

External performance can be seen as a dimension where the company is being viewed from the outside and the performance analysis can be based solely on publicly available information and data. External performance analysis can be done by the company itself or by an external viewer. Companies usually pursue to affect the publicly shown information by shaping their balance sheets' statistics to more favourable for measurement. The most traditional external performance measurement for listed companies is based on the statistics found from the balance sheet. Commonly used elements of external performance measurement are profitability, liquidity and solvency but also competitiveness. Competitiveness is usually measured through the company's growth rate. (Rantanen and Holtari, 2000, pp. 14-15)

4.3 Service metrics

The difference between a manufacturing-centered view and service-centered view is that while manufacturing focuses on selling products, service goal is set to fulfill customer's needs as thoroughly as possible. As a result, the deep understanding of customer needs can act as a useful insight when industrial services are perfected. The aim for service design and goal setting is to make sure that the offered services are helpful, practical and desirable from the customer viewpoint, and efficient and distinctive from the service provider viewpoint. (Ojasalo, 2009, p.125)

It is necessary for every organization to have well defined objectives and goals. These goals should be understandable, measurable, challenging but also achievable via hard work. Performance goals give important data for benchmarking purposes and also results against an organization's internal standards and customers' needs. Without well defined goals, it is very challenging to know where the possible bottlenecks of performance are or where the performance is already at a good level. (Patton, Feldmann, 1997, pp. 57-58)

When measuring either external performance or internal performance, the performance measurement metrics can be divided in to two different sections: financial metrics and non-financial metrics. The traditional financial metrics have been heavily criticized as they encourage for short term planning and partial optimization and lack strategic aspect. Financial metrics also encourage management to minimize deviations from the set standard level rather than aim for continuous improvement. Lack of customer needs is also one downside when using financial metrics. (Neely, 1999, p. 206) Still for many companies the traditional way is to use financial metrics as the results gained from these metrics are required by stakeholders and funders. (Rantanen and Holtari, 1999, p.11).

Even if the financial metrics are criticized, they also have good qualities that favor the use of them. Financial metrics have been in use for years and their reliability has been tested and is commonly known. Formulas have been stabilized and results can be compared between different organizations or even companies. Financial metrics also grant the results which are the most important business-wise. (Lönnqvist and Mettänen, 2003, p. 33)

Non-financial metrics measure different areas of an organization which are not based on financial figures. These kinds of metrics are, for example, lead time, warehouse turnover and customer satisfaction, all important from logistical viewpoint. Another difference compared to financial metrics is that non-financial metrics are usually more concrete and are more easily understandable. Also in comparison, non-financial metrics' formulas are not so established and the results are not always as reliable and can't be compared between organizations.

(Lönnqvist and Mettänen, 2003, p. 33) It can also be difficult to indicate how some good results from non-financial measurements affect to the company's financial performance. (Laitinen, 1998, p. 281)

Almost in every situation and in every company, used metrics, operating conditions and users are different from each other. Therefore a user friendly format should be created for defining each metric. Lönnqvist and Mettänen (2003) introduce an 11 step -model for creating specific metrics for a specific use (table 2). Using this 11 step -model allows the principles of the use to be determined right from the start and therefore the use of these metrics is explicit and clear. This model is suitable for the creation of new metrics but also for documenting already existing metrics.

Table 2. 11 step -model for creating metrics (Adapted from Lönnqvist and Mettänen, 2003, p. 99)

	Title	**Explanation**
1.	Metric	Name of the metric (should be such which is linked to the objective)
2.	Usage	If any usage is not found the metric is useless
3.	Influence	Recognize the business targets in which the metric is involved
4.	Target	The desirable level of performance and the time to achieve it
5.	Formula for calculation	How is the metric's outcome formed
6.	Frequency	How often is the metric used
7.	Reporter	Personnel responsible for the use of the metric
8.	Source of information	From where is the data gathered?
9.	Who will respond to results?	Personnel responsible for the decision making based on the results
10.	How to act?	Describe the measures that will get the metric's values closer to the target.

11.	Notes	Problems or special features involved in the metric

The basis for service metrics lies in measuring the success in serving (or not serving) customers properly. In general, it is difficult to quantify the cost of stock outs or late deliveries. For that reason, the targets are aimed towards customer service metrics. Spare parts can be divided into two different supply policies which both require different kind of measuring and management approaches. These policies are Make-To-Stock (MTS) and Make-To-Order (MTO). (Harrison et. al., 2003, pp. 66)

Table 3. Customer service performance measurement metrics: MTS vs. MTO. (Adapted from Harrison et. al., 2003, pp. 66)

Make-To-Stock (MTS)	Make-To-Order (MTO)
Line Item Fill Rate	Quoted Customer Response Time
Complete Order Fill Rate	On-time Completion %
Delivery Process On Time	Delivery Process On Time
$ of Backordered/Lost Sales	$ of Late orders
Number of Backorders	Number of Late Orders
Aging of Backorders	Aging of Late Orders

Harrison et al. (2003) introduces some commonly used time-tested service metrics for these MTS and MTO policies shown in table 3. Make-To-Stock spare parts are the kind of items which the customers expect to be always available and delivered almost immediately so the supply chain must have these parts in stock. Therefore *Line Item Fill Rate* and *Order Fill Rate* are very popular metrics to use for these items. These two metrics are quite similar with only one difference. While the Line Item Fill Rate is the percentage of individual order lines on all customer orders which are filled immediately, the Order Fill Rate is the success percentage of orders which all order lines are filled. It is not surprise that the customers prefer the Order Fill Rate metric over the Line Item Fill Rate. However if the customer orders tend to have lots of order lines, then the Order Fill Rate metric is usually on a rather low level compared to the Line Item Fill Rate because it wouldn’t be cost-

wise not to try negotiate for partial shipments to maintain a higher overall service level. (Harrison et. al., pp. 66-67)

4.4 Balanced Scorecard

It is important and also challenging to plan the service performance analysis metrics in such a way that it includes all the core activities of the supply chain in a balanced manner. The main purpose of performance measurement and analysis is to produce outlined and reliable information to support decision making. (Neely, 1997, pp. 1131-1132) From 1990's to early 2000 many different guidelines for creating performance measurement models can be found from the literature and many of these weighted the importance of a balanced measurement. The scientific literature and also industrial practice have pointed out the need for integrated financial and operational measurement systems, and also the need for integration of strategic planning related long-term metrics with financial short-term metrics. Gaiardelli P., Saccani N., Songini L., 2007, p.699)

In this thesis the purpose is to find such performance measurement tool which could be used to measure every important aspect from the spare part supply while focus is being set in to the lead time performance. It was seen as an important benefit in the case company that aside from lead time analysis, the tool could also be used and adapted to measure different performance areas from internal and external performance. The tool should also be able to be scalable to other functions.

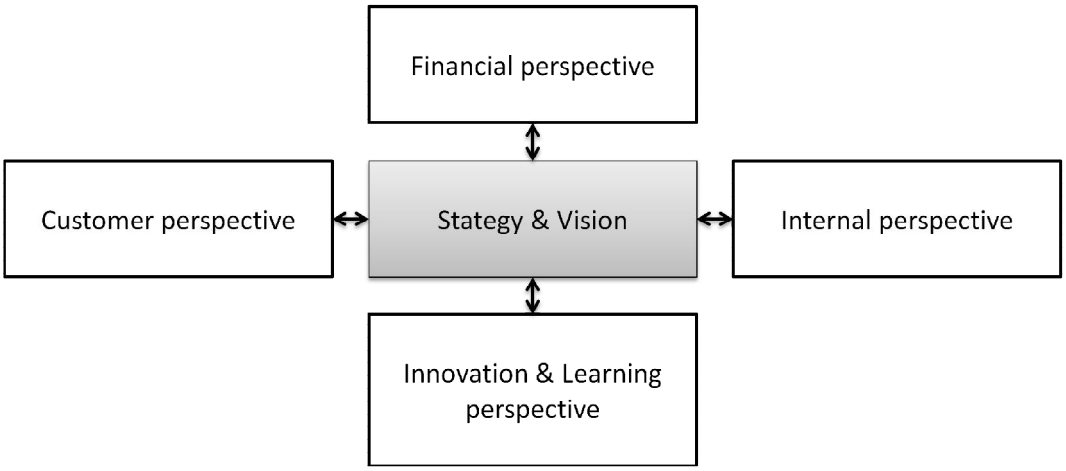


Figure 6. Four dimensions of a Balanced Scorecard

An important tool for balanced measurement was first introduced by Kaplan and Norton (1992) and is referred as the balanced scorecard (BSC), shown in figure 6. The balanced scorecard is a tool for company's managers which can motivate breakthrough improvements in multiple different areas such as product, process, customer and market development. The Balance Scorecard is used to monitor how efficiently the company's strategy is being executed and what kind of corrective actions may be needed. (Laitinen, 1998, pp. 284-285) The BSC technique presents managers four different perspectives: financial indicators, measures of performance for customers, internal processes and also innovation and improvement activities. This technique is still widely in use and has value in locking in supply chain changes – Use of concepts behind the balanced scorecard approach will help evaluate if the supply chain changes are having the desired effect or not. Balanced Scorecard is always built case-specific and the developed metrics have to be in line with the company's strategy. Balanced Scorecard forces management to focus the performance measurement into few important metrics ruling out any partial optimizations. (Kaplan & Norton, 1992, p. 72)

According to Kaplan and Norton (1996), the challenge of creating a balanced measurement tool is conquerable by developing a balanced group of metrics which answer to the following questions:

- How the stakeholders see us? (Financial perspective)
- Where do we have to improve ourselves? (Internal perspective)

- How the customer sees our performance? (Customer perspective)
- How can we continue to improve our performance and create more value? (Innovation and learning perspective)

The measurement system includes metrics from four different perspectives: financial perspective, internal perspective (or process perspective), customer perspective and innovation and learning perspective. These according to Lönnqvist and Mettänen (2003) the financial perspective metrics describe the past, customer and internal perspective the present and innovation and learning perspective the future. When moulded in to Balanced Scorecard format, these all metrics have different meanings:

- Financial perspective metrics have two separate objectives: to define the strategic performance level and to act as the basis for metrics from other perspectives.
- Internal perspective metrics must focus on processes which have the greatest impact on customer satisfaction and financial targets.
- Customer perspective metrics must focus on issues which are the most important when viewing the company from customers' perspective: lead time, flexibility and reliability.
- Innovation and learning perspective metrics are metrics which measure the organizational growth and learning. The objectives for these metrics are derivative from the targets set to the other three perspectives. (Lönnqvist, Mettänen, 2003, p. 33)

5. CASE STUDY: OUTOTEC (FILTERS) OY, SPARE PART SERVICES

This chapter contains the lead time case study of the company Outotec (Filters) Oy's spare part service. Outotec (Filters) Oy is a one part of Outotec and it is the leading company in filtration business, nevertheless it seeks growth via more efficient after-sales business. Also finding more sustainable solution offerings to customers' needs is kept in focus.

The objective is to utilize the theories viewed in the literature section to practice in a form of spare part supply analysis. The spare part service supply organization and operation model are first explained in chapter 5.1 and 5.2. Secondly the performance measurement tool is created and metrics are chosen to suit the case company's strategic approach. The measurement tool is introduced in chapter 5.3 and the actual performance analysis in chapter 5.4. The findings obtained from the performance analysis are then discussed further together with challenges the spare part supply is facing are introduced and explained chapter 5.4. Lastly the suggestions for the spare part supply chain managers are gathered in chapter 5.5.

5.1 Spare parts delivery organization

In general, Outotec's organization structures have undergone major changes in the past few years and the most changes have affected Outotec (Filters). Its organizational structures have been changing almost constantly since the Outotec's acquisition of Larox. The old structure of Larox was modified to suit Ouotec's other functions' structures better. Some good general structure designs were adapted from Larox to Outotec's structures also, so the new design was a bit of mix-up between two different companies. However the organizational changes in Outotec made the structures of Outotec (Filters) change a few times in the past years. The current structure has been intact for a while and seems to be the most stable one yet.

The current corporate structure is formed around two main business areas (BA): Metals, Energy & Water and Minerals Processing. These business areas serve customers in three different market areas: Americas, EMEA (Europe, Middle-East, and Africa) and APAC (Asia, Pacific, Australia). Spare parts delivery organization is cross-functional covering both business areas and all three market areas. Spare parts delivery organization is divided in to three different sections: ALPHA (Finland and Sweden), BETA (Germany) and GAMMA (Australia). In this organization structure, Outotec (Filters') spare part delivery belongs under Mineral Processing business area in ALPHA organization serving customers in all market areas. The Outotec (Filters') organizational structure is shown in figure 7.

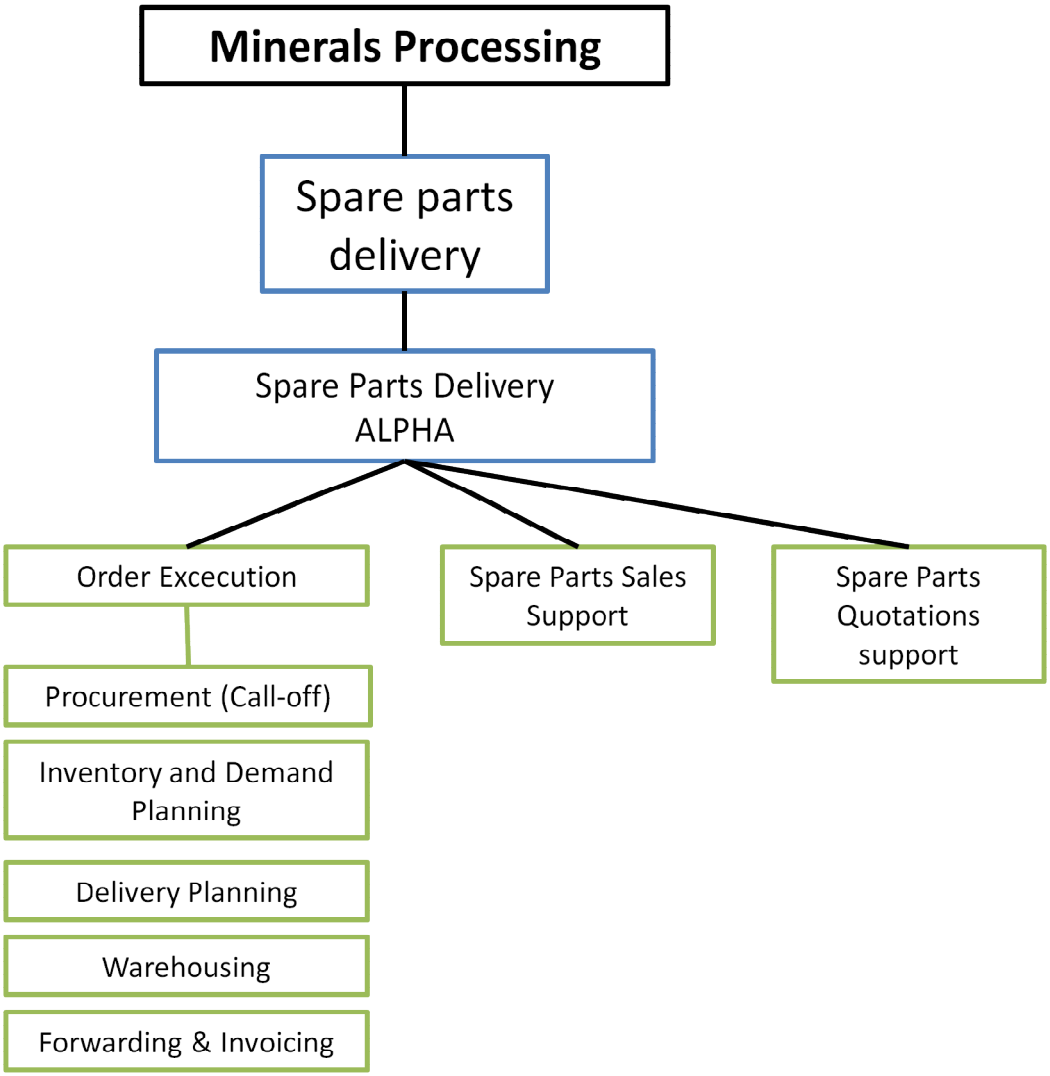


Figure 7. Spare Parts Delivery (ALPHA) organization

5.2 Spare Part Delivery operating model

Spare Part Delivery's mission statement includes three strategic key components, which are:

- Enable and promote profitable growth for our customers and Outotec.
- Provide professional spare part service with high reliability and availability at competitive prices.
- To be a global team with local presence, dedicated to sustainable customer relationship and excellent service experience. (Outotec internal info, 2013)

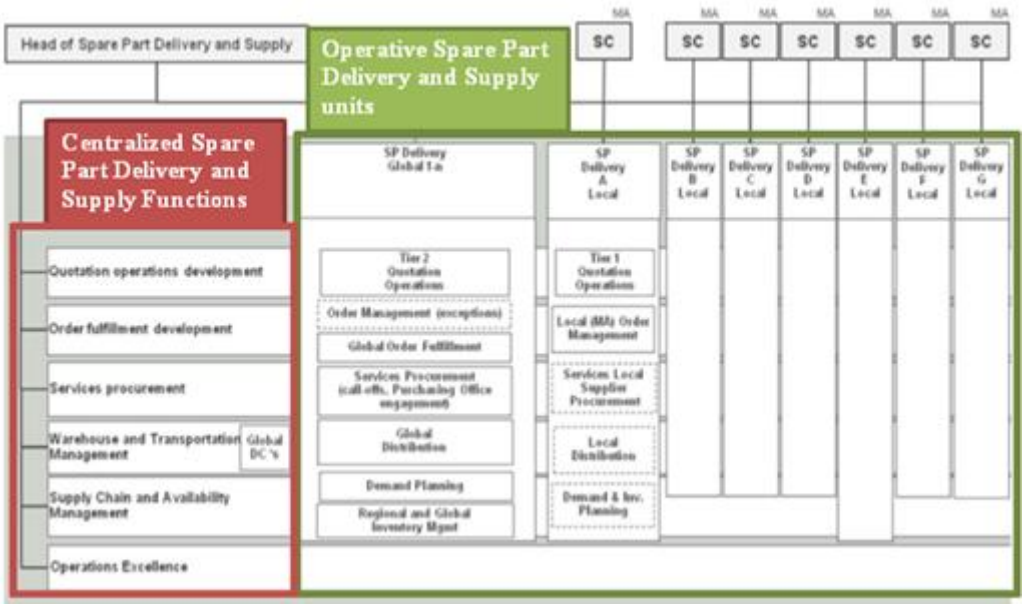


Figure 8. Spare Part Supply operating model

In the current operating model, shown in figure 8, there are two main operational units which focus on different areas of the Spare Part Supply but also consolidate together. These areas are:

- centralized Spare Part Delivery and Supply Functions for harmonization and development and
- operative Spare Part Delivery and Supply units for the execution of end-to-end quote-to-invoice process through local and global organizations.

Spare Part Delivery ALPHA provides spare parts to multiple different technologies from two globally managed warehouses located in Finland (FI02) and in Netherlands (FI04). Outotec (Filters) has also local presence in all over the world in form of Service Centers and warehouses. These warehouses keep some critical parts in stocks for local customers for unexpected demands such as breakdowns to improve lead times.

In this case study, only the spare parts belonging to filter technology and which are delivered from globally managed warehouses, located in Finland and Beringe, are included. The total amount of different spare parts sold annually by Outotec (Filters) is very wide and the number of delivered filter spare part order lines under Spare Part Delivery ALPHA in year 2012 was around 24000 pieces (FI02+FI04). These factors added with the fact that short lead times are an absolute necessity make the after-sales environment quite challenging for purchasing and supply chain management to handle.

In Outotec (Filters) the spare part business has long traditions and the process has been molded in to its current state over the years. The sales organization is divided globally in to Service Centers and Service Product Centers. Most of the communication and information flow peaks into the SPC where handled quotations and sales orders are then divided back in to the SCs and end-customers. Spare part purchasing is focused into the SPC and purchasers are rarely in touch with the actual spare parts as the material flows are outsourced between logistical service providers and warehouses. Negotiations between Outotec and suppliers regarding global price lists, warehousing agreements and frame contracts are handled by dedicated Supply organization. The spare part delivery process in Outotec (Filters) is very similar to the order-to-delivery cycle introduced in chapter 4.1.1 and is illustrated in Figure 9.

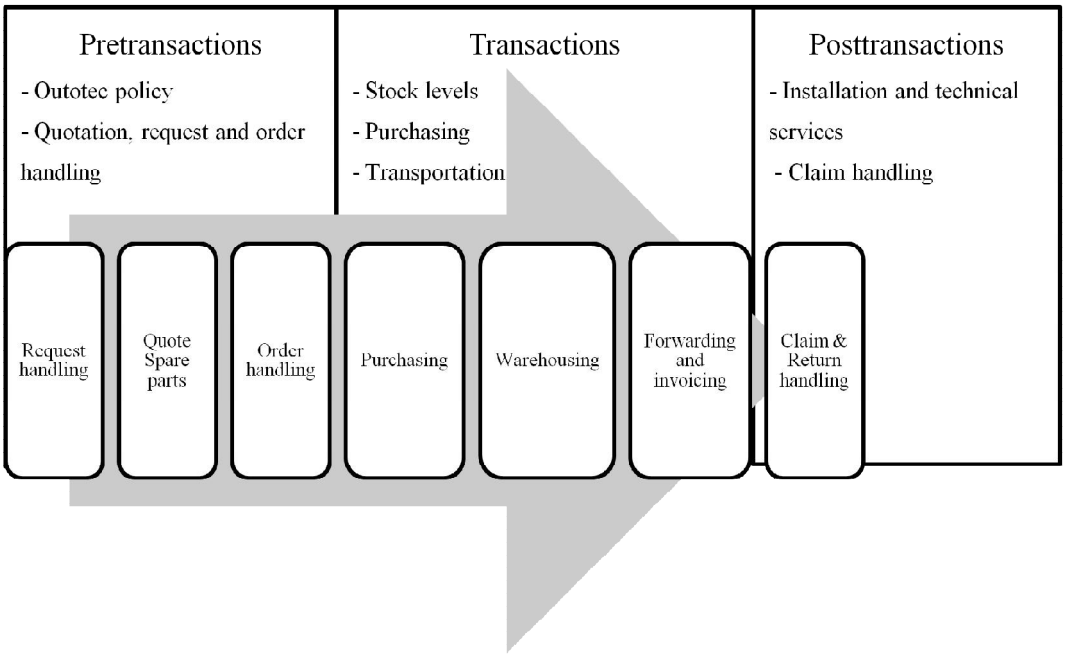


Figure 9. Spare part delivery process Outotec (Filters)

The spare part delivery process or order-to-delivery process in Outotec (Filters) can be divided in to the three groups of customer service elements which were introduced in the chapter 3.1.1. The spare part deliver process divided in to the customer service elements is shown in figure 9. Request handling, spare part quotations and order handling are all pretransactions which are acting as a basis of the Outotec's customer service. Within these three stages the customer's needs are handled and the customer will be given an expected lead time for the needed spare parts and other services in the form of an official quotation and later an order confirmation. Usually the sales organization will contact the procurement department for confirmation of lead times for the needed parts. Confirmations from procurement are sometimes needed because the lead time data acquired from the ERP is not always accurate so a double checking must be done before a correct customer order confirmation can be send. So the pretransactions and transactions blend to each other. Transactions in Outotec's customer service process contain spare parts purchasing, stock management, transportation of the sales and purchase orders and also invoice handling. Post transactions include the claim and return order handling and also technical services for the local service centers or for the end-users and installation services if needed.

5.3 Spare Part Delivery performance measurement tool

In this sections the performance measurement tool and metrics for a successful Outotec (Filters)' spare part supply chain analysis are formed using the 11-step model and Balanced Scorecard introduced in chapter 4. When creating the measurement tool purely from logistical viewpoint, the logistical requirements have to be reflected in to planning. The metrics chosen must include every step of the order-to-delivery cycle of spare part supply and must fit in to the four Balanced Scorecard perspectives so that the focus remains on the company strategy and vision. This way any possible bottleneck can be determined and found. For the purpose of the lead time study the Balanced Scorecard will be used mainly from logistical perspective and the four aspects will all include lead time and customer satisfaction as the main strategy for spare parts supply. The financial perspective and innovation and learning perspective will be included in some level but the focus will be set on other perspectives, in specially customer perspective and internal perspective, which have greater impact on the objective of this study which are lead time and customer satisfaction.

Spare part delivery metrics, categorized in to the Balanced Scorecard are shown in figure 10. Also as the main focus in using the BCS is in the internal and customer perspectives, not all of the selected and formed metrics will be used in the analysis but only the most important ones for lead time study. Other metrics are also important when measuring the performance as whole from different perspectives and should be included when implementing this study in to practice.

The Balanced Scorecard measurement system and metrics will be divided in to the seven different processes, as shown in figure 9, which form the spare part delivery process. For fluency purposes and as an example, only the first metric will be shown in the 11-step model but all of the selected metrics could be defined in the same manner by the management.

5.3.1 Request handling metrics

Request handling is the first aspect of customer service for spare part business in Outotec (Filters). As it was stated in chapter 2.1.1 that customer services impact on buyer behavior it is important for Outotec (Filters) to serve customers with utmost *respect* and *speed* and the metric used for customer request handling should be consistent with this statements. Customer perspective and internal perspective are the main focus in request handling as this phase in spare part supply is the first contact between a customer and Outotec. Two time based metrics can be formed to describe these two factors which are respect and speed:

- "Total Request Handling Time" – Internal perspective
    - Total time spent in customer request handling - Days
- "Time from Request to Answer" – Customer perspective
    - Time spent before an answer were given to customer – Hours

Table 4. Example of the 11-step metric form

	Title	**Explanation**
1.	Metric	Total request handling time
2.	Usage	To measure total time spend in customer request handling
3.	Influence	Customer satisfaction and fast service
4.	Target	All request to be handled within 2 days
5.	Formula for calculation	The time it takes from first customer request input to conclusive feedback to customer
6.	Frequency	Weekly tracking to determine trend
7.	Reporter	Sales support manager / determined spare parts engineer
8.	Source of information	Workflow tool
9.	Who will respond to results?	Sales support manager
10.	How to act?	Finding root causes for requests older than 2 days and finding solutions to prevent them to appear in future
11.	Notes	Finding solutions to root causes can involve many organizations such as procurement, product management or accounting

5.3.2 Spare parts quotation metrics

After the customer's need have been identified and customer request has been noted and answered, a spare part engineer will quote the requested spare parts to the customer. This quotation phase is one part of the process which can have a major impact on the total cycle time as the requested spare parts can sometimes be difficult to quote. The metrics for spare part quotation process can be chosen to fill all four BSC perspectives:

- "Total Quotation Response Time" – Internal perspective
    - Total time spent from quotation request to quotation - Days
- "Quotation Activity" – Financial perspective
    - How much lines quoted to customer/customers – Pieces / Euros
- "Quotation Hit-Rate" – Financial perspective
    - How much quotations turned in to customer orders - %
- "Customer Satisfaction" – Customer perspective
    - Was customer satisfied with the service level / received quotation – Customer satisfaction query
- "Common ways of working" – Innovation and learning perspective
    - Are the ways of communication to customers same regardless of the point of contact?

5.3.3 Order handling

Customer will most likely send a purchase order to Outotec (Filters) if the price and lead time offered were acceptable and the quotation was sent within satisfying response time. Order handling itself doesn't consume much time because the preliminary work has been already done in the request handling and quotation phases and also because a good number of orders are received through Electronical Data Interchance, EDI. EDI orders reduce the handling times because confirmations can also be transmitted electronically so any manual order creation or email conversations are no longer needed. To get reliable performance measuring results, the metrics concerning order handling should contain metrics

based on both new orders and also already handled and delivered orders. For new, undelivered orders the main metrics are:

- “Order Backlog” – Financial perspective
    - How much undelivered order backlog – Euros / Lines
- “Requested Delivery Time vs. Confirmed Delivery Time” – Customer perspective
    - How big is the gap between requested delivery time and the confirmed delivery time – Days

For all orders, delivered and undelivered, the following metrics were chosen:

- “Order Intake” – Financial perspective
    - How many new orders received – Euros / Lines
- “Sales” – Financial perspective
    - What was the total amount of sales - Euros
- “Order-to-Delivery Cycle time” – Internal perspective
    - What was the total lead time from order to delivery - Days
- “On-Time-Accuracy vs. confirmed delivery time” – Internal perspective
    - What was the reliability of spare parts supply - %

5.3.4 Purchasing metrics

If the sold spare parts are not Make-To-Stock oriented, the procurement team will place purchase orders to suppliers and try to get them supply the parts in to stock before the promised delivery date on customer order is on hand. These parts which supply policy is Make-To-Order can cause some unwanted delays towards customer order lead times and the performance of suppliers has to be measured. Procurement team also handles purchases for MTS parts. The warehousing parametrics set for MTS parts are calculated by the inventory planners and procurements task is to take care that any unplanned stock-outs don’t occur. In addition to the actual purchasing process, procurement team also handles price and availability queries received from the sales engineers. These parts that need

quotations from suppliers are usually new spare parts or the existing purchasing information is invalid due to expired dates. After the quotation is received from the supplier the information is updated in to ERP and informed to the sales engineer who will then create a quotation to the customer.

The chosen metrics for purchasing process are:

- "On-Time-Accuracy" – Internal perspective
    - What was the supplier reliability / confirmed vs. requested - %
- "Supply Lead Time" – Internal perspective
    - What was the lead time for purchase orders – Days
- "Lead Time vs. Volume" – Internal perspective
    - What was the avg. lead time vs. ordered volume / supplier
- "Delay of Arrivals" – Customer perspective
    - How much delay in late purchase orders - Days
- "Spend" – Financial perspective
    - Total spend/supplier – Euros
- "Total Quotation response time" – Customer perspective
    - Total time spent from quotation request to quotation – Days
- "Quotation activity" – Internal perspective
    - How many new price and availability quotation cases created - Pieces

5.3.5 Warehousing metrics

The list of metrics for warehouse management is chosen based on their direct impact on lead times.

- "Availability from Stock for Sold Lines" – Customer perspective
    - How many sold order lines available from stock - %
- "Availability from Stock for All Lines" – Internal perspective
    - The number of stocked spare parts vs. all spare parts - %
- "Inventory Turn Ratio" – Internal perspective
    - Rolling 12 months averages of inventory turn ratios

Other important metrics are from financial aspect that heavily affect on the number of stocked parts and therefore the availabilities from stock. These metrics are:

- “Stock Value” – Financial perspective
    - How much spare parts are kept in stock - €
- “Non-Turning Stock Value” – Financial perspective
    - How much non-turning spare parts are kept in stock - €

5.3.6 Forwarding and invoicing metrics

When the whole customer order or the partially shipped order is ready at warehouse, the order will be forwarded to the customer and invoice will be send. The metrics chosen for this process contain mainly metrics for transportation selection and comparison:

- “Transportation times to different locations for different transportation models” – Internal perspective
    - How much difference there is time-wise when using air freights, sea freights or courier freights to different locations - Days
- “Transportation costs to different locations for different transportation models” – Financial perspective
    - How much difference there is cost-wise when using air freights, sea freights or courier freights to different locations - €
- “Terms of delivery to different locations for different transportation models” – Customer perspective
    - What kind of terms of deliveries are used when using different freights to different locations - Incoterms
- “Invoiced Sales Orders” – Financial perspective
    - How much invoiced sales orders monthly - €

5.3.7 Claim and return handling metrics

The last spare parts delivery process is claim and return handling. This process includes all the customer claims and return orders regarding faulty deliveries. Customers send claims for multiple different reasons, for example, incomplete delivery, broken spare part or even completely wrong delivered spare part are all common reasons in claim handling. The claim and return handling does not have direct impact on lead times but at customer satisfaction. Metrics chosen are:

- "Value of Claims" – Financial Perspective
  - How much costs claim orders cause - €
- "Root Causes of Claims" – Innovation and Learning perspective
  - What are the root causes behind customer claims and how to prevent them from happening in the future
- "Total Claim Handling Time" – Customer perspective
  - Total time spent in claim handling – Days

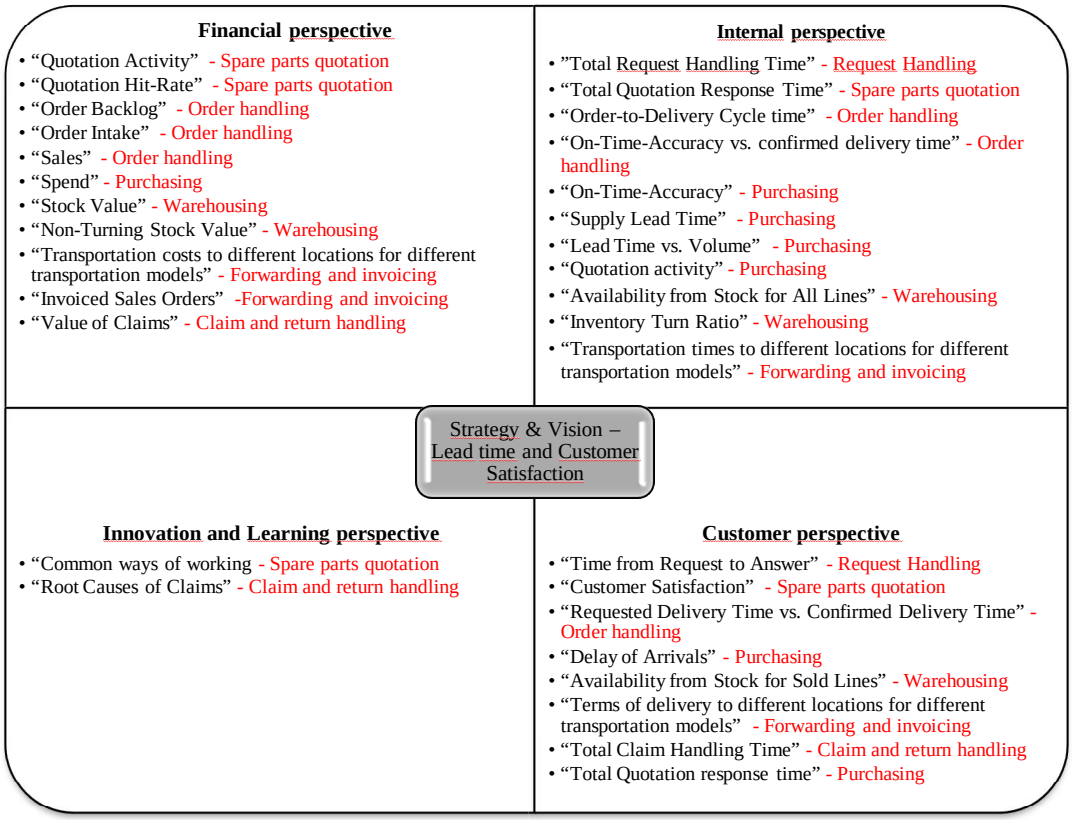


Figure 10. Spare part delivery process metrics in Balanced Scorecard

5.4 Current performance of Spare Part Delivery

After the measuring system has been done and the metrics are chosen, analysis of the spare part delivery process can begin. Customers need filter spare parts to replace faulty or damaged parts, to maintenance their existing filters or when commissioning a new filter. Spare parts are also needed by Outotec's internal subsidiaries as warehouse replenishments. Filters' spare parts are sold to the end-customers either by the subsidiaries' Service Centers (SCs) located in every continent or by the Service Product Center (SPD) Alpha located in Lappeenranta, Finland. Spare part sales in year 2012 formed approximately one third of the 2 billion Euros of Outotec's total sales in the year 2012, and filter spare parts formed the most sales cross the service business lines making it a very considerable profit source.

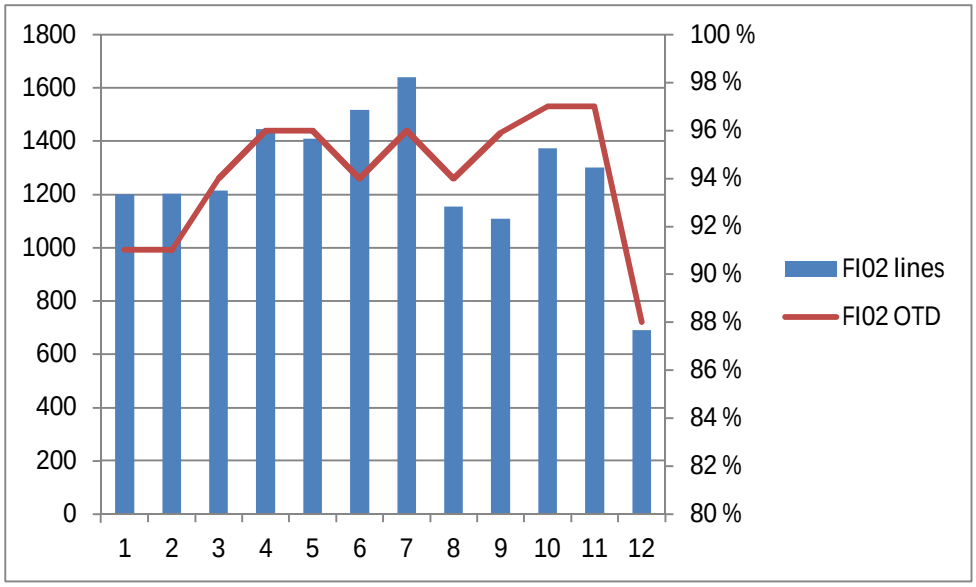


Figure 11. On-time-delivery rates and customer order lines in site FI02

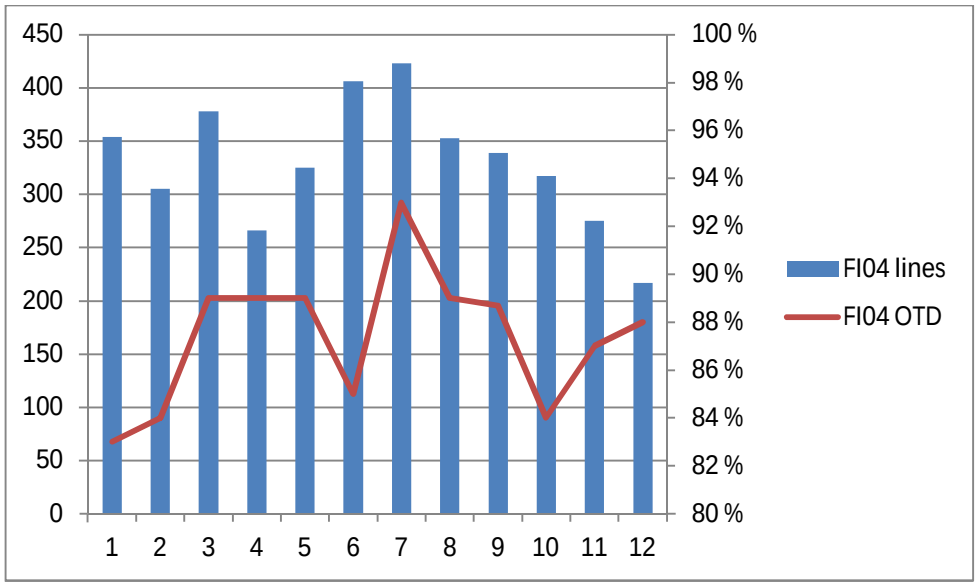
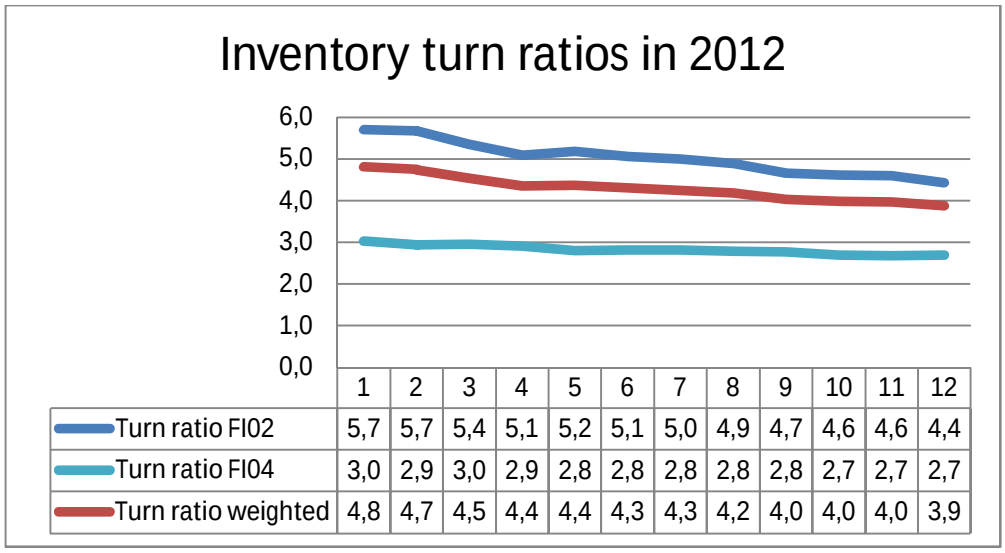


Figure 12. On-time-delivery rates and customer order lines in site FI04

Figures 11 and 12 highlight the on-time-delivery (OTD) performance against promised delivery time ex-works and the amount of delivered customer order lines from sites FI02 and FI04 in the year 2012. Bars represent customer order lines, showing the stochastic nature of spare parts demand. Also a downward trend is noticeable in the number of sales order lines towards the end of the year. This trend is not uncommon and is partly caused by customer's postponing their purchases to the beginning of next year. Customers usually order spare parts at the last quarter if they have still planned resources in budgets or some filters needs to be fixed as soon as possible due to a breakdown. OTD percentage varies monthly in FI02 from 88% to 97% bringing the average to 94%. The average percentage in FI04 is 87% and variation from 83% to 93%. Both average figures are in quite good level but still the end-customers are unsatisfied of the spare parts delivery performance. Because the measurements used to indicate the performance of after-sales business in Outotec contain both internal customers and external customer, it is clear that these measured OTD figures by themselves are not enough to justify whether the spare part delivery performance level is good or bad. The internal customer setup adds another link in the logistics chain and has to be noted when calculating the performance toward the end-customers. Due to the invisibility of performance data from internal customers to end-customers, this last link from this logistics chain has to be ignored data-wise from this thesis but

should be still noted and raised as an important issue when efforts towards better customer satisfaction are concluded.



	1	2	3	4	5	6	7	8	9	10	11	12
Turn ratio FI02	5,7	5,7	5,4	5,1	5,2	5,1	5,0	4,9	4,7	4,6	4,6	4,4
Turn ratio FI04	3,0	2,9	3,0	2,9	2,8	2,8	2,8	2,8	2,8	2,7	2,7	2,7
Turn ratio weighted	4,8	4,7	4,5	4,4	4,4	4,3	4,3	4,2	4,0	4,0	4,0	3,9

Figure 13. Inventory turn ratios in 2012.

The inventory turn rations, shown in figure 13, show a trend towards more slowly turning inventories. At the beginning of the year the weighted turn ratio average was almost five but in the end of the year 2012 the weighted average was only 3,9. The turn ratio of spare part warehouses are slowing down which means more committed capital in stocked parts and that wrong items compared to sold parts are being stocked.

5.5 Challenges in Spare Part Delivery

The problem with the poor visibility of performance from Service Centers to end-customers has been noted already a long time ago. However it is still very hard to get accurate data from the Service Centers around the world regarding the end-customer needs due to the lack of visible and compatible data. While it has seems that the measured performance levels in SPD are quite high customers are still complaining regarding the provided service levels.

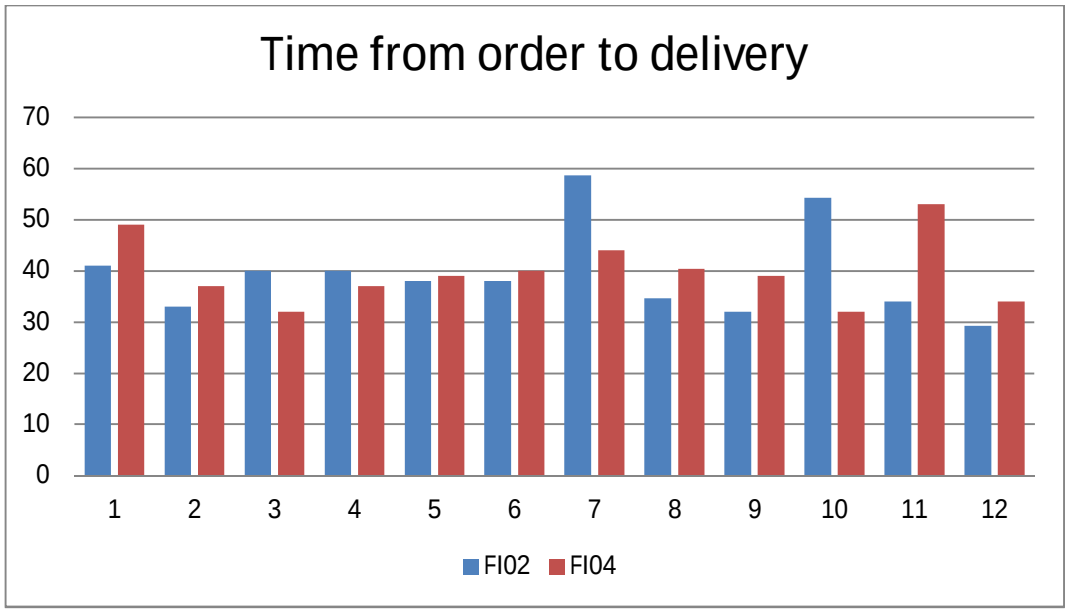


Figure 14. Time from order to delivery time (days) in FI02 and FI04 sites

The figure 14 describes monthly order-to-delivery cycle time of Outotec (Filters)' spare part sales in year 2012 from both warehouses in days. The average time it took from a customer's or a Service Center's order to be shipped from Outotec (Filters)' warehouses in year 2012 were 40 days. The average lead time include all shipped order lines, both the ones sold immediately from stock and the ones purchased from suppliers.

Immediate availability from both stocks combined for all sold items was 55% (avg.) in year 2012. The immediate availability of sales order lines for items that were planned to be stocked was 86% (avg.) in year 2012 meaning that for every 100 sold Made-To-Stock parts 14 lines had to be still purchased from suppliers. The average lead times shown in figure 14 are rather high considering that over half of the sold items were already in stock. Interviews with sales engineers support the conclusion also formed from the analysis that partial shipments are not very common and the orders are mainly delivered full.

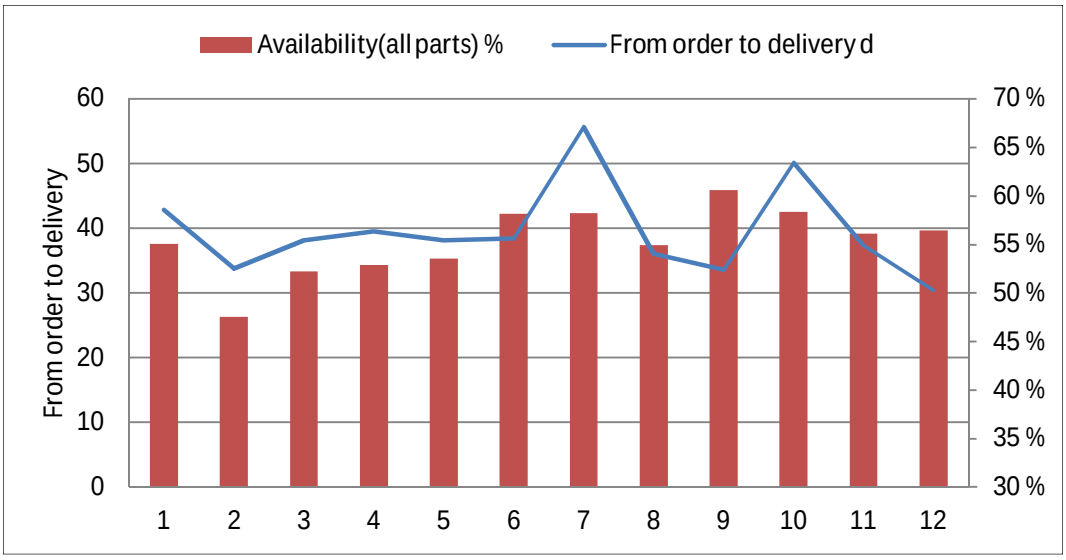


Figure 15. From order to delivery time and all parts availability correlation

Direct correlation between availability of all parts and the time from order to delivery is hard to notice from the figure 15. It seems that although items are kept in stock it does not have much of an impact towards delivery times and in some months even when the availability from stocks is at the lowest, the delivery time is the shortest. This finding means that the stock levels do not affect the total lead times as much as some other reasons. The problem seems to be in the parts which are not kept in stocks but has to be ordered from suppliers. Some parts may have lead times of several months towards the end-customers due to this fact.

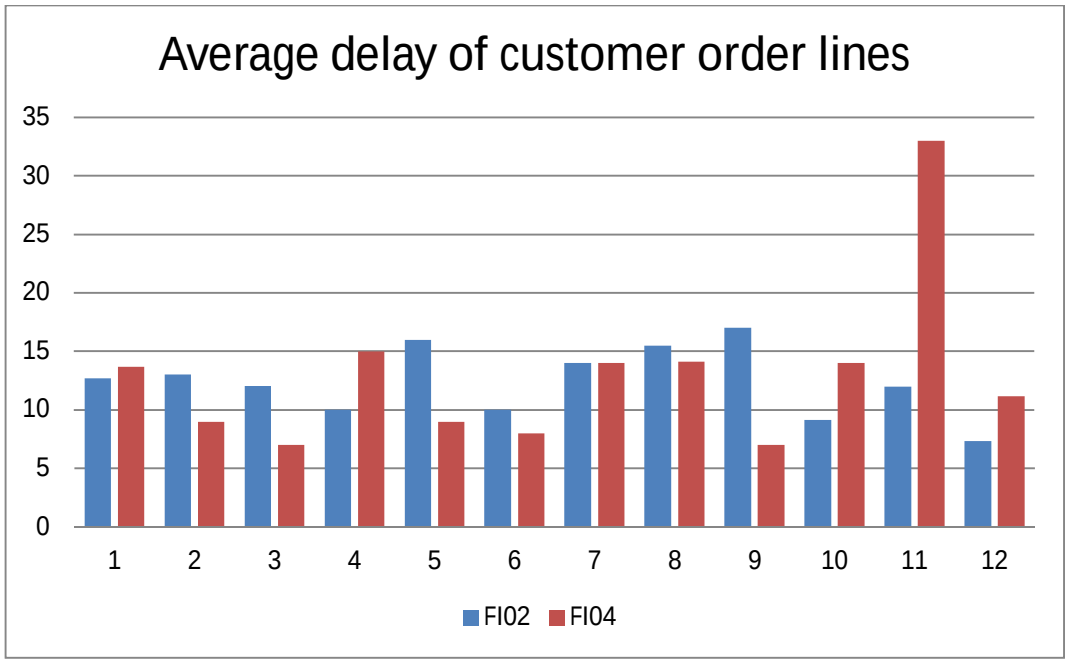


Figure 16. Average delay of customer order lines

The unavailability of items from stocks and long lead times from suppliers are both causes for the average delay of customer order lines. In the year 2012, the average delay in late customer order lines was 13 days and varied from 7 days to 33 days per month. Figure 16 illustrates the monthly delays in days from both warehouses. After internal interviews it was revealed that both figures 14 and 16 are not the ultimate truth regarding lead times and delays because there were some rather big customer orders that were postponed intentionally because the customer wanted the parts later than what they had originally planned and what was set in the ERP. These kinds of exceptions have to be taken in notice when analyzing the lead times and delays of orders objectively as they are not revealed when analyzing the raw data.

5.5.1 Demand side challenges and findings

Reasons why the immediate availabilities from stocks for sold customer order lines were not higher and why the lead times are quite long can be a cause from several problems and challenges. One challenge is that the installed base of filters around the world is very large and there are tens of different filter types manufactured and sold. Outotec (Filters) Oy has always been keen on optimizing and customizing its products for almost each of its customers. Because of the customizations done in the project phases, there are lots of different variations even between the same filter types. Ultimately this leads to the point where spare parts become incompatible between different filter types and also between the different variations of the same filter types. Big installed base and variations in products cause stochastic and fluctuating demand which is very hard to properly forecast creating a very challenging environment for spare part business. Forecasting lacks reliability also due the fact that it is almost solely based on historical information. In addition to historical data, the heads of SCs' provide some forecasts for the future needs to the SPC. These forecasts are based on the personal experiences of the Heads of the SCs' and rumors heard from the field and from the operational employees.

From system-wise, an ERP system with a standard structure and transactions does not favor a company such as Outotec (Filters) that is operating in industrial after-sales business. An ERP system which is used to combine different fixes "blocks" such as time is very challenging for spare parts demand planning because the system can`t calculate unreliability. The unreliability factor is substantially present in service business as the batch sizes are usually small and delivery times long.

From an interview with spare part operations Global Demand and Inventory Planner, few other demand side challenges were found. One seemingly small fact in project phase can cause problems later in the after-sales market. Project delivery does not always take in notice that when delivering and commissioning a new filter to a customer, service business line is not informed about the needed spare parts for the new filters. This makes warehousing planning demanding as

the demand of these filters' spare parts occur only after the customer's need for the spare parts is at hand or is already urgent. Also because the installed base and spare part portfolio both are huge, warehousing only the right parts without exceeding the tolerance set on committed capital is experienced very challenging task.

Also because the customers are served from both the local Service Centers and from the global Service Product Center the promised lead times to the customers can vary a lot. The lead time expectations for spare parts set up in the ERP are sometimes far from reality for a lot of parts so it can be a difficult task for a local Service Center to know the real lead time for certain parts. This can cause them to "play safe" and add an additional week or two to the lead time they see in the ERP and then offer the parts to the customer.

5.5.2 Information flow challenges and findings

Identifying the customers' real needs is also an issue to be noted. As the Service Centers may have more difficult time to estimate the lead times for spare parts than the Service Product Center, the SPC has more problems knowing the real needs behind the customer orders. The lack of visible information of the customer needs in the current systems is the biggest reason why the SPC's may struggle more in this area. Of course some information is changed between the customers, the SC's and the SPC but this information is usually sent via E-mails and cause unnecessary lag in response times. Even if the customers' needs would be identified correctly, satisfying the needs would still be a challenge because the number of order lines going through the SCs and SPC in daily basis is rather high; pinpointing the urgent spare part needs to procurement is difficult. Also larger planned or unplanned customer orders can cause unexpected demand peaks. These larger customer orders are usually big site erections, maintenance operations or even claim orders. Larger and seemingly unexpected orders seem to appear out of nowhere as the time it takes for the information of customer's need to arrive from Service Center to procurement takes can take days or even weeks.

As the lack of visible and compatible data from different internal entities makes spare part demand forecasting and anticipating market area changes very difficult, it also makes the whole spare part delivery process work in separate silos. Communication and bureaucracy consume time and the work input is usually focused only on the own silo's output and performance – a bigger picture of supply chain performance is lost. When every process and organization focuses only on itself and its own performance working becomes reactive and cause unnecessary delay. Also understanding the effects which the own organization's actions has to other close organizations functions, which are working in the same process are kept hidden.

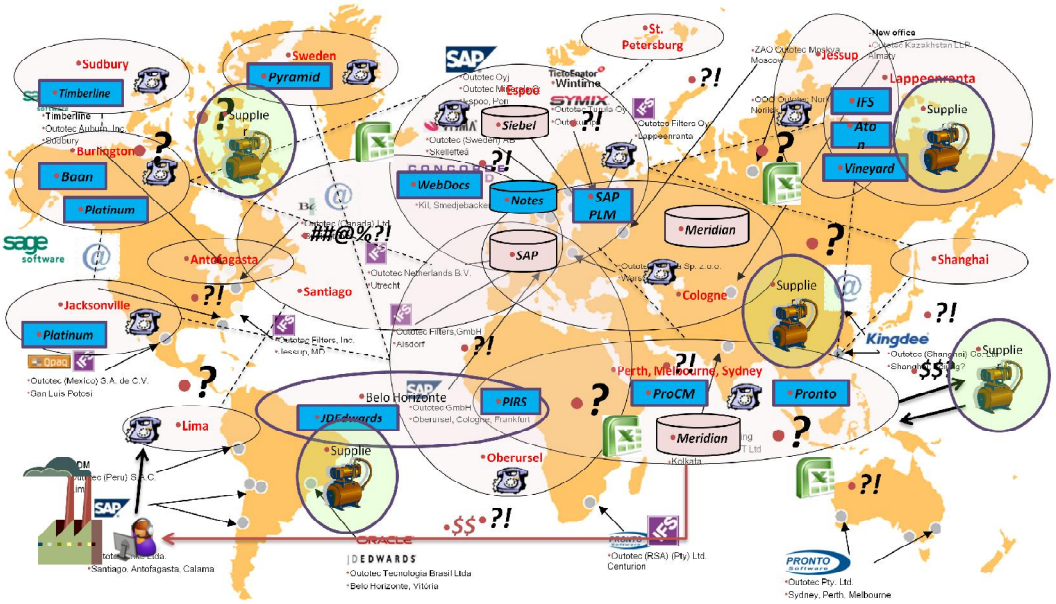


Figure 17. The information and application landscape in 2011

The lack of visible and compatible data is caused by the huge variety of different systems within the Outotec's own subsidiaries. This problem does not affect only Outotec (Filters) but the whole Outotec. The figure 17 illustrates the global landscape of Outotec's internal information systems. A clearer picture is found from appendix 1. A more clearer and defined landscape and way of information flow is definitely needed to be able to tackle the invisibility and incompatibility of internal and external data.

5.5.3 Supply side challenges and findings

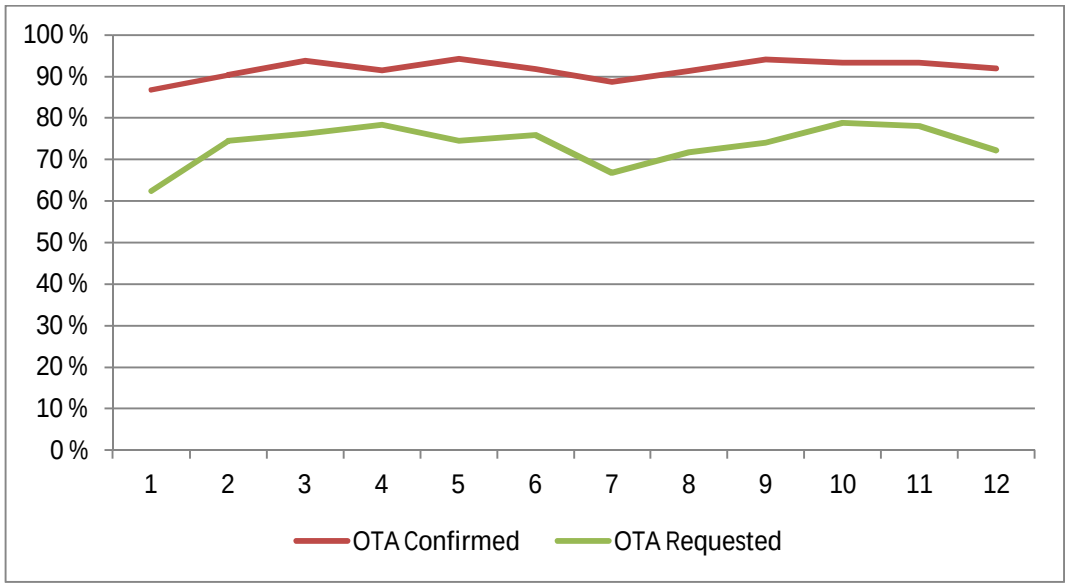


Figure 18. Suppliers' On-Time-Accuracy

Lead times provided by Outotec (Filters)' suppliers are not short enough to satisfy neither customers' needs nor demands. The average suppliers' On-Time-Accuracy (OTA) differs approximately 10-15% monhtly when compared between the confirmed date and requested date. As shown in the figure 18, the confirmed delivery accuracy is at a rather good level throughout the chart but the accuracy towards the requested delivery dates is much lower. This means that the lead times which were requested are not short enough for the suppliers to be able to supply.

The requested dates in the purchase orders are usually in line with the dates set on the sales orders towards Service Centers or end-customers. However some "anomalies" occur because sometimes critical parts were requested even earlier from the supplier than they were offered to the customers and some stock replacement parts were requested later than they were requested by the ERP-system. These anomalies are caused when Procurement Specialists purchase parts experience based. Even though there are possibility to request the deliveries sooner or later than the need is shown in the ERP, purchasers feel that they can't affect the supply lead times as much as they would need to. They must still heavily rely on the lead time data in ERP because of the vast spare part offering.

Spare parts procurement is divided category-wise between the Procurement Specialists and personal professional knowledge of the spare parts belonging to each dedicated purchase categories ease the dependency of ERP based purchasing. However, interview with the Procurement Specialist working in service purchasing revealed that the professional knowledge is not appreciated enough and spare part product trainings are arranged too seldom.

Purchasing is done via emails or EDI. EDI procurement is used mainly with the most important suppliers and majority of suppliers the main communication media is still email. Some suppliers even have only a fax machine and no email so the purchase order placement can be difficult because the uncertainty of the fax number validity emphasizes.

The purchase order delivery controlling is performed by purchasers. Order status queries are done via emails or phone calls. There are no penalty protocols towards the suppliers regarding late deliveries and all the purchasers can do is politely request and remind the supplier for the urgency of the order. If the order is going to arrive late, the purchaser inform the actual delivery time to the sales engineer whom sales order the ordered parts are purchased to.

Huge supplier base causes variation in lead times even within the same products or product categories. In year 2012 over 210 suppliers were used at FI04 site purchases and almost 300 suppliers were used at FI02 site purchases. Both FI02 and FI04 sites combined the total amount of different suppliers used in the year 2012 was 410. Total of 100 suppliers overlapped meaning they were used at both sites.

Varieties of different parts which are supplied by Outotec (Filters) to its customers and by suppliers to Outotec (Filters) are astonishing. However as the variety of different parts is huge the normal ordered batch size is usually very small. Small batch sizes are not very attractive business for a lot of suppliers so they tend to handle them with less care as it would be needed to. Outotec (Filters)' has many problematic suppliers which lead times, product qualities and customer service levels vary a lot. Still these suppliers are still used as replacing suppliers are not

found. The service's sourcing organization does not take enough actions in consolidating the current supplier base or trying to find alternative suppliers to replace the problematic ones. Sourcing organizations' focus is currently set on making price lists and warehouse agreements with the most important suppliers. The information flow between sourcing and procurement organizations is not yet on satisfying level. Sourcing is not informed enough regarding the problematic suppliers and procurement is not informed enough about the ongoing or even completed price list or warehousing agreement negotiations.

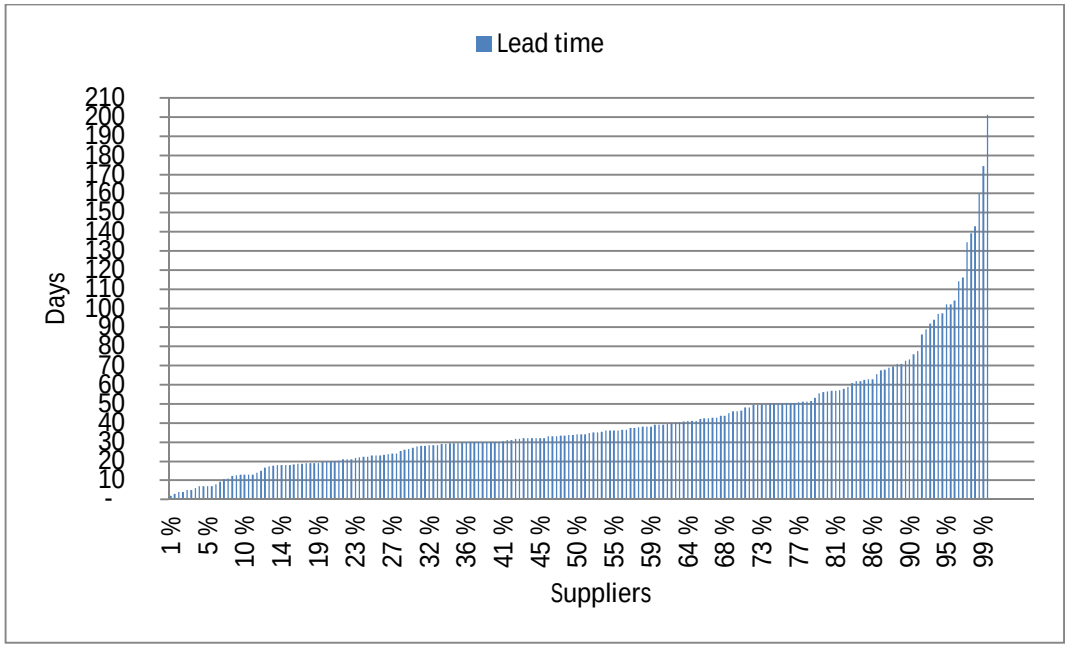


Figure 19. Lead times in site FI04

Figure 19 shows the average lead times from all suppliers in FI04 site. The results are interesting. Average lead time for all the suppliers and order lines combined was 42 days. Total number of ordered lines to Netherlands warehouse was almost 3200 pieces. The shortest lead times are only few days which usually mean the ordered spare parts are common and standard small parts such as bearings, bolts, nuts and washers which have a really low impact to the revenue. The Netherlands warehouse is usually being used as a hub for parts mainly purchased from Central Europe and is used for the spare part needs of customers which are using older Outotec (Filters)' filter technologies originally manufactured in Germany and Netherlands. There are not as many warehousing agreements with the suppliers

used only for FI04 site needs and which are located in Central Europe than there are with suppliers located in Finland. The spare parts with the longest lead times in FI04 site are big and rather expensive spare parts such as filter belts, vacuum pumps, filter plates and membranes for the filter plates. The mid-range parts with lead times ranging from 20 days to 60 days contain hydraulic parts such as pumps and cylinders, parts for pipelines such as valves and pipes, big rollers and steel structures.

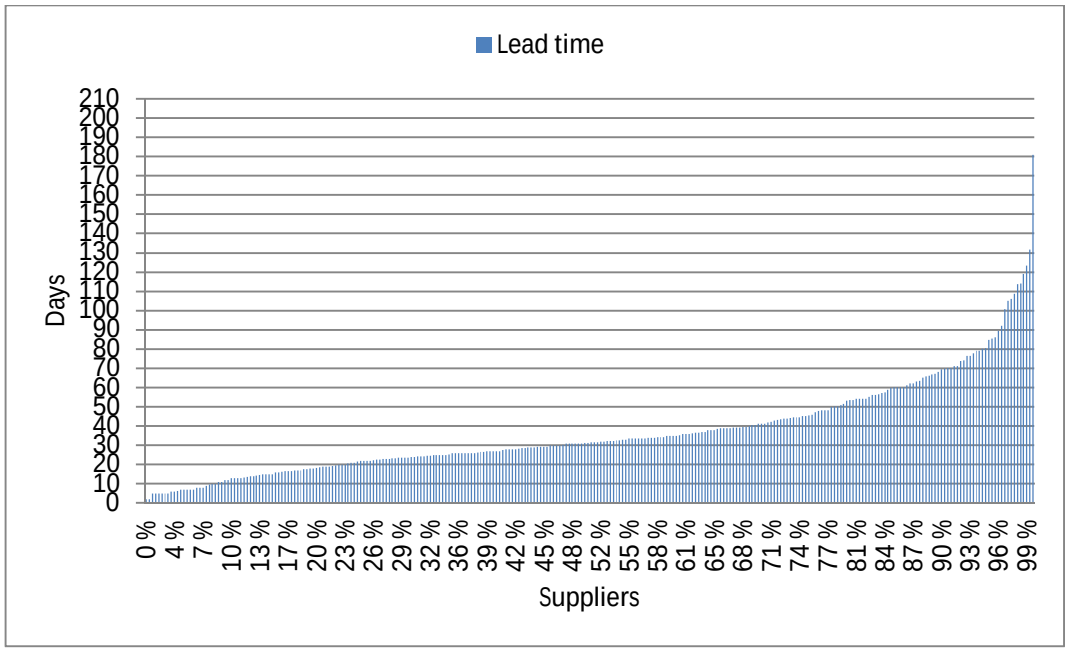


Figure 20. Lead times in FI02 site

The lead times to FI02 site from all suppliers is shown in figure 20. The trend of the diagram is similar with the one of FI04 sites'. Total number of order lines was almost 10500 pieces. The amount is roughly three times the lines delivered to Netherlands. Even with more ordered lines, the average lead time at Finland's site was 37 days which was 5 days shorter than in Netherlands.

Reasons for shorter average lead time can be found from both the supplier base and from the spare part portfolio. The supplier base used mainly to FI02 site contain few suppliers which are already under the SRM program and they have generally agreed terms for stocked parts and annual price lists and are aware of the customer service level required by Outotec (Filters). Suppliers located

physically in Finland are also audited more often to ensure the agreed terms are met.

Documentation in PDM for the spare parts ordered to FI02 is far more thorough and consistent than the documentation of spare parts ordered to FI04. Good documentation reduces the time it takes to solve any issues regarding misleading or unclear drawings and materials. The time it takes to solve any obscure documentation of an already ordered spare part can take even week or more and is added to the total lead time.

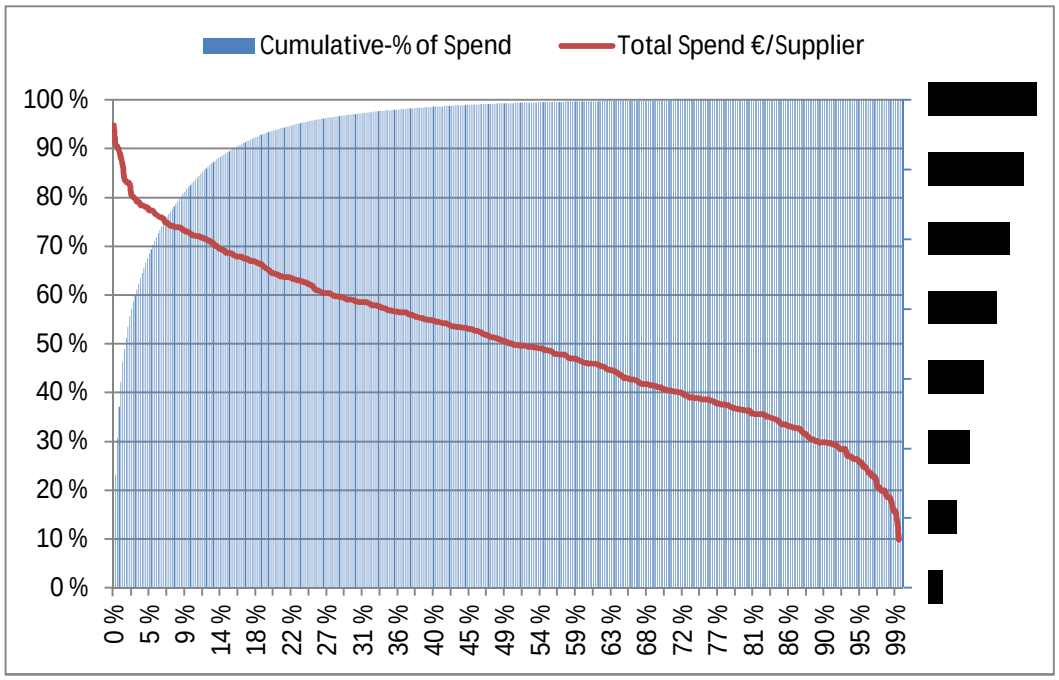


Figure 21. Cumulative spend and total spend per supplier both sites FI02 and FI04 (€ figures blackened)

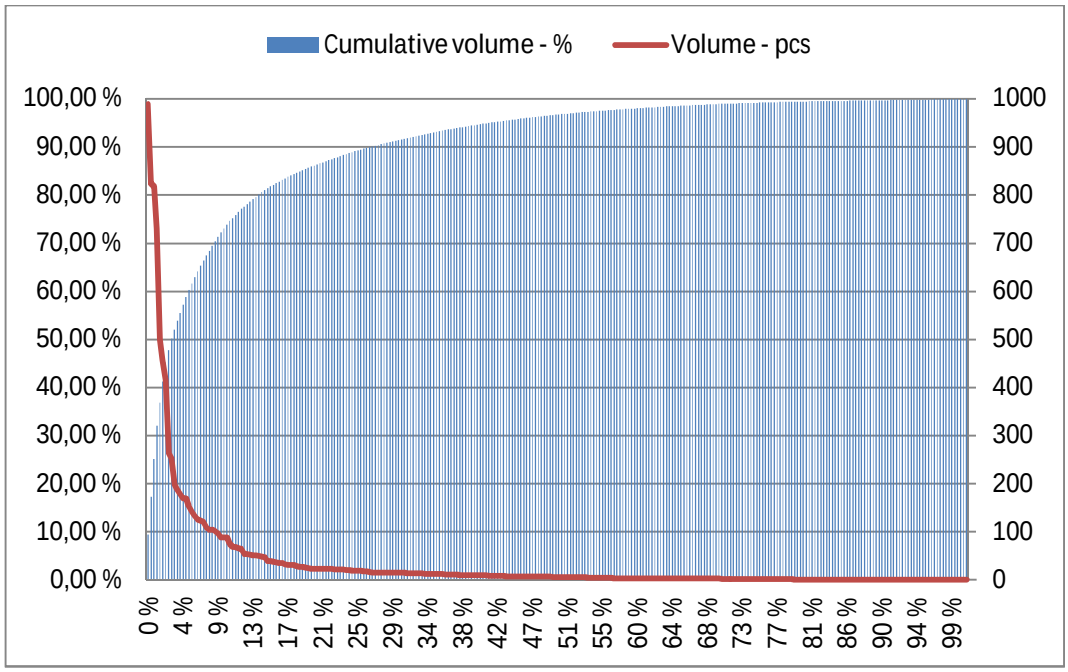


Figure 22. Supplier cumulative volume and volume in FI02

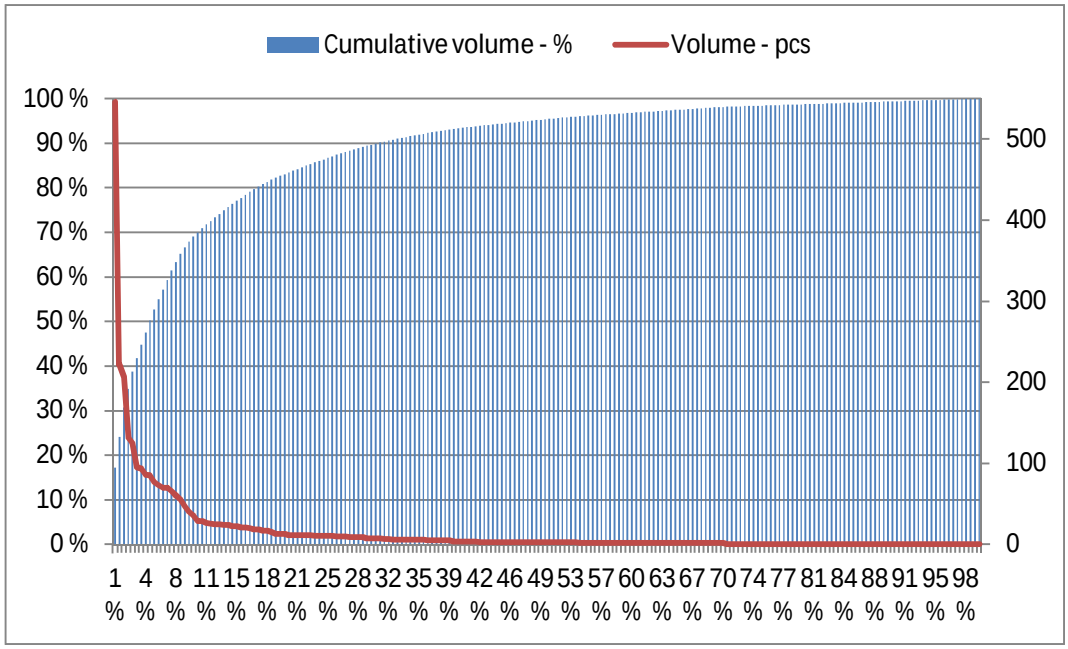


Figure 23. Supplier cumulative volume and volume in FI04

The figure 21 shows that 90% of the total purchasing spends is divided between approximately 15% of all the suppliers and majority of suppliers have very small annual spends and volumes. Volume-wise the situation is not as drastically divided although minorities of suppliers supply the most of the ordered volume.

This volume comparison is described for both sites in figures 22 and 23. In FI02 site approximately 25% of suppliers have 90% of the total volume and in FI04 site 30% of suppliers have 90% of the volumes. When analyzing volumes in order lines per supplier, a similar trend can be found. The number of ordered order lines from suppliers to FI02 site varied from 990 lines to only one line per supplier and the suppliers which supplied less than 50 order lines made up to 86% of the total used supplier base. Similar figures in FI04 site were 546 to one order line where 91% of suppliers supplied less than 50 order lines.

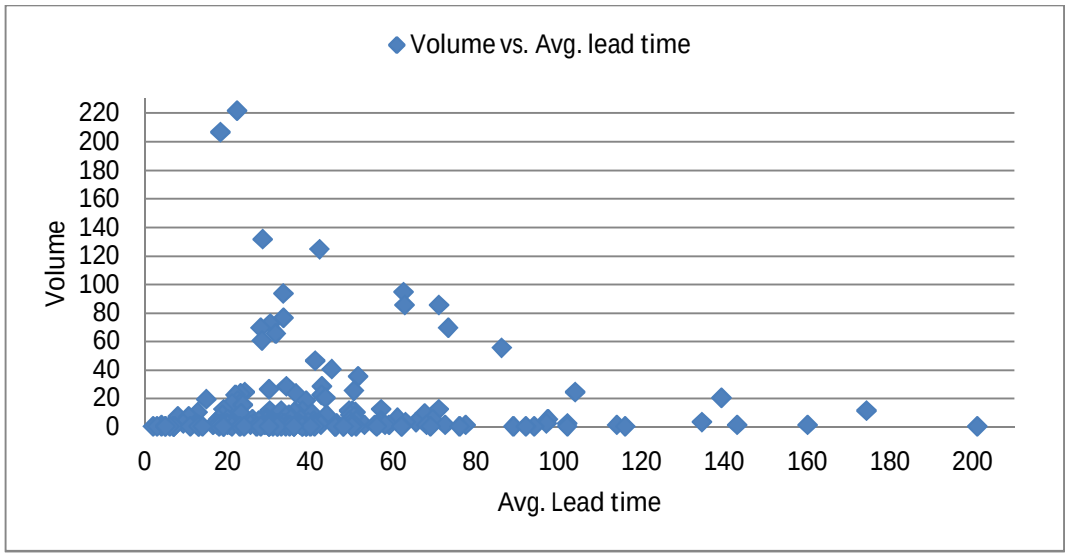


Figure 24. Volume versus average lead time in site FI04 (To make the figure more clear to read, the biggest supplier excluded from the Figure 25 - Volume 546, lead time 32 days).

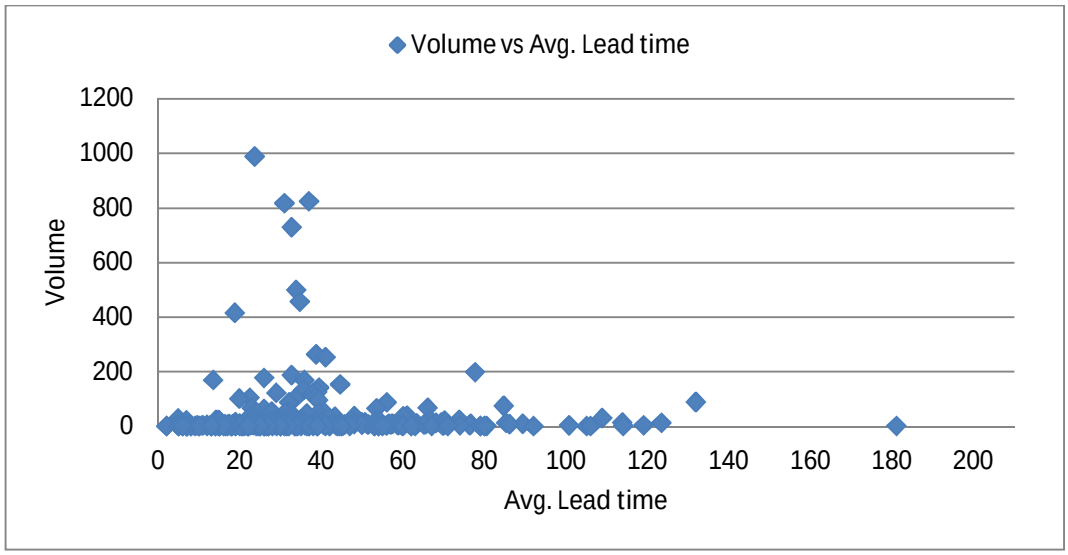


Figure 25. Volume versus average lead time in site FI02

In figures 24 and 25 the average lead times and volumes of both sites are put in to cross table analysis. From these figures 24 and 25 can be seen a trend which shows that suppliers with low volumes have the longest lead times. These figures and analysis show where the main focus areas for improvement considering supplier lead times should be and reveals those suppliers which lead time reductions would provide the best overall results and consolidation of supplier base could be done.

5.9 Suggestions for improving the order-to-delivery cycle

In this chapter, the focus is to point out the main issues behind the long lead times revealed from both the performance measurement analysis and from interviews with employees working in the spare part supply and to give suggestions to supply chain managers for enhancing the order-to-delivery cycle. The total order-to-delivery cycle time in Outotec (Filters)' spare part service is accumulation of time spent in processes, described in figure 9, which form the spare parts delivery.

All the sections in the spare part delivery process can cause unwanted delay to the total lead time, as shown in figure 4, so it is important to improve every aspect of

the process to gain the most agile process and furthermore the shortest possible lead time. Important guidelines to reduce the cumulative lead time formation can be seen as:

1. Unified, efficient ways of working
2. Global visibility to whole supply chain
3. Supporting continuous optimization of service delivery network
4. Backlog management

To be able to work within these guidelines and making the spare part delivery process more cost-efficient and agile some major changes has to be done to the current way of working.

As it was stated in chapter 5.2 the Spare Part Delivery's mission statement included three strategic key components, which were enabling and promoting profitable growth for Outotec's customers and Outotec, providing professional spare part service with high reliability and availability at competitive prices and to be a global team with local presence, dedicated to sustainable customer relationship and excellent service experience.

To achieve these mission objectives, several different obstacles have to be overcome. Based on the internal interviews it is important to note that the current operating and organizational models are perceived rather complex both externally and internally so by reducing the complexity and globally managing the complete end to end spare part supply chain via common processes and organizations would enable the set mission statements to be achieved better. Secondly it is crucial to care and understand the customer's needs and strive to resolve their issues. And lastly continuous improvement in performance of operational efficiency, ways of working, competencies and capabilities is important in achieving the set goals.

5.9.1 Improving information flow

The *external information* landscape described in chapter 5.5.2 has to be clearer so that customers would have only single point of contact towards Outotec (Filters).

At the current process, customers tend to get confused and can get even annoyed because of the Outotec (Filters)' multiple contact points for the same process.

Also the *internal information* landscape has to be clearer and information flow visible within Outotec (Filters) so that a centralized database for optimized request and resource management could be established and end-to-end inventory and demand visibility could be achieved leading to more efficient global and local inventory planning. This would mean better control of service operations, faster responses both internally and externally and therefore enabling business growth via scalability of operations.

The use of common systems such as ERP, CRM, PDM and DMS throughout Outotec (Filter)' SPC and SCs would allow further developing of service operations and would also allow scalability of processes through common ways of working. Customer requests and orders should be entered in to a common system and new customers created in to ERP and items in to PDM directly upon arrivals. Spare parts quotation should offer only itemized products. Non-itemized products cause often, if not always, challenges in procurement and warehousing. Also a common workflow tool for spare part sales in both SCs and SPC and procurement is needed for enhanced communication and escalation of queries and orders. The common workflow tool would also allow the use of the set metrics for spare parts request handling, order handling and procurement which measure the time spent in handling requests and orders. It would also allow the measurement of individual workloads and would help managers to allocate works better between employees.

A common forum for procurement and sourcing teams is also needed because the current state of information sharing is not enough to satisfy either party. The forum for procurement and souring could also be set in to the workflow tool or in some other commonly used forum, for instance Outotec's internal website's community.

By adopting common ways of working and by establishing a solid service culture via visible information sharing and communication with the customers is

important tasks towards continuous learning and development. The customer service culture must be integrated in every organization working in spare parts delivery so that every organization (procurement, sales and warehousing) work towards the best customer experience and satisfaction. The customer interface must be proactive in predicting customers' incoming spare part needs and every organization must focus on a common goal.

5.9.2 Sophisticating the spare part delivery process

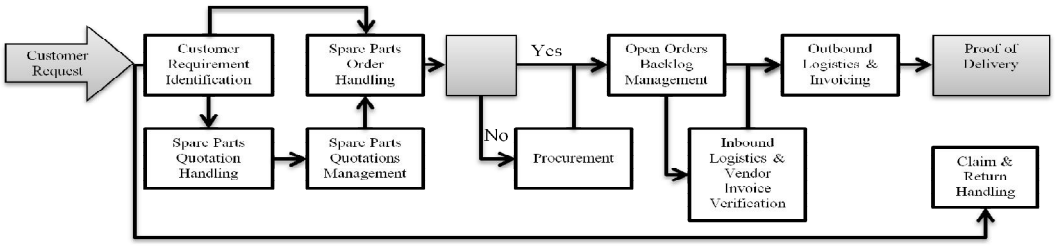


Figure 26. Sophisticated spare parts delivery process

The spare part delivery process was previously shortly introduced in figure 9. To be able to enhance the process and order-to-delivery cycle the process has to be described and analyzed further. A more sophisticated version of the Outotec's spare part delivery process is illustrated in figure 26. In this version of the spare delivery process, some new functions have been set to aid and to complete other functions and the roles have been set to complete each others.

Customer Requirement Identification will act as the single point of contact for Ouotec (Filters)' customers for quotations and for purchase orders. In this process, all requests are entered in to one common ERP system.

Spare Parts Quotation Handling and *Spare Parts Quotation Management* offer only itemized items (spare parts) to customers. All the quotations are entered in to one common ERP system. Quotations received from suppliers are updated in to ERP so that itemization and quotation/order creation is more agile. A common workflow tool is used to enhance the communication between spare parts

quotation handling and procurement. Quotation Management measures the quotation and request handling times and also quotation activities. Escalation of quotations is also communicated through workflow tool by quotation managers.

Spare Parts Order Handling enters only itemized orders in to ERP system. Focus is on fulfilling the customers' requested delivery times whenever it is possible. Promised delivery times and updates on delivery times communicated to customers regularly.

Procurement maintains the item and supplier data in ERP. Focus is on fulfilling the customers' requested delivery times whenever possible, and if not possible, the focus shifts on fulfilling the promised delivery times. Any delays concerning purchase orders are immediately communicated back to Spare Parts Order Handling. Procurement measures supplier performance.

Open Orders Backlog Management follows the backlog of open sales and purchase orders to ensure the on time accuracy and act as an intermediary between Procurement and Spare Parts Order Handling. Open Orders Backlog Management measures the open backlog value and quantities and order intake.

Inbound Logistics & Vendor Invoice Verification handles the inbound delivery inspections and goods receipts in to ERP. Also handles the invoice verifications against purchase orders.

Outbound Logistics & Invoicing handles the outbound deliveries and all the transactions such as export declarations and picking parts and removing them from ERP stocks. Also sends export documents to the recipient and the forwarder.

Claim & Return handling gets claim and return order requests from Customer Requirement Identification and focuses on solving the issue as promptly as possible. Measures also the value of claims and tries to solve the root causes behind the claims.

5.9.3 Improving material availability

The spare part delivery lead time analysis showed that procurement is facing some major challenges with the current supplier base. To be able to shorten the lead times towards customers, material availability has to be improved meaning that either the ordered parts have to be located from stocks or that the requested lead times are enough for the suppliers to supply. Although the immediate availability from stocks for ordered lines was in a decent level, the overall lead times were high. So by reducing the supply lead times will lead to shorter order-to-delivery cycle altogether.

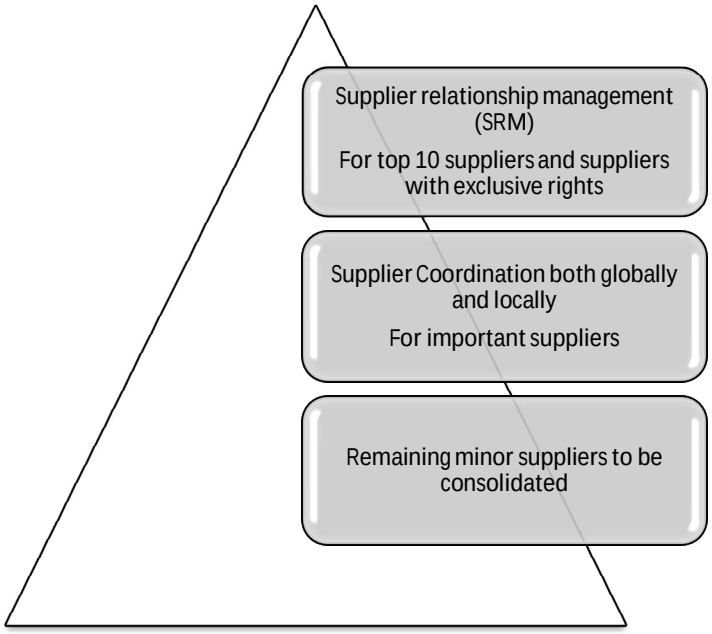


Figure 27. Supplier relationship management

It would be a very important task to implement a supplier relationship management (SRM) program to consolidate the supplier base and to strengthen the cooperation between Outotec (Filters) and its most important suppliers. SRM program would also increase the leveraging volume with decreased supply risks. Also quality, lead time and innovation management would be more visible. When prioritizing the lead time improvement activities, the focus should be set in to the suppliers with largest volumes (order lines, figures 22 and 23) and spend (€, figure 21). Also suppliers which are challenging but important in other ways and have some special features such as exclusive manufacturing or supply rights or

supply spare parts based on their or Outotec's own molds should be considered under the SMR program. Therefore the SRM program should be implemented to the most important suppliers as shown in figure 27. Other important suppliers should be coordinated both locally and globally together by the sourcing organization and delivery organization.

For the minor suppliers a consolidation should be done to reduce the number of suppliers in to more manageable amount. Consolidating smaller suppliers would also have a positive impact to the total quantity of annual order lines per small supplier and therefore raise their interests toward Outotec's spare part needs even if the batch sizes were to remain small.

The incoherent and incomplete item data in PDM is a cause of some of the delays and long lead times. It would be absolutely crucial to get the PDM working in such a manner that both the sales engineers and purchasers would be able to rely on the information available. The lack of trust in the product data affects both internal and external parties. Suppliers can get confused when the ordered items' descriptions conflict with the drawings or prices. All this uncertainty creates more work load for procurement and consumes important time which could have been used on other important issues such as order status monitoring. So by creating an effective PDM system and documenting all spare parts would increase the work efficiency considerably and would remove any uncertainties regarding the sold or purchased parts, leading to a more reliable spare part supply.

EDI purchasing should be formed as a norm and actions to implement it to all suppliers should be done. EDI suppliers are still the minority but the trend should be shifted towards EDI majority so more reliable and agile order placement procedure could be achieved. For the order delivery controlling, an automated notification system towards suppliers should be formed. In the current process, it is up to the purchasers to inform suppliers regarding the unconfirmed and undelivered late orders. This is a time consuming work because of the high order amounts and could be eased with a more automated system.

The professional education of the spare part supply organizations is also substantial task from the internal learning perspective and also from the work efficiency perspective. Motivating sales personnel and procurement personnel is an important task for maintaining the effectiveness levels when the workloads are high. As well as motivating the company's own personnel, also suppliers have to be motivated to pursue common goals at satisfying the end-customers' needs.

6. CONCLUSIONS

In this thesis, the today's global industrial service business and its dynamics markets were introduced. Staying efficient and gaining competitive in this challenging environment means that the customers' needs must be understood. Customers in service business are very time-sensitive and their purchasing behavior is increasingly demanding towards lead times making finding new ways of value creation towards customers a demanding task. As the after-sales business is both stochastic and quickly evolving, a customer oriented approach is the best way in pursuing business growth and customer satisfaction. The case company Outotec (Filters) was struggling in this after-sales environment as the customer satisfaction levels were decreasing, caused by the long lead times to the end-customer. This thesis was made to aid the supply chain managers in realizing the causes behind the long lead times by analyzing the performance of the current spare part supply processes and to raise the awareness of the special features which apply in the industrial after-sales business from the customer perspective. In the literature section, only theories which were relevant to the case company's environment and business were introduced.

In the case study section, the structure for performance analysis was formed based on both internal documents and data analyzed with quantitative statistical methods together and qualitative interviews with different persons working in the Spare Part Supply organizations. The used performance measurement tool was Balanced Scorecard which was deployed in the single processes creating the whole spare part supply chain. Findings showed that many different processes in the spare parts supply were facing different kind of challenges in achieving the lead time levels wanted.

Customer needs created a problem which accumulated from the sales personnel all the way to the procurement. To the procurement, customers' needs didn`t appear until the quotations were sent and orders were placed in to the ERP system. The lack of clear and coherent informational landscape caused both internal and external information flow to be too slow and confusing. It also caused

the internal information and data to be incompatible between different business units and subsidiaries. Without a clear information landscape and proactive sales team working in the customer interface, the real customer needs will remain mystery and the response times long. Adopting common ways of working and by establishing a solid service culture via visible information sharing and communication with the customers would both be important tasks towards continuous learning and development. The customer service culture should be integrated in every organization working in spare parts delivery so that every organization would work towards the best customer experience and satisfaction.

The Balanced Scorecard performance measurement tool was used to analyze the current spare parts supply performance. At first the measured performance levels showed results which were not too alarming but long that the real issues behind the long lead times were revealed. Aside from informational issues, the issues behind long lead times to customers were a cause of insufficient material availability and challenging demand planning. The insufficient material availability was caused by challenges in the supply side. Outotec (Filters)' supplier base was too large and the ordered batch sizes too small to make the suppliers committed enough to pursue common goals with any means necessary. The supplier base should be consolidated and the efforts to improve the supply lead times should be focused on the suppliers with the most spend and volume or other special features such exclusive rights or parts manufactured from molds.

Internal spare parts supply processes could be defined in a bit more sophisticated manner and some support functions could be added. These functions would act as intermediates between different processes providing support and management activities for more agile and lean overall performance. The management functions would also have the main responsibilities in daily performance measurement.

This thesis offers possibilities for further studies as this thesis was objective was to study the current performance and find ways and suggestions for improvement areas. These improvement areas for further studies are the internal information landscape, supplier base and demand planning and the reasons are the ones already mentioned.

REFERENCES

Axelsson, Björn and Wynstra, Finn (2002), Buying Business Services. Chichestesr: John Wile & Sons Limited.

Ayers, James B. (2001), Handbook of Supply Chain Management. The St.Lucie Press/APICS Series on Resource Management. Boca Raton, Florida

Ballou, Ronald H. (2004), Business Logistics / Supply Chain Management – Planning, Organizing, and Controlling the Supply Chain. 5th edition. Weatherhead School of Management. Case Western Reserve University. New Jersey: Prentice hall.

Ballou, Ronald H. (1999), Business Logistics Management: Planning, Organizing and Controlling the Supply Chain. 4th edition. New Jersey: Prentice Hall.

Brax, Saara (2005), A Manufacturer Becoming Service Provider – Challenges and a Paradox, Managing Service Quality, Vol. 15, No. 2, pp.142-155.

Christopher, Martin (1998), Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service. 2nd edition. London: Prentice Hall.

Coyle, John J., Bardi, Edward J., Langley, John C. (1996), The Management of Business Logistics. 6th edition. St Paul.

Gaiardelli, Paolo., Saccani, Nicola., Songini, Lucrezia. (2007), Performance measurement of the after-sales service network – Evicende from the automotive infusrty. Computers in Industry 58, pp. 698-708.

Grieco, Peter L. Jr. and Cooper, Carl R. (1995), Power Purchasing: Supply Management in the 21st Century. PT Publications, Inc. West Palm Beach.

Grönroos, Christian (2000), Service Management and Marketing: A Customer Relationship Management Approach. 2nd edition. Wiley: Chichester.

Harrison, Terry P., Hau, Lee L., Neale, John J. (2003), The Practice of Supply Chain Management: Where Theory and Application Converge. Kluwer Academic Puplishing. Boston/Dordrecht/London.

Hayes, Bob E. (1992), Measuring Customer Satisfaction: Development and Use of Questionnaires. ASQC Quality Press: Milwaukee, Wisconsin.

Huiskonen, Janne & Kerkkänen Annastiina. (2007). Toimitusketjut ja logistiikka. Lecture material. 60 pp.

Johansson, Pontus and Olhager, Jan (2004), Industrial Service Profiling: Matching Service Offerings and Processes, International Journal of Production Economics, No. 89, pp. 309-320.

Kaplan, Robert, S. & Norton, David, P. (1992). The Balanced Scorecard – Measures that drive performance. Harvard business review, January-February 1992, pp.71-79.

Kaplan, Robert, S. & Norton, David, P. (1996). The balanced scorecard: translating strategy into action. Boston, Harvard Business School Press. 322 s. ISBN 0-87584-651-3.

Kotler, P. (2003), Marketing Management. 11th ed., Pearson Education, New York, NY.

Laitinen, Erkki K. (1998). Yritystoiminnan uudet mittarit. Helsinki, Kauppakaari Oyj, Yrityksen tietokirjat. 360 p.

Lönnqvist, Antti., Mettänen, Paula. (2003). Suorituskyvyn mittaaminen – Tunnusluvut asiantuntijaorganisaation johtamisvälineenä. Helsinki, Edita Prima Oy. pp. 147. ISBN 951-37-3960-0.

Neely, Andy. (1997). Designing performance measures: a structured approach. International Journal of Operations & Production Management, Vol. 17, No 11, pp. 1131-1152.

Ojasalo, Katri (2009), Designing Industrial Services – What is the Role of Customer?, The Business Review, Cambridge, Vol. 14, Num.1, pp.125-131.

Patton, Joseph D. and Feldmann, Herbert C. (1997), Service Parts Handbook. The Solomon Press Publishers. New York.

Peppers, Don and Rogers, Martha (2004), Managing Customer Relationships: A Strategic Framework. New Jersey: Wiley & Sons Inc.

Rantanen, Hannu & Holtari, Jami. (2000). Suorituskyvyn analysointi päijäthämäläisissä pkt-yrityksissä. Lappeenranta, Lappeenrannan teknillinen korkeakoulu, Tuotantotalouden osasto, Tutkimusraportti 120. 33 pp. ISBN 951-764-436-1.

Saccani N., Johansson P., Perona M. (2007), Configuring the After-Sales Service Supply Chain: A Multiple Case Study, Int. J. Production Economics 110, pp, 52-69.

Zeithaml, Valarie A. and Bitner Mary J. (2003), Services Marketing: Integrating Customer Focus Across the Firm. 3rd edition. New York: McGraw-Hill.

Internet References

Outotec (2003)

Available at World Wide Web: URL:

http://www.myoutotec.com/en/About-us/Our-business/ (viewed 9.10.2003)

http://www.myoutotec.com/en/About-us/Our-values/ (viewed 9.10.2003)

Interviews

Delivery planner, Services, 7/2013

Procurement specialist, Services, 9/2013

Procurement manager, Services, 11/2013

Spare parts engineer, Services, 10/2013

Global Demand and Inventory Planner, Services, 3/2014

Outotec internal information and data

IFS Reports