

Aalto University

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Degree Programme in Electronics and Electrical Engineering

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# **Challenges and Development Opportunities of Supply Chain Process in Spare Part Services**

Master's Thesis

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ABSTRACT OF  
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<p>Companies must be able to develop their business processes in order to maintain their competitiveness. Core processes are the activities that relate directly to the product of a company and therefore contribute to the creation of value in the company. A supply chain is a cross-organizational core process that can be managed using process management theories and practises. In today's highly competitive environment, customers are demanding increasingly shorter lead times, supply chain flexibility and real-time tracking possibilities for their orders. This puts huge pressure on the companies to create fast-reactive supply chains that can answer to these customer requirements. In spare part business, the demand can be sporadic and volatile in nature. This makes spare part supply chains especially difficult subjects to manage and control. In spare part business, the fast availability and reliable service are keys to achieving customer satisfaction.</p> <p>The subject of this research was the largest supplier of industrial cranes in the world. The purpose of this study was to recognise the development opportunities in the case unit's supply chain process. The research work was performed by first analysing the current state of the process through the modelling and performance analysis executed on the supply chain process. In addition, the bottlenecks and challenges in the supply chain process were recognized in order to find the optimal development opportunities. The research data in this study was gathered through multiple collection methods including key person interviews, brainstorming with colleagues, unstructured observations and gathering data from the company's business intelligence software in the form of different process performance indicators. The results of this research revealed eight main development opportunities including information flow and sharing practises, documentation and data quality, common working practises, visibility and performance measurement of the whole supply chain, customer communication and cooperation, sourcing and supplier relationship management, claim handling, and motivation and training of employees.</p>			
<b>Keywords:</b>	Supply chain process, Order-to-delivery process, Process Management, Process modelling, Process performance analysis, Spare parts		
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<p>Monen nyky-yrityksen toiminta nojaa prosessiorganisaation toimintaperiaatteisiin, jossa yritys tuottaa asiakkaalleen lisäarvoa toiminto- ja tehtäväsarjoissa eli prosessien kautta. Yrityksen on pystyttävä kehittämään prosessejaan säilyttääkseen kilpailukykyä. Ydinprosessit ovat prosesseja, jotka liittyvät suoraan yrityksen tuotteeseen tai palveluun, ja tuottavat siis suoraa arvoa asiakkaalle. Tilaus-toimitusprosessi on yksi yrityksen ydinprosesseista, joka ulottuu eri organisaatioiden yli. Tilaus-toimitusprosessia voidaan hallita ja kehittää prosessijohtamisen tarjoamien teorioiden ja käytäntöjen avulla. Jatkuvasti kiristyneessä kilpailuympäristössä, asiakkaat vaativat yhä lyhyempiä toimitusaikoja, tilaus-toimitusketjun joustavuutta ja mahdollisuutta tilauksen reaaliaikaiseen seurantaan. Tämä luo painetta yrityksille kehittää nopeasti reagoivia tilaus-toimitusprosesseja, jotka pystyvät vastaamaan asiakkaan kasvaviin tarpeisiin. Varaosaliiketoiminnassa kysyntä voi olla erityisen hajanaista ja vaihtelevaa. Tämä tekee varaosaliiketoiminnan tilaus-toimitusprosesseista erityisen vaikeita hallita. Varaosaliiketoiminnassa pohjan asiakastytytyvyyden saavuttamiselle luo osien nopea saatavuus ja luotettava palvelu.</p>			
<p>Tutkimus tehtiin maailman suurimmalle teollisten nostolaitteiden valmistajalle. Tutkimuksen tavoitteena oli tunnistaa tilaus-toimitusprosessin kehittämismahdollisuudet case-yksikössä. Tutkimus suoritettiin analysoimalla ensin tilaus-toimitusprosessin nykytilaa. Nykytila-analyysi sisälsi tilaus-toimitusprosessin mallintamisen ja suorituskyvyn analysoimisen. Lisäksi tilaus-toimitusprosessin haasteet ja pullonkaulakohtat tunnistettiin optimaalisten kehitysmahdollisuuksien paljastamiseksi. Tutkimuksen aineistonkeruumenetelmiin kuuluivat avainhenkilöiden haastattelut, strukturoimaton havainnointi, keskustelut ja aivoriihet kollegoiden kanssa sekä avainlukujen kerääminen yrityksen tietojärjestelmistä. Tutkimuksessa tunnistettiin kahdeksan potentiaalista kehitysmahdollisuutta liittyen tiedonjakamisen käytäntöihin, dokumetaatioon ja datan laatuun, yhteisiin työtapoihin, toimitusketjun näkyvyyteen ja mittaukseen, asiakasviestintään ja yhteistyöhön, hankintaan ja toimittajien johtamiseen, reklamaatioiden käsittelyyn ja työntekijöiden motivoimiseen ja kouluttamiseen.</p>			
<b>Asiasanat:</b>	Tilaus-toimitusprosessi, Prosessijohtaminen, Prosessien mallintaminen, Prosessien suorituskyvyn arviointi, Varaosat		
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# Table of Contents

Abstract.....	ii
Tiivistelmä .....	iii
Acknowledgements.....	iv
List of Figures.....	viii
List of Tables .....	ix
Abbreviations.....	x
1 Introduction .....	1
1.1 Background .....	2
1.2 Objectives, research questions and scope of research.....	3
1.3 Structure of the thesis.....	4
2 Business process management and development .....	5
2.1 Process, business process and value chain.....	5
2.2 History of business process management .....	8
2.3 Process-based organizations and business process management.....	9
2.4 Process modeling .....	13
2.4.1 Process modelling steps.....	14
2.4.2 Process modelling tools and techniques .....	16
2.5 Process performance and development.....	19
2.5.1 Internal and external performance .....	19
2.5.2 Performance indicators and measurement systems .....	20
2.6 Process development.....	22
3 Spare part supply chain management.....	25
3.1 Supply chain and supply chain management .....	25
3.1.1 Supply chain process and order-to-delivery process .....	27
3.1.2 Order-to-delivery process performance .....	29
3.2 Spare parts.....	30
3.2.1 Spare part logistics.....	31
3.2.2 Developing spare parts logistics strategy.....	32
3.2.3 Spare part classification .....	33

3.2.4	Forecasting methods and inventory management.....	36
4	Company introduction and research design .....	38
4.1	Company introduction: Konecranes Finland Oy.....	38
4.1.1	Konecranes business processes.....	39
4.1.2	Spare part delivery organization: Ports Part Center.....	40
4.2	Research methodology .....	43
4.3	Data collection .....	44
4.4	Data analysis .....	45
5	Results .....	47
5.1	Current state of the order-to-delivery process.....	47
5.1.1	Quotation process .....	49
5.1.2	Sales order process.....	50
5.1.3	Purchasing process.....	51
5.1.4	Warehouse and logistics processes .....	52
5.1.5	Customer support process .....	52
5.2	Current performance of the order-to-delivery process.....	53
5.2.1	Key performance indicators of the order-to-delivery process .....	53
5.2.2	Response time .....	54
5.2.3	Delivery punctuality .....	55
5.2.4	Delivery time .....	57
5.2.5	Delivered on same day.....	58
5.2.6	Fill rate from stock.....	59
5.2.7	Inventory turn .....	59
5.2.8	Other performance indicators .....	60
5.3	Challenges in the order-to-delivery process.....	69
5.4	Suggestions for improving the order-to-delivery process.....	77
5.4.1	Information flow and sharing practices .....	77
5.4.2	Documentation and data quality .....	78
5.4.3	Common working practises and service culture .....	79
5.4.4	Visibility and performance measurement of the whole supply chain	80
5.4.5	Customer communication and cooperation .....	80

5.4.6	Sourcing and supplier relationship management .....	81
5.4.7	Claim handling.....	82
5.4.8	Motivation and training of employees .....	82
6	Discussions .....	84
7	Conclusions .....	88
	References.....	91

## List of Figures

Figure 1: Structure of the thesis .....	4
Figure 2: Model of process modified from Martinsuo & Blomqvist, (2010) .....	6
Figure 3: Value chain of a company (Porter, 1998, p. 37) .....	7
Figure 4: The process management cycle (Hammer, 2015, p. 5) .....	11
Figure 5: Process modelling steps, modified from JUHTA (2012) .....	14
Figure 6: Precision levels of process modelling according to JHS152- recommendation, modified from JUHTA (2012) .....	17
Figure 7: Basic flowchart shapes and model, modified from Martinsuo & Blomqvist (2010). .....	18
Figure 8: The internal and external performance of a company, modified from (Rantanen, 2001) .....	20
Figure 9: Process as a part of process performance system Lecklin, (2002, p. 153) .....	22
Figure 10: The relation between continuous improvement and process reengineering, modified from Hannus (1994, p. 103) .....	23
Figure 11: PDCA cycle modified from Deming (1986) .....	24
Figure 12: A model of supply chain, modified from Chopra & Meindl (2007, p. 5) .....	26
Figure 13: Example of costs incurring in supply chain, modified from Simchi- Levi (2008, p. 2) .....	26
Figure 14: Typical OTD process steps, modified from Christopher, (2011, p. 125) .....	28
Figure 15: Example of lead time variabilities in the OTD process, modified from Christopher (2011, p. 126) .....	28
Figure 16: An integrated approach to spare parts management, modified from Bacchetti & Saccani (2012) .....	33
Figure 17: Four control characteristics for classification of maintenance spare parts. (Huiskonen, 2001) .....	35
Figure 18: Classification of spare parts by Cavalieri et al. (2008) .....	36
Figure 19: Konecranes customer offering (Konecranes, 2014) .....	38
Figure 20: Konecranes business processes, modified from Konecranes (2015) ...	39
Figure 21: Variety of Konecranes port cranes. (Konecranes, 2014) .....	41
Figure 22: Konecranes spare part organization (unofficial), modified from Konecranes presentation (2014) .....	42
Figure 23: Shared operations between PPC and CPC .....	43
Figure 24: The OTD process of PPC (Appendix 2) .....	47
Figure 25: Response time in 2015 .....	55
Figure 26: Delivery punctuality in 2015 .....	56
Figure 27: Average delivery times in 2015 .....	57
Figure 28: Same date deliveries in 2015 .....	58



Figure 29: Fill rate from stock .....	59
Figure 30: Inventory turn in 2015 .....	60
Figure 31: Quotation activity in 2015 .....	61
Figure 32: Order lines and delivery punctuality in 2015 .....	62
Figure 33: Average delay of order lines in 2015 .....	63
Figure 34: Purchase order lines and procurement punctuality in 2015 .....	64
Figure 35: Average supplier delay and lead time in 2015 .....	65
Figure 36: Supplier spend and average lead time of a supplier in 2015 .....	66
Figure 37: Purchase value and the amount of order lines in 2015.....	66
Figure 38: Average delivery time and stock fill rate in 2015 .....	68
Figure 39: Average delivery processing time in 2015 .....	68

## List of Tables

Table 1: Comparison between primary and spare part supply chains modified from Morris, et al. (2006) .....	32
Table 2: OTD process flow.....	48
Table 3: Key performance indicators used in Ports Part Center.....	54
Table 4: Observed challenges in the OTD process.....	69

## **Abbreviations**

BI	Business intelligence
BPM	Business process management
BPR	Business process reengineering
CPC	Crane Part Center
CRM	Customer relationship management
CTO	Configure-to-order
DFS	Delivery-from-stock
EDI	Electronic data interchange
ERP	Enterprise Resource Planning
ETO	Engineer-to-order
IDEF	Integrated definition for function modelling
JIT	Just In Time
KPI	Key performance indicator
MTO	Manufacture to Order
MTS	Manufacture to Stock
OEM	Original Equipment Manufacturer
ORiGO	ERP system implementation program
OTD	process Order-to-delivery process
PDCA	plan–do–check–act
PDM	Product data management
PLM	Product lifecycle management
PPC	Ports Part Center
PPMS	Process performance measurement system
PTO	Purchase-to-Order
SCM	Supply Chain Management
SKU	Stock keeping unit
VMI	Vendor managed inventory

# 1 Introduction

Logistics management can have a vital impact on the achievement of competitive advantage. The supply chain process is one of the company's most crucial core processes. Failing to deliver right goods at the agreed time into the correct place will easily collapse the level of customer satisfaction. Thus, the successful managing of this process is important to any companies, big or small, and is usually a good indicator of business profitability. (Christopher, 2011)

Logistics is often perceived mainly as warehousing and delivering goods to the customer in the companies. Logistics is, in reality, a far more complex concept. Logistics is the coordinating and realizing the flow of things between the point of origin and the point of consumption in order to fill customers' requirements. In addition to managing the material flows, logistics' task is also to manage the information flow and financial flows relating to the supply chain process. (Sakki, 1999, pp. 23-25)

Supply chain process (also referred as an order-to-delivery process in this study) covers all the functions and steps that are needed in order to fill the customer need. Supply chain process starts always from the customer need and ends to the fulfilment of the need. Supply chains process is a cross-organizational process with multiple internal units and also external actors participating in it. Therefore, an optimally working supply chain needs working information sharing practices and a resilient mindset for collaboration. (Sakki, 1999, pp. 23-25; Karrus, 1998, pp. 12-14)

In today's highly competitive environment, customers are demanding increasingly shorter lead times. In addition to shortening lead times, customers expect flexibility and real-time tracking possibilities for their orders. This puts huge pressures on the companies to create fast reactive supply chains with improved chain visibility. Many companies are still facing great difficulties in managing their supply chains. This can result from companies focusing too much on developing separate functions of the supply chain, instead of looking a supply chain as a whole process starting and ending with a customer. Not managing the supply chain process as a complete process flow and failing to recognize the underlying causes behind the challenges, will result in fluctuating delivery times and constant issues in the organization's supply chain process.

The spare part business has additional requirements for organization's supply chain. Especially in spare part business, the delivery times must be kept relatively short and the organization must be capable of answering flexibly to fluctuating demand of parts. In other words, the customer must be able to rely on that they can get the needed part fast enough in order to stay operative. As a result from the dynamic

nature of the spare part business, creating a stable and reliable supply chain is crucial for maintaining a high level of customer satisfaction.

## **1.1 Background**

This research is done for Konecranes Finland Oy. Konecranes is the world's largest supplier of industrial cranes with a large service network and a complete range of lifting equipment (Konecranes, 2011). The spare part business in Konecranes has been growing on a yearly basis. The increasing demand and order volumes are putting a strain on the supply chain process. The motivation for this thesis raised from poor delivery punctuality values in the case unit after the SAP enterprise resource planning (ERP) system was implemented in early 2014. Even though the sales were rising, numerous customer complaints of the long lead times and delays were received and for any supply chain, there is only one source of revenue which is the customer. It was clear that the supply chain process needed to be modelled and analysed in order to understand the reasons behind the declining performance indicators and customer satisfaction.

Finnish companies cannot, in general, compete with prices when comparing for example to Asian businesses but they can commonly compete with service level and quality. Spare part business is a very time-sensitive field of industry. If the customer is experiencing an equipment break-down, their whole operation might be in full stop. Therefore, the lead time of parts is one of the most important factors in spare part business. This factor creates an even greater pressure to develop the supply chain of spare parts operations as efficient as possible. In addition, it has to be taken account that the same developing methods implemented to the primary product's supply chain might not be effective in the actual spare part supply chain because of its special nature.

Customer satisfaction is tightly bound to the successful execution of supply chain process (Heikkilä, 2002). In the case unit, the supply chain process had easily detectable bottlenecks which were causing delays to the process. One of the main ideas of this thesis was to uncover these bottlenecks and also clarify the whole supply chain process to the people participating in it. Uncovering the challenges and bottlenecks was designed to also help with discovering the best development opportunities in the process. The results of this thesis may be used in future for further supply chain development projects in the case company.

## 1.2 Objectives, research questions and scope of research

The purpose of this research is to find development opportunities in the case unit's supply chain process. In order to reach this objective, the supply chain's current state must be investigated through process modelling and current performance analysis. In addition, the challenges and bottlenecks in the process must be recognized in order to identify the optimum development opportunities in the process.

This thesis' main research question is:

*R1: What are the development opportunities in the supply chain process?*

In order to answer the main research question, the following sub-questions need to be clarified:

*R1.1: What is the current supply chain process model?*

*R1.2: What is the current performance of the supply chain process?*

*R1.3: What are the main challenges and bottlenecks in the current supply chain process?*

In addition to answering these questions, this research will go through basics of business process management in the theory chapter. This will give the researcher the tools to understand, model and analyze the supply chain process in the research section. Theory related to supply chain and spare part logistics will be also briefly covered in the theory section in order to gain an understanding of the basic supply chain managing and the specific nature of the spare part business.

The scope of this research is to examine the supply chain process of Ports Part Center (PPC) unit excluding all spare part business in any other Konecranes units. However, because of the shared services (procurement, warehouse and logistics), the Crane Part Center (CPC) is automatically included in the supply chain process and therefore also included in the research.

This research should produce a concrete model of the current supply chain process, a mapping of the current bottlenecks and challenges in the process and a list of recognized development opportunities in the process. All this are designed to give the reader a comprehensive description of the unit's supply chain process and its development opportunities. However, it should be noted that the development opportunities suggested are not executed during this research process but rather serve as an idea pool for future logistic development in the unit.

### 1.3 Structure of the thesis

The thesis will be structured into the following main parts: introduction, literature review, company introduction and research design, results, discussions and conclusions as shown in Figure 1. The first chapter presents the research problem and background of the study. The second chapter covers the recent literature and most important theoretical trends of business process management. The third chapter covers the theoretical background of supply chain process management and spare part logistics. The fourth chapter introduces the case company and describes the research methodology. The fifth chapter represents the findings of the study. The chapters six and seven gather the discussions and conclusions relating to the study.

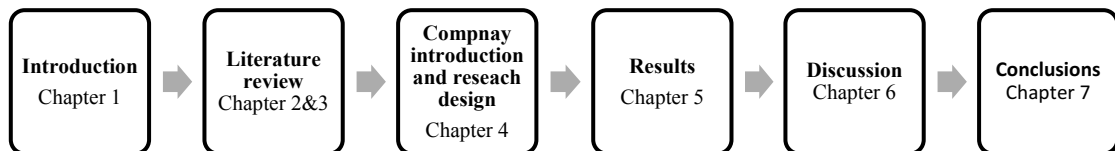


Figure 1: Structure of the thesis

## **2 Business process management and development**

### **2.1 Process, business process and value chain**

The term process can take on a variety of meanings, depending on perspective and field of enquiry (Ahmed & Simintiras, 1996) . The word process itself is used in many connections, such as development process and change process, for describing transformation and progress of subjects (Laamanen, 2001, pp. 19-22). Becker et al. (2003, p. 4) define the process as a logical sequence of activities that have to be executed in order to reach particular goal or result. A process can also be seen as completely closed and limited in relation to time. In other words, a process must have a starting and an ending point and have clearly defined inputs, outputs, and boundaries. A business process is a special type of process that is guided by the business objectives of a company and by the business environment. A business process is the structured activities that produce a specific service or product for a particular customer. In other words, business process has always interfaces to the business partners of the company such as customers and suppliers. (Becker, et al., 2003, p. 4)

According to Davenport and Short (1990) process is a set of logically inter-related tasks performed to achieve a defined business outcome. Business processes have defined outcomes and process activities cut across organizational boundaries. In addition to these characteristics, business processes have also the attribute of adding value (Rockart & Short, 1988) . According to Sakki (1999, p. 19) process can be defined as the integrated chain of actions. Every business process has to have an owner that is responsible for the process planning, actions, and fulfillment of customer needs. Sakki (1999, p. 19) emphasizes that all business processes begin from customer needs and ends in the fulfillment of these needs.

Hammer (2015, p. 4) suggests that there have been two main approaches in defining processes historically. Firstly, a process can be seen as essentially any sequence of work activities. In this approach, an organization can have thousands of processes because every sequence of actions, such as checking customer credit status or packing of products are qualified as individual processes. Secondly, a process can be seen as an end-to-end work across an enterprise that creates customer value. According to this approach, a minor task such as packing of a product, would not qualify as a process itself, but it would be a part of an enterprise process called order fulfilment. The second approach, seeing the process as an end-to-end work, is widely accepted and used in the current business process management field. (Hammer, 2015, pp. 4-5)

Karrus (1998, p. 219) and (Martinsuo & Blomqvist, 2010) list the most essential features of business processes:

- Business process has always a customer(s) , who will receive the predefined outcome
- Customers can exist inside or outside the business organization
- Business process starts and ends at the customer
- Business process transforms inputs into value adding outputs, such as products, services or experiences, through interrelated actions
- Business processes require recourses, such as raw material, labor, and knowledge. Resources can be obtained from inside or outside of the company and spending these resources increases costs.
- Business processes stretch over cross-organizational boundaries and are not dependent on organizational structures
- The performance of business processes is evaluated from the customers point of view

In this thesis, the term process is used as a synonym for the business process from this point forward. The simplified model of the process is represented in Figure 2.

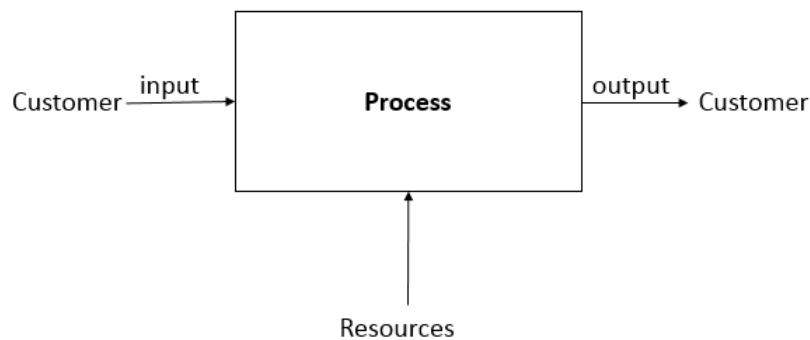


Figure 2: Model of process modified from Martinsuo & Blomqvist, (2010)

In the 1980s, Michael Porter presented his model of the value chain where he divided the activities of a company into primary and supporting activities, see Figure 3. Porter suggested that every company is a collection of activities that are performed to design, produce, market and deliver and support its product and that



all these activities can be described using value chain. According to Porter, activities generate costs and create value for customers, thus, activities are the basic building blocks of competitive advantage and differences between competitors' value chains are a key source of competitive advantage. (Porter, 1998, pp. 36-52)

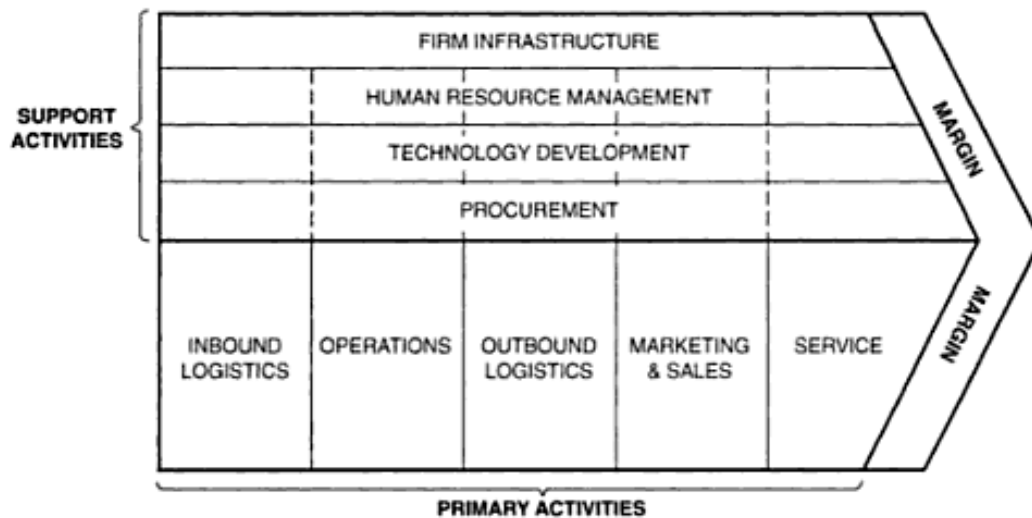


Figure 3: Value chain of a company (Porter, 1998, p. 37)

Primary activities, also called as core processes, are the activities that relate directly to the product of a company and therefore contribute to the creation of value in the company. When a core process is implemented, anything can be added to make the process more efficient, but nothing can be eliminated. The core processes relate to the core competencies of the company which are needed to remain the competitive advantage of the product or service. The core process can also be divided further into sub-processes. Support activities, also called as support or enabling processes, have no direct contact with manufactured products or services but their main function is to support core processes. Support processes enable the core processes execution and value creation. (Becker, et al., 2003, pp. 4-5) (Hannus, 1994, pp. 36-37). The core processes such as OTD process, have a direct influence on the customers and their perception of the performance of the company's product or service. Recognizing the company's core processes is crucial when developing the company because the increase in value creation can happen only through core processes. (Karrus, 1998, pp. 210-212)

## **2.2 History of business process management**

The idea that work can be viewed as a process, and then improved reaches back to the turn of the last century. In the early 20th century, Frederick Taylor and his colleagues developed a new method for improving the manufacturing in their factories through modern industrial engineering and process improvement. This attempt to apply science to the engineering of processes gave birth to management theory called Taylorism (also referred as scientific management) that analyzes and develops workflows in order to improve economic efficiency and labor productivity. (Davenport, 2006) Taylorism is recognized as the first management “model” or “paradigm” and it was widely practiced in the United States until the 1950s. (Pindur, et al., 1995)

The next step forward in process management theories was a combination of Tayloristic process improvement and statistical process control, by Shewart, Deming, Juran and others. Their version of process management was based on measuring and minimizing process variation, the idea of continuous quality improvement and the empowerment of workers to improve their own processes. In Japan, the idea of continuous improvement was well adopted and Toyota, in particular, took these approaches and turned them into a distinctive advance in process management. The Toyota Production System (TPS) consisted of statistical process control with continuous learning by decentralized work teams. However, the rigidity of TPS prevented it from becoming a widely implemented system on a global scale. Nonetheless, the lean method adopted by many firms nowadays is based partly on the less stringent approach of TPS. (Davenport, 2006)

In the 1990s, many of westerns firms were facing difficult economic situations and tough competition, especially from Japanese firms. This led to new variations and approaches of business process management (BPM). Business process reengineering (BPR) was the first process management movement that focused primarily on non-production, white-collar processes such as order management and customer service. (Davenport, 2006) BPR focuses on the analysis and redesign of workflows and business processes within an organization and helps organization fundamentally rethink how they do their work. BPR stretches also to the re-engineering of cross-organizational business processes and uses information technology of enabler of new ways of working. (Hammer, 1990) On the one hand, at least in its early days, reengineering was seen as an episodic rather than an ongoing effort and it lacked the continuous dimension of quality improvement (Hammer, 2015, p. 4).

The most recent enthusiasm in BPM has revolved around process management paradigm Six Sigma, which is an approach created at Motorola in the 1980s and popularized by General Electric in the 1990s. Six Sigma aims to improve the quality of the output of a process by identifying and eliminating defects and reducing variability in business processes. (Davenport, 2006) The Six Sigma approach utilizes a set of quality management methods mainly focusing on statistical process control and measuring process outcomes to isolate the root causes of performance problems (Hammer, 2015, p. 3). Each Six Sigma project within an organization follows a certain sequence of steps and has defined value targets such as reduce process cycle time, reduce costs, increase customer satisfaction, and increase profits. (Davenport, 2006) In recent years, some practitioners have also combined the Six Sigma ideas into lean techniques creating a new methodology called Lean Six Sigma (Harmon, 2015, p. 41).

## **2.3 Process-based organizations and business process management**

The operative environment of organizations is going through a fundamental change. Companies are facing factors such as global competition, digitalization and information network evolution, increased mobility, environmental challenges (e.g. global warming), ever tightening productivity requirements, new patterns in customer purchasing behavior and changes in the age structure. (Laamanen & Tinnilä, 2009, p. 6) Functional organization structure, that emerged from the mindset of the Second Industrial Revolution, has been the dominating organization structure model of companies until to the end of the 1980s (Dumas, et al., 2013, p. 9). In functional organizations, the employees are grouped hierarchically, managed through clear lines of authority, and report ultimately to one top person. In functional organization employees are strictly divided on to units such as procurement, manufacturing, sales and customer service departments, according to their field of specialty and the function that they perform in the organization. Each department will have its own department leader who is responsible for the performance of the section. The communication in functional organization flows vertically inside the departments and the sharing of knowledge between the departments or so-called silos can be slow-moving. The goal of functional organization structure is to maximize labor and cost efficiency within the company. (Laamanen, 2001, p. 15; 133)

Functional organizations are designed to operate in static environments and are generally slow to adapt to changes (Gardner, 2004, p. 18). In today's business world, organizations are forced to quickly adapt to emerging complexity and constant changes in order to survive. Due to these reasons, companies have shifted

more towards process-oriented thinking and horizontal process-based organizational structures. In the process-based organizational structure, managed through business process management (BPM), the emphasis is on flexibility, adaptability and customer needs. By focusing and organizing around core business processes rather than functions, the company establishes a more natural fit between work and structure than the traditional vertical structure can achieve. In addition, the process orientation helps to overcome coordination problems and, ultimately, it delivers the value to a customer, creating a source of the competitive advantage for the company through shorter cycle times, higher product quality and other advancements. (Hernaes, 2008) Sakki (1999, p. 30) and Gardner (2004, p. xii) have listed the following changes that usually occur as the company shifts towards more process oriented thinking:

- Focus from separate functions towards end-to-end cross-organizational processes
- Development of partnership and cooperation with customers and companies outside the organization instead of focusing on intra-organizational factors
- Focus on customer goals instead of localized functional goals
- Performance measurement of process level results instead of departmental efficiency
- Forecasting future developments instead of recording past occurrences

As the companies are shifting towards process-based organizational structure, they need a systematic way to manage the processes. BPM is a management discipline focused on using business processes as a major contributor to achieving an organization's objectives through the improvement, ongoing performance management and governance of essential business processes. BPM requires end-to-end organizational view and continuous maintaining from management. (Jeston & Nelis, 2006, pp. 9-11) Business process management includes the concepts, methods, and techniques to support the design, administration, configuration, performance, and analysis of business processes (Weske, 2007, p. 5). Importantly, BPM is not about improving the way individual activities are performed but rather, it is about managing entire chains of events, activities, and decisions that eventually add value to the organization and its customers (Dumas, et al., 2013, p. 1). The basis of BPM is the systematic representation of business processes with their activities and the execution constraints between them. Definition and modelling of business process, enables the process to be analyzed, improved, and implemented (Weske, 2007, p. 5).

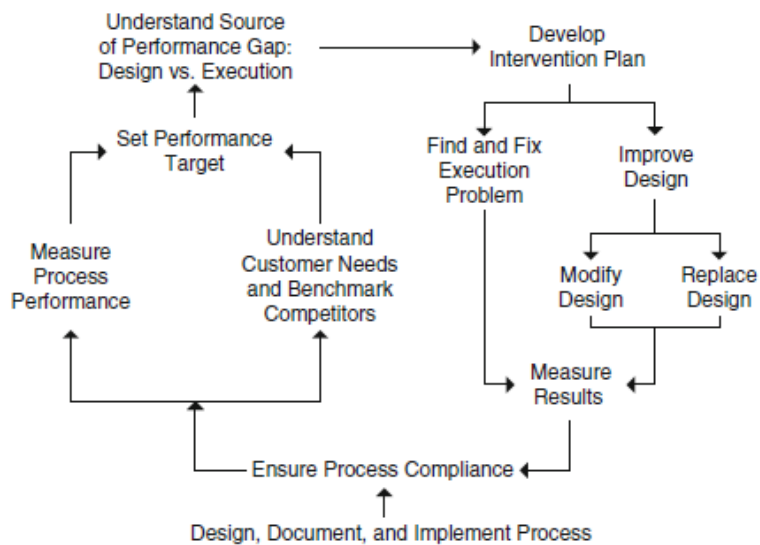


Figure 4: The process management cycle (Hammer, 2015, p. 5)

Figure 4 represents the essential process management cycle. The cycle derives from Deming's PDCA (plan-do-check-act) cycle (Deming, 1986). It begins from the bottom with the creation of a well-defined formal process. Businesses often have operations that seem to be erratic and coincidental in nature. This kind of creative processes such as product development or customer relationship management are often treated each situation as a one-off and unique case and handled with improvisation. However, this kind of processes become more predictable when they are well-defined and documented in the form of a process model. Once the process in hand has been defined and implemented, it needs to be managed on an ongoing basis. (Hammer, 2015, pp. 4-6)

The next step of the BPM cycle is the performance measurement of the process. The process performance needs to be compared to the targets that the process has. The process targets can be based on customer expectations, competitor benchmarks, enterprise needs and other sources that can be measured through the metrics that relate to these aspects. If the process fails to meet the performance targets it's generally either the process design or the execution that is to blame. Faulty process design causes usually pervasive performance shortcomings and bad execution causes occasional difficulties in reaching targets. After the process performance gap is recognized, the problem solving can begin. If the process performance fault lies in the execution of the process, the root cause of the problem such as inadequate training or insufficient resources, must be first recognized. This can be challenging because there can be multiple overlapping reasons that can cause the execution

difficulties. However, once the root cause has been found, it is fairly easy to fix. If the problem is in the design of the process, the root cause is usually easily recognized because it causes constant disruptions, but the fixing of the design is often challenging. In order to fix the process design flaw, the whole structure of the process must be often rethought. Once the suitable intervention has been selected and implemented, the results are then measured and assessed and the entire cycle begins again. (Hammer, 2015, pp. 4-6)

The goals of BPM are good financial results, customer satisfaction, high productivity and employee satisfaction. (Sakki, 2003, p. 29). In addition, BPM provides a better understanding of the operations a company performs and their relationships. The explicit representation of business processes is the core concept to accomplishing this better understanding. Business process models also allow stakeholders to communicate about these processes in an efficient and effective manner. (Weske, 2007, p. 21) Through BPM, a company can create high-performance processes, which operate with much lower costs, faster speeds, greater accuracy, reduced assets, and enhanced flexibility. BPM enables that processes deliver on their promise and operate consistently at the sufficient level. By using BPM, a company can also determine when a process no longer meets its and its customer needs and those of and thus needs to be replaced. BPM also offers a variety of strategic benefits. BPM enables companies to respond better to periods of rapid change because the change is reflected in the decline of operational performance metrics, which are noted by the BPM system and which will consequently affect the design of the processes. (Hammer, 2015, p. 7)

Processes and their management are at the very heart of every organization because they are the means through which companies create value for their customers (Vanhaverbeke & Torremans, 1999). Hammer (2015, p. 6) emphasizes that BPM is an especially customer-centered approach to organizational management because it's deliberate management of the end-to-end business processes through which all customer value is created. The customer is not interested in the internal issues that concern the company management such as strategies, capital structures or organizational design. The customer is only interested in the results that he or she receives from the company, and these results are the outputs of the business processes. (Hammer, 2015, p. 6) Sakki (1999, pp. 29-30) also points out that BPM is thoroughly founded on the customers point of view. Karrus (1998, p. 218) emphasizes that most attention should be focused especially on to those processes that cut through the customer interface because they influence the most on the value experienced by the customer. Daft (2008, p. 115) summarizes that BPM and process-based organization can significantly increase company's flexibility and respond to changes in customer needs because of the enhanced coordination in the

company. Overall, through BPM, the customer's role has evolved from being the necessary evil into being partners in the value-creating network of the company (Laamanen & Tinnilä, 2009, p. 7).

## **2.4 Process modeling**

Process modelling is an activity that produces models that represent particular processes of a firm. Process modelling helps to improve the understanding and analyzing of processes. Business process modelling has been an important practice for companies in the recent years. Companies everyday operations may include hundreds or even thousands of processes that may be formal and documented or informal and exist only as tacit knowledge. Most of the business processes are typically complex, and need to be communicated in a clear way in order to be understood comprehensively (Mohapatra, 2013, pp. 117-118) and only modelled knowledge can be efficiently shared and transferred (Laamanen & Tinnilä, 2009, pp. 69-70). Needless to say, process modelling plays thus a crucial part when companies design and develop how they provide products and services to their customers and organize their internal operations.

Process models can be used for several different purposes. They can be as a starting point for redesigning or optimizing processes, they can be used for sharing knowledge or vision, or they can provide specific instructions for executing business tasks. (Polyvyanyy, et al., 2015, pp. 147-148) Process models can be also harnessed for identifying the weak spots and bottlenecks in the processes (Bandara, et al., 2005) and can help organizations to work with each other by improving the documentation of operations and actions in a company. Process models and descriptions help to develop services, measure results and perform risk and quality assessment. In addition, process modelling can be used to facilitate change in the merging of multiple organizations. (JUHTA, 2012)

Conceptual modelling of business processes can be also deployed on a large scale to assist the development of software that supports the business processes, and to enable the analysis and re-engineering or improvement of them (Aguiler-Saven, 2004). A successfully modelled process generates common mental models inside the organization, which support fluent co-operation throughout the organization (Laamanen & Tinnilä, 2009, p. 70)

### 2.4.1 Process modelling steps

Process modeling is a part of process development and business process management cycle (see Figure 5). In many circumstances, the process modelling starts from the development need of a company. The process modelling steps are described in figure 5.

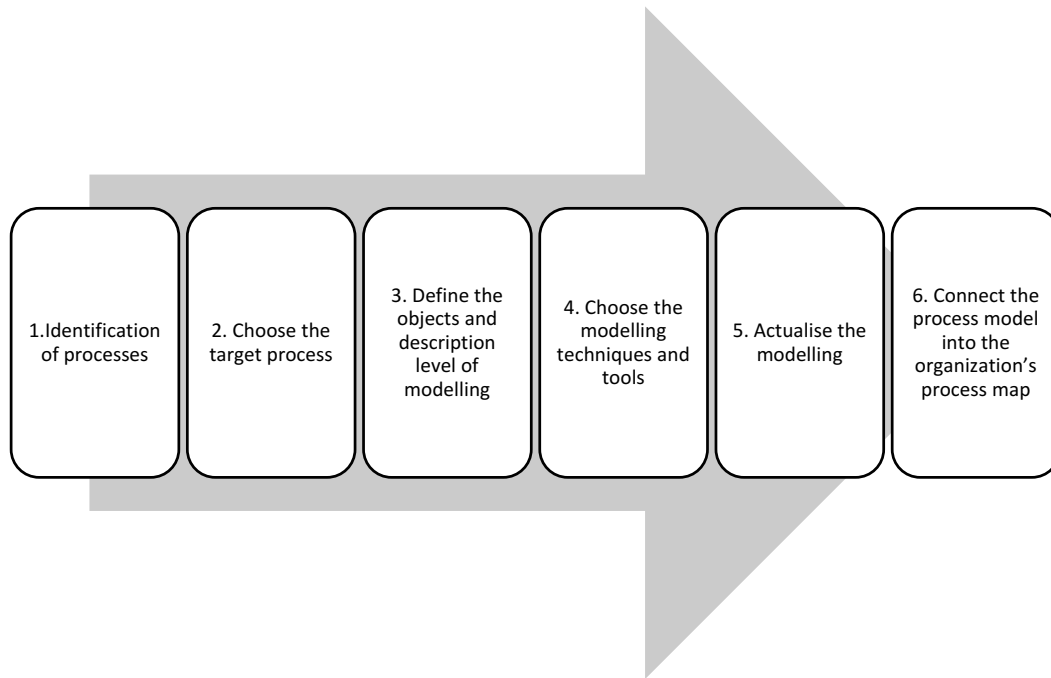


Figure 5: Process modelling steps, modified from JUHTA (2012)

The first step of process modelling is the identification of processes. The start and end points of the process and process owners are defined in the identification phase. The process owner(s) is responsible for the development and functioning of the process. (JUHTA, 2012). Laamanen (2001, p. 52) emphasizes that processes should always start and end to customers (internal or external). In the identification phase the essential function, activities and participants of the processes are recognized. In addition, the process customers, inputs, outputs, resources, linkages to other processes and other important elements such as roles, duration, knowledge, and workflow of the process are listed down provisionally. After the processes have been identified, they should be named and grouped accordingly. The name of the process is an important tool for communicating the object, result and purpose of the process. The named processes can be also grouped in many ways, but the most common way is to divide the processes into core processes, that deliver straight value to the customer, and to the enabling processes



that enable and support the core processes. (Laamanen, 2001, pp. 52-59) In addition, some use a third category called the management processes for the processes, which manage the core and enabling processes (Melão & Pidd, 2000).

The second step in process modelling is choosing the target process for modelling. The modelling of a process must always produce some advantages for the company (JUHTA, 2012). Often the processes that have the most development potential or strategical significance are chosen to be modelled (Laamanen, 2001, p. 83). In this step, it is also useful to double check that the identification has been done thoroughly and the process starts and ends at the customer.

After the target process has been chosen, the next step is to define the objects and description level of modelling. (JUHTA, 2012) The objectives of the modelling can be various such as clarifying the process and its understanding, helping the development and redesigning of the process, gaining a quality standard for the process, , documenting and storing knowledge, improving process benchmarking possibilities helping to pick and develop a suitable software program for the company and identifying the bottlenecks and weaknesses in the process (Becker, et al., 2003, pp. 43-48). The objective of modelling and for what purpose the actual model is used defines the level of precision in modelling. If the process model is for example used to orientate employees to a particular work task, the model must be reasonably accurate. On the other hand, if the model is used to for example to familiarize the management to the company processes at a general level; the model is good to be kept as simple as possible. (JUHTA, 2012) Processes can also be modelled in their current state (As-is modelling) or in their ideal target state (To-be modelling) or somewhere between these states. As-is modelling provides a good description of the current state of the process and its bottlenecks, but can, on the other hand, reinforce the image of the already dysfunctional process. To-be modelling can be an efficient way to visualize the ideal state of the process, but if the model is too radical and too far from the existing process, it can remain too abstract for the viewers to fully comprehend it. (Laamanen, 2001, p. 87; Becker, et al., 2003, pp. 107, 135) Thus, the state that the process to be modelled, should be also decided with consideration in this stage At the latest in this point, a written process description that names the owner(s) and other participants and their main activities and responsibilities should be documented in black and white before moving on to the next step. (JUHTA, 2012)

The fourth step of process modelling is choosing the correct modelling techniques and tools. There are various different graphical process modelling methods and tools represented in the BPM literature such as flow charts, data flow diagrams

(DFD), role activity diagrams (RAD), role interaction diagrams (RID), Gantt charts and the integrated definition for function modelling (IDEF) (Aguiler-Saven, 2004). In addition to graphical models, also written process descriptions are tools that are recommended to use together with the graphical modelling techniques. The most commonly used process model methods and their precision levels are presented in the next chapter. The basic principle in process modelling is that the more precise the processes are modelled the more formal the models get. In this stage, it is also useful to decide how the actual modelling will be performed and where the actual model will be stored (JUHTA, 2012) . After the suitable tools and the methods have been chosen, the actual modelling work can begin. JUHTA (2012) recommends that at least one-page basic process description (the objects of process modelling and critical process information) and process action description (process steps, actions, roles outputs, and inputs) are documented along with the chosen graphical model. Usually, the process owner prepares the written documentations. All of the written documents and the graphical models should complete each other's knowledge and fit together forming a comprehensive description of the process. (JUHTA, 2012)

The last step in the modelling process is the incorporation of the new process model into the organization's high-level process map. This means the process model is positioned to the company's process map in relation with the other processes. This positioning should help to detect the interfaces between the different processes in the organization. A separate process model should always be easily traceable into whole company's process map as well as be linked to other processes. In addition, process models with different description levels should not conflict with each other but rather work as complementary parts in the entity of processes. (JUHTA, 2012)

## **2.4.2 Process modelling tools and techniques**

Process modelling tools have developed rapidly along with the development of information technology. According to Hannus (1994, p. 51) a process modelling tool should:

- Be user-friendly
- Enable easy modelling of knowledge and material flows
- Enable easy modelling of process hierarchy
- Be built to be process-oriented and include key performance metrics
- Enable easy documenting of resources and duration of different process stages
- Enable easy modelling of process gateways and endpoints
- Enables effortless updating of models

Process models commonly include the actual diagram of the process and a written process description that includes the basic data of the process such as name, function, customers, objectives, performance indicators, roles inputs and outputs of the process (Lecklin, 2002, pp. 152-156). The language and methods used for process modelling and descriptions are important to be common and consistent at least inside the organization. Standardized options for process modelling and descriptions are recommended because they enable benchmarking between companies. With common process modelling methods, the company gains synergies because it can easily compare current and future target processes. (JUHTA, 2012)

Graphical presentations of a process can take many forms such as process maps, charts, data flow diagrams (DFD), role activity diagrams (RAD), role interaction diagrams (RID), Gantt charts and the integrated definition for function modelling (IDEF) (Aguiler-Saven, 2004). In addition, the precision level of the modelling can vary and some process model techniques suit better to precise modeling. In Figure 6, is a one outlook to the precision levels of process modelling.

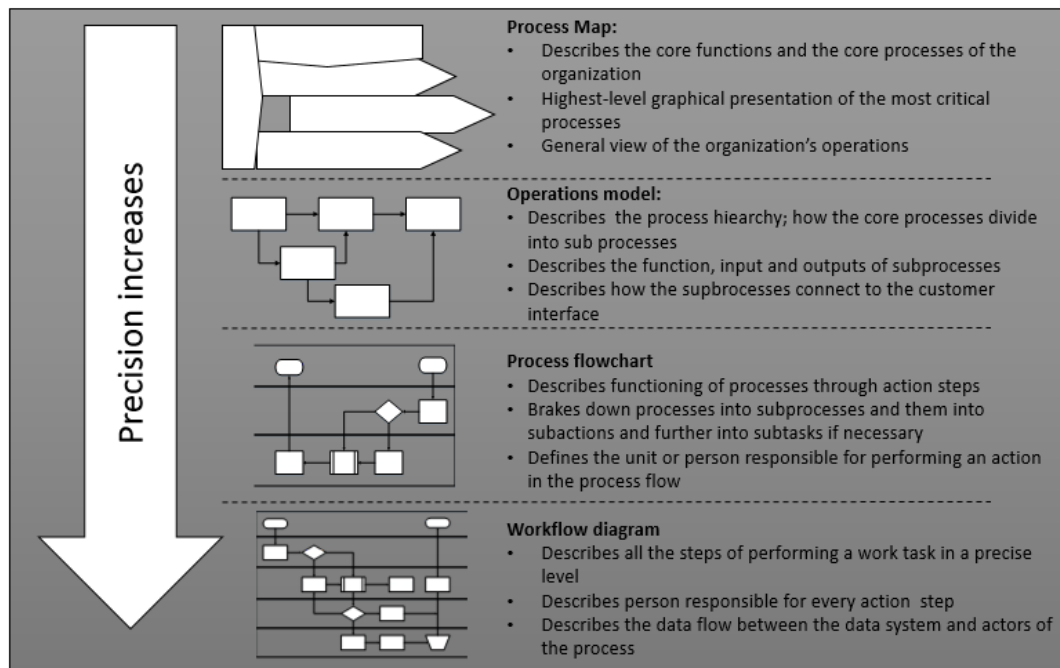


Figure 6: Precision levels of process modelling according to JHS152-recommendation, modified from JUHTA (2012)

A process map is a common way to model processes in a high-level. The term process map implies to a graphical presentation of the key processes in a business and the relationships between them. A process map is a comprehensive level presentation of the business model and revenue logic of the organizations. A process map can contain information about the vision of the organization, along with customer process, and core and support processes (Laamanen & Tinnilä, 2009, p. 126) Another very commonly used process model is a flowchart. A Flowchart is a formalized graphic presentation of a work or manufacturing process, organization chart, an algorithm or similar systematic structure. Flowchart uses graphical symbols that represent steps as boxes of various kinds, and their order by connecting them with arrows. (Aguiler-Saven, 2004) Figure 7 characterizes the basic flowchart symbol and a simple flowchart model.

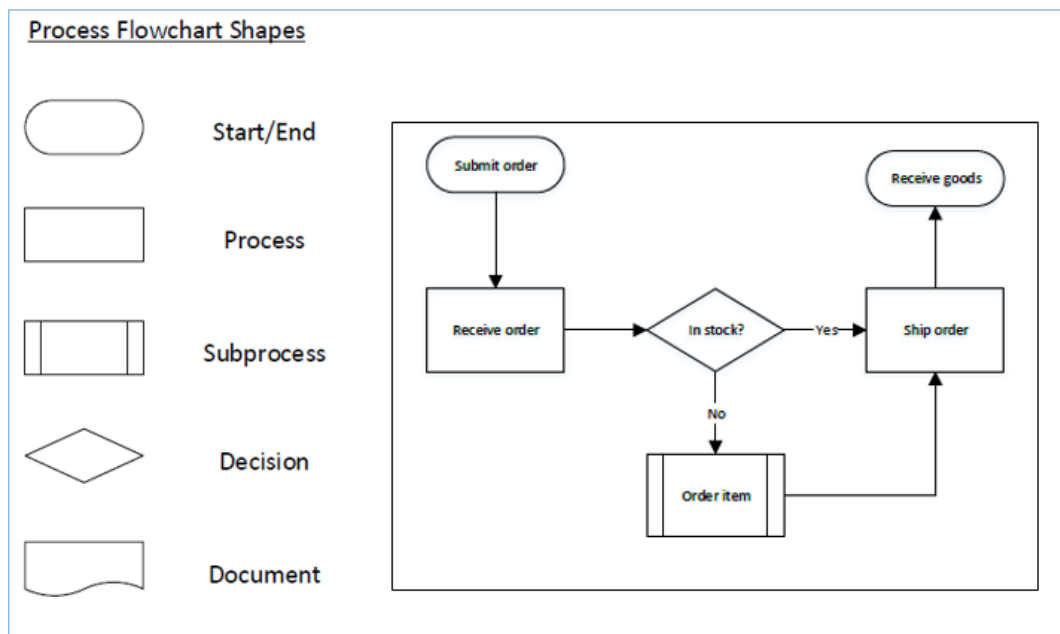


Figure 7: Basic flowchart shapes and model, modified from Martinsuo & Blomqvist (2010).

The flowchart modelling method uses flowcharts to describe processes and the method is utilized in analyzing, designing, documenting or managing a process or program in various fields. Flowchart method is very flexible because it includes certain standard building blocks but the rest lies in the designer's hands. Flowcharts are also easy to use and learn as a method. The weakness of the flowchart method is that the chart becomes easily too large and hard to navigate. On the other hand, the flowchart model enables the easy detection of bottlenecks and inefficiencies in the process, which can be then streamlined. Overall, the flowchart is a good method for dealing with processes that need a high level of detail. On the contrary, it is not

a very efficient method for giving an overview. (Aguiler-Saven, 2004) In this thesis, the processes are modelled using a swim lane chart, which is a particular form of a flowchart. In swim lane chart, every process actor is given their own swim lane where the process steps they perform are described. Swim lane method helps to describe the process roles and their responsibilities. (Martinsuo & Blomqvist, 2010)

## **2.5 Process performance and development**

### **2.5.1 Internal and external performance**

The goal of any business is to attain the best possible result with the resources available. When the results are not satisfying, the organization must start to develop its operations. In order to develop and improve, the company must know how to measure the performance of its current operations. Usually, the performance of an operation is measured using a certain set of quantitative indicators. Traditional financial performance indicators may not be always sufficient for the needs of process management and new indicators must be developed in order to measure the performance throughout the whole process. (Sakki, 1999, p. 41)

According to Laitinen, (1998, p. 279) performance can be defined as the company's capability to deliver outputs with the available resources in relation to the targets set. Measuring this performance can be described as the process of quantifying effectiveness and efficiency of action (Chan & Qi, 2003). Performance measurement helps to bring more scientific analysis into companies and diminishes the effect of experience and judgment into the decision-making process. (Rezaei & Baalousha, 2011) A company drives to satisfy the needs of its owners and other stakeholders with its operations. Many researchers (Laitinen, 1998; Sakki, 1999; Hannus, 1994; Lynch & Cross, 1995; Keegan, et al., 1989) divide performance of a company into two categories: internal and external performance. When a company is viewed from the inside and the performance measurement is concentrated on the processes of a company, internal performance is being assessed. Internal performance measures are used to observe and assess the internal operation of an organization. Most commonly used internal performance metrics relate to productivity, operational performance, and cost efficiency. Internal performance measurement is usually performed by a company itself because it has a wider access to company's internal information than any other external party. In external performance measurement, the company is viewed from outside, as a whole, through the customers and shareholders eyes. External performance measures are used to evaluate an organization's performance in terms of its externally observable outputs such as profitability, liquidity, and competitiveness. External performance measurement can be executed by many parties. The division between the internal and external metrics in performance measurements is flexible and many metrics can

be viewed through both viewpoints. For example, return on investment can be seen as internal metrics when measured from one single department but also as external metrics when measured from the whole company. (Rantanen, 2001) The internal and external performance of a company is illustrated in figure 8.

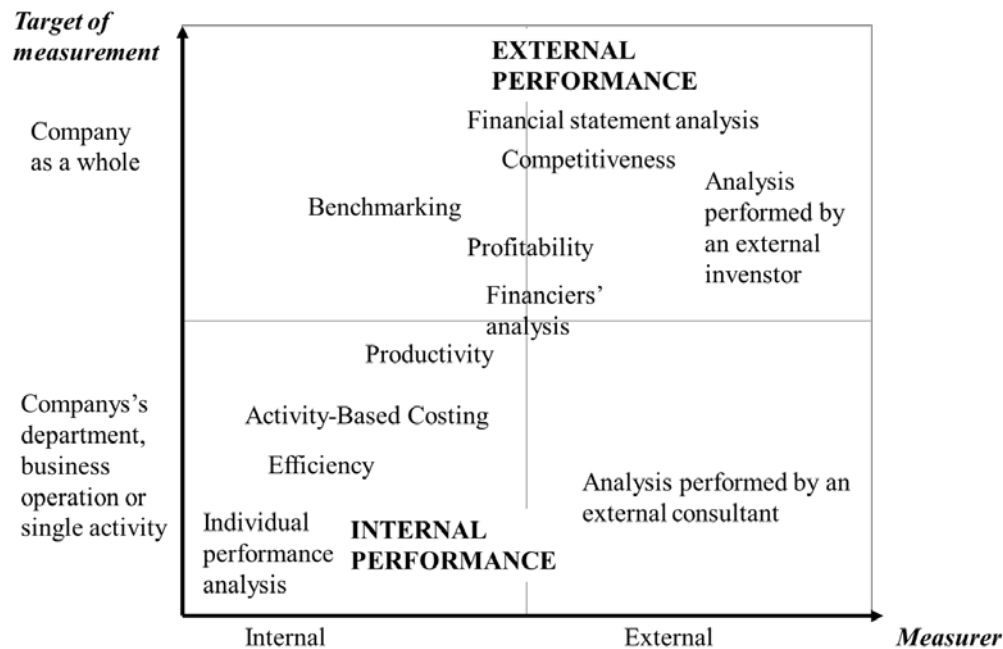


Figure 8: The internal and external performance of a company, modified from (Rantanen, 2001)

## 2.5.2 Performance indicators and measurement systems

In order to be able to measure, control and manage processes it is necessary to define suitable process performance indicators. Cost, time and quality are the three performance indicators that are used in varying forms in most companies. (Kueng, 2000). In order to recognize suitable performance indicators, the company must first understand its customer needs (Laamanen, 2001, p. 150). Lecklin (2002, p. 173) and Kueng (2000) mention following requirements for a good process performance indicator:

- **Quantifiability:** If the indicator is not quantitative in nature, there has to be a possibility to transform it to one. For instance, customer dissatisfaction could be transformed into a number of complaints received.
- **Sensitivity:** Indicator has to react to small changes in the performance in order to pick up early warning signs.
- **Linearity:** Indicator values must follow congruently the changes in performance.

- Reliability: Indicator must be free from measurement errors and results must be consistent.
- Efficiency: Indicator must be cost-beneficial.
- Improvement-oriented: Indicator should emphasize improvement rather than conformity with instructions.
- Comprehensible: Indicator must be easy to understand and adopt to use.

Instead of using individual performance indicators, the company can also choose from multiple performance measurement systems developed in the management literature. A performance measurement system is a balanced and dynamic framework and tool that supports the decision-making process by gathering, elaborating and analyzing information. (Garengo, et al., 2005) The most well-known performance measurement frameworks are Kaplan's and Norton's balanced scorecard (1992), performance measurement matrix by Keegan et al. (1989), Lynch and Cross's performance pyramid (1995) and service performance framework by Fitzgerald et al. (1991).

Particularly, when measuring process performance, it is crucial to know if the current process performance is better than before. The process performance measurement system (PPMS) is an information system that gathers, through a set of indicators, performance relevant data of one or several processes compares the current values against past and target values and disseminates the results to the process actors. The main objective of PPMS is to provide comprehensive and relevant information on the performance of business processes. This information enables easy communication of current performance and goals to the process team. The data can be also used improving resource allocation and process output regarding quantity and quality, finding early warning signals of process failure, diagnosing for weak spots and bottlenecks in the process and deciding whether corrective actions are needed. (Kueng, 2000) The basic concept of PPMS is presented in Figure 9.

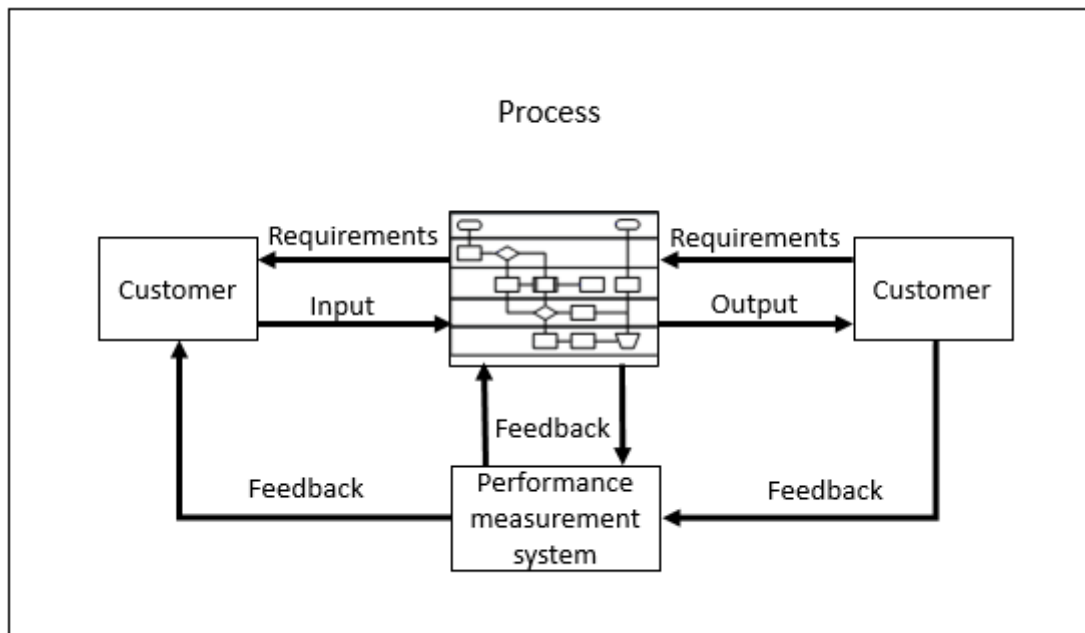


Figure 9: Process as a part of process performance system Lecklin, (2002, p. 153)

## 2.6 Process development

As already discussed, the nature of process development can be continuous improvement or periodic re-engineering or something in between. Continuous improvement is suitable for environments that change slowly, staff is engaged to the change (bottom-up) and competitor's actions are predictable. Process re-engineering is a good method if the environment is in a rapid state of change, competitors are fast and aggressive and upper management is the change catalyst (top-down). Radical changes cannot be pushed through very often without the risk of employee dissatisfaction and exhaustion. Thus, usually, the most effective way to develop process is in cycles in which continuous improvement and process reengineering fluctuate periodically, see Figure 10 for clarification. (Hannus, 1994, pp. 103-105).



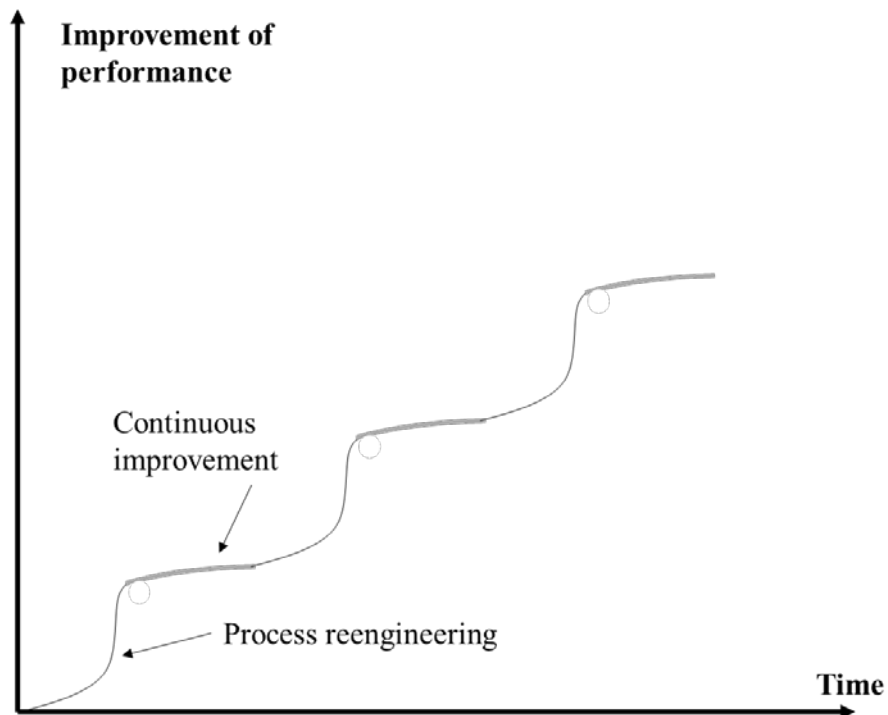


Figure 10: The relation between continuous improvement and process reengineering, modified from Hannus (1994, p. 103)

There are various different frameworks, tools, and techniques developed for process development. However, all of these include process modelling, measuring, analyzing and solution testing in some form. All of these phases can be seen also in Deming's PDCA cycle, in Figure 11, which is one of the most known representations of process development framework.

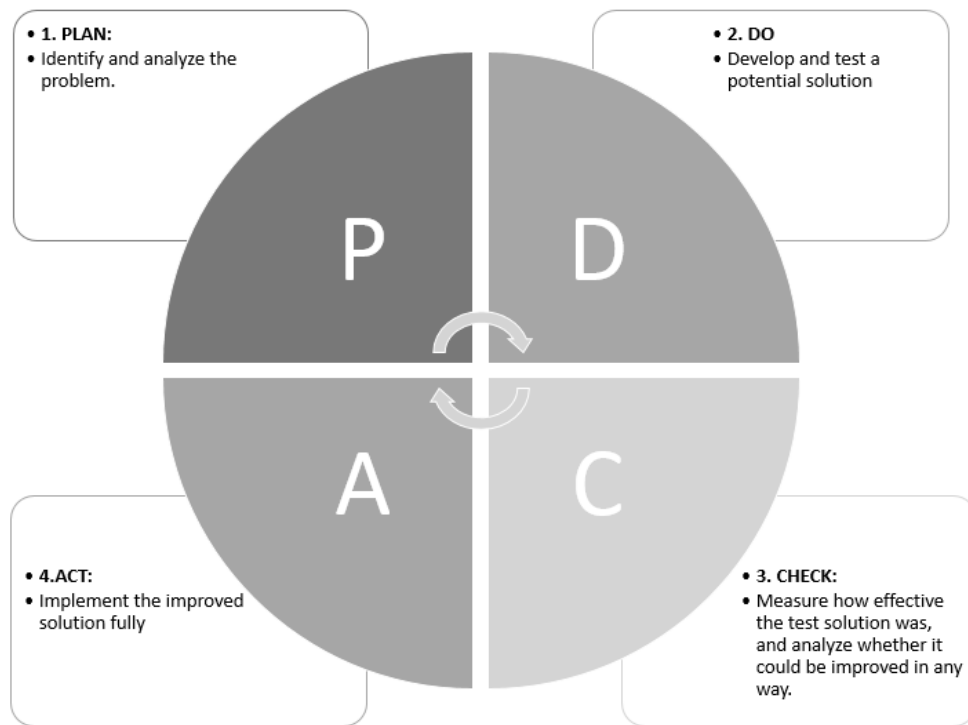


Figure 11: PDCA cycle modified from Deming (1986)

In process development, developers must always also consider the customer's point of view. Laamanen (2001, p. 226) lists the most important principles of process development:

1. Remember that the result of process development must add customer value
2. Outsource the activities that are not essential to the core business
3. Measure process performance and reduce dispersion
4. Reduce lead-time
5. Simplify operations
6. Add flexibility and visibility
7. Exploit new techniques and information systems
8. Perform benchmarking
9. Manage processes as starting from customer and ending to customer
10. Encourage to develop and give positive feedback on good results

All in all, process development is always related to change which can lead to improvement or deterioration of the situation. Developers must choose the correct method and tools to support the change and monitor the impacts the changes are causing in the process, not forgetting the people that are going through it. (Laamanen, 2001, pp. 201-205)

### **3 Spare part supply chain management**

This chapter covers the basic topics relating to supply chains and supply chain performance. In addition, some parts of spare part logistics literature are discussed in order to clarify the nature of the after-sales business. For a reader, it is important to understand that the nature of spare part and aftersales business differs fundamentally from the manufacturing of primary parts. Therefore, the principles used in the supply chain management of primary parts, do not always apply to or at least do not produce efficient results in the case of spare parts.

Some of the focus in this chapter is also in the literature covering the developing of spare part logistic strategy and spare part classification. The purpose of this chapter is to describe the characteristics and challenges specific to spare part business and to spare part logistics and identify ways of overcoming these challenges and constructing efficient logistic strategies for spare parts operations.

#### **3.1 Supply chain and supply chain management**

As a result of the tightening competition, products with short life cycles and increased customer expectations in the global markets, supply chains have become an important focus point for companies all over the world. Development of communication and transportation technologies has enabled a fast evolution of supply chain and its management. (Simchi-Levi, et al., 2008, p. 1) Through the growing interest towards supply chains and supply chain management (SCM), the amount and variety of definitions and terminology concerning the subject have increased considerably (Tan, 2001).

According to Chopra and Meindl (2007, pp. 3-5), a supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer need. The supply chain includes manufacturers, suppliers, transporters, warehouses, retailers and even customers themselves (see figure 12). The primary purpose of a supply chain is to satisfy customer needs and generate value for the customer and at the same time create profit. The value generated in the supply chain is the difference between the product's worth to the customer and the cost of the supply chain filling the customer's request. A constant flow of material, information and funds are occurring between the different stages of a supply chain. (Chopra & Meindl, 2007, pp. 3-5) The Material flow consists of raw materials and products moving in the supply chain. At the beginning of material flow are the suppliers and at the end is the customer receiving the products. Information flow is all the information that moves in the supply chain for example questions from the purchaser to the supplier or order confirmations send to the customer. The flow of funds is the all the assets that move within the supply chain such as customer paying the goods to the distributor. (Sakki, 1999, pp. 24-25) These flows can occur in both direction and

form a network of actors, thus, the term supply network can be also used in describing a supply chain (Chopra & Meindl, 2007, p. 3).

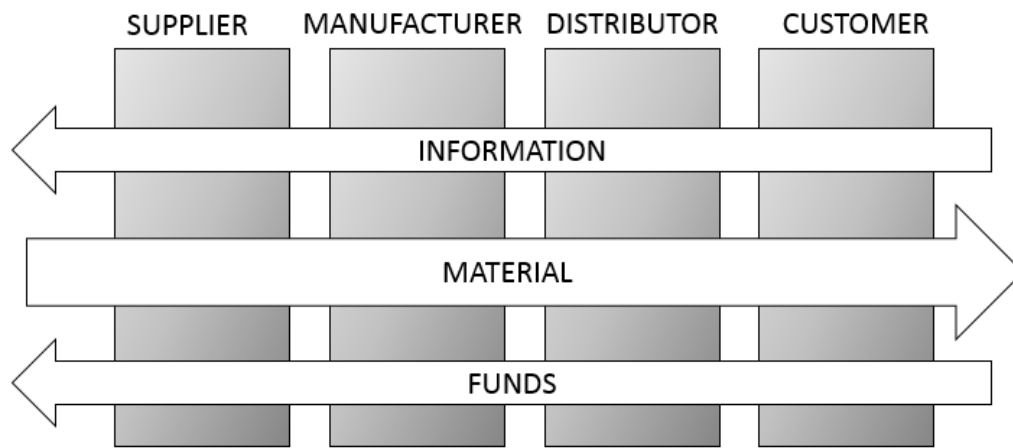


Figure 12: A model of supply chain, modified from Chopra & Meindl (2007, p. 5)

According to Simchi-Levi et al. (2008, pp. 1-2) a supply chain consists of suppliers, manufacturing centers, warehouses, distribution centers, retail outlets, raw materials, work-in-process inventories, and finished products that flow between the listed facilities (see figure 13). A supply chain can be also referred as a logistic network where the chain forms a network of organizations through upstream and downstream linkages which produce value to the customer in the form of supplied product and services. An efficient supply chain creates value but also incurs costs such as material, transportation and inventory costs to the organizations in the chain.

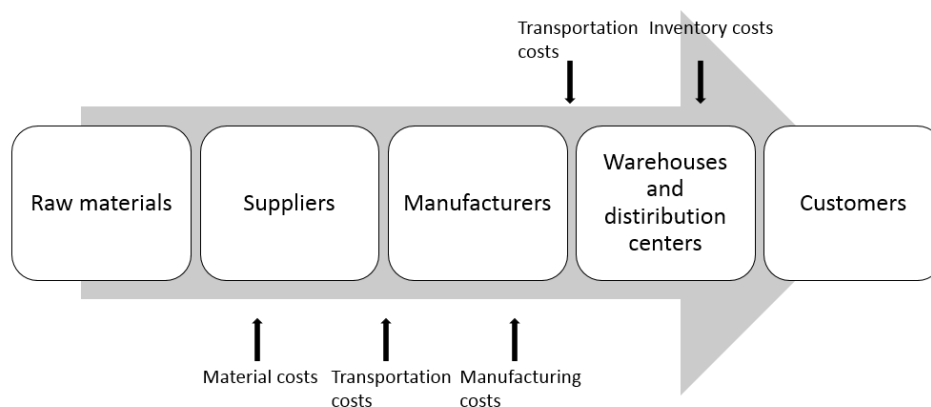


Figure 13: Example of costs incurring in supply chain, modified from Simchi-Levi (2008, p. 2)

As all flow of information, material or funds generates costs in the supply chain, the management of these flows is essential for a supply chain success. SCM involves managing of the supply chain assets and information, material and fund flow to maximize the profitability of the supply chain. (Chopra & Meindl, 2007, p. 6) Global Supply Chain Forum defines SCM as the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders (Lambert & Cooper, 2000).

Christopher (2011, p. 3) defines SCM as the management of upstream and downstream relationships with suppliers and customer in order to deliver superior customer value at less cost to the supply chain as a whole. Thus, the focus is in the SCM is in the management of relationships in order to increase the profits for all parties in the chain. (Christopher, 2011, p. 3) This is related to the business management paradigm, that businesses do not no longer compete as solely individual businesses but rather as integrated supply chains. The ultimate success of a single business relies on company's ability to manage its intricate network of business relationships. Ultimately, SCM is seen as a new way of managing the business and its relationships. (Lambert & Cooper, 2000)

### **3.1.1 Supply chain process and order-to-delivery process**

A process is a specific set of activities across time and place, with a beginning, an end, clearly identified inputs and outputs, and a structure for action. A supply chain process is the actual physical business functions, institutions, and operations that characterize the way a particular supply chain moves products and services to market through the supply pipeline. (Ross, 1998) The Order-to-delivery (OTD) process (also referred as an order-to-delivery cycle in literature) is a process that starts with the recognition of a need to order and ends when the delivery of goods is made available for use. The process starts and ends at the customer. (Forslund, et al., 2008) In this research, the supply chain process and OTD process terms are interchangeable. From this point forward, the OTD process term is used because it depicts the researched case process best.

The OTD process has at least three actors which are the supplier, the customer, and the logistic service provider. The four major sub-process of the OTD process are the following:

1. The ordering process starts when a customer recognises a need and ends when a purchase order reaches a supplier.
2. The delivery process starts when the supplier receives the customer's order and ends when the goods are available to ship.

3. The transportation process starts when the goods are available for pickup and ends when the goods are unloaded in the customer's premises
4. The goods receipt process starts when the ordered goods are received and ending when the goods are made available for use. (Forslund, et al., 2008)

Lead time is the latency time between the beginning and execution of a process. The order lead time is the time elapsed from the placement of an order to the delivery of the order. Short lead times are a major source of competitive advantage in today's fast-paced service markets. Another important factor is the reliability of the lead times. The failure to deliver the goods in confirmed time frame affects customer satisfaction profoundly. The OTD process comprises of multiple process steps (Christopher, 2011, pp. 124-126) Please see Figure 14 for most typical OTD process steps.



Figure 14: Typical OTD process steps, modified from Christopher, (2011, p. 125)

Every of these steps consumes variable amount of time. Because of bottlenecks, fluctuations in the volume of orders and inefficient execution of the process, considerable variation may be caused to lead time (see Figure 15). This may, consequently, cause a substantial reduction in the reliability of delivery. (Christopher, 2011, pp. 125-126)

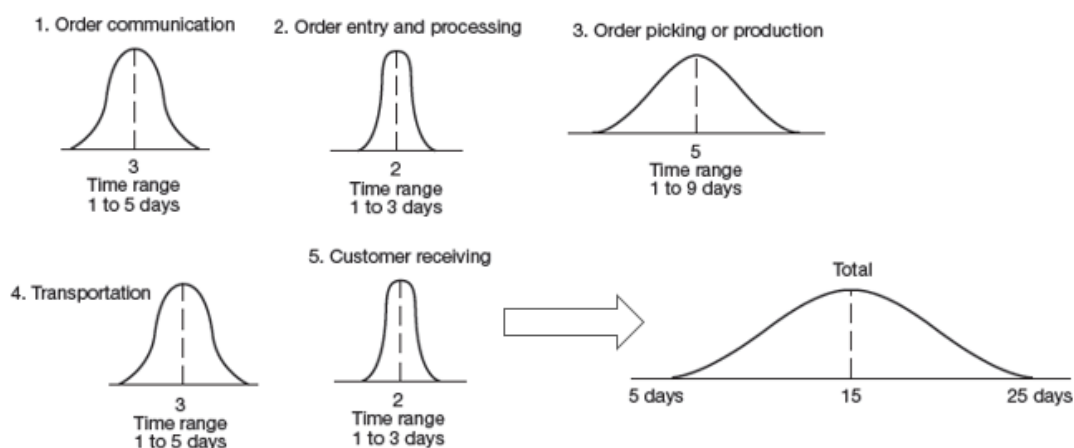


Figure 15: Example of lead time variabilities in the OTD process, modified from Christopher (2011, p. 126)

### **3.1.2 Order-to-delivery process performance**

There are a vast amount of metrics that can be used to measure OTD process performance. These metrics can be grouped into financial costs, quality, time, innovativeness and flexibility measurements. (Shepherd & Gunter, 2006) In accounting, costs are defined as the capital spent to acquire a raw material, a product, or a service. Costs are one of the effective ways to evaluate the performance of an OTD process. The most common measures of costs in the OTD process are distribution costs, manufacturing costs, inventory costs and information processing costs. (Elrod, et al., 2013)

Quality is a crucial measure for the OTD process performance. Quality can be defined as the perception that the product or service meets the customer's demand. Or in other words, quality is the customers' perception of the value of the suppliers' work output. The most important quality metrics are perceived value of the product or service, buyer-supplier relationship, shipment errors, accuracy and the number of faulty invoices. (Elrod, et al., 2013)

Time is essential for performance measurement. Most typical time-related measures are order lead time, manufacturing lead time, product lateness time, average lateness time and customer order path time. As earlier defined, the order lead time is the time elapsed from the placement of an order to the delivery of the order. Manufacture lead time is total time required to manufacture an item, including order preparation time, queue time, setup time, run time, move time, inspection time, and put-away time. Product lateness time is the time difference between the actual delivery date and the confirmed delivery date. Average lateness time is the average delay of all products. Customer order path is all the stages from a raw material to finished product. Customer order path time identifies separately the time taken at each step in the production process. (Elrod, et al., 2013) All in all, time is very important in supply chain performance. A lengthy logistics pipeline means more inventory costs which will reflect on to the product price. Also, a long lead time means a slower response to customer requirements which together with the high product prices decline customer satisfaction greatly. (Christopher, 2011, pp. 133-136)

Innovativeness is the firm's willingness and ability to change old procedures, technologies or work practises to new improved ones. Innovativeness in supply chains facilitates developments in information and related technologies with new operational procedures to improve efficiency and improve service effectiveness, Company's supply chain innovativeness can be difficult to measure in practise but for example, a measure such as the number of development projects on supply chain per year can be used to evaluate innovativeness in a company. (Panayides & Venus Lun, 2009)

Flexibility can be defined as the company's ability to adapt to change. The changes can be any kind of situations such as rapid increase in demand, machine breakdown or even a strike. Common measures of flexibility are plant volume flexibility, delivery flexibility, labour flexibility, modification flexibility, and expansion flexibility. Plant volume flexibility evaluates the company's ability to change the volume of products produced, depending on demand. Delivery flexibility measure assesses the company's ability to answer to sudden changes in the delivery schedule such as a customer asking for an urgent delivery. Labour flexibility assesses the number of work task an employee can perform. A flexible employee is capable of performing many processes at a company which is beneficial for the company. Modification flexibility evaluates the company's ability to modify a product or a product line according to customer wishes without incurring high costs. Expansion flexibility assesses the company's capability to expand the company in case of rapid growth. (Elrod, et al., 2013)

Overall, even though there are many individual metrics developed to measure the supply chain performance it's important to remember that a supply chain should be always managed as a whole. Failing to recognize and manage the supply chain as an integrated system will usually lead to situations that considerable periods of time are consumed at the interfaces between adjacent stages in the total process and in inefficiently performed procedures. (Christopher, 2011, p. 133)

### **3.2 Spare parts**

Gopalakrishnan & Banerji (2013, p. 257) define spare parts as parts that are identical to the part of a machine which needs replacement due to wear and tear during the operating life of the equipment. Patton & Feldmann (1997, p. 26) define spare parts as components that can be completely interchangeable with corresponding items installed or in use, and can be used to replace items during maintenance. According to Luksch (2014), a spare part can be an original part that is either produced by the original equipment manufacturer (OEM) or that can be produced by a separate supplier who has the recourses for the manufacturing.

Primary products are the products that have been originally sold to a customer by a company and are different from replacement parts. Spare parts are required when a segment of the primary product breaks. (DHL, 2008) The function of spare parts is to secure or re-establish the operability of primary products. In other words, spare parts are only demanded after the primary products have been sold to the customer (Wagner, et al., 2012). The primary product can be for example a car or a washing machine and an equivalent spare part a wearing electrical part in the car or in the washing machine. (Herrmann, et al., 2007) Primary or the so-called main products are the templates for spare parts (Wagner, et al., 2012). Spare parts are predominantly designed and manufactured along with the primary product (Inderfurth & Mukherjee, 2008). Specific characteristics of spare part supply and



provisioning should be considered in the early stages of primary product development because the decisions made regarding the primary product will predetermine spare part strategy options available in the later phases. In other words, late modifications and adjustments of spares that differ from the design and specifications of the primary product are expensive and difficult to execute, and thus, spare parts features should always be kept in mind when developing the primary product. (Wagner, et al., 2012)

### **3.2.1 Spare part logistics**

Spare part logistics contains the planning, design, realization and control of the spare part supply and distribution. The concept of spare part logistics includes also the associated information and funds flows within a firm and between its network partners in the supply and distribution processes. The aim of spare part logistic is to ensure the optimal level of availability or reliability of the primary product through the demand-driven and cost-minimal provision of the required spare part that enables smooth-running defective or preventive maintenance of the primary product. Spare part customers demand service and long-time availability of spare parts through the whole product lifecycle of the primary product. (Wagner, et al., 2012) Availability of spare parts is often also an important factor that creates a competitive advantage for original equipment manufacturers (OEMs). However, the demand for spare parts is often sporadic and volatile which makes the forecasting of demand challenging for businesses (Wagner, et al., 2012).

Well-aligned and implemented spare part logistics can enable businesses to lower costs, increase revenues and differentiate a business from its competitors. Strategically aligned spare part logistics can also help the firm to generate greater value for their customers which leads to greater profits. (Wagner, et al., 2012) The requirements for planning of spare part logistics differ from planning of primary product logistics in many ways: service level and requirements are usually high, the demand for parts is volatile and fluctuating making it difficult to forecast, the prices of individual products may be high and stockouts can lead to substantial financial losses (Huiskonen, 2001). In Table 1, the typical characteristics of a primary part supply chain and a spare part supply chain are compared.

Table 1: Comparison between primary and spare part supply chains modified from Morris, et al. (2006)

Parameter	Primary part supply chain	Spare part supply chain
Nature of demand	Predictable can be forecasted	Unpredictable, sporadic
Required response	Standard, can be scheduled	Immediate (same or next day)
Number of stock keeping units	Limited	15 to 20 times more
Product portfolio	Largely homogenous	Always heterogeneous
Inventory management aim	Maximize velocity of resources	Provide for possible demand
Reverse logistics	Doesn't handle	Handles return, repair, and disposal of failed components
Performance metric	Fill rate	Spare part availability
Inventory turns	Six to 50 times a year	One to four a year

### 3.2.2 Developing spare parts logistics strategy

Companies with a well aligned spare parts logistics strategy can add value for their customers beyond primary product benefits, consequently building long-term customer loyalty and achieving high-profit margins (Wagner, et al., 2012). Alignment is the adjustment of an object relation to other objects leading to optimization of the results (Nadler & Tushman, 1980). Aligning an organization to it to its external environment requires forethought and planning. Strategic alignment recognizes the need for any strategy to take account both external and internal conditions. Spare part logistic strategy should be aligned not only with corporate strategy but also with company-specific and environmental factors in order to achieve optimal results. (Wagner, et al., 2012)

Shrinking material and time buffers in supply chains create a pressure for streamlining the logistics systems of spare parts (Huiskonen, 2001). Development of spare parts logistics strategy requires usually long-term decision making in businesses. Thorough knowledge and analysis of strategy components of spare parts logistics is essential in the development process. It is essential to take account all the different phases of the primary product life cycle and firm's specific situation in order to develop a well-aligned spare part logistic strategy. (Wagner, et al., 2012)

An approach for developing spare part logistics and its strategy is presented in the article "Spare parts classification and demand forecasting for stock control: Investigating the gap between research and practice" by Bacchetti and Saccani (2012) (see figure 16).

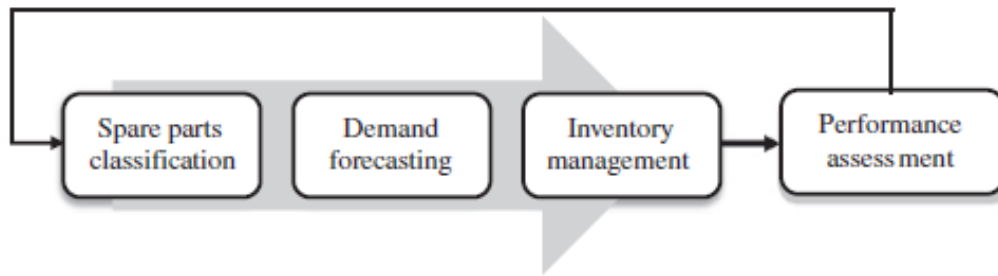


Figure 16: An integrated approach to spare parts management, modified from Bacchetti & Saccani (2012)

The integrated perspective emphasizes the relation between the steps of spare parts classification, demand forecasting, and inventory management, and the subsequent performance measurement. When moving forward on the steps, the decisions on these aspects should be made with a systemic perspective and with a differentiated approach. In practice, this means that the type of the part (according to the classification step) affects also to the selection of demand and inventory management techniques that are decided on the subsequent steps. In other words, decisions made in the previous step of the process will always affect the decisions made in the next step. (Bacchetti & Saccani, 2012)

### 3.2.3 Spare part classification

There are many different spare part categorization criteria and classification methods suggested in the scientific literature, for example, see the list of Bacchetti and Saccani (2012). A proper classification of spare parts is needed because parts vary greatly in technical and economical features (criticality, specificity, value, type of suppliers, etc.) which affects to the establishment of correct stocking policy (Cavalieri, et al., 2008). The most popular criteria for classifying spare parts are associated with part cost and part criticality. Other commonly used criteria are demand volume, value and variability and supply characteristics such as replenishment lead time, supplier availability and risk of non-supply. (Bacchetti & Saccani, 2012)

Huiskonen (2001) proposes four control characteristics for classification of maintenance spare parts: criticality, specificity, demand pattern and value of parts (see Figure 17). Criticality of an item is related to the impact that a part failure would have on the process. Theoretically, criticality level of a part could be estimated from the downtime costs of the process. In practice, parts are usually divided into few classes of criticality based on the time and costs that the failure of that part could be tolerated. (Huiskonen, 2001) The VED classification system divides spare parts into Vital, Essential and Desirable criticality classes from the point of view of their functional necessity in production and maintenance

operations. Vital spares include the most critical items to equipment functionality in case of a part failure. Stock-out of a critical spare can cause great losses by preventing the function of equipment needing the spare. Essential spares are fairly critical and can cause moderate costs if not available when a failure occurs. Equipment with a broken essential spare can stay partly operable for some time but not for long periods of time. Desirable spares are classified to the lowest criticality level. The stock-out of a desirable spare part will cause a minor disruption in case of failure but may lead to more severe operational problems in time. (Gajpal, et al., 1994) In the logistics control and spare part supplier's point of view, the most important element to know is the amount of time there is to react to the demand need of the customer. The amount of time to react impacts to the positioning of stock. If the customer's parts are critical and demand immediate supply, local safety stocks are usually the safest option for provisioning but if the supplier has some time to operate a centralized structure with direct deliveries is also a viable option. (Huiskonen, 2001)

Part specificity is another classification characteristic of spare parts. In the wide range of maintenance spare parts, there are typically a certain amount of standard and tailored parts. Standard parts are parts that are commonly used by many users and thus are readily available from many different suppliers. Standard parts are characterized by good availability because there are stocks of these parts at different levels of supply chain. With standard parts, suppliers are usually eager to cooperate with the users as the volumes are high and offer economies of scale. Tailored parts are parts that are made for user-specific needs for a particular customer. With tailored parts, the suppliers are unwilling to stock the parts because of the low volumes and tying of capital to stock. Thus, the responsibility for availability and control of the tailored parts remain commonly with the user of the parts. (Huiskonen, 2001)

Another way to classify spare part is the demand patterns of parts. The demand pattern builds on to volume and predictability of parts. The volume of demand and the economies of scale are associated with all material in the logistic chain. Spare parts stand out from other items because of large amounts of parts are characterized by low and irregular demand. This feature combined with other common spare part characteristics such as high price and criticality make the demand hard to predict and attract to increase safety stocks needed to cover unpredicted situations. In addition, low volumes decrease suppliers' willingness to offer any additional services and forces the end-user take responsibility for the availability of the spares. Predictability of the demand is linked to the failure rate of a part and to the possibilities to estimate failure patterns and rates by statistical methods. Parts can be divided into at least into two categories in relation to predictability: parts with random failures and parts with predictable wearing patterns. The predictability of part demand affects the strategical decision of whether the part provisioning or periodical service and maintenance should be provided. (Huiskonen, 2001)

The value of items affects all materials from primary products to spare parts. It is useful to divide spare parts at least to the high and low-value category. High value makes stocking unappealing solutions for any party in a supply chain. High value creates pressure for the logistic chain to develop other solutions than stocking of parts and in general favors positioning of high-value materials backward in the supply chain. Nonetheless, stocking of parts is a necessity except for the case of make-to-order items and has to be arranged by some party of the supply chain. On the other hand, also, low-value parts have to have an efficient replenishment arrangements and stocking policy so that the administrative costs do not increase over the to the value of the items themselves. (Huiskonen, 2001)

Criticality	Specificity	Demand pattern	Value of Parts
<ul style="list-style-type: none"> <li>• Vital</li> <li>• Essential</li> <li>• Desirable</li> </ul>	<ul style="list-style-type: none"> <li>• Standard</li> <li>• Tailored</li> </ul>	<ul style="list-style-type: none"> <li>• Volume</li> <li>• Predictability</li> </ul>	<ul style="list-style-type: none"> <li>• High</li> <li>• Low</li> </ul>

Figure 17: Four control characteristics for classification of maintenance spare parts. (Huiskonen, 2001)

Cavalieri et al. (2008) suggested slightly different classification for spare parts which presented in Figure 18 Spare parts are divided into four categories: Consumables and auxiliary materials, Generic spare parts, Specific spare parts and Strategic spare parts. Consumables and auxiliary materials are items that are characterized by stable and continuous consumption and extensive supplier base. An example item of this category could be a consumable filter. Generic spare part are parts which can be mounted onto various pieces of equipment and are easily available such as standard bearings and small electrical components. Specific spare parts are particularly used for a certain piece of equipment and available only through a certain supplier. Specific spare parts are characterized by sporadic and volatile demand. Specific spare parts can be further divided into spare parts whose expected wear-out time is foreseeable or not. The fourth category, strategic spare parts, are also specific spare parts that have expected wear-out time which is not foreseeable. In other words, the failure of strategic spare parts is difficult to predict. Strategic spare parts are also characterized by prolonged supply delivery time and high relevant costs. (Cavalieri, et al., 2008)

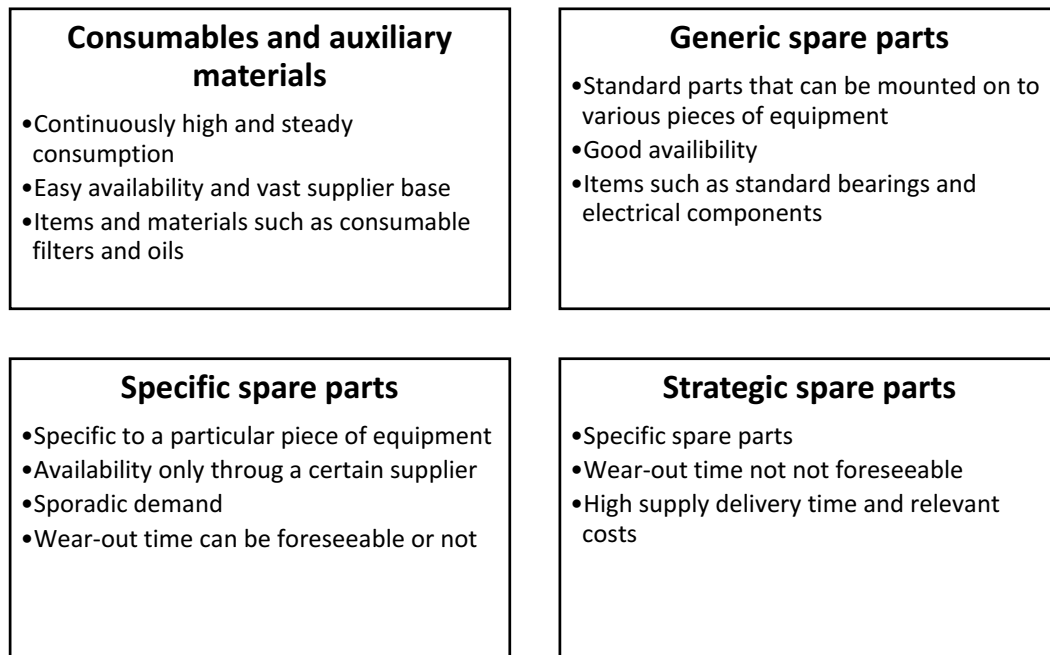


Figure 18: Classification of spare parts by Cavalieri et al. (2008)

Consumables, auxiliary materials and a large share of generic spare parts can be handled with the same inventory policies that are used for production related items. Traditional stock re-ordering policies, use of VMI (vendor managed inventory) through specific contracts with suppliers and consignment stock policies are used in these spare part categories. On the other hand, specific spare parts require a more careful analysis in order to choose a correct stock management policy or, rather, decide their purchase on demand whenever they are required. If the expected wear-out time of a specific part is foreseeable, it can be useful to adopt a preventive maintenance program. This allows the maintenance personnel to plan the type, volume, and timing of spare parts needed for planned preventive maintenance. A preventive maintenance program can reduce the risk of unexpected breakdown greatly. However, there is always a small chance for sudden unexpected breakdown and it may be needed to keep appropriate stock levels of specific parts if the cost of the downtime is considerable. Concerning strategic parts, the main problem is to decide whether to stock the parts regardless of their high value and low consumption or manage them on demand suffering from the long lead times and high hidden costs. (Cavalieri, et al., 2008)

### 3.2.4 Forecasting methods and inventory management

Optimal strategic alignment of spare parts logistics requires reliable forecasting for the demand of spare parts. Else, the risk of over or under stocking spares is inevitable. (Wagner, et al., 2012) Different stock keeping units (SKUs) have different underlying demand structures, which require different methods for

forecasting and stock control. Spare part demand is characterized by a sporadic behavior with a large amount of zero values with no demand. The demand pattern can vary greatly depending on the type of the part and industry. (Boylan, et al., 2008; Cavalieri, et al., 2008) This makes spare part demand forecasting especially challenging task for firms, although the demand forecasting can be made more accurately for wearing parts that have a regular wearing pattern. For breakdown parts, that are built to last the primary product's lifetime, the forecasting is more complicated. Breakdown parts have unpredictable wearing patterns and they are exposed to unscheduled failures. The maintenance strategy of the customer also affects the nature of spare part demand. Preventive maintenance strategy will lead to deterministic (predetermined) demand because the customer prepares for spare failures and tries to prevent them before they happen. On the other hand, reactive maintenance strategy will lead to stochastic (random) demand because customers will react to part failure only after it has happened. (Wagner, et al., 2012) In order to overcome the difficulties in spare part demand forecasting, firms try to anticipate the wearing patterns of parts and also use a different kind of forecasting methods such as subjective estimations, indicators and coefficients, stochastic methods, and model-based methods in their work (Boylan, et al., 2008).

Spare part classification and forecasting results affect the inventory options that can be selected. (Bacchetti & Saccani, 2012) Inventory options contain decisions that influence stock levels, warehouse locations, the degree of storage centrality and storage equipment. Inventory strategies determine warehousing structure and inventory management. The warehousing structure is the basis for the inventory management. The goals of the spare part business should be always taken into consideration when making inventory decisions. If the goals are to maximize the profits on a short-term, the manufacturer should centralize the spare warehousing in order to lower stock costs and avoid overstocking and obsolescence of parts. On the other hand, if the ultimate goal is to gain long-term customer loyalty and thus the high availability and prompt delivery of spare parts is crucial, manufacturers should consider local stocks near the customers. (Wagner, et al., 2012)

## 4 Company introduction and research design

In this chapter, the case company is first introduced. In addition, the research methodology, data collection methods and data analysis are represented.

### 4.1 Company introduction: Konecranes Finland Oy

Konecranes is the world's largest supplier of industrial cranes with a large service network and a complete range of lifting equipment. Konecranes services a broad range of customers, including manufacturing and process industries, shipyards, ports, and terminals. Konecranes provides productivity-enhancing lifting solutions globally as well as services for lifting equipment and machine tools of all makes. Konecranes Group has 11 900 employees at 600 locations in 50 countries. Konecranes has 12 production facilities in all the leading continents including the United States, Europe, and China. Konecranes' headquarter is located in Hyvinkää, Finland. Konecranes is divided into two business areas: Service and Equipment. Business Area Service offers specialized maintenance and modernization services for all types and makes of industrial cranes, hoists, machine tools, and port equipment through a global service network. The whole Konecranes customer offering is represented in figure 19. Business Area Equipment offers components, cranes, and material handling solutions for a wide range of customers, including process industries, the nuclear sector, industries handling heavy loads, container handling, intermodal terminals, shipyards, and bulk material terminals.



Figure 19: Konecranes customer offering (Konecranes, 2014)



Konecranes has a history of being active in growing the company through acquisitions. These acquisitions have created a need to harmonize the operations inside the corporation. Over the last years, Konecranes development work has focused on the three core strategic initiatives: Industrial Internet, Segment-based Offering and oneKONECRANES (1KC). 1KC is a development program which focuses on achieving benefits through harmonized processes in three core subjects:

1. Improved operational efficiency
2. Better customer relationship management
3. Transparent data for management decision making (Konecranes, 2015)

As a part of 1KC Konecranes has also launched ORiGO program in 2010 which is the Enterprise Resourcing Planning (ERP) system implementation program. ORiGO will deliver a common ERP system (SAP) to Konecranes globally. (Konecranes, 2015) In March 2015, SAP was released in the reseached unit. The unit faced serious problems in the rollout of the new ERP and delivery punctuality dropped near to 30 percent temporarily from the earlier 90 percent. The writer of this thesis was employed in the company October 2014 and started working with order follow-up in order to improve our delivery punctuality. The subject to this thesis arose from the need to improve the whole OTD process. In order to do that, it is required to assess the current state of the OTD process, recognize the issues in it and discover the development possibilities in the process.

#### 4.1.1 Konecranes business processes

Figure 20 represents the business processes of Konecranes.

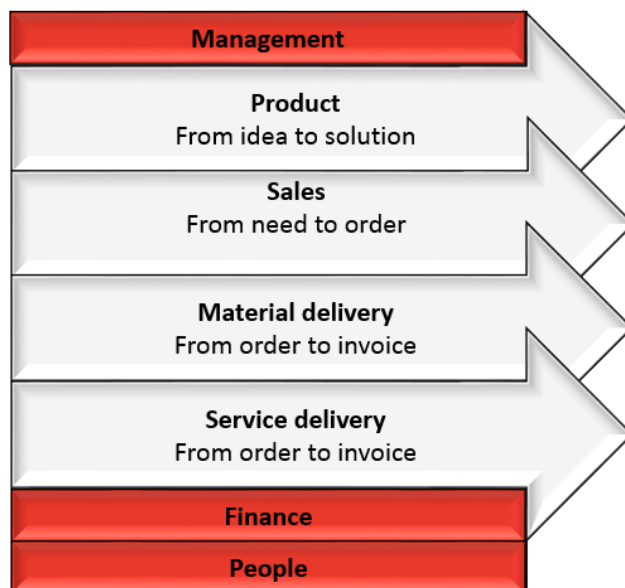


Figure 20: Konecranes business processes, modified from Konecranes (2015)

Company's core processes are the product, sales, material delivery and service delivery processes. Product process includes the developing of new products, technology development, managing changes to existing products. Sales Process covers the activities from demand creation and customer relationship management to a confirmed order from a customer that can be handed over to delivery or service process. The material delivery process covers the activities from sold solution to customer delivery, including the handling of the product structures, production planning, strategic sourcing, manufacturing, and final delivery to the customer and invoicing. Service delivery process provides specialized maintenance services for cranes, port equipment, and machine tools, ranging from a single piece of equipment to entire maintenance operations. (Konecranes, 2015)

The supporting processes are management, finance, and people processes. Management process describes how Konecranes governs their operations including developing business strategies and annual plans, preparing and utilizing management reports, managing health, safety, environment and quality. Finance process covers the financial business information flow through management accounting to support management's decision making and provide financial information for external stakeholders. People process is designed to look after the different phases of an employee's employment lifecycle in the company including resource management, recruitment, onboarding, performance, and compensation management. (Konecranes, 2015)

#### **4.1.2 Spare part delivery organization: Ports Part Center**

The research focuses on the unit of Ports Part Center which belongs to the Equipment business area. Konecranes port based products include the massive Goliath shipyard cranes, ship-to-shore and bulk handling cranes for vessel loading & unloading, and all types of container handling cranes - ranging from rubber-tired gantry cranes (RTG's) to lift trucks designed to handle full or empty containers and lift up to 80 tons. (Konecranes, 2015) An example of the variety of port cranes is illustrated in Figure 21.



Figure 21: Variety of Konecranes port cranes. (Konecranes, 2014)

PPC works as a global owner of spare parts for Konecranes port equipment. In practice, PPC supplies port crane spare parts for customers and in addition provides customer support and technical support services on a global scale. PPC works as a hub for technical support and supply during the full lifetime of a product and ensures that the support for spare parts is maintained until the customer decides to retire the product. PPC is also responsible for spares packages with new equipment delivery. The unit is located in Hyvinkää along with the Konecranes group headquarters. The unit forms of nine full-time team members and four managers.

PPC serves both internal and external customers with a wide portfolio of port crane spares for all equipment makes and brands. In the year 2015, PPC sold approximately 36 percent to external customer and 64 percent to internal customers such as various distribution centers. PPC's sales operations are divided into two segments which are the daily spare part sales and the spare part package sales. The daily spare part sales or so-called fast sales supply individual spare parts in a quick schedule. The spare part package sales supply large-scale part packages to new equipment deliveries either to ensure a trouble-free commissioning of a port crane or provide the customer a stock of the most critical items in case of preventive maintenance or product failure. In the year 2015, the division between the fast and package sales was approximately fifty-fifty.

Konecranes has three business regions: Americas (North, Central, and South America), EMEA (Europe, the Middle East, and Africa) and APAC (Asia-Pacific).

The global spare part organization in Konecranes is divided into Distribution Centers (DC) and Part Centers (PC). Konecranes has thirteen DCs and ten PCs located all around the world. DCs are placed in strategic locations and offer regional customer support and part supply. DCs ensure fast response to regional customer requests and high availability of multi-branded parts. PCs have a global ownership for certain proprietary parts and offer technical documentation, management and support globally. In addition, PCs are responsible for market-specific pricing, procurement, supply and support for parts relating to large projects and new equipment deliveries. There have been some organizational changes made to the structure of spare part organization over the recent years but it has not affected largely on the everyday operations of the centers. In Figure 22, you can see the Konecranes spare part organization. Please note that this is not the official organization structure of the spare part organization, but rather a demonstrative example for the reader of how the DCs and PCs are organized around the world. (Konecranes, 2014)

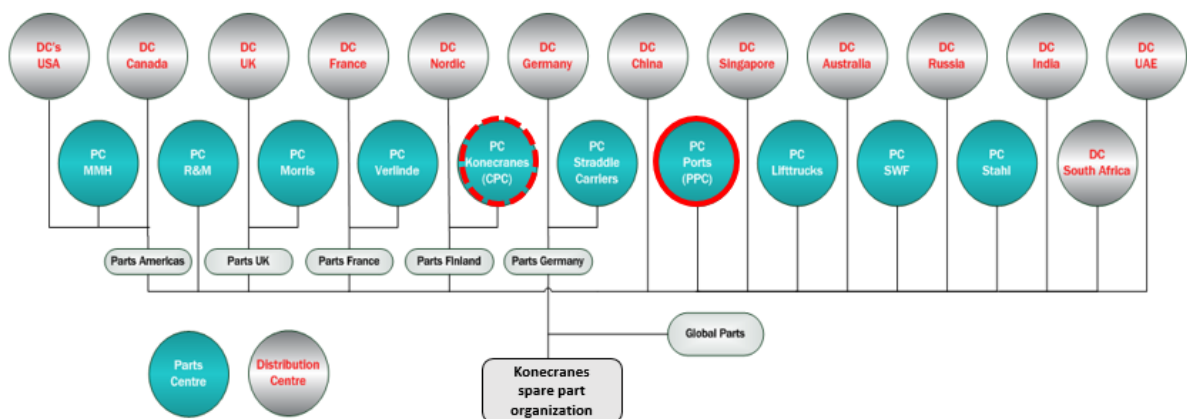


Figure 22: Konecranes spare part organization (unofficial), modified from Konecranes presentation (2014)

For synergy reasons, PPC has a common procurement, warehouse and logistics organization with the Crane Parts Center (CPC) located also in Hyvinkää, see Figure 23. Crane Parts Center provides spare parts for lifting equipment and machine tools excluding port cranes. (Konecranes, 2015) Because the studied OTD process covers also these parts of the shared operations, CPC is automatically included in the study.

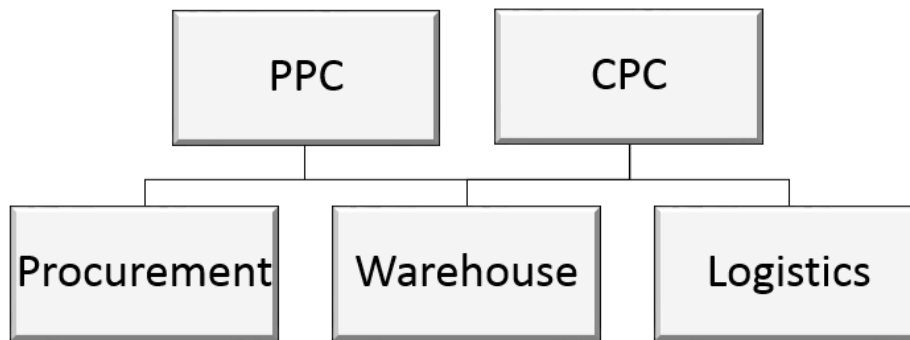


Figure 23: Shared operations between PPC and CPC

Konecranes uses corporation-wide enterprise resource planning (ERP) system SAP ERP which collects, stores and manages data from many business activities such as production planning, purchasing, manufacturing, marketing and sales, inventory management, shipping, and payment. Other information systems exploited in PPC are a web-based service request system, customer relationship management (CRM) system, product data management system (PDM), product lifecycle management (PLM) system, business intelligence (BI) system, claim management system, and some other small software.

Konecranes promises their customer a global and demand-driven supply chain. In the annual report 2011, Konecranes emphasizes that supply chain also needs to be flexible so that the company can adapt to fluctuations in demand, while offering competitive lead and delivery times, and avoid excessively large inventory levels. (Konecranes, 2011)

## 4.2 Research methodology

The focus of this research is to understand, describe and analyse the state, performance and challenges of the OTD process of one business unit. Based on this knowledge, development opportunities of the process are recognized and represented. This researched is based on qualitative research methods. Qualitative research is a wide-ranging methodological approach that includes many research methods. Qualitative research studies the totality of a phenomenon or a situation. (Hirsijärvi, et al., 1997, p. 165) Qualitative research report builds usually from the theory of the research subject, empirical data and researcher's own reasoning and conclusions (Saaranen-Kauppinen & Puusniekka, 2006).

This research is a qualitative research that includes characteristics of both action and case study research. Case study research can be performed either through quantitative or qualitative approach. In case study research individual, organization, event or any bounded system is studied in specific time and place.

The case study research method can be also used to study the processes of bounded systems. The goal of the case study research is to understand the case in-depth and understand the hows and whys of the case. Thus, particularly rich research data and multiple data collecting methods are preferred. (Saaranen-Kauppinen & Puusniekka, 2006) Yin (2009, p. 99) mentions six most important sources for data collecting qualitative method including documentation, archival records, interviews, direct observations, participation-observation and physical artefacts. The main objective of case study research is not to create generalized knowledge but to provide understanding to a contemporary phenomenon (Saaranen-Kauppinen & Puusniekka, 2006).

Action research is initiated to solve an immediate problem or improve communities of practice in the organization. Action research is based on a practical and problem-solving approach where the researcher and research shareholders participate to the change situation whilst simultaneously conducting research. Action research is usually classified as a qualitative method and is suitable for studying work-related phenomes and work practices. (Saaranen-Kauppinen & Puusniekka, 2006) This researcher was performed during a one-year length period to study the case of the OTD process in the particular unit of the company. Because the researcher was a part of the work team that performed the studied process on a daily basis, she also actively contributed to the research subject and conceivably changed the results of the study with her actions.

### **4.3 Data collection**

The data in this research was collected through multiple different methods including

- key person's interviews
- observations
- performance data collection from the company's BI system
- brainstorming with colleagues

The interviews were performed as a theme interview in order to get a profound understanding of the OTD process and its flow in the studied business unit. According to Kauppinen and Puusniekka (2006), the style in the theme interviews is very much conversational and based on free communication. Theme interview requires in-depth knowledge of the research problem from the interviewer and also the interviewed person should be chosen by evaluating who could have the relevant knowledge on the research themes. (Saaranen-Kauppinen & Puusniekka, 2006) Therefore, only few key persons with the most extensive knowledge of the process were interviewed during the research.

Observation was chosen as a data collection method in order to capture everyday challenges in the OTD process. Observations were unstructured and done during

normal workdays. The researcher took notes down from the events, circumstances and problems she observed in the operation of the OTD process on a weekly basis. The observing was participant observation by nature because the researcher had an active role in the process researched.

The researcher also collected data of different process performance indicators from the company's BI system. The indicators chosen for the research were either process key performance indicators (KPIs) or very closely related to the OTD process. This data collection method was chosen because it produced unbiased quantitative data of the process performance.

The brainstorming with colleagues was performed through everyday discussions and occasionally in weekly meetings. The researcher took notes of the most useful ideas at regular intervals. This data collection method was mainly used to support the data gathered from the other collection methods.

## **4.4 Data analysis**

In order to answer to the research questions a current state, performance and challenges of the OTD process had to be understood and analysed.

The current state of the process was formed based on the data gathered from the theme interviews and observations. The first step in starting to comprehend the OTD process of the unit was to model the process. The unit had an existing model of the OTD process made at a very general level. However, this model was dated and inaccurate. The modelling was done mainly according to process modelling step presented in the chapter 2.4.1. The first step was to identify the start and the end points of the process. The OTD process has to start from and end to the customer. The process owner, customers, participants, purpose and process flow were also defined. Please see the process description in Appendix 1. The process description was drafted according to JUHTA (2012) recommendations. The objective of the modelling was to clarify the OTD process in a way that it would be easier to understand and develop the process. Other goals were to identify possible bottlenecks and clarify the working tasks of the different roles participating in the process. Reaching these objectives required a precise description level and thus, a flow chart model was chosen. The process was modelled in the current state (As-is modelling). It was also known that there was going to be changes made to the process in the form of a web-based part store. The parts e-store was soon to be in its pilot stage and thus, it was considered beneficial to model also a version of the OTD process with the store in it (To-be modelling). However, this model is not displayed in the research, since the complete realization of the e-store was still unclear during the study. Microsoft Visio was chosen to be the modelling tool, because in addition it being one of the official software used in the company, it is also considered to be very user-friendly and easily learnable software. In the

modelling stage, five different sub-processes were recognised. These sub-processes formed a natural framework for presenting the findings of the process modelling.

The process performance was mapped with the aid of the data collected from the company's BI system. The data was analysed and presented through illustrative graphs. The research focused mainly on the analysis of the process KPIs but also some other performance indicators were used in order to support the performance analysis. In 2014, Janne Romppanen developed a balanced scorecard based spare part delivery performance measurement tool for an industrial company in his master's thesis (Romppanen, 2014). Some performance measurement metrics of this tool were exploited in this study.

The data collected from the observations and brainstorming was used to recognize challenges of the OTD process. The challenges were gathered and sorted into a table (see table 4) according to the sub-processes. The root reason of every challenge observed was also described in the table in order to increase the understanding of underlying reasons behind the challenges and bottlenecks.



## 5 Results

This chapter aims to provide answers for all the research questions. First the current state of the process is described. Second, the process performance is represented and third the challenges of the process are defined. Finally, the results are summarized and based on the findings, the development opportunities are represented.

### 5.1 Current state of the order-to-delivery process

In Figure 24, the modelled OTD process is presented in its current state (see also Appendix 2). This OTD process model is the main model for the process and can be used for both fast and package sales. In Figure 24, the sales order is abbreviated to SO and purchase order to PO.

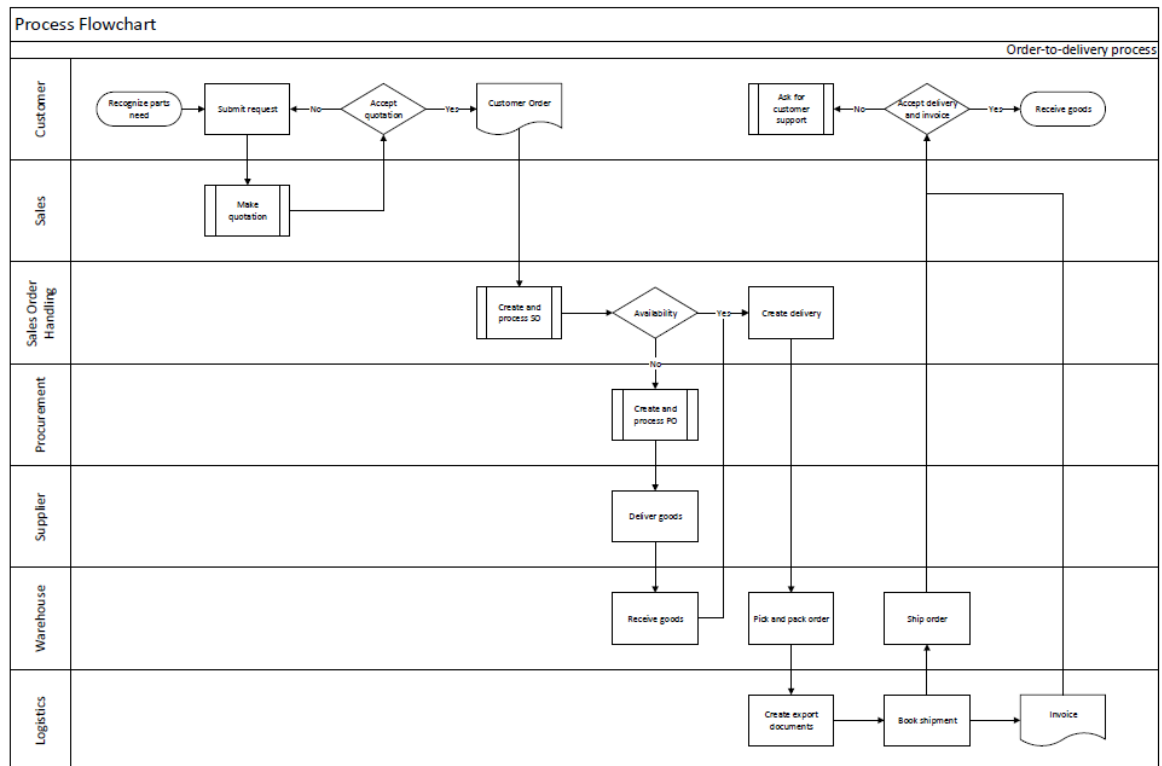


Figure 24: The OTD process of PPC (Appendix 2)

The OTD process starts from when the customer recognizes a part need. This is the process input that triggers the whole chain of actions. The output of the process is the fulfilment of the customer need by receiving the ordered products. The verbal description of OTD process flow is represented in Table 2.

Table 2: OTD process flow

Process Flow	<ol style="list-style-type: none"> <li>1. Customer recognizes a spare part need and submits a request.</li> <li>2. Sales create a quotation based on the request and sends it to the customer.</li> <li>3. The customer receives the quotation. Customer can either: <ol style="list-style-type: none"> <li>A) Reject the quotation: Sales will modify the offer and send a revised one to the customer or mark the case as lost.</li> <li>B) Accept the quotation: Customer decides to order.</li> </ol> </li> <li>4. Customer submits a purchase order.</li> <li>5. Sales order handling creates a sales order and processes it according to customer's purchase order.</li> <li>6. Sales order handling checks the availability of the ordered goods. If the items are: <ol style="list-style-type: none"> <li>A) Available: Sales order handling creates a delivery in SAP which will trigger the warehouse to start processing the goods.</li> <li>B) Not available: Procurement orders the goods from a supplier-&gt;Supplier delivers the goods-&gt;Warehouse receives the goods -&gt; Sales order handling creates a delivery in SAP which triggers the warehouse to start processing the goods.</li> </ol> </li> <li>7. Warehouse picks and packs the goods</li> <li>8. Logistics creates export documentation and books the shipment</li> <li>9. Warehouse ships the goods by using an external logistics company</li> <li>10. Logistics creates and sends an invoice to the customer</li> <li>11. The customer can either: <ol style="list-style-type: none"> <li>A) Decline the invoice and the delivery: Asks for customer support</li> <li>B) Accept the invoice and the delivery: Receives goods</li> </ol> </li> </ol>
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There are multiple sub-processes in the OTD process that cannot be represented in detail in the main model because it needed to be easily comprehensible for the viewers. The sub-processes that are modelled in this research are quotation process,

sales order process, purchasing process and customer support process. Other sub-processes and process steps are gone through verbally.

### **5.1.1 Quotation process**

Please see Appendix 3 for a detailed flowchart of quotation process. The quotation process begins when the customer submits a request. This request can be a result of previously made active sales work or can arise spontaneously for example from a sudden part failure situation. In PPC, the fast sales side requests are mainly handled through a specific web-based service request system. Every request creates a service ticket which should be closed during 48 hour time period. The package sales requests are usually attained from the internal customer and are handled mostly through company email. After a member of the sales team has received a request from the customer, he or she will identify the product inquired. If the product identification does not succeed with the given information, sales engineer asks the customer to provide additional information. When the product has been identified the sales engineer has to look for the product id in the ERP system. A specific product code or so called item number has been created for every spare part in the database. This item number is the key to the basic technical knowledge and the procurement information (supplier, data sheet, purchase price and delivery time) for the product. If the item number is found, the sales engineer can proceed straight to creating a quotation. However, if this item number does not exist, the process complicate and the sales engineer has to ask for an item number be created. The quotation can be also created with a general item number used for all spares. However, this can be only done if the sales engineer wants to send the quotation to the customer while the real item number is in the item creation queue.

Item creation request cannot be made without the necessary knowledge of the product. In order to attain the product information needed, the product has to be sourced by the sales engineer. Sourcing means the process of finding and evaluating suppliers for acquiring goods and services (BusinessDictionary, 2016). Konecranes has a vast pool of suppliers registered with a vendor number in the ERP system. For the suppliers that cover approximately 80 percent of the yearly spend, list prices, warehousing agreements and supply frame agreements are negotiated by the global sourcing team. Konecranes has a factory located in the Hyvinkää plant that produces parts such as gear, inverters, and travel wheels , and therefore the supplier can be also internal in addition to external suppliers. Once the supplier has been found, the sales engineer will ask for an offer from the supplier. If the spare part is, for example, a standard electrical part, a specification of the product will usually be enough for the supplier to recognize the product, but if it the product is a more complex mechanical part, the sales engineer has to dig out the correct technical drawing for the spare part from the PDM system or the archives.

Once the supplier offer has been received, the sales engineer will create a request (ItemQ ticket) for the item to be created. This request will then be processed by the item creation team. The item number creation can take from one hour up to a week depending on the case urgency and queue. The average time for the item number creation is approximately two days. When the item number is ready, the sales engineer gets a notification and he or she can check-up the item number created. Once the item number is ready, the quotation can be created. The most essential information in the quotation are the price, delivery time, quotation validity time and incoterms offered. Once ready, the quotation is sent to the customer. The customer will evaluate the quotation and decide whether to accept, ask for revised version or reject the offer. Most significant offers are inserted into CRM system and followed up on a weekly basis. The whole quotation process can last from one day to many weeks depending on the case difficulty. In the year 2015, approximately 35 percent of offers turned into orders. As the process flow chart and description indicate, that quotation process is one of the most complicated sub-process in the OTD process and can have a substantial impact on the total lead time.

### **5.1.2 Sales order process**

The sales order process starts when the customer sends the purchase order forward. Purchase orders can be received traditionally by email or with an electronic data interchange (EDI) link. EDI technique allows companies to place immediate and paperless purchase orders with suppliers (Chopra & Meindl, 2007, p. 57). All EDI orders originate from internal customers which are other Konecranes units. The amount of EDI orders is growing, because of increasing amount of business units are moving to SAP ERP system. EDI orders enable rapid order processing but cause issues if the order has to be modified greatly. In EDI orders, the purchase order and sales order have to match exactly and in the case of changes both have to be immediately modified. On the other hand, the orders received from external customers have to be inserted into ERP system line by line especially if they are not based on any quotation which can be time-consuming. Detailed flow charts of the sales order process are represented in Appendix 4 and 5.

EDI order or not, it needs to be processed in SAP ERP system. Sales order processing is a rather straight forward procedure which is usually performed by either the one person responsible for sales order processing in the team sales or in some cases the sales engineer who made the quotation. There has been also some division of work within the sales team on the grounds of customer's geographical locations. Every sales order is targeted to be processed on the same day as it has arrived.

When the order is being processed in the SAP, the order type is determined by the system according to the product type being ordered. Konecranes has multiple order and production types available:

- Engineer-to-order (ETO): Company designs and manufacturers a product from the start based on very specific customer requirements.
- Make-to-order (MTO): Company manufactures the goods according to customer's order.
- Make-to-stock (MTS): Company manufactures products for stock based on demand forecasts. When customer order arrives, goods should be in stock.
- Configure-to-order (CTO): Is a hybrid of MTS and MTO operations. It is a set of components that are built to stock whereas the end products are assembled to order.
- Purchase-to-Order (PTO): A customer places an order with a company and the company buys the products from an external supplier.
- Delivery-from-stock (DFS): A customer places an order with a company and the company delivers the goods from its stock. (Konecranes, 2015)

The most common order types in the unit are the MTO, PTO, and DFS. After sales order processing, the order can be confirmed to the customer. The delivery date promised to the customer in the order confirmation is crucial. If the goods are not delivered by the promised delivery date, the customer will count the products delayed. Part availability should also always be checked by the order handler. If the parts are available, the goods can be immediately moved to be processed by the warehouse triggering the delivery document in SAP ERP system.

### **5.1.3 Purchasing process**

Approximately 50 percent of all spare parts ordered from the unit need to be purchased from suppliers. The purchasing process is initiated when SAP ERP system automatically creates a purchase requisition based on the sales order created. Purchase requisitions are targeted to be processed on their creation date. Processing starts when purchaser will process this requisition into a purchase order and send it forward to the supplier. In some occasions, the supplier requires additional information for the order. Purchaser will then forward this request on to the person who offered or handled the order. Konecranes' suppliers are advised to confirm the orders within a week from ordering and notify from possible delays.

Once the purchase is confirmed, the confirmed delivery date will be entered into the ERP system, which enables the visibility for the order schedule for every team member. If the supplier is delayed, the delivery date should be changed to the system and the sales order handler should be noted of the delay. Once the products arrive from the supplier, the warehouse will mark them received and the supplier's

invoice can be accepted. Detailed flow chart of the purchasing process is presented in Appendix 6.

#### **5.1.4 Warehouse and logistics processes**

The unit's warehouse located in Hyvinkää receives the goods sent by internal or external suppliers. Receiving goods is a two staged procedure: products need first to be physically received and after that they have to be marked as received also to the ERP system. Once all the products in one sales order are either received or already available in stock, the delivery document can be formed in SAP ER system. The delivery document will trigger processing of the order in the warehouse. All the parts in the delivery are first picked and then packed together. Depending on the order size, the picking and packing can last from ten minutes to one week. Warehouse will create the packing list which will go on to the logistics units. When the goods are packed, logistics team starts to process the delivery. The logistic team creates the export documents and books the shipments using an external freight company, or in the case of customer pick up, informs the customer about the prepared package. The freight company picks up the delivery from the warehouse and delivers it to the customer.

Once the delivery has been shipped, the order can be invoiced by the export. The customer receives the delivery and the invoice and decides to accept or decline it. If the delivery or invoice is declined and needs to be modified, the customer will ask for customer support from the sales team. The final step of the OTD process is the customer receiving and accepting the ordered goods and the invoice. This seemingly straightforward sub-process has many critical points to it and it's the last stepping stone before the order fulfilment is complete.

#### **5.1.5 Customer support process**

Customer support process is initiated if the customer is unsatisfied with the delivery or invoice. This sub-process is not a part of the official OTD process definition because the customer has already received the goods, but since it's very closely related to the process, it is included in the study. Usually, the sales team member, who has processed the order related, handles the customer complaint. The most common complaints concern defected products, incorrect amounts, wrong products or incorrect invoicing. In some rare occasions, the sent goods have been damaged in the transit. There is no official statistics on the number of customer complaints received because the unit has just recently started using a software for claim handling.

In the beginning of the process, sales order handler will first start to locate the origin of the fault or mistake. After this warehouse, supplier or logistics service provider will be claimed with the help of procurement and logistics unit. If there is a clear

reason for the complaint, a free-of-charge order is created to cover the replacement goods. If a replacement product is available in stock, it will be sent to the customer immediately after the complaint. If the product needs to be purchased, it will proceed to the purchasing process as an urgent case. As soon as replacement product is available, it will be sent forward to the customer. If the mistake has been made in the invoicing, it's much easier to correct. In this case, the sales order handler will check the product prices and ask the logistics to update and resend the invoice to the customer. The customer process ends in the same step as the whole OTD process, which is the customer need fulfilled by receiving the (replacement) goods and (revised) invoice. Detailed flow chart of the customer support process is represented in Appendix 7.

Typically, after sales complaints can be complicated and resource demanding to sort out. These are also the cases, where the level of customer service becomes most concrete for the customer. All in all, customer support process is a complex set of actions that requires seamless co-operation from different units.

## **5.2 Current performance of the order-to-delivery process**

### **5.2.1 Key performance indicators of the order-to-delivery process**

KPIs are a set of quantifiable measures that a company uses to evaluate the factors that are crucial to the success of an organization. (Parmenter, 2007) In PPC, KPIs are measured on a daily basis. The measured data flows from The ERP system data to the BI system which updates the data once a day. KPIs are followed constantly and presented to the whole team in weekly meetings. KPIs give the team members insight into unit's current performance. KPIS are also integrated into the criteria for performance-related pay in the unit. Table 3 represents the main KPIs used in the unit and their definitions.

Table 3: Key performance indicators used in Ports Part Center

KPI	Definition
Response Time 48h-%	Response time measures how many percentages of customers' service request tickets are closed within the 48-hour deadline.
Delivery Punctuality-%	Delivery punctuality measures how many percentages of order lines are shipped on the promised delivery date.
Delivery Time	Delivery time measures the days between the sale order creation date and shipping date.
Delivered on same day-%	This indicator measures how many percentages of order lines are delivered on the same day as the sales order was created.
Fill rate from stock -%	This indicator measures how many percentages of sales order lines can be fulfilled from stock.
Inventory Turn	This indicator how many times the unit's inventory is sold and replaced over a period of time.

Next, we will go through the indicators measured in 2015 in order to form a comprehensive picture of the current state of the OTD process.

### 5.2.2 Response time

Response time is an important indicator because it reveals how quickly the unit is able to react to customer requests, whether them being quotation requests, orders or technical support requests. The time taken to handle to requests effects on customer satisfaction and to the customer's perception of the level of the customer service level. Figure 25 displays, how many percents of the requests were closed within the 48 hour target time in 2015. The average value of 2015 was 54 percent and the target value was 58 percent.



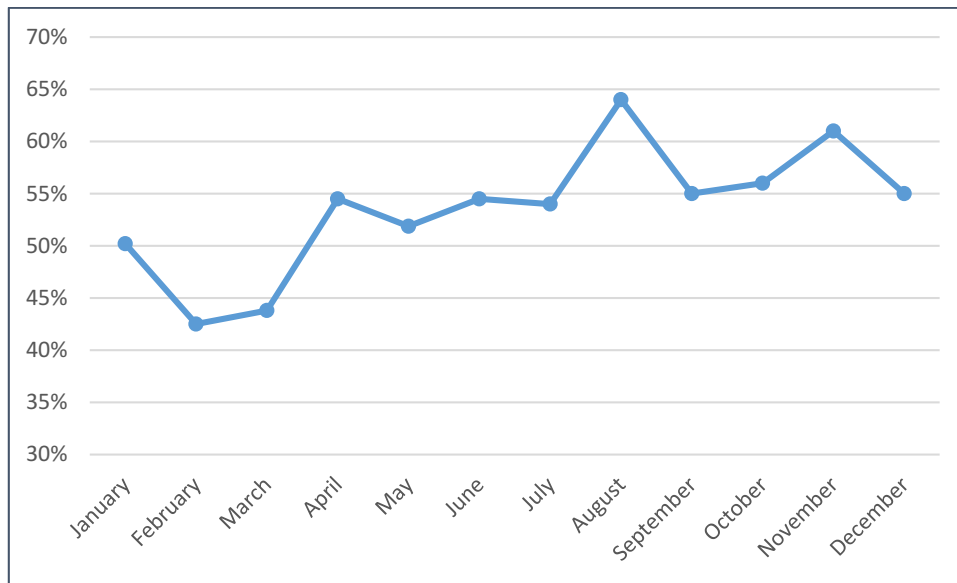


Figure 25: Response time in 2015

Poor response time results in loss of customers and revenue, especially if this happens repeatedly (Stewart, 1995). The target value was reached last year in two months. There can be numerous conclusion made from that fact. In observing the team, the researcher found following possible reasons for the underachievement to be continuously complicating customer requests, requests with inadequate information, unevenly divided workload and long response times in supplier side to start with. The response time also runs through the weekend and thus request arrived on Friday would be automatically delayed on Monday which distorts the measuring and causes systematic measurement error

### 5.2.3 Delivery punctuality

Delivery punctuality is one of the most crucial indicators in OTD process (Sakki, 1999, pp. 168-169). The motivation for this master thesis was triggered from poor delivery punctuality numbers earlier in 2014. In PPC, the delivery punctuality is measured per order line. The delivery punctuality in 2015 is represented in Figure 26.

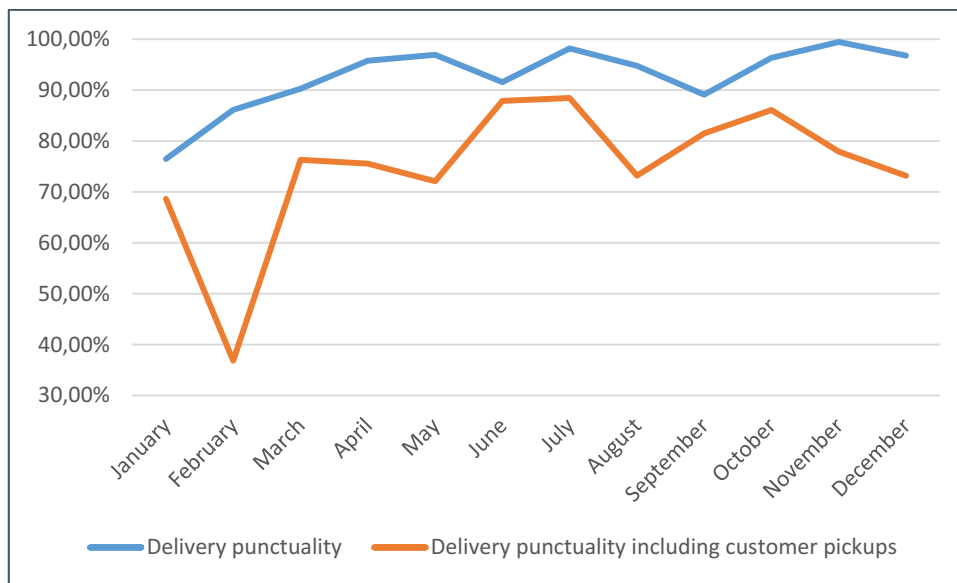


Figure 26: Delivery punctuality in 2015

In Figure 26, there are two different delivery punctuality value series. The delivery punctuality series is the official value used in the unit that excludes all the customer pickup cases. The delivery punctuality including customer pickups series takes also to account all the customer pickup cases. PPC offers their customer a possibility to arrange the shipment of their order by themselves. This delivery type is called a customer pickup. In the customer pickup cases, the logistics unit informs the customer when the order is packed and ready to be picked up. The customer can then arrange a pickup on the desired delivery date. In the year 2015, approximately 21 percentage of order lines were customer pickup cases, which indicates that this a popular logistics service. However, in only 32 percent of cases, the goods are picked up on the same date as they were ready to be shipped, which makes many of these cases delayed in the system's point of view. The unit has faced pickup times ranging from same day pickups to goods waiting for many months for pickup, which creates some uncertainty in the process.

The average delivery punctuality in the year 2015 was 75 percent for all orders and 92 percent for all orders excluding the customer pickup cases. The target value for the delivery punctuality is over 85 percent which was realized in 11 out of 12 months in the official values. However, the delivery punctuality is measured from the system's point of view which is not always the same value as the customers perceive. In the ERP system, an order line that has a matching or earlier delivery date (also referred as First date) than the shipping date (also referred as Actual goods issued date), is on time. However, the delivery date entered to the system is not always same as the delivery date confirmed to the customer. In many occasions, the delivery dates are manipulated and moved forward afterwards in the system because of unexpected delays or overly optimistic delivery time estimates to begin

with. In addition, the delivery date has to be also altered if the sales team wants to send a revised order confirmation to the customer. This leads to a situation where the order might be delayed in customer's point of delivery but the ERP system still counts the order to be on time. There are indicators that this problem occurs also in other units and affects the validity of the measurement.

#### 5.2.4 Delivery time

Delivery time measures how many days it takes to get the ordered goods shipped. The ERP system starts counting the days from the moment the sales order is entered and released in the system and ends when the goods are shipped out. In Figure 27, average delivery times of the unit are displayed.

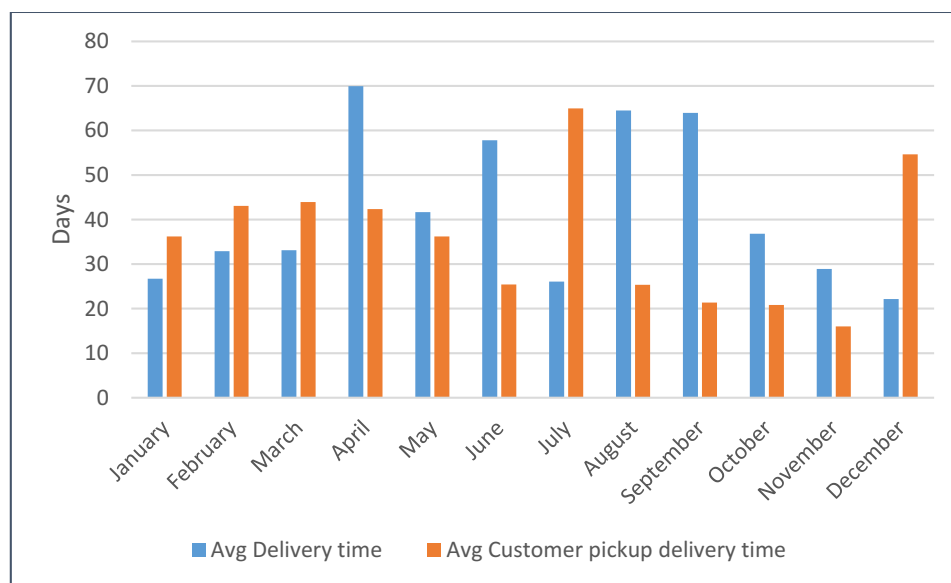


Figure 27: Average delivery times in 2015

As can be easily spotted from the chart, delivery times can vary greatly between the months. The first series, average delivery time, includes all the orders except the customer pick up cases. The second series, average customer pickup delivery time, includes the monthly averages of only the customer pickup cases. The average delivery time for all orders was 42 days in the year 2015. The target delivery time set for the unit is under 10 days average delivery time which was not reached in any month. The unit supplies many specific spare parts, such as port crane gears, with sporadic and volatile demand. Specific spare parts are particularly used for a certain piece of equipment and available only through a certain supplier which can make the supply chain fragile to delays (Cavalieri, et al., 2008). Because of the nature of the port crane spare part business, it's reasonable to contemplate is the current target set achievable for the unit, without making massive changes to the range of products supplied.

### 5.2.5 Delivered on same day

This indicator measures how many percentages of order lines are delivered on the same day as the sales order was created. Monthly averages of same date deliveries are represented in Figure 28.



Figure 28: Same date deliveries in 2015

Figure 28 displays two series; one with values from all the orders and one with values from all the orders except the customer pickup cases. As can be interpreted from the chart, the customer pick up cases reduce the same date rates slightly. This can be explained by the fact that the same date delivery rate for the customer pick up cases alone is only 0,6 percent. This implies that a very small amount of customer pickup cases are ready and picked up the same date the sales order is created.

The unit's target value for same date deliveries is over 50 percent of all orders to be delivered on the same date. The average rate for the same date deliveries was approximately 4 percent for all orders and 5 percent excluding the customer pickup cases in the year 2015. From these values, it can be concluded that the unit is far behind its target. In observing the process, the researcher found the following potential reasons behind the low same date rates: team's lack of confidence in the speed of the warehouse process, immediate unavailability of stock goods and great amount of PTO goods.

### 5.2.6 Fill rate from stock

The fill rate from stock indicator measures how many percentages of sales order lines can be fulfilled from stock. Monthly values of fill rate are displays in Figure 29.

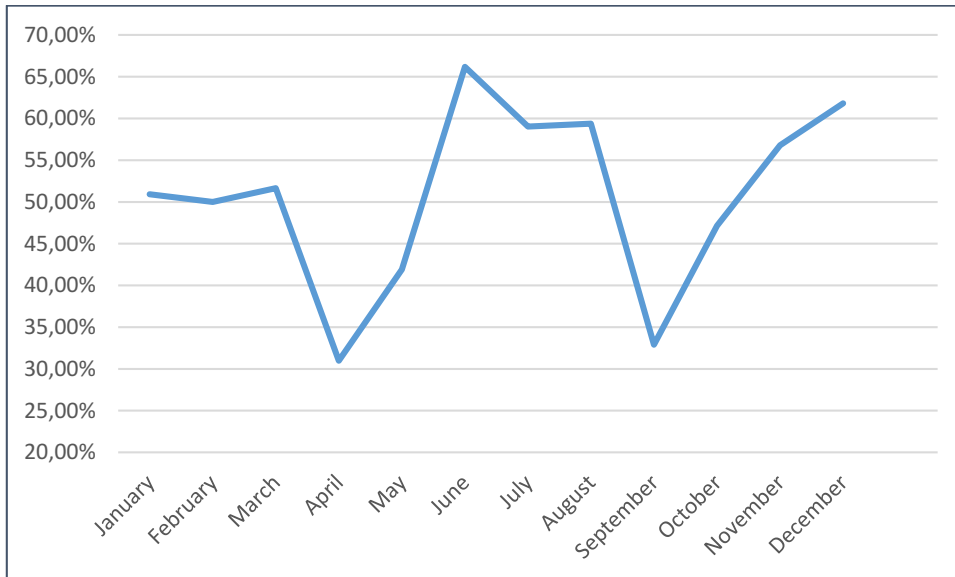


Figure 29: Fill rate from stock

Figure 29 illustrates the fill rate from stock fluctuating from 30 percent to over 65 percent during the year 2015. The target value for the unit is over 80 percent fill rate from stock which is not reached in any month. The average value of the fill rate is 50 percent for the whole year. It should be also noted that the order line fill rate from stock does not specify is the product actually physically available in stock, but rather is the good ordered defined as a stock item. In many occasions, even though the ordered product is a stock item, other orders have already booked the available amount of products in stock and the order has to wait for the next batch fill-up. Thus, a high fill rate from stock does not guarantee high availability. The fill rate from stock could be increased by sgrowing the amount of stock items on the products but on the other hand, this would lead to increased inventory carrying costs.

### 5.2.7 Inventory turn

Inventory turnover measures the number of times inventory is sold in a time period. The inventory turnover rate offers a good instrument for assessing the capital bound to different parts of stock. A low turnover rate may indicate to overstocking and high rates to insufficient inventory levels. (Lehmuskoski, 1982, pp. 210-215). This

indicator is shared with the CPC because of the common warehouse used. Figure 30 displays the monthly inventory turn rates in 2015.

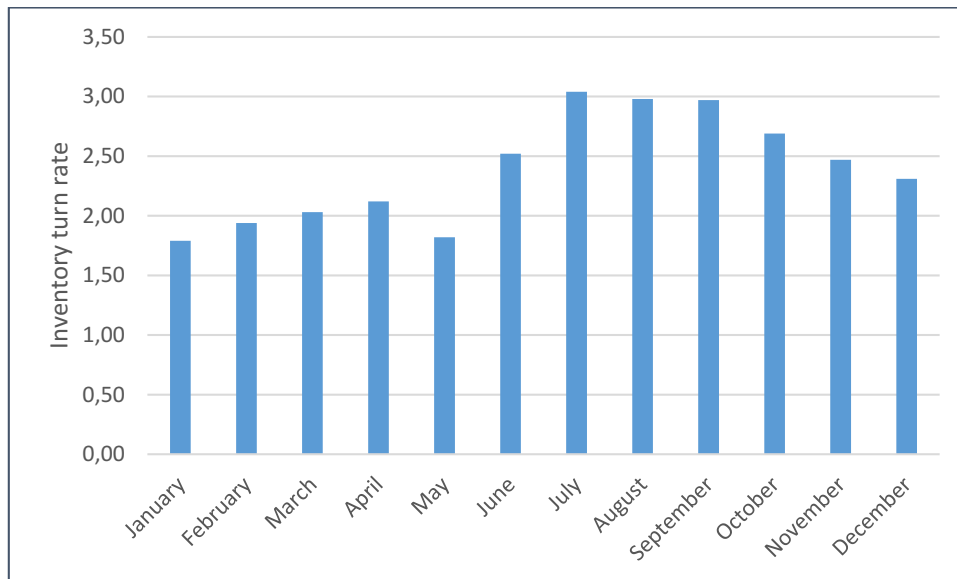


Figure 30: Inventory turn in 2015

The inventory turnover target is 3 for the unit. The average inventory turn was 2,4 in the year 2015, which implies that some part of the stocked goods stay too long unsold in the inventory. Because the inventory management software was not fully operational during the year 2015, the data in the chart is suggestive.

### 5.2.8 Other performance indicators

The KPIs alone are not sufficient enough to give a full picture of the OTD process' current state. Thus, additional performance metrics are presented in the following section. Performance metrics are acquired from the company's BI software. In 2014, Janne Romppanen developed a balanced scorecard based spare part delivery performance measurement tool for an industrial company in his master's thesis (Romppanen, 2014). Some performance measurement measures of this tool are exploited in this study.

#### Quotation process performance metrics

Quotation process can be evaluated through the following metrics:

- Total quotation response time is the time spent between receiving the customer request and quotation to be sent to customer
- Quotation activity indicates how many lines (or the financial value of lines) are quoted to customers in certain time period.
- Quotation hit-rate is the ratio of quotations turned into customer orders.

- Customer satisfaction measures are the customer satisfied with the customer service level and received quotations.
- Common ways of working measure that are the ways of communication to customers same regardless of the point of contact. (Romppanen, 2014)

All of these metrics are not presented in this study because of data availability and confidentiality issues. Therefore, the metrics left out are suggested to be areas of further study in the unit. In the year 2015, the hit-rate was approximately 35 percent and the average volume was around 130 quotations per month. The quotation activity of the unit is represented in Figure 31.

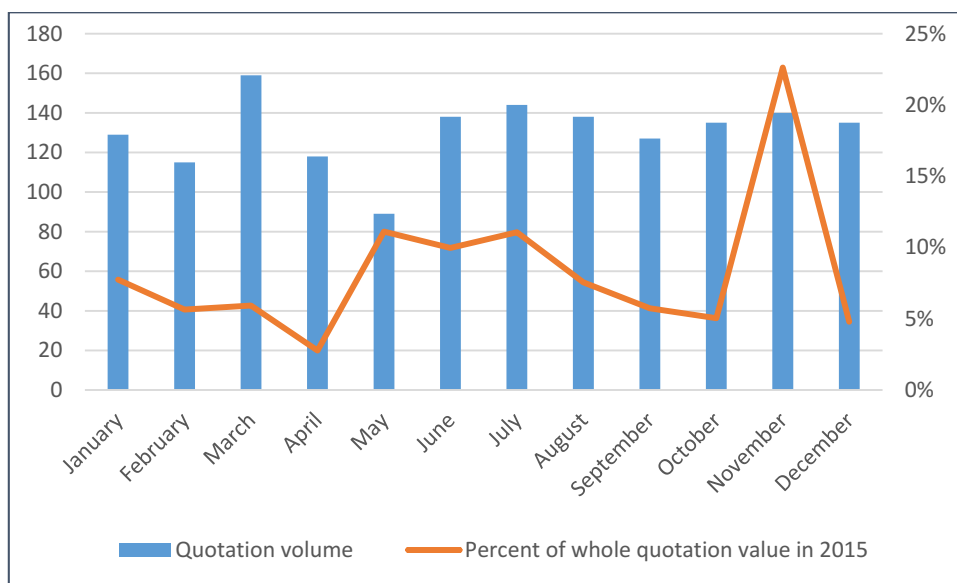


Figure 31: Quotation activity in 2015

As can be observed from Figure 31, the quotation volume peaks in March with 159 quotations created. However, the financial percent value of quotations does not correlate straight with quotation volume. Approximately 23 percent of the whole year's quotation value is created in November. This phenomenon response to the nature of the spare part business. The quotation volume tends to escalate towards the end of the year because the businesses want to use up their yearly budgets and on the other hand prepare for the beginning of a new budget year. Approximately 40 percent of quotations are offered to external customers and 60 percent to internal customers. This indicates that the business is centred slightly around internal customers. One of the unit's goals is to add the amount of external customers and their order intake. In order to achieve that, the unit must focus on increasing the volume and hit-rate of quotations offered to external customers.

### Sales order process performance metrics

Sales order process can be evaluated through many metrics such as order intake, order backlog, sales and lead time (Romppanen, 2014). In Figure 32, the order lined and delivery punctuality of all orders are represented.



Figure 32: Order lines and delivery punctuality in 2015

In Figure 32, the sporadic nature of spare part demand is revealed. The amount of order lines almost triples between May and June. This creates massive pressure for the OTD process and thus, the process flexibility is crucial in order to maintain the required customer service level. The delivery punctuality seems to partly correlate with the amount of order lines. When the amount of order lines grows, the delivery punctuality improves, excluding February. Usually, large drops in punctuality are caused from big spare part package delays. When one line from a spare part package is delayed, the whole package, which could have up to 300 order lines, is counted as being delayed in case of complete delivery. Therefore, the spare part packages should be closely monitored and if the order lines have very varying lead times, splitting the order into delivery batches should be considered.



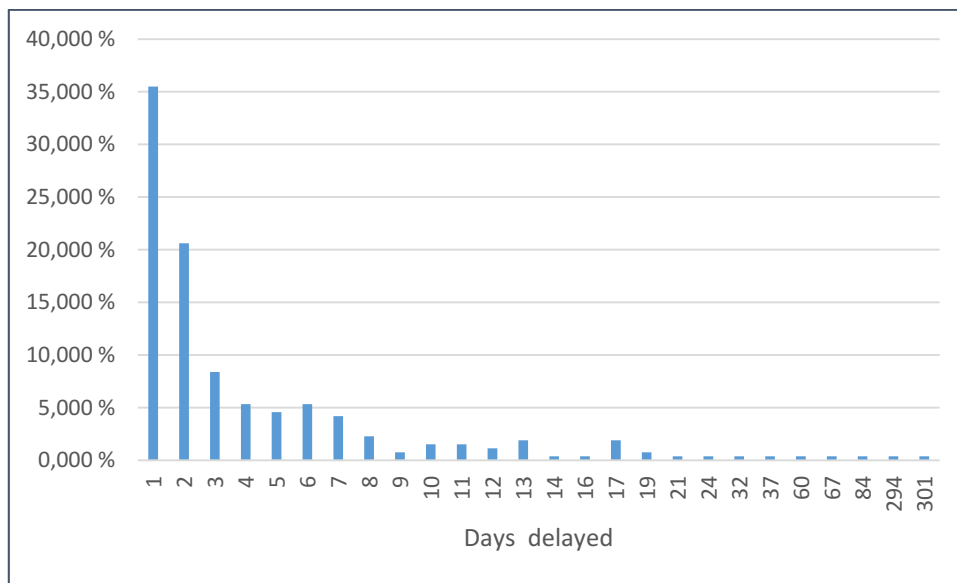


Figure 33: Average delay of order lines in 2015

The average delay of order lines is displayed in Figure 33. Over 35 percent of orders are one day late and the majority of orders appear to be delayed by a week. However, this is time measured from the ERP system's internal view rather than from the end customer's perspective. As earlier discussed, the entered delivery dates are manipulated in the system in many occasions and do not always respond to the original delivery date confirmed to the customer. For this reason, the researcher has strong doubt that average delay of orders is more than one day and further study of this subject is highly recommended.

### **Purchasing process performance metrics**

Supplier punctuality, supply lead time and average delay of supplied goods are some of the metrics used for evaluating the purchasing process performance (Romppanen, 2014). The amount of purchase order lines and procurement punctuality are displayed in Figure 34. Since PPC and CPC have shared procurement functions, the data represented is also common for both units. The complete amount of purchase order lines in 2015 was over 25 000 order lines and the average amount of lines per month was approximately 2940 lines. The procurement punctuality indicates how many percents of purchase order lines are received on the same date confirmed by the supplier. In the year 2015, average procurement punctuality was 72 percent. The procurement punctuality remained stable throughout the whole year with minor fluctuations. This indicates that purchasing process is flexible enough to handle the fluctuating amount of workload but has a certain part of orders delaying systematically in every month.

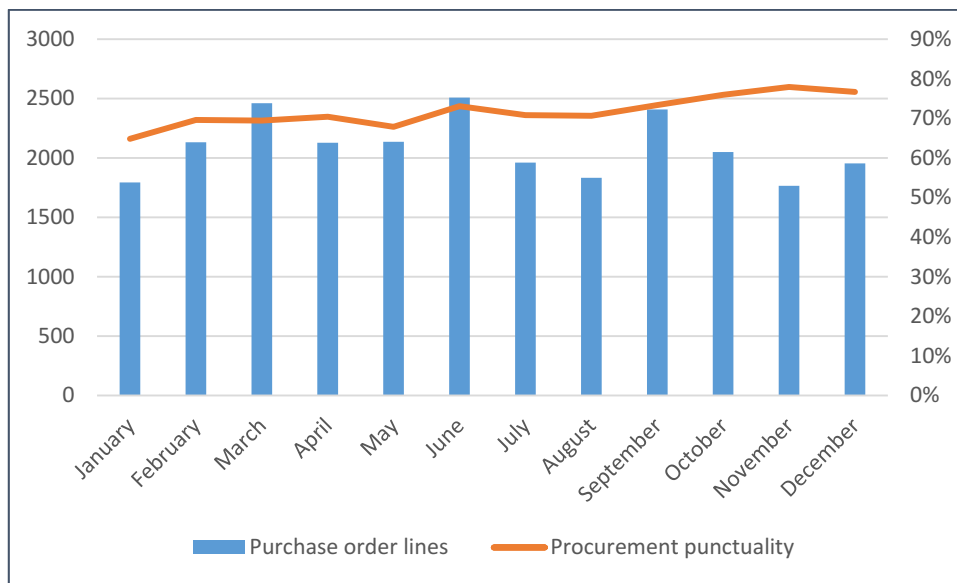


Figure 34: Purchase order lines and procurement punctuality in 2015

In Figure 35, the average lead time and delay of purchase orders is represented. The average lead time is calculated from the purchase order creation date until to the warehouse receiving the goods sent by the supplier. The average supplier lead time varies from 22 to 29 days throughout the year. The whole year's average of supplier lead time was approximately 25 days. However, the individual lead times of parts may vary from one day to many months depending is the part a common standard part or a specific part manufactured for a certain order. The relatively long average lead times can be a result of these non-standard manufactured to order goods which tend to increase the lead times significantly.

The average delay of suppliers varied from two to five days averaging around four days. This indicates that when a supplier delay occurs, it's usually almost a week long (counting only workdays) which can be seen as a significant delay from an end customer's point of view. On the other hand, the delay times of suppliers are also affected by the purchaser's ability to estimate the shipping time from the supplier to the warehouse. If the purchaser underestimates the time for the shipping of goods from the supplier, the goods will be delayed even though they have been sent from the supplier on time. The use of different shipping methods such as different couriers and the ability estimate the shipping times from the suppliers is entirely down to every purchaser's expertise. This leads to situations that more experienced purchasers are more precise in their estimates and thus have better procurement punctuality. Following up on their purchase orders is also mainly done by the purchasers themselves. This leads to variable practises and success on the order follow up. Some purchasers tend to notice straight away when a purchase order is delayed and some do not notice at all. All the communicating towards the suppliers is made either by email or phone and claiming the supplier for delays is very rare.

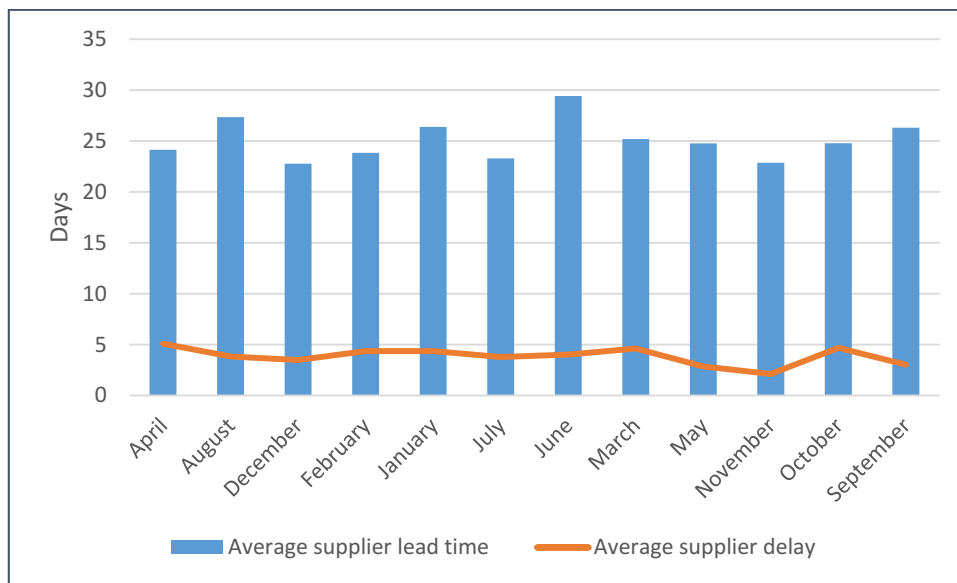


Figure 35: Average supplier delay and lead time in 2015

The percentage value of procurement spend and average lead time per supplier is displayed in Figure 36. From this figure, it's easily notable few of the suppliers consume the most of the annual procurement spend. In fact, only nine suppliers consume over 50 percent of the yearly procurement spent. In this group of suppliers, the average lead time was approximately 49 days. The majority of the suppliers have a much smaller annual spends. It can be also observed from Figure 36 that the lead time peaks in few places with the suppliers that have a low annual spend. This can be directly related to the fact that because of the low value and volume of purchases made, the suppliers may not be motivated to maintain a high customer service level. On the other hand, the group of nine biggest spend suppliers have also relatively (average varying from 8 days to over hundred days) long lead times which indicates that high-value purchases does not guarantee short lead times and thus more focus should be given be on to supplier relationship management.

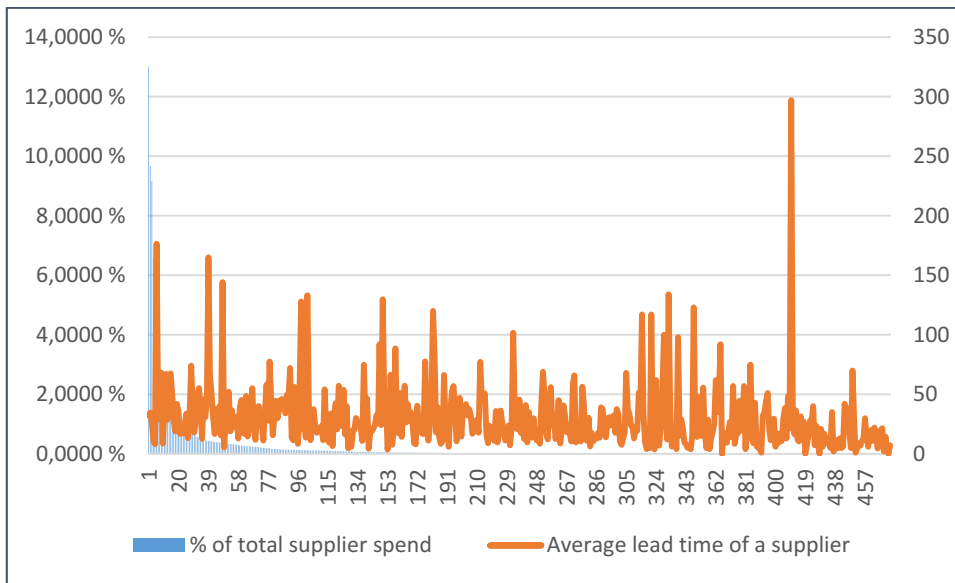


Figure 36: Supplier spend and average lead time of a supplier in 2015

In Figure 37, the value of purchases and amount of order lines per supplier is represented. Procurement has huge supplier base with over 470 suppliers. As depicted in Figure 37, most of the suppliers received under 25 000 euros of purchase orders that had under 250 order lines in the year 2015. In fact, over 80 percent of suppliers had under 50 order lines purchased from them. From the figure 37, the biggest suppliers also stand out very clearly.

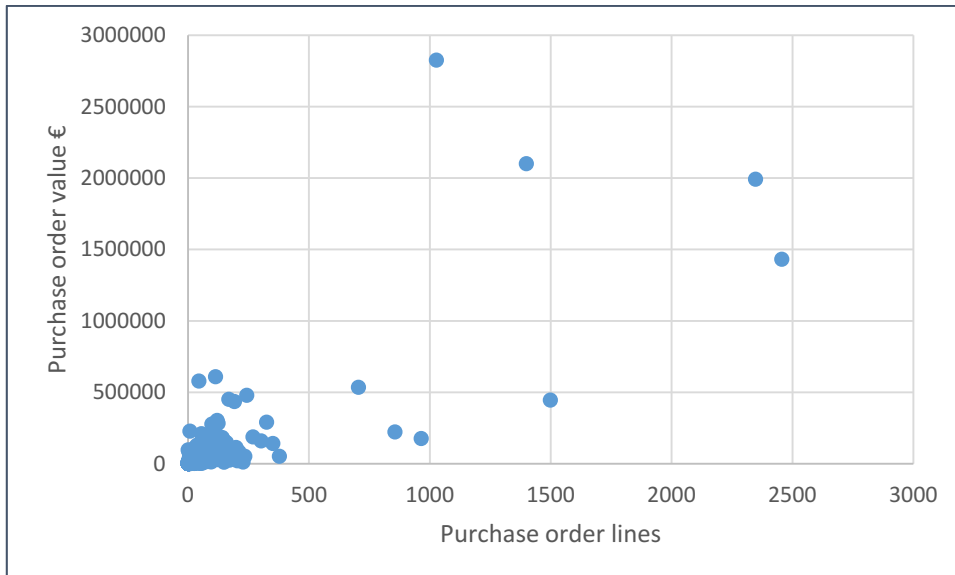


Figure 37: Purchase value and the amount of order lines in 2015

Spare parts units have usually very large product ranges. When the product range is large and variable, the ordered batch sizes tend to be small. Due to the large product range, purchase orders have usually a low value and the orders are scattered between many different suppliers. As earlier noted, low volume and value of purchase orders do not motivate the suppliers to invest in keeping a good customer service level. PPC has many suppliers that have difficulties in keeping the promised lead time, product quality or customer service level. In addition, many of these suppliers have not confirmed the Konecranes supplier agreement which makes claiming erratic and hard. These problematic suppliers are still used because of hardship to source the specific parts from anywhere else. The most important suppliers have a named supplier manager in Konecranes who is responsible for the particular supplier. However, the supplier managers are many times hard to reach and do not necessarily have the time to sort out all the problems with the suppliers. In addition, the responsibility for finding replacement suppliers for the low-performing suppliers is scattered around the units and in many cases it's unclear who should be responsible for the sourcing in this kind of cases.

### **Warehouse and logistics process performance metrics**

Warehouse and logistics processes can be evaluated through many metrics such as stock value, stock fill rate and inventory turn rate (Romppanen, 2014). In Figure 38, the correlation between the stock fill rate and average lead time is represented. It can be noted from few points in Figure 38 that when the fill rate drops steeply the average delivery time increases. On the other hand, an increase in stock fill rate does not automatically decrease the delivery time. It can be determined from Figure 38 that other factors than stock availability impact on the delivery times of orders. Since approximately half of all spares are purchased to order, the long lead times of these items affect the average delivery times of orders. In order to decrease the average delivery time, the stock fill rate should be kept at a sufficient level but also focus on improving the lead times of PTO parts.

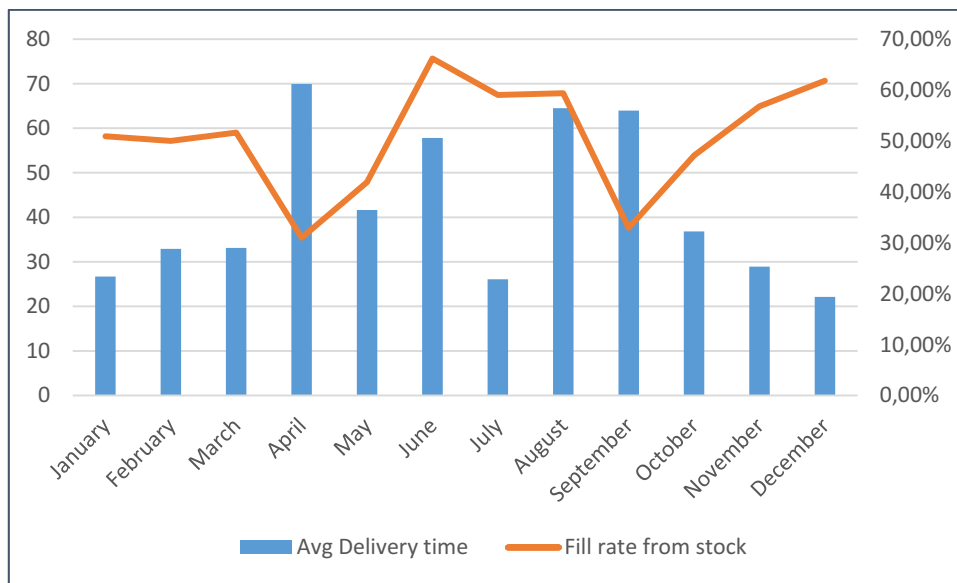


Figure 38: Average delivery time and stock fill rate in 2015

The average delivery processing time is represented in Figure 39. The delivery processing time is calculated from the delivery document creation date to the actual goods issue date or so called shipping date. In other words, this is the time spent in picking, packing and other shipping preparations in the warehouse. The average delivery processing time is 3,6 days for the whole year. This is a significant amount of time in customer's point of view and reducing, this time, would help to shorten the total lead time in the unit.

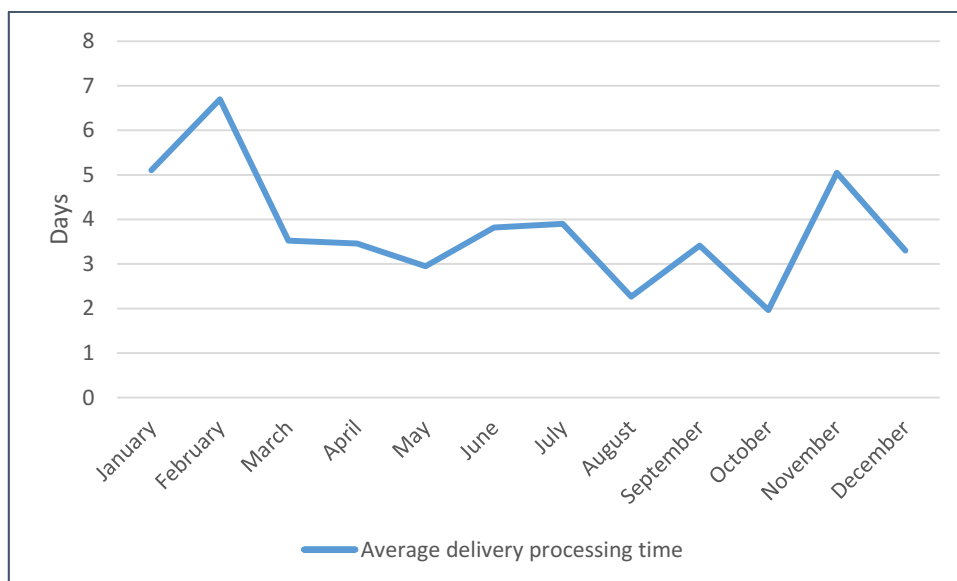


Figure 39: Average delivery processing time in 2015

### 5.3 Challenges in the order-to-delivery process

The next section covers challenges and bottlenecks observed in the OTD process. The researcher spent one year period studying the process. Observations were unstructured and done during normal workdays. Recognizing the challenges and bottleneck of the OTD process was necessary in order to identify the most optimal delivery opportunities. The findings of observations are composed and classified according to OTD sub-processes. Observation findings are presented in Table 4.

Table 4: Observed challenges in the OTD process

Sub-process	Observed challenge or bottleneck	Root cause
<b>Quotation process</b>	<b>Product identifying:</b> Sales engineers receive various vague requests with inadequate information from the customers on a daily basis, which lead to an inability to identify correct products. This, on the other hand, creates a ball game of information going back and forward between the customer and the sales team, which can slow things down significantly and create frustration at both ends.	Insufficient level of customer communication and cooperation
	<b>Sourcing:</b> Finding the best supplier for the product can turn out to be difficult occasionally because the supplier that is the most suitable might not have a vendor number in the ERP system. Opening a new vendor number in the ERP system is time consuming and expensive and will not be done for a single product. Thus, many sales engineers satisfy to use the old suppliers with existing vendor numbers, even though they may not get the best price or quality for the product. Also in cases of spare parts for very old models of port cranes, sourcing can be a problem because of inability to find a manufacturer for the spare or its replacement.	Inflexible ERP system, Obsolete products
	<b>Finding technical or electrical drawings:</b> Sales engineers have occasional difficulties in finding all of the needed technical or electrical drawings especially the older models of port cranes. This, as expected, will cause additional work for the spare part sales team and delays for the customers.	Insufficient, unattainable, and scattered product documentation

	<p><b>Item number creation:</b> As this process step is expected to become more infrequent because the existing item number amount keeps on growing day by day, it is still one of the most critical stages in the quotation process. Before the actual item creation requests can be handled, the sales engineer must attach the needed information to the request. However, on many occasions, the information was not adequate or incorrectly entered to the request for the item number creation to succeed. Thus, the item creator must boomerang the request back to its owner and ask for additional information or corrections to be made to the request. If the item creator was experiencing a heavy workload and a long queue of tasks, these problematic requests would be easily left waiting for a relatively long time period. In addition, there was an issue of many duplicate and obsolete item numbers in the ERP system which also confused the quotation creators.</p>	Poor information quality and internal communication
<b>Sales order process</b>	<p><b>Defective sales orders:</b> Sales team receives occasionally customer orders with inaccurate information or incorrect item numbers. Some spare part types require mandatory background information such as original part serial numbers from the end customer before it can be manufactured. This leads to situations where the sales order cannot be processed before the customer provides a clarification for the issues or additional information which leaves the sales order waiting and prolongs the lead time. The sales team has found this especially problematic with certain internal customers.</p>	Insufficient level of customer communication and cooperation
	<p><b>Defective quotations:</b> Quotations can be created with a general item number if the item number is stuck in item creation queue. However, this kind of quotations can cause problems in the sales order processing stage. Several cases were the item number creation task was forgotten to be created by the sales engineer or the item number was still in the queue because the necessary information was not provided to the creator, was observed. Another issue arose from the fact that the person processing the sales order was not always the same person who had made the quotation.</p>	Poor information quality, Deviations in common work practises



	Occasionally, a sales order processes had difficulties of finding all the information related to quotations made by another sales team member, even though there was an agreement to save quotation information to the unit's common network drive.	
	<b>Processing of EDI orders:</b> EDI orders are designed to speed up the order processing between the customer and the supplier. However, the unit experienced some bottlenecks in EDI order processing in particular. EDI purchase order received from the customer has to match exactly the sales order of the supplier. If the purchase order is in any way faulty or has insufficient information, the customer has to fix it and resend it in the ERP system before the sales order can be completely processed. This is an issue especially with customers working in different time zones because the request to alter a purchase order takes at least a day for the customer to process which causes unnecessary delays. In addition, the customers were not always trained to handle the EDI orders correctly, which caused additional bottlenecks in the process because the sales team had to advise the customer. Also, some technical glitches were observed in the ERP system that caused minor delays in the order processing.	Working in different time zones, insufficient know-how of internal customers, inflexible ERP system
<b>Purchasing process</b>	<b>Missing product or other documentation:</b> Some products need additional information such as technical or electrical drawings or supplier's offer for purchasing. There were many occasions observed where the purchaser couldn't find the necessary information and the person responsible for quotation was not available. Thus, the parts might wait, even for many weeks, for the needed information for purchasing. There was also varying work practises relating to providing the necessary documents for procurement observed. Some sales team member send the information straight to purchaser's email and some save it to the common network drive which causes confusion in some cases.	Poor information availability and internal communication, deviations in common work practises
	<b>Supplier order confirmation:</b> Konecranes requires all purchase orders to be confirmed within a week period of ordering. However, many suppliers do not always	Inadequate supplier relationship

<p>follow this rule. The researcher observed that many suppliers do not confirm the order on time unless it was particularly asked for which creates extra work for the procurement. It was also observed that different purchasers have different ways of handling the confirmation. After the confirmation is received, it's recommended to save the order confirmation and mark the confirmed delivery date to the ERP system. This way, all around visibility to confirmed orders is secured for everybody. However, many of the purchasers either saved the order confirmation or marked the confirmed date to ERP system and only a few did both of the actions.</p>	<p>management, deviations in common work practises</p>
<p><b>Lead time gaps:</b> A lead time gap is born when the customer is expecting a certain lead time but the supplier cannot reach the desired lead time. It was observed that very often the unit's suppliers confirmed significantly later lead times than was expected. The expected lead times for the products are determined from the item data in the ERP system. It was also noted that especially in stock items, some products had excessively long lead time stated in the ERP system and the products could be attained earlier by just asking the supplier.</p>	<p>Inadequate supplier relationship management, poor data quality</p>
<p><b>Supplier delays and communication:</b> Supplier delays were quite usual in the unit and on many occasions the suppliers did not inform the purchaser of a delay. The delay was usually noted when the goods had been already delayed from the confirmed delivery date. This led to the situation that the purchaser responsible had to start asking after the order which caused extra work and took time from the actual purchasing work. There was also variety in practises between the purchasers in following after the purchase orders. Some purchasers did not follow their orders actively and usually, the delays were noted by the sales order creator who had received a complaint from the end customer about the delayed order. Some purchasers followed their orders but did not always inform the changes in lead times to sales order creators.</p>	<p>Inadequate supplier relationship management, insufficient order follow-up, lack of internal communication</p>

	<p><b>Claim handling:</b> Supplier claiming was observed to be quite uncommon and happened only in the most major cases. Many of the suppliers had not signed the Konecranes supplier contract and thus were not under common claiming policies. There was also some confusion in the claiming practises and it experienced difficult to execute in the ERP system by few of the purchasers.</p>	<p>Inadequate supplier relationship management, obscure claim handling practises and insufficient skills in the ERP system</p>
<p><b>Warehouse and logistics processes</b></p>	<p><b>Receiving goods:</b> The researcher observed periodic bottlenecks in the receiving function of the warehouse. Goods were almost always physically received to the warehouse but often the worst delay was in entering the goods receipt into the ERP system. Without the goods receipt in the ERP system, other OTD process participants had no visibility on if the goods had arrived or not. This lead to a situation that especially towards ends of the moths or quarters when the amount of receivable goods usually increased, purchasers or sales order creators had to ask the warehouse to check if the goods have already arrived and could be marked to the ERP system. Sometimes, the goods were found only after when the sales team member had a tracking number from the supplier and could prove that the goods have been physically received. Needless to say, this caused frustration in the sales team and at worst many days of delays to the deliveries. In addition, sometimes the goods were delivered to the wrong place in the Hyvinkää area by the freight companies and it could take may weeks before anybody noted and informed that they had the wrong goods in the wrong place.</p>	<p>Inadequate resources, inefficient ways of working, lack of internal communication</p>
	<p><b>Packing:</b> There were some particular issues observed in the packing function. Since packing time is dependent on order size, large orders need more packing time. In addition, if the packed product is particularly large and heavy, such as certain crane gears, special packing arrangements such as container packing needed to be made. Also, large numbers of small separate items, require a long time from packing. There were many cases observed where the sales team</p>	<p>Unclear responsibilities, lack of internal communication, insufficient logistics know-how</p>

<p>had assessed overly optimistic time schedules for packing of an order, which could not be fulfilled by the warehouse and ultimately led to the delaying of the order. Many times, there was also unclarity between the sales team, warehouse, and logistics concerning the packing arrangements and who's responsible it was to find out the correct packing method in the tricky cases. In addition, there was a lack of logistical know-how observed in the process participants concerning the special packaging cases.</p>	
<p><b>Booking shipments:</b> Logistics unit books the shipment based on the shipping type and incoterms specified in the sales order. In cases of delivery outside the European Union, additional details such as the pro forma value (commercial value), country of origin and net weights of shipped goods might be required. Providing this information is primarily on the responsibility of the sales order handler and should be inserted in the order on order processing stage. However, this information is many times forgotten or left unmarked because of carelessness and lack of written instructions in the unit. This leads to a situation where many of the deliveries get stuck to this final stage because of insufficient information on the sales order. This leads to information request emails between the logistics and sales team, which cause extra workload for everyone and delay the shipment. At the same time, the delay in shipment causes a delay in invoicing process because usually the goods cannot be invoiced before shipment</p>	<p>Poor information quality, lack of written instructions and internal communication</p>
<p><b>Atypical shipping types:</b> Another type of delays can originate from atypical shipping arrangements such as customer pickups or in cases where the customer wants to collect all of their orders over a long period time into one collective shipment. The customer pick up times vary from one day to many months, which can be an issue. The long pick up times consume recourses because logistics team has to constantly remind the customer to arrange the pickup and also incurs costs because the uninvoiced goods are waiting in the warehouse. There are no contracts or recommendations</p>	<p>Insufficient customer relationship and contract management</p>

	between the end customer and the unit of the recommended pick up time for the orders.	
<b>Customer support process</b>	<b>Customer claim handling:</b> During the year 2015, the researcher was able to be part in multiple customer complaint cases. On based on observations, the two most critical stages are in the process are finding out what party has caused the issues and how to proceed with the case. Some problems in the process occurred from the inflexibility of the ERP system to handle complex complaint cases. There was also some obscure practices how to proceed with different types of claims and people were inexperienced to handle these cases. Also in PTO cases, it was occasionally difficult to get the supplier to handle the cases as urgent, especially if the supplier was not the fault of the failure. There was also no claim handling system actively in use, which caused the inability for the claim cases to be documented and researched afterwards.	Lack of written instructions, obscure claim handling practises, inflexible ERP system, no active usage of claim handling system
<b>Other observations</b>	<b>General informing and communication:</b> The informing and communication in the unit is mainly done by emails in meetings or in face-to-face conversations between colleagues. There is no general cloud-based communication and information sharing platform in use for the unit. This has led to variable levels of communication in the unit. In many occasions, someone in the team did not get the email sent or was absent in the meeting and thus was left out of the general communication. In addition, the communication between units was often slow and insufficient which led to significant difficulties in the OTD process. Also, the OTD process participants arrange rarely common meetings or confront each other face-to-face in their daily work which makes the efficient communication through other methods even more important.	Lack of common communication practises in and between the units
	<b>Lack of written instructions:</b> The researcher observed a notable lack of written instructions for different work tasks in the unit. This lead to a situation where only one or few people knew how to operate certain systems or do certain kind of tasks and in cases of unexpected sick leaves or holidays which led to	Lack of written instructions, unevenly divided information and know-how

	<p>problematic situations in the unit. On the other hand, there was also a vast amount of tacit knowledge held by a few individuals in the unit. This led to a situation where other team members constantly kept bombarding these certain people with questions and requests for advice causing extra workload for these individuals. All in all, the knowledge in the unit was unevenly divided between the individuals.</p>	
	<p><b>Supply chain control and visibility:</b> The OTD process participants have a limited visibility and control over the other functions of the process. Many of the actors in the process experienced that they did not fully understand what is exactly going to happen in the next or previous stage of the process or where they could view the progress of the process. This manifested itself in practice for example in the sales team's inability to look up the tracking number from the ERP system. This was partially caused by the insufficient understanding of the OTD process and lack of technical skill in the ERP system but also the lack of rights to view or control anything else but their own part of the process in the system. In the previous ERP system used in the unit, the actors had much more visibility and possibility to guide the whole OTD process which gave the users a sense of control over the process. The current ERP system divides the OTD process into different modules which on the other hand clarifies responsibilities and roles in the process but at the same time makes the process incoherent and divides the participant into silos.</p>	<p>Lack of technical skills and rights in the ERP system, Inadequate understanding of the different functions of the OTD process, modularity of the ERP system</p>
	<p><b>Focus on customer view:</b> There are few customer's satisfaction surveys done in company and unit level yearly. However, the result of these surveys are not commonly gone through in the unit. This means that the unit's members get rarely feedback from the customers except in the cases of customer complaints. Because of the lack of documentation of customer claims and their corrections, the sales team gets also fairly little amount of information about the claims and how the cases should be handled in the future. This leads to situations where the same mistakes are easily</p>	<p>Lack of discussion regarding the customer survey results, lack of claim documentation and learning from mistakes</p>

	repeated in the process which can lead to unsatisfied customers.	
	<b>Demand forecasting and spare part categorization:</b> Demand forecasting and spare part categorization relay mostly on the experience and know-how of few key persons in the unit. No scientific method is used in demand forecasting as it's solely based on previous demand and perceived part criticality. In focusing of proper demand forecasting and spare categorization the unit could improve the availability through more precise stocking and improve lead times of parts.	Demand forecasting and spare part categorization based on experience

## 5.4 Suggestions for improving the order-to-delivery process

As was stated in the previous results, all of the sub-processes consume time and can cause bottlenecks to the OTD process. Therefore, it's crucial to improve every stage of the process in order to gain a fully working OTD process with an optimal lead time. The following development opportunities were recognized based on the research results:

1. Information flow and sharing practises
2. Documentation and data quality
3. Common working practises and service culture
4. Visibility and performance measurement of the whole supply chain
5. Customer communication and cooperation
6. Sourcing and supplier relationship management
7. Claim handling
8. Motivation and training of employees

In the next chapters, the development opportunities and suggestions for improvements are described in detail.

### 5.4.1 Information flow and sharing practices

As was described in the table 4, the information flow challenges are causing slow-downs in many parts of the OTD process. Thus, it is recognized as a significant development opportunity in the whole process.

The information sharing in PPC is mostly done via weekly team meetings and sending general notifications through different email lists. The documentation sharing is typically done through network drive and email. Konecranes offers its units a possibility to use a cloud-based information sharing platform. However, this

platform is not in use in the unit. This kind of platform could be a viable solution for sharing information such as new instructions relating to OTD process work tasks or other notifications in the unit. Cloud-base solutions tend to improve information availability since emails are easily lost and somebody is usually forgotten from the distribution. In addition, network drives can have complicated folder structures which leads to difficulties in finding information and also any new information is hard to distinguish from the old.

Documented instructions for work tasks or procedures increase the amount of explicit knowledge in the unit. Adding the amount and coverage of work task related instructions will enable easier orientation for new employees and prevent the knowledge accumulating only to certain employees. Lack of precise instructions can also cause delays in the OTD process because people have to start searching after the needed knowledge in the middle of process execution. Lack of adequate instructions also adds the risk of the process actors making mistakes that have to be corrected on later stages of the process. In addition to adding the work task related instruction coverage, special attention should be also applied to adding the OTD process understanding throughout the process. In many cases, the problems occur when the process participants do not understand what is happening in different stages of the process. Thus, the OTD process model and other process related instructions should be easily available and comprehensible communicated to every actor working in the process.

The information sharing between the units working in the OTD process is mostly done by email and occurs often only in urgent situations. No regular proactive status updates between the units are done. Thus, special situations such as machine breakdowns or employee absences are rarely communicated directly between the units and are usually found out by chance through “a person who knows a person”. This leads to situations where for example the sales team has to spend too much time following up after basic functions of the other sub-processes such as warehouse receiving the goods in time because they have no idea what is the situation in the warehouse. Usually, this kind of bottlenecks, such as delays in receiving goods, in the process are down to some temporary reasons, but without proper communication between the units, these reasons can be only guessed. When a delay or bottleneck in the process occurs, other process participants start usually asking after it which creates an even bigger workload for the already congested process part. With wide and proactive communication between the units, this kind of situations could be mostly avoided.

#### **5.4.2 Documentation and data quality**

Insufficient, unattainable, and scattered product documentation caused significant problems in the quotation, sales order, and purchasing process. Especially in the quotation phase, the difficulty to find proper documentation for old model cranes



causes big increases in the response times. Since correcting and filling the gaps in the old inadequate documentation would be a huge project, it should be at least confirmed that the current and future documentation of port cranes is made in consideration of the future spare part business.

The data quality in the ERP system affects the fluency of the OTD process. The correct lead times, suppliers, purchase and retail prices are the most important pieces of information for the spare parts in the ERP system. If any this information is missing or the data is outdated, it will cause delays in the OTD process since the sales engineer or purchaser has to clarify these before he or she can proceed. Also adding extra information such as weights and countries of origin can ease the sales order processing and shorten the OTD process lead times since this information is needed in some of the sales cases. Special attention should be also applied to keeping estimated lead times up-to-date in the system since many of the purchasers rely solely on this estimate. Thus, it is crucial to maintain, check and develop the data quality in the ERP system regularly.

### **5.4.3 Common working practises and service culture**

There were many deviations observed in working practices inside and between the units in the OTD process (see table 4). There was usually a common way of working agreed on certain crucial tasks but over time, many people had started to deviate or shortcut on these practices. This was demonstrated for example in situations such as a sales engineer not saving quotations he or she had created on the network drive or purchaser not changing the confirmed delivery date on delayed purchase order. This created issues in the OTD process if the person deviating from the common practices was absent and someone had to finish the process. Common ways of working create efficiency, cohesion, clarity and decrease the amount of overlapping work in the process and should be thus cultivated and strengthened with the process participants.

Strong customer service culture is a crucial part of the OTD process success. Every participant of the OTD process should work towards the best possible end customer satisfaction. In the current OTD process, sales, procurement, warehouse, and logistics seem to work in their own silos that are only interested in their own internal performance. The attitude, that we are all working to guarantee the satisfaction of one and the same end customer, should be strongly integrated and cultivated throughout the whole OTD process. On the other, not forgetting the end customer, every OTD process participant should be also made to consider who is their customer on the internal process( such as procurement's internal customer is sales) and how can they work in a way that serves the best this customer and makes their work as easy as possible. Together with this strong and integrated customer service culture towards both the end customers and internal process customers, the overall OTD process performance and flexibility could be improved in many cases.

#### **5.4.4 Visibility and performance measurement of the whole supply chain**

As noted in this research, PPC and also other OTD process participants carry out active internal performance measurement. However, these performance measurements do rarely extend over the whole supply chain. For example, little measuring is done to evaluate the complete lead time experienced by the end customers. More of the measuring focus should be made towards end customer and the customer satisfaction. There are few customer satisfaction surveys done yearly organization-wide but they have not been necessarily customized enough to pinpoint the customers' view on the service level offered in PPC. In addition, the results of the current and future customer satisfaction surveys should be more carefully analyzed and learned from within the unit. If satisfactory and accurate customer service level and satisfaction measurement could be done on a regular basis in the unit, the results of the surveys could be even possibly be considered to be tied to yearly incentives in order to improve the organization's customer focus. In addition, some of the KPIs used to measure OTD process should be re-evaluated and the measuring method modified because of validity issues described in the chapter five.

The use of common ERP system enables the visibility over the functioning of internal units, suppliers, and customers. However, in many cases, it was observed that the process participants did not have the viewing rights or know-how to acquire the needed data outside their own unit from the system. This leads to situations where process participants ask the data that they could have acquired themselves from the other units. This on the other hand consumes time and creates extra work for the different organizations in the OTD process. It should be remembered, that the benefits of a common integrated system are only fully utilized when everybody has the visibility and ability to exploit the visibility in the system. In addition, increasing the supply chain visibility to external parties such as external suppliers is also a potential development opportunity in the future. EDI purchasing should be highly preferred and future investments in automated order handling and integrated order controlling systems with the suppliers could relieve the workload of purchasing and increase the efficiency in the OTD process.

#### **5.4.5 Customer communication and cooperation**

Customer communication problems were mostly reflected on the quotation requests and sales orders that had inadequate or misleading information. During the research, it became clear that many of the customers were confused with the unit's spare parts offering and did not have the technical knowledge to order the parts correctly. Many of these obscure requests and orders from the customers, consumed a lot of the sales teams' time and increased the lead time of the OTD process. A lot of these vague

and inaccurate requests could be reduced with providing customers product training and implementing better customer relationship management policies. The soon to be launched parts e-store will most likely improve the situations with this issue but the meaning of customer training and cooperation should not be forgotten as a potential development opportunity in the unit.

#### **5.4.6 Sourcing and supplier relationship management**

Lead time analysis on purchasing process represented in the chapter 5.2.8 revealed some room for improvement in the process performance. The overall procurement punctuality was 72 percent, the average supplier lead time 25 days and the delay of goods approximately four days in the year 2015. Lead times of PTO goods affect greatly to the total availability of the spare parts because half of the unit's parts are in this category. Reducing the supply lead times will thus decrease the total average lead time of the OTD process.

Procurement has a huge supplier base with over 470 suppliers. However, only nine suppliers consumed over 50 percent of the procurement spent in 2015. Still, in this group of top suppliers, the average lead time was relatively long, varying from eight to hundred days. This is a strong message that the supplier relationship management should be improved especially within the top suppliers that are offering far too long lead times. The performance of the top suppliers should be monitored continuously and in the case of a decline in negotiated lead times or service level, fast communication towards the supplier should be established. In addition, exclusive and improved supplier contracts with these suppliers should be negotiated.

In addition, managing the relations and contracts with smaller suppliers should not be forgotten. The units (PPC and CPC) have a great amount of low volume purchasing activity distributed to many small suppliers. As it was stated in previously, over 80 percent of suppliers had under 50 order lines purchased from them in the year 2015. Small volume and value purchasers are not very alluring to suppliers and do not motivate to keep up a good service level. Therefore, the supplier base should be studied for any consolidating possibilities within the smaller suppliers. Consolidating the suppliers could raise the volume and value of the purchases made from particular suppliers and simultaneously increase the supplier's motivation to provide better customer service. Increasing the yearly spent per consolidated supplier could also give the unit some leverage on negotiating better purchasing prices.

The supplier base includes also a few problematic suppliers that offer very long lead times, inflict often delays but on the other hand supply goods that are hard to source from anywhere else. Special attention to these suppliers should be paid because these suppliers are critical but also cause constant delays to the OTD process. Any possibilities to replace these problematic suppliers should be researched. In cases

where the changing of a problematic supplier is not viable, good and long-lasting relationship with these suppliers should be established. In addition, primary product lines use a lot of the same products in port cranes manufacturing projects that are sold as spare parts. Thus, many of the spare parts could be sourced simultaneously with the primary product line manufacturing projects to gain leverage and better purchasing prices.

#### **5.4.7 Claim handling**

As described in table 4, claim handling was found difficult in many situations. Supplier claiming was observed to be quite uncommon and happened only in the most major cases. Claiming suppliers of unsuccessful customer service is very important because otherwise delays and poor service do not have any concrete consequences to the supplier. Therefore, it would be essential to add the monitoring of supplier performance and claiming. In addition, purchasers should receive more training on claim handling and obscure claiming practises in the organization should be clarified and made easily understandable and to all.

The claim handling between the units was also experiencing issues. A claim handling software had just recently been taken actively in use in the PPC. Previously, mistakes made in other units of the OTD process were corrected but no actual claiming or documentation of the error was done. In order to develop a top-performing OTD process, proper claim documentation and analysis is crucial throughout the process.

Claims received straight from customers are processed in the same way as claims between the units. There was an obvious lack of documentation and analysis of customer claims in the unit observed. The positive side of this was the fact that the errors made were immediately corrected and usually customers received good customer service relating to claims. Customer claim handling and error analysis is an important aspect of quality management. On other words, organizations need to document and learn from the mistakes done and every claim can be seen as a learning opportunity for improving the OTD process. Thus, improving claim handling is a potential development opportunity for the unit in the future.

#### **5.4.8 Motivation and training of employees**

Highly motivated and skilled workforce is crucial to the success of every complicated process. Especially in high workload situations, the motivation of the employees is essential. The people acting in the OTD process work in a very knowledge intensive environment. In this kind of working environment, people can easily experience information overload and get tired of constantly changing and updating information. Thus, it is important to keep everybody informed and offer training in change situations such as in cases of new system releases.

Some lack regarding technical skills in the ERP systems was also observed in the unit. The ERP system skills of the process participants should be maintained and updated on a constant basis. The unit did not currently have any person responsible for ERP system and its training which caused sometimes issues and slow-downs and frustration because the needed advice had to be asked from a different unit in problem situations. Overall, well-trained and motivated workforce is a necessity for reaching the best possible process performance in a company and this element should not be disregarded in any unit working in the OTD process.

## 6 Discussions

The purpose of this study was to answer to the following main research question:

*R1: What are the development opportunities in the supply chain process?*

In order to answer the main research question, the following sub-questions needed to be also answered:

*R1.1: What is the current supply chain process model?*

*R1.2: What is the current performance of the supply chain process?*

*R1.3: What are the main challenges and bottlenecks in the current supply chain process?*

The first sub-question (R1.1) was answered by modelling the supply chain process according to the process steps recommended by JUHTA (2012). In the modelling, five sub-processes were recognized. These five sub-processes were quotation process, sales order process, purchasing process, warehouse and logistics process, and customer support process. According to Mohapatra (2013, pp. 117-118), companies' everyday operations can include hundreds or even thousands of processes that may be formal and documented or informal and exist only as tacit knowledge. Most of the business processes are also typically complex, and need to be communicated in a clear way in order to be understood comprehensively. In this research case, the knowledge of the OTD process existed mostly as vaguely documented or as tacit knowledge among the key persons working in the process. Thus, the modelling of the process produced a needed documentation of the process and enabled the researcher to piece a together a picture of the process' current state. The OTD process model created in this research can be also exploited to improve the overall process understanding of the participants in the company.

The main weaknesses of the modelling was that it was conducted solely by the researcher. The modelling was based on the data collected with the theme observations and interviews. However, this data was mainly gathered inside the unit and only one process participant outside the unit was interviewed. Thus, the modelling was basically constructed primarily on the view point of the case unit. Therefore, it would have been beneficial to include more people outside the case unit to get a wider perspective on the modelling. Other difficulties in the modelling related to defining the process boundaries and to the collection of sub-processes the OTD should include. Christopher (2011, p. 125) limited the OTD process to start from the customer order and end at the customer receiving the goods. On the other

hand Ross (1998), defined the OTD process as a process that starts with the recognition of a need to order and ends when the delivery of goods is made available for use. This difference in process outlines was significant for the researcher because it defined whether the quotation process and customer support process could be included to the process model. The researcher decided to use the wider definition and model the process as starting from customer need and ending to the customer need being fulfilled. This made the OTD process a very large entity to research and led to prolongation of the study. Choosing the narrower definition for the OTD process, could have led to more easily manageable and comprehensible process model and possibly enabled the analysis of sub-processes on a more specific level.

The current process performance was studied and evaluated in order to answer the second sub-question (R1.2). The metrics chosen for the research were either process key performance indicators (KPIs) or other indicators very closely related to the OTD process. Performance measurement helps to bring more scientific analysis into companies and diminishes the effect of experience and judgment into the decision-making process. (Rezaei & Baalousha, 2011). This data collection method was particularly chosen because it produced unbiased quantitative data of the process performance.

The performance analysis indicated that even though the KPIs were generally on a good level, the target levels were still not often reached. There were also some validity issues noticed in the KPIs used. Some of the KPIs were either measured mainly from the unit's and not the customer's perspective or manipulated intentionally or accidentally to in order to get more favorable results. The sales order line amount analysis revealed the sporadic nature of the spare part business noted also in the literature (Wagner, et al., 2012; Morris, et al., 2006; Huiskonen, 2001). This stochastic variation was for example exposed in the amount of order lines tripling occasionally between months. The purchasing process performance analysis revealed some interesting facts about the supply operations. The results indicated that even though of the huge supplier base in use, only a tiny group of suppliers consume most of the overall procurement spend. The performance analysis also revealed that these group of suppliers have still fairly long lead times despite the big expenditure. In addition, the general supplier lead time and average delay of goods were discovered to be quite lengthy. Overall, the process performance revealed many places for improvement in on all of the sub-processes.

Major challenges in the performance analysis were data availability and confidentiality. All the data relating to the process was not attainable for the researcher. In addition, the researcher had to consider confidentiality issues when presenting data collected from the BI system. Another weakness of the performance analysis, was that it did not study the performance of the sub-processes equally. This research focuses mainly on evaluating the performance of sales order process

and purchasing process. The metrics for quotation, warehouse and logistics, and customer support process were not studied in-depth in this research. This distorts the results, because the attention is more easily turned to only the issues relating to the processes with the most extensive performance analysis and other sub-process issues are left unnoticed. To prevent an unbalanced analysis, it could have been valuable to form a performance measurement framework such as balanced scorecard that could have helped to analyze the performance of the whole OTD process equally from different angles.

One limitation to performance analysis was also that it studied the performance of the process only during the year 2015. When measuring process performance, it is crucial to know if the current process performance is better than before (Kueng, 2000). Therefore, a longer time sample of the process performance could have produced a more precise picture of the process performance and its variations. On the other hand because of the strict time limit relating to this thesis, a bigger sample could have been too difficult to analyse and prolonged the study time.

The third sub-question (R1.3) was answered by recognizing the challenges and bottleneck based on observations made of the OTD process. Brainstorming and discussions with colleagues were also used to pinpoint the most troubling bottlenecks in the process. The results revealed that every sub-process had multiple overlapping challenges. The most common challenges observed included internal communication, data quality, product documentation, customer communication and cooperation, written work instructions, claim handling, ERP system, and common work practises.

The research managed to recognise significant challenges and bottleneck in the OTD process. However, once again, the observation data was gathered entirely from inside the unit. A much more extensive and versatile data could have been gathered by conducting observations, surveys or interviews in the other units participating to processes. Another weakness in the challenge recognition was that the data gathering was mainly done by observing, which is a data collection method sensitive to bias. The researcher was a part of the daily functioning of the OTD process and thus very vulnerable for opinions and assumptions originating from the other team members and the researcher herself. A data collecting method resulting to quantitative data, such as time study, could have resulted in independent data and helped to reveal the most time consuming bottlenecks in the process.

The main research question (R1) was answered based on the findings made from the sub-questions. Eight main development opportunities were recognized and described in detail. These development opportunities were related to information flow and sharing practises, documentation and data quality, common working practises and service culture, visibility and performance measurement of the whole supply chain, customer communication and cooperation, sourcing and supplier relationship management, claim handling, and motivation and training of



employees. In addition, some suggestion improvements on the development opportunities were made.

The main research question was answered in a satisfactory level in this study. However, because the development opportunities were recognized based on the previous findings, the same weaknesses and limitations that were present in the sub-questions affected also these results. In overall, the research project succeeded quite well. Significant challenges and potential development opportunities were recognized in the process. These findings can be used as a starting point for any future supply chain development projects in the company. The company also received valuable information on the performance and flow of the OTD process. However, it should be noted that best results in supply chain performance are achieved when the supply chain is managed as a whole (Christopher, 2011, p. 133). Relying on this assumption, this research could have focused overall more on the view of managing the supply chain as an integrated system instead of dividing the process in to smaller process parts and thus, emphasizing the modularity of the supply chain process.

## 7 Conclusions

In today's highly competitive environment, customers are demanding ever shorter lead times and first-rate customer service. In addition to shortening lead times, customers expect flexibility and real-time tracking possibilities for their orders. This puts huge pressures on the companies to create fast-reactive supply chains with improved chain visibility. In spare part business, the demand can be sporadic and volatile in nature. This makes spare part supply chains especially difficult subjects to manage and control. In spare part business, the fast availability of parts and reliable service is key to achieving customer satisfaction. The subject to this thesis arose from the need to improve the whole OTD process in the spare part unit of a leading supplier of industrial cranes in the world.

The purpose of this research was to recognize the challenges and development opportunities in the OTD process. In addition, this thesis was made to help the managers to understand the challenges and root reason behind the issues in the OTD process which could make the improvement of the process easier. Another practical target of study was to increase the overall understanding of the process among the process participants with the aid of the created process model. This thesis also aimed to increase the managers' theoretical knowledge on the nature of the spare part business and the special characteristics relating to spare parts supply chain management.

The research project was started with accumulating knowledge about the relevant theories from the scientific literature. The results of this knowledge gathering were then broken down in the study's theory section. In the theory section of this thesis, the basics of business process management and spare part logistics was represented. The purpose of the theory section was to support and give a scientific framework for the research project.

In the results section, the current process model, performance, challenges and development opportunities were represented. Modelling of the process revealed that the OTD process was constructed from five sub-processes which were quotation process, sales order process, purchasing process, warehouse and logistics process, and customer support process. The performance of these sub-processes was evaluated using the process KPIs and additional performance metrics. The general performance of the OTD process was on a satisfactory level, although many of the KPI target levels were not reached. Most important issues revealed in the performance analysis were fluctuating order amounts, long supplier lead times, and long average delay of suppliers. It was also shown that supplier spend did not correlate direct to supplier lead time.

The most substantial challenges and development opportunities of the OTD process were recognized in this study. One of the challenges was insufficient information

sharing inside and between the units working in the process. Without proper information sharing, delays are easily born in the process. Also deviation work practices and lack of written instructions caused issues in the actual process execution. In addition, the performance analysis indicated that there was room for improvement in sourcing and supplier relationship management which was also identified as an important development opportunity in the process.

One of the main development opportunities recognized was related to customer service culture. Strong customer service culture is a crucial part of the OTD process success. Together with this strong and integrated customer service culture towards both the end customers and internal process customers, the overall OTD process performance and flexibility could be improved in many cases.

Lack of supply chain visibility is a major problem in today's global supply chains which often span across multiple organizations. Visibility is needed into demand, inventory, and shipments throughout the whole supply chain. The benefits of a common integrated system are only fully utilized when everybody has the visibility and ability to exploit the visibility in the system. For these reasons, the supply chain visibility was identified as a potential area for improvement in the process.

Insufficient, unattainable, and scattered product documentation cause significant problems in the quotation, sales order, and purchasing process. In addition, the data quality in the ERP system affected significantly the fluency of the OTD process. The product documentation and data quality were both identified as important improvement areas for the unit. Also, the customer claim handling and error analysis is an important aspect of the process quality management that was neglected in the unit. On other words, the organization needs to document and learn from the mistakes done and every claim must be seen as a learning opportunity for improving the overall OTD process.

There were notable amounts of vague and inaccurate customer requests that caused bottlenecks in the OTD process. This indicates that the communication and cooperation should be improved with the customers. It must be also noted that highly motivated and skilled workforce is behind the success of every complicated process. Especially in high workload situations and knowledge intensive environments, the motivation of the employees is essential and thus it should be maintained and improved on a continuous basis in the unit.

The OTD process always starts and ends at the customer. However, the emphasis of the process performance measurement is currently on the internal performance of the process. The customer's point of view and the complete lead time from the customer order to the customer receiving the goods is rarely measured. Therefore, a time study of the whole process is recommended for a future research subject. Measuring the time consumed by every step in the OTD process with different sales order and part types could give more accurate data and a complete picture of the

whole lead time and reveal hidden bottlenecks in the process. This would help to discover the underlying problems and reduce the lead time throughout the process. In addition, a survey of the OTD process sent to every unit participating in the process could be beneficial for increasing the understanding of the working practices and challenges experienced by other parties in the process.

Customer satisfaction is the most important measure of the OTD process. Thus, more research on how the customers are experiencing the process performance and what the customers would like to be improved in the process could be also a prolific subject for further study. Also, supplier base and lead time analysis are recommended areas for further research.

The main goal of this research was to recognize the challenges and development opportunities in the OTD process. There were multiple challenges development opportunities recognized and represented in this study. However, none of these development suggestions should be directly applied to the process without careful consideration. It should be noted that the development opportunities presented in this thesis are intended to provide solid background information and work purely as an idea pool for future supply chain development projects.

## References

- Aguiler-Saven, R. S., 2004. Business process modelling: Review and framework. *International Journal of Production Economics*, 90(2), pp. 129-149.
- Ahmed, P. K. & Simintiras, A. C., 1996. Conceptualizing business process re-engineering.. *Business Process Re-engineering & Management Journal*, 2(2), pp. 73-92.
- Bacchetti, A. & Saccani, N., 2012. Spare parts classification and demand forecasting for stock control: Investigating the gap between research and practice. *OMEGA*, December, 40(6), p. 722–737.
- Bandara, W., Gable, G. & Rosemann, M., 2005. Factors and measures of business process modelling: Model building through a multiple case study. *European Journal of Information Systems*, 14(4), pp. 347-360.
- Becker, J., Kugeler, M. & Rosemann, M., 2003. *Process Management. A Guide for the Design of Business Processes..* 1st ed. Berlin: Springer.
- Boylan, J., Syntetos, A. & Karakostas, G., 2008. Classification for Forecasting and Stock Control: A Case Study. *The Journal of the Operational Research Society*, 59(4), pp. 473-481.
- BusinessDictionary, 2016. *What is sourcing? definition and meaning.* [Online] Available at: <http://www.businessdictionary.com/> [Accessed 1 April 2016].
- Cavalieri, S., Garetti, M., Macchi, M. & Pinto, R., 2008. A decision-making framework for managing maintenance spare parts.. *Production Planning & Control: The Management of Operations*, 19(4), pp. 379-396.
- Chan, F. T. & Qi, H. J., 2003. Feasibility of performance measurement system for supply chain: a process - based approach and measures. *Integrated Manufacturing Systems*, 14(3), pp. 179-190.
- Chopra, S. & Meindl, P., 2007. *Supply chain management: Strategy, planning, and operation.* Upper Saddle River(New Jersey): Pearson Prentice Hall.
- Christopher, M., 2011. *Logistics & supply chain management.* Harlow: Financial Times Prentice Hall.
- Daft, R. L., 2008. *Organization Theory and Design.* 10th ed. Mason: South-Western Cengage Learning.

- Davenport, T. H., 2006. Foreword: A brief history of business process management. In: *Business Process Management Practical Guidelines to Successful Implementations*.. 1st ed. Oxford: Butterworth-Heinemann.
- Davenport, T. H. & Short, J. E., 1990. The new industria engineering: information technology and business process redesign.. *Sloan management review*, 31(4), pp. 11-27.
- Deming, E. W., 1986. *Out of the Crisis*. Cambridge: Massachusetts Institute of Technology, Center for Advanced Engineering Study. Cambridge University Press.
- DHL, 2008. *DHL Logbook - in cooperation with Technical University Darmstadt*. [Online]  
Available at: [www.dhl-discoverlogistics.com](http://www.dhl-discoverlogistics.com)  
[Accessed 5 July 2015].
- Dumas, M., La Rosa, M., Mendling, J. & Reijers, H., 2013. *Fundamentals of Business Process Management*. 1st ed. Berlin: Springer-Verlag Berlin Heidelberg.
- Elrod, C., Murray, S. & Sundeeep, B., 2013. A Review of Performance Metrics for Supply Chain Management. *Engineering Management Journal*, 25(3), pp. 39-50.
- Fitzgerald, L. et al., 1991. *Performance Measurement in Service Business, CIMA, London*.. London: CIMA.
- Forslund, H., Jonsson, P. & Mattsson, S.-A., 2008. Order-to-delivery process performance in delivery scheduling environments. 58(1), pp. 41-53.
- Gajpal, P., Ganesh, L. & Rajendran, C., 1994. Criticality analysis of spare parts using the analytic hierarchy process.. *International Journal of Production Economics*, June, 35(1-3), pp. 293-297.
- Gardner, R. A., 2004. *The Process-focused Organization: A Transition Strategy for Success*. Milwaukee: ASQ Quality Press.
- Garengo, P., Biazzo, S. & Bititci, U. S., 2005. Performance measurement systems in SMEs: A review for a research agenda. *International Journal of Management Reviews*, 7(1), pp. 25-47.
- Gebauer, H., Kucza, G. & Wang, 2011. Spare parts logistics for the Chinese market. *Benchmarking: An International Journal*, 18(6), pp. 748-768.
- Gopalakrishnan, P. & Banerji, A. K., 2013. *Maintenance and Spare Parts Management*. 2nd ed. Delhi: Delhi PHI Learning Private Limited.

- Hammer, M., 1990. Reengineering Work: Don't Automate, Obliterate. *Harvard Business Review*, July-August, pp. 104-112.
- Hammer, M., 2015. What is Business Process Management?. In: M. Rosemann & J. vom Brocke, eds. *Handbook on Business Process Management 1: Introduction, Methods, and Information Systems*. 2nd ed. Berlin: Springer-Verlag Berlin Heidelberg, pp. 3-16.
- Hannus, J., 1994. *Prosessijohtaminen - ydinprosessien uudistaminen ja yrityksen suorituskyky painos*. 4th ed. Jyväskylä: Gummerus Kirjapaino Oy.
- Harmon, P., 2015. The Scope and Evolution of Business Process Management. In: J. vom Brocke & M. Rosemann, eds. *Handbook on Business Process Management 1. Introduction, Methods, and Information Systems*. 2nd ed. s.l.:Springer, pp. 37-80.
- Heikkilä, J., 2002. From supply to demand chain management: efficiency and customer satisfaction. *Journal of Operations Management*, 20(6), p. 747–767.
- Hernaus, T., 2008. *Process-based Organization Design Model: Theoretical Review and Model Conceptualization*, Zagreb: University of Zagreb.
- Herrmann, C., Bergmann, L., Thiede, S. & Halubek, P., 2007. *Total Life Cycle Management - An Integrated Approach Towards Sustainability*. Zurich, University of Zurich.
- Hirsijärvi, S., Remes, P. & Sajavaara, P., 1997. *Tutki ja kirjoita*. Tampere: Kirjayhtymä Oy.
- Huiskonen, J., 2001. Maintenance spare parts logistics: Special characteristic. *International Journal of Production Economics*, Volume 71, pp. 125-133.
- Inderfurth, K. & Mukherjee, K., 2008. Decision support for spare parts acquisition in post product life cycle.. *Central European Journal of Operations Research*, 16(1), pp. 17-42.
- Jalil, M. N., Zuidwijk, R. A., Fleischmann, M. & Van Nunen, A. E. E., 2011. Spare parts logistics and installed base information.. *Journal of the Operational Research Society*, Volume 62, pp. 442-457.
- Jeston, J. & Nelis, J., 2006. *Business Process Management. Practical Guidelines to Successful Implementations*. 1st ed. Oxford: Butterworth-Heinemann .
- JUHTA, 2012. *JHS 152 Prosessien kuvaaminen*, s.l.: Julkisen hallinnon tietohallinnon neuvottelukunta.

Kaplan, R. & Norton, D., 1992. The Balanced Scorecard – Measures That Drive Performance.. January-February, pp. 71-79.

Karrus, K. E., 1998. *Logistiikka*.. 3rd ed. Helsinki: WSOY.

Keegan, D., Eiler, R. & Jones, C., 1989. Are your performance measures obsolete?. *Management Accounting*, 70(12), pp. 45-50.

Konecranes, 2011. *Konecranes' Annual Report*. [Online]  
Available at:  
[http://www.konecranes.com/sites/default/files/investor/kc\\_2011\\_annual\\_report\\_english.pdf](http://www.konecranes.com/sites/default/files/investor/kc_2011_annual_report_english.pdf) [Accessed 16 March 2016].

Konecranes, 2014. *Konecranes Corporate Presentation 2014*, s.l.: Konecranes.

Konecranes, 2014. *PPC Internal presentation 2014*, Hyvinkää: Konecranes.

Konecranes, 2015, Intranet. *mykonecranes.com*. [Online]  
Available at: <https://www.mykonecranes.com/> [Accessed 16 5 2015].

Kueng, P., 2000. Process performance measurement system: A tool to support process-based organizations. *Total Quality Management*, 11(1), pp. 67-85.

Laamanen, K., 2001. *Johda liiketoimintaa prosessien verkkona*.. Keuruu: Suomen Laatu keskus Koulutuspalvelut.

Laamanen, K. & Tinnilä, M., 2009. *Prosessijohtamisen käsitteet - Terms and concepts of business process management*. 4th ed. Tampere: Teknologia info Teknova Oy.

Laitinen, E. K., 1998. *Yritystoiminnan uudet mittarit*. Helsinki: Kauppakaari Oyj.

Lambert, D. & Cooper, M., 2000. Issues in Supply Chain Management. *Industrial Marketing Management*, 29(1), pp. 65-83.

Lecklin, O., 2002. *Laatu yrityksen menestystekijänä*. 4th ed. Helsinki: Kauppakaari.

Lehmuskoski, M., 1982. *Varastoinnin talous*. Jyväskylä: K.J Gummerus Osakeyhtiö.

Luksch, S., 2014. *After sales supply chain risk management*, Louisville: University of Louisville.

Lynch, R. & Cross, K., 1995. *Measure Up!: Yardsticks for Continuous Improvement*. 1st ed. Oxford: John Wiley and Sons Ltd.



- Martinsuo, M. & Blomqvist, M., 2010. *Prosessien mallintaminen osana toiminnan kehittämistä*. Tampere: Tampereen teknillinen yliopisto.
- Melão, N. & Pidd, M., 2000. A conceptual framework for understanding business processes and business process modelling. *Information Systems Journal*, 10(2), p. 105–129.
- Mohapatra, S., 2013. *Business Process Reengineering: Automation Decision Points in Process Reengineering*. New York: Springer Science+Business Media New York.
- Nadler, D. & Tushman, M., 1980. A diagnostic model for organizational behavior. In: J. Hackman, E. Lawler & L. Porter, eds. *Perspectives on Behavior in Organizations*. New York: McGraw-Hill, p. 83–100.
- Panayides, P. M. & Venus Lun, Y. H., 2009. The impact of trust on innovativeness and supply chain performance. *International Journal of Production Economics*, 122(1), p. 35–46.
- Parmenter, D., 2007. *Key Performance Indicators: Developing, Implementing, and Using Winning KPIs*. 1st ed. Hoboken(New Jersey): John Wiley & Sons.
- Patton, J. D. & Feldmann, H. C., 1997. *Service Parts Handbook*. New York: The Solomon Press Publishers.
- Pindur, W., Rogers, S. E. & Kim, P. S., 1995. The history of management: a global perspective.. *Journal of Management History*, 1(1), pp. 59-77.
- Polyvyanyy, A., Smirnov, S. & Weske, M., 2015. Business Process Model Abstraction. In: J. v. Brocke & M. Rosemann, eds. *Handbook on Business Process Management 1: Introduction, Methods, and Information Systems*. 2 ed. Berlin: Springer-Verlag Berlin Heidelberg, pp. 147-165.
- Porter, M. E., 1998. *The Competitive Advantage: Creating and Sustaining Superior Performance*.. Republished with a new introduction. ed. New York: The Free Press.
- Rantanen, H., 2001. *Suorituskyvyn osa-alueiden mittaaminen pkt-yrityksissä*, Lappeenranta: Digipaino.
- Rezaei, A. R. & Baalousha, T. Ç. Y., 2011. Performance measurement in a quality management system. *Scientia Iranica*, June, 18(3), p. 742–752.

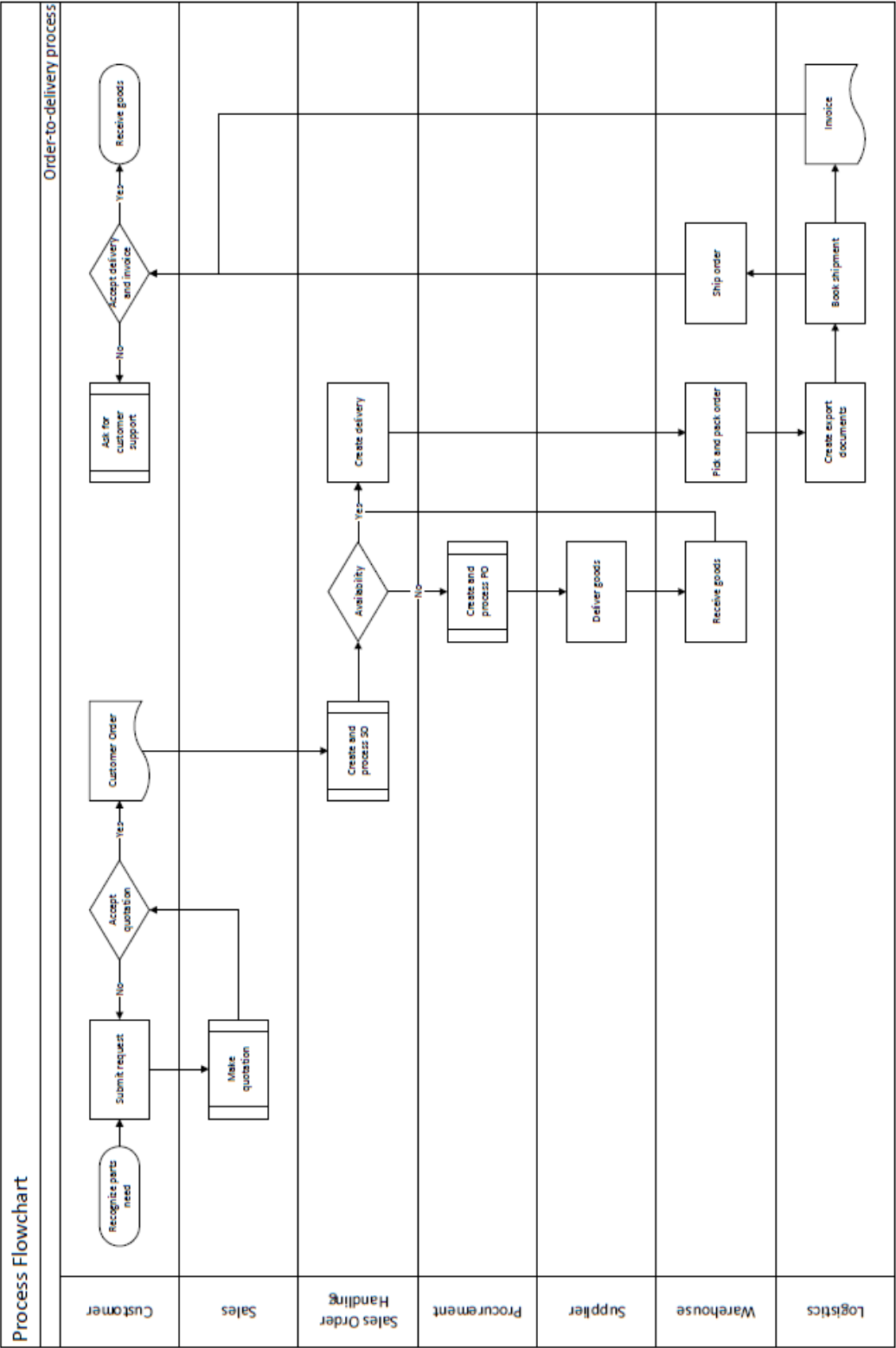
- Rockart, J. F. & Short, J. E., 1988. *Information technology and the new organization: towards more effective management of interdependence.*, s.l.: Center for Information Systems Research.
- Romppanen, J., 2014. *Global Spare Parts Supply Chain Analysis*, Lappeenranta: Lappeenranta University of Technology.
- Ross, D. F., 1998. *Competing Through Supply Chain Management*. New York: Chapman & Hall.
- Saaranen-Kauppinen, A. & Puusniekka, A., 2006. *KvaliMOTV - Menetelmäopetuksen tietovaranto.* [Online]  
Available at: <http://www.fsd.uta.fi/menetelmaopetus/> [Accessed 5 May 2015].
- Sakki, J., 1999. *Logistinen prosessi. Tilaus-toimitusketjun hallinta.* 4th ed. Espoo: Jouni Sakki Oy.
- Sakki, J., 2003. *Tilaus-toimitusketjun hallinta: Logistinen B-to-B prosessi.* 6 ed. Suomi: Jouni Sakki Oy.
- Shepherd, C. & Gunter, H., 2006. Measuring supply chain performance: current research and future directions. *International Journal of Productivity and Performance Management*, 55(3/4), pp. 242-258.
- Simchi-Levi, D., Kaminsky, P. & Simchi-Levi, E., 2008. *Designing & Managing the Supply Chain*. 3rd ed. Boston: McGraw-Hill Irwin.
- Stewart, G., 1995. Supply chain performance benchmarking study reveals keys to supply chain excellence. *Logistics Information Management*, 8(2), pp. 38-44.
- Tan, K. C., 2001. A framework of supply chain management literature. *European Journal of Purchasing & Supply Management*, 7(1), pp. 39-48.
- Wagner, S., Jönle, R. & A.B, E., 2012. A Strategic Framework for Spare Parts Logistics.. *California Management Review*, 54(4), pp. 66-92.
- Vanhaverbeke, W. & Torremans, H., 1999. Organizational structure in process-based organizations. *Knowledge and Process Management*, 6(1), pp. 51-52.
- Weske, M., 2007. *Business Process Management: Concepts, Languages, Architectures*. 1th ed. Berlin: Springer-Verlag.
- Yin, R. K., 2009. *Case study research: Design and methods*. 4 ed. Thousand Oaks: SAGE.

## APPENDIX 1. Process description

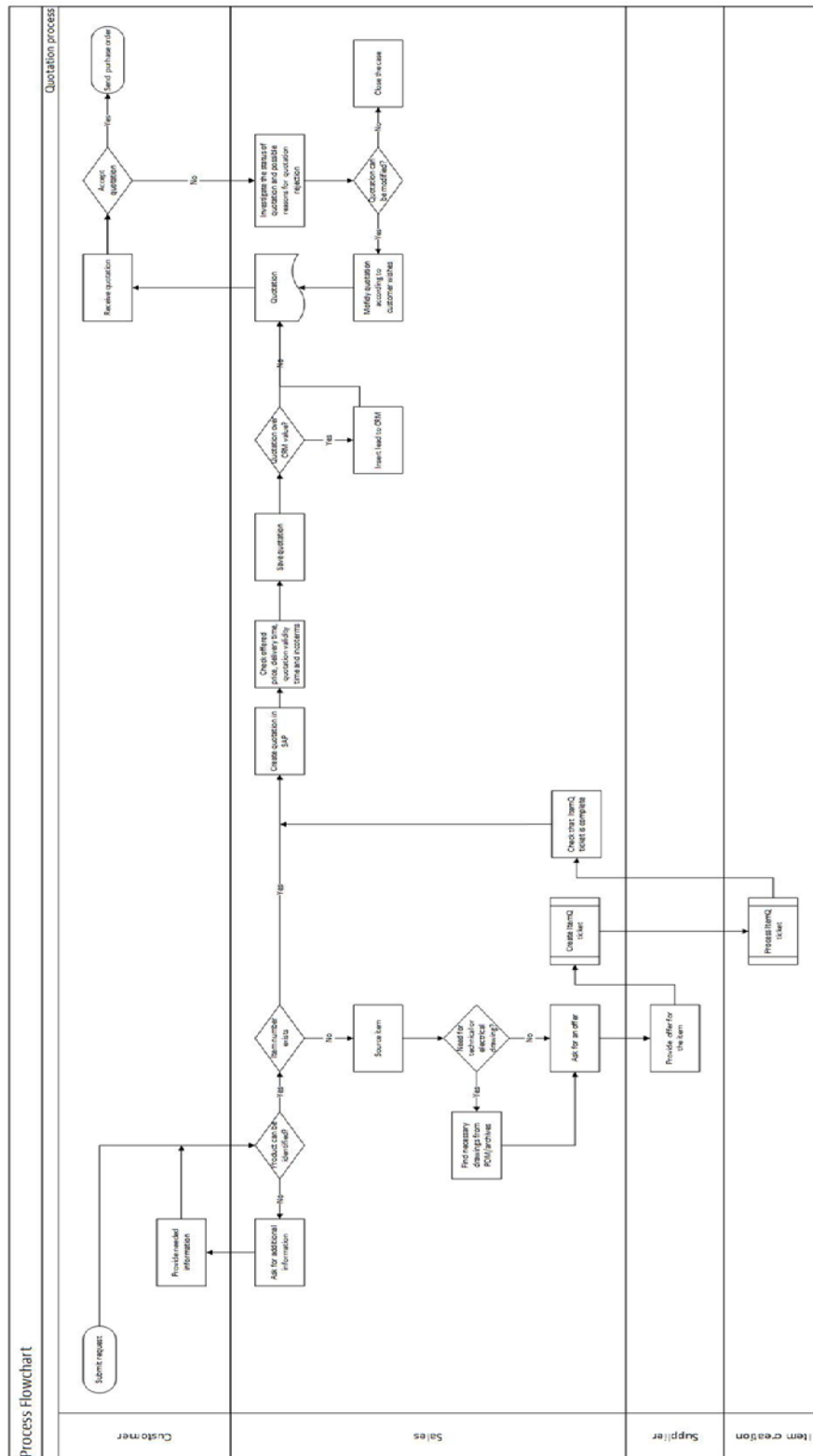
1	Process name	Order-to-delivery process of Ports Part Center
2	Model creator and creation date	Heidi Burman 1.2.2016
3	Process purpose	The purpose of the order-to-delivery process is to create customer value by enabling the ordering and delivering of the right products in the right place at the right time to the customer.
4	Process owner	Jukka Parkkonen
5	Process input	The process input for the order-to-delivery process is the customer's recognition of the spare part need. Once this input is detected, the order-to-delivery process will be initiated.
6	Process output	The output for the order-to-delivery process is the fulfillment of a customer need by receiving the ordered products.
7	Process customers	Internal and external customers
8	Process business units	Ports Part Center and Crane Part Center
9	Process participants	Customer, sales, order handling, procurement, supplier, warehouse, logistics and external logistics companies
10	Interface processes	Before input: R&D and marketing. After output: Financial, after sales processes
11	Process Flow	<p>12. Customer recognizes a spare part need and submits a request.</p> <p>13. Sales creates a quotation based on the request and sends it to customer.</p> <p>14. Customer receives the quotation. Customer can either:</p> <p>C) Reject the quotation: Sales will modify the offer and send a revised one to the customer or mark the case as lost.</p> <p>D) Accept the quotation: Customer decides to order.</p> <p>15. Customer submits a purchase order</p> <p>16. Sales order handling creates a sales order and processes it according to customer's purchase order.</p>

		<p>17. Sales order handling checks the availability of the ordered goods. If the items are:</p> <p>C) Available: Sales order handling creates a delivery in SAP which will trigger the warehouse to start processing the goods.</p> <p>D) Not available: Procurement orders the goods from a supplier-&gt;Supplier delivers the goods-&gt;Warehouse receives the goods -&gt; Sales order handling creates a delivery in SAP which triggers the warehouse to start processing the goods</p> <p>18. Warehouse picks and packs the goods</p> <p>19. Logistics creates export documentation and books the shipment</p> <p>20. Warehouse ships the goods by using an external logistics company</p> <p>21. Logistics creates and sends an invoice to the customer</p> <p>22. The customer can either:</p> <p>C) Decline the invoice and the delivery: Asks for customer support</p> <p>D) Accept the invoice and the delivery: Receives goods</p>
12	Process performance indicators	<p>Delivery Punctuality-%</p> <p>Response Time 48h-%</p> <p>Delivery Time</p> <p>Delivered on same day-%</p> <p>Inventory Turn</p> <p>Fill rate from stock -%</p>
13	Process success factors	Customer satisfaction, Short lead times, Availability, Flexibility

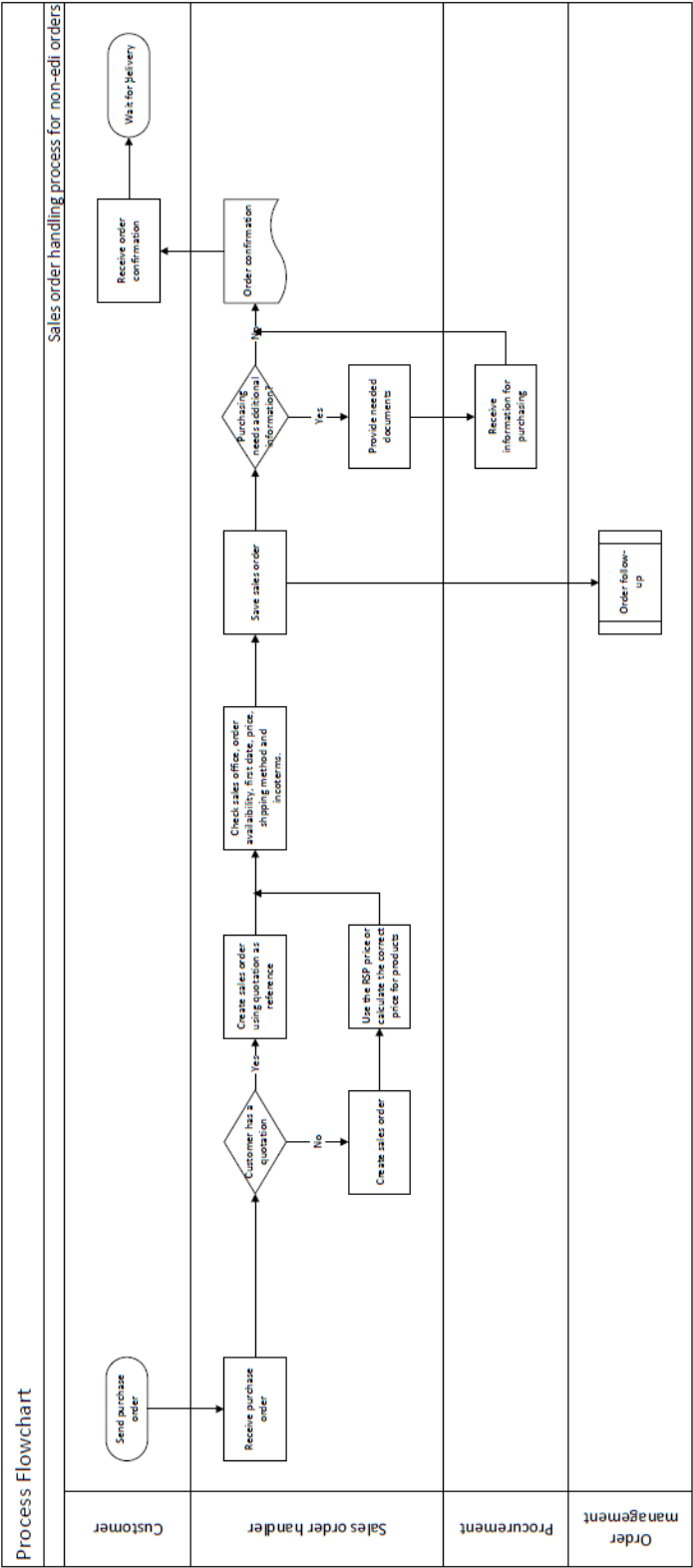
APPENDIX 2. OTD process flow chart



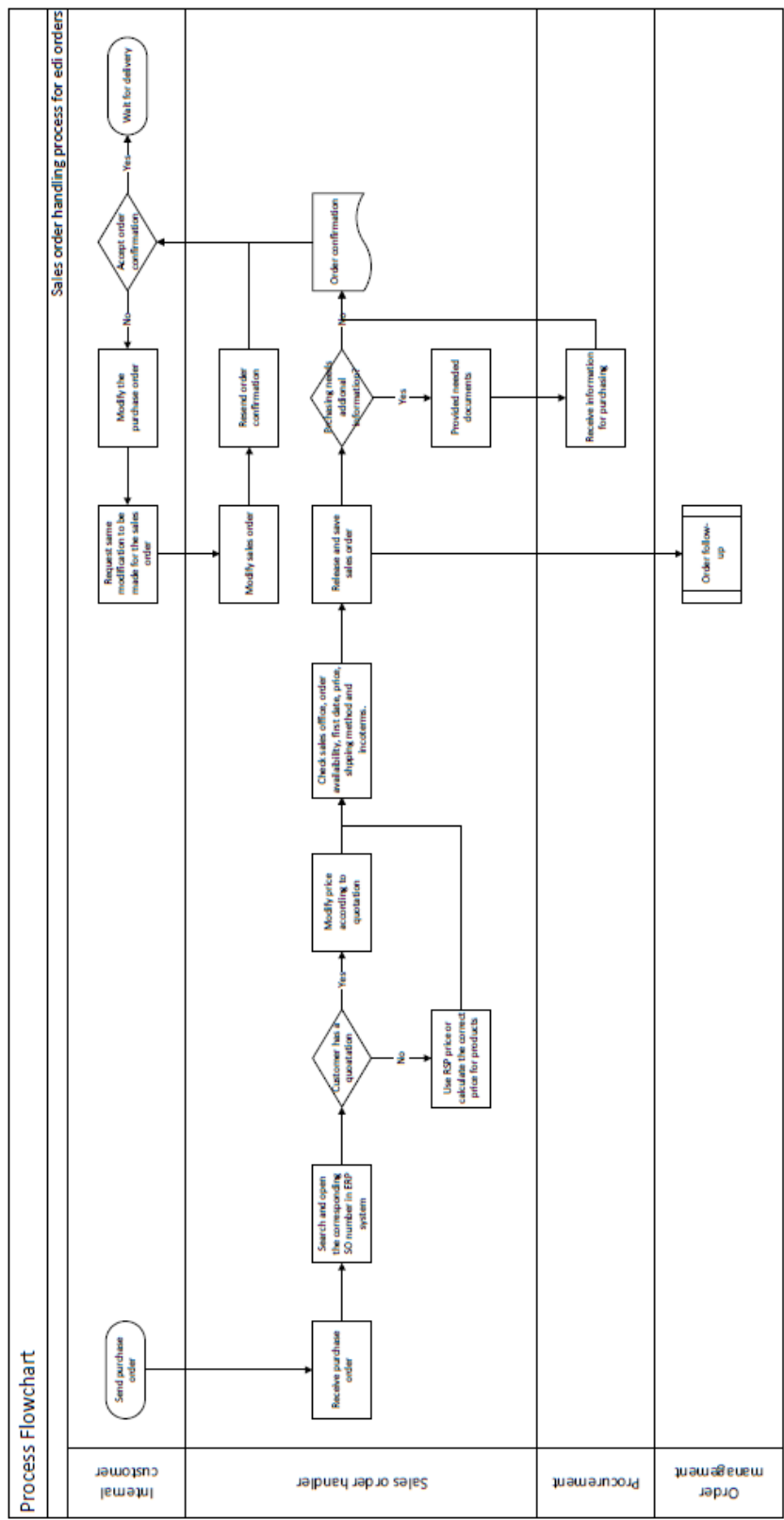
### APPENDIX 3. Quotation process flow chart



# APPENDIX 4. Sales order process (non-edi orders) flow chart

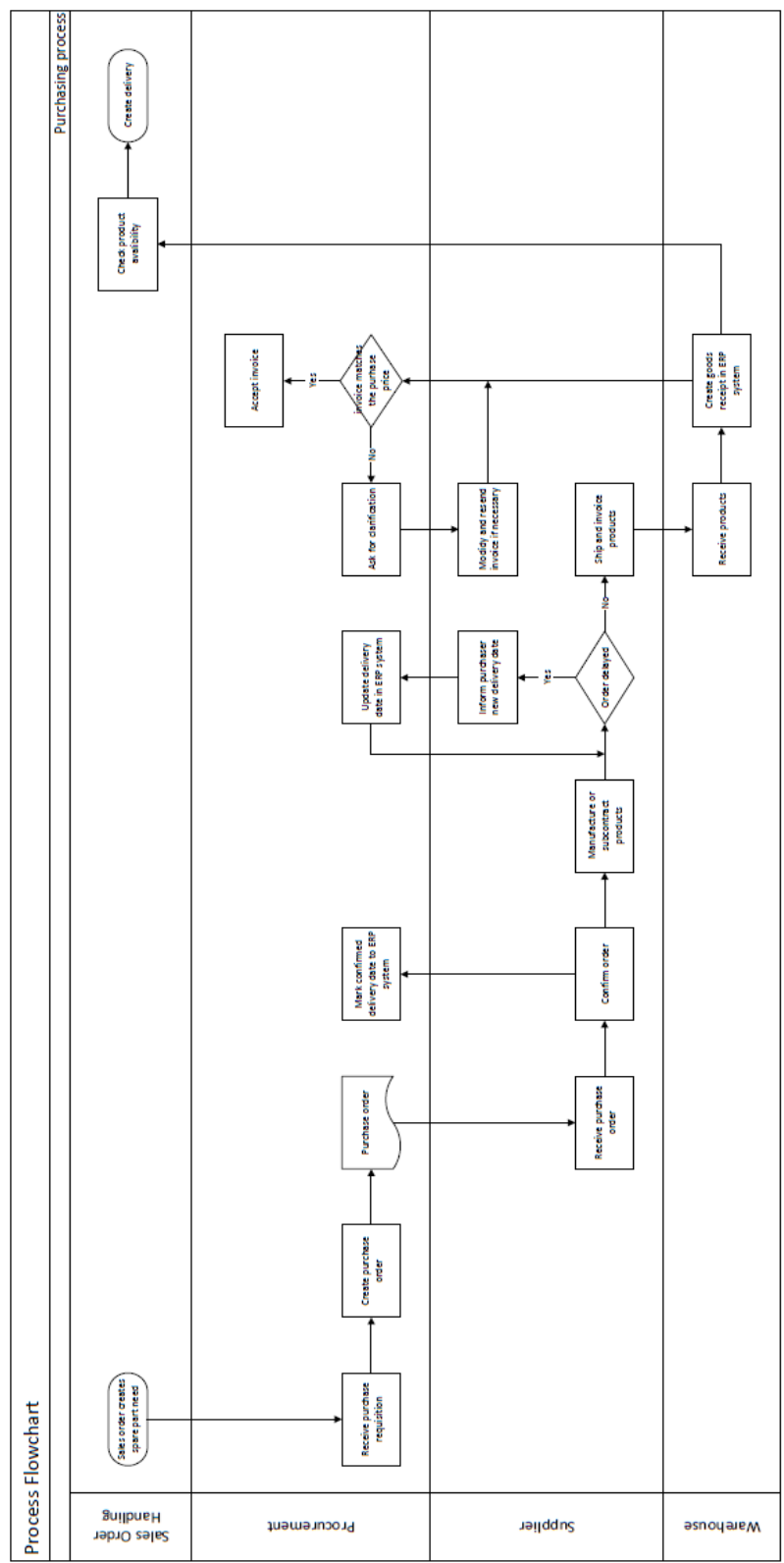


**APPENDIX 5. Sales order process (edi orders) flow chart**





APPENDIX 6. Purchasing process flow chart



APPENDIX 7. Customer support process flow chart

