TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

NIKKE ROTONEN

INTERCOMPANY SHIPMENT CONSOLIDATION PROCESS IN A THIRD-PARTY WAREHOUSE

Master of Science thesis

Examiner: Assistant Professor Heikki Liimatainen
Examiner and topic approved by the Council Meeting of the Faculty of Business and Built Environment on February 24th, 2017

ABSTRACT

NIKKE ROTONEN: Intercompany shipment consolidation process in a third-party warehouse
Tampere University of Technology
Master of Science Thesis, 104 pages
November 2017
Master's Degree Programme in Information and Knowledge Management
Major: Transportation, Logistics and Information
Examiner: Assistant Professor Heikki Liimatainen

Keywords: shipment consolidation, process development, supply chain management, supply chain, third-party logistics, logistics outsourcing

Shipment consolidation is often utilized for gaining transportation cost reductions by economies of scale. This study examines the intercompany shipment consolidation process in a third-party warehouse from the viewpoint of the case company's main distribution center (MDC), which is responsible for spare parts distribution. The case company is a manufacturer of industrial machinery and the requirement for shipment consolidation arose from a special capital equipment sales, in which a specific spare parts package is offered along with the capital equipment. Due to the scarcity of such special orders, the intercompany shipment consolidation process has not been defined at MDC. The main objective of this study was to define the intercompany shipment consolidation process, recognize its bottlenecks and problems and provide improvement ideas to it.

The theoretical part of the study concentrates on supply chain and supply chain management, while discussing topics such as logistics and supply chain integration. Also, more specific subjects regarding this study were covered, as the basics of shipment consolidation, third-party logistics and spare part logistics were introduced, as these subjects are relevant in the case process. The information systems used in supply chain management were briefly presented too.

The empirical part of the study is done by conducting a case study of a special project order that requires intercompany shipment consolidation. Several parties around the world are included in the process. Different parties were interviewed to form an understanding of the process. The process was defined utilizing a flowchart and written coverage. The definition and the interviews were used to identify the different bottlenecks and issues in the process. The problems of the process and their root causes were also assessed. A large part of the issues, such as communication problems were traceable to the rigid information systems that do not directly support such special needs of the case.

The development ideas to the process were divided into short-term and long-term ideas. The short-term ideas, such as consolidation order instructions, a streamlined process and different IT-tools, were emphasized, as they could be implemented in a fast schedule from none to little costs. It was noted, that for most benefit practically all presented short-term ideas should be implemented. The long-term ideas provide more of an aspirational state and visions for future. Most notable long-term ideas relate to virtual ERP-plants, consolidation at forwarder premises and material extension to MDC or centralized warehousing. However, most long-term ideas require quite radical changes from the company.

TIIVISTELMÄ

NIKKE ROTONEN: Yritystenvälisten lähetysten konsolidointiprosessi kolmannen osapuolen varastossa
Tampereen teknillinen yliopisto
Diplomityö, 104 sivua
Marraskuu 2017
Tietojohtamisen diplomi-insinöörin tutkinto-ohjelma
Pääaine: Liikenne, logistiikka ja informaatio
Tarkastaja: apulaisprofessori Heikki Liimatainen

Avainsanat: lähetysten konsolidointi, prosessikehitys, toimitusketjun hallinta, toimitusketju, kolmannen osapuolen logistiikka, logistiikan ulkoistaminen

Lähetysten konsolidointia hyödynnetään usein mittasuhde-edun saavuttamiseksi, jotta toimituskulut pienenisivät. Tämä työ tarkastelee yritystenvälisten lähetysten konsolidointiprosessia kolmannen osapuolen varastossa tutkittavan yrityksen pääjakelukeskuksen (MDC) näkökulmasta. Tutkittava yritys on teollisten laitteiden valmistaja ja pääjakelukeskus vastaa varaosien jakelusta. Tarve yritystenväliselle lähetysten konsolidoinnille nousi esiin erityisestä laitekaupasta, johon sisältyy tietyn varaosapaketin tarjoaminen itse laitteiston lisäksi. Kyseisten tilausten harvinaisuuden vuoksi yritystenvälistä konsolidointiprosessia tai työskentelytapoja niissä ei ole määritetty MDC:llä. Tämän työn päätavoitteena oli määrittää yritystenvälisten lähetysten konsolidointiprosessi, tunnistaa sen pullonkaulat ja ongelmakohdat ja tarjota niihin kehitysideoita.

Työn teoriaosuus keskittyy toimitusketjuun ja sen hallintaan käsittelemällä esimerkiksi logistiikkaa ja toimitusketjuintegraatiota. Myös työn kannalta spesifimpiä aiheita käsiteltiin, kuten esittelemällä lähetysten konsolidoinnin, kolmannen osapuolen logistiikan ja varaosalogistiikan perusteita niiden ollessa olennaisessa osassa tutkittavaa prosessia. Lisäksi toimitusketjun hallinnassa käytettäviä tietojärjestelmiä sivuttiin.

Työn empiirinen osuus toteutettiin suorittamalla tapaustutkimus erityisestä projektitilauksesta, joka vaatii yritystenvälisten lähetysten konsolidointia. Prosessiin osallistui monia osapuolia ympäri maailmaa. Eri osapuolia haastateltiin, jotta ymmärrys prosessista saavutettaisiin. Prosessi määritettiin vuokaavion ja kirjallisen selityksen avulla. Prosessin määritelmää ja haastatteluja hyödynnettiin prosessin pullonkaulojen ja ongelmakohtien tunnistamiseksi. Myös prosessin ongelmakohtia ja niiden juurisyitä arvioitiin. Suuri osa ongelmista, kuten kommunikaatio-ongelmat, olivat jäljitettävissä kankeisiin tietojärjestelmiin, jotka eivät suoraan tukeneet prosessin erityisvaatimuksia.

Esitellyt kehitysideat prosessiin jaettiin lyhyen aikavälin ja pitkän aikavälin ideoihin. Lyhyen aikavälin kehitysideoita, kuten konsolidointitilausohjeet, virtaviivaistettu prosessi ja erinäiset IT-työkalut, painotettiin, sillä niiden käyttöönotto voidaan toteuttaa nopealla aikataululla ja ilman kustannuksia tai pienillä kustannuksilla. Työssä huomioitiin myös, että suurimman hyödyn saavuttaakseen käytännössä jokainen lyhyen aikavälin kehitysideoista tulisi ottaa käyttöön. Pitkän aikavälin kehitysideat esittelevät visioita ja tavoitetilaa tulevaisuutta varten. Huomattavimmat pitkän aikavälin ideat käsittelevät virtuaalisia ERP-lokaatioita, konsolidointia huolitsijoiden tiloissa ja nimikkeiden laajentamista MDC:lle tai keskitettyä varastointia. Suuri osa pitkän aikavälin ideoista vaatii kuitenkin radikaaleja muutoksia yrityksessä.

PREFACE

I started to work on this master's thesis in fall 2016, commissioned by the case company to analyze and define the intercompany shipment consolidation process. I was not familiar with process and its concepts, which presented me with an opportunity to explore something new. I have learnt enormously about the company, its supply chain and in general about the supply chain related theory during the study. The research process was not always fun and it had its ups and downs, but it did provide me with true experiences of success along the way. I did not quite manage to reach my grand schedule I set for myself in the beginning of the research, but in the end, I am positive that the prolonged work with the study was not in vain, as it allowed me to polish and refine the study. The funny thing is that as the study progressed, the feeling of only scratching the surface increased – there are so many things and details that had to be left out of the study, as otherwise the research would still continue for a few years.

First of all, I would like to thank the case company for providing me a chance to study such company and process. I want to thank my supervisors from the company for your comments, support and patience throughout the study process. I would also like to thank all the participants of the study, and especially the interviewees from the different supply chain parties.

Thank you Assistant Professor Heikki Liimatainen for the revision of this master's thesis and the assistance provided during the study.

I also want to thank all my family and friends who have supported me and shown genuine interest in my study. However, at the same I am also very relieved that I am finally done answering your questions regarding the thesis' progression. Special thanks also to my brother Ossi, who recently sacrificed his scarce free time for proof-reading this thesis. Anni, thank you for the everyday support and positiveness that helped me through the year.

Tampere, 18th of November 2017

Nikke Rotonen

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND TERMS

3PL, TPL	Third-party logistics.
CS	Customer service.
DC	Distribution center.
DST	Dock scheduling tool, study's 3PL's internal tool.
EDI	Electronic data interchange.
ERP	Enterprise resource planning system. Integrates different business functions and operations across a supply chain. Often integrated to other information systems.
HS	Hub-and-spoke.
Intercompany shipment	In terms of this study, a shipment from another legal entity to another under the case company.
IS	Information system.
IT	Information technology.
Logistics	The management of the flows (e.g. material) in a supply chain.
MCC	Multiple country consolidation.
MDC	Main distribution center, the client of this study.
ODR	Order discrepancy report, created by the warehouse employees in case of problems with the orders.
PDM	Product data management system.
PL	Product line.
PO	Purchase order.
SCI	Supply chain integration, the integration of information and material flow in a supply chain.
SCM	Supply chain management, the integration and management of business processes throughout the supply chain.
Shipment consolidation	A process where smaller shipments are grouped into a larger shipment, often to take advantage of economies of scale.
SO	Sales order.
STO	Stock-transfer-order.
Supply chain	A network of partners that is involved in forwarding a product or a service from supplier to customer.
TMS	Transportation management system.
VAT	Value-added tax.
WMS	Warehouse management system.

1. INTRODUCTION

As the ever-fierce competition on manufacturing industries grows even fiercer, the manufacturing companies try to find a competitive edge wherever possible. One classic competitive advantage is the price. The manufacturing processes have often been honed to the maximum efficiency, which is why the companies' interest has been channeled to other aspects that could be improved, one being supply chain and its management. According to Cheng et al. (2008) the strength of a company's supply chain is a dominant factor in the company's success, which is one reason why it is one of the aspects that has recently gotten more attention. The supply chains are nowadays global and the distances long, which means that a small optimization could result in a big profit. However, the lower costs are not the only way to attract customers. The competitive edge can be reached by, for example, offering something that the competitors do not offer.

This study concentrates on a specific supply chain-related process, where several shipments from different company locations are shipped to a single location, consolidated and forwarded to the customer. At current state, the process is quite resource consuming, making it an appealing target for development. The process also enables a potential competitive edge gain in a form of a value-adding service.

1.1 Background of the study

The target company of this study is a technology company that provides industrial machinery solutions for its customers. The company operates internationally on six continents, but operates from Finland. The case company is part of several subsidiaries and sales offices that operate around the globe as separate legal entities.

The logistics network of the company has been separated into several distribution centers and warehouses due to the locations of the subsidiaries and sales offices and the different technologies they support. The study concentrates on the target company's main distribution center in Europe (main distribution center, MDC), that provides spare parts for the company's products for company's international customers. MDC operates from Finland but their main warehouse is located in the Netherlands. The main warehouse is operated by a third-party logistics provider. MDC has also a smaller satellite warehouse in Finland that is mainly used for domestic customers. MDC is the main distribution center of the company in Europe and its warehouse in the Netherlands is crucial for the company's supply chain.

MDC's warehouses ship around 16 000 order lines monthly. The volume is quite large compared to the other distribution centers in Europe, as the average order lines shipped for the company's other European DCs is approximately 2 000 per month. The monthly sales of MDC equal to roughly 10 to 13 million euros. MDC serves customers around the globe, as per company policy different distribution centers support different products. Usually, if a customer requires materials from different distribution centers, they place their purchase orders to them without the different company locations knowing of the other DCs' orders.

Recently there has been some large project orders, that require spare parts from several locations (distribution centers). Several of these intercompany shipments have been delivered to the MDC warehouse in the Netherlands, where the goods have been consolidated as one shipment before delivery to the customer or customer's collection. The target consolidation process could be described as an application of cross-docking and hub-and-spoke, where the MDC main warehouse would act as the central hub. The consolidation of different shipments is not a new way of working for any of the parties involved, but the recent changes in the organization have caused a need to 're-learn' the process. Probably the largest of the changes was the change of the warehouse operations provider, which plays a crucial role in the consolidation process.

Currently the intercompany shipment consolidation process has not been defined, which has caused some problems. For example, there has been confusion with the responsibilities in different phases of the order. Follow-up of the pre-consolidated shipments has also been problematic, as the intercompany shipment consolidation has not been implemented to the current release of the company ERP system, so the shipments' visibility in the system is almost nonexistent. The uncertainty of the process causes also large amounts of unnecessary and redundant email conversations and actions. The 3PL warehouse accumulates multiple questions, such as the distance between the parties and communication with the warehouse and MDC.

Despite the problems and the workload with the consolidation orders, the attractiveness of these orders is obvious. The large volumes of the orders usually mean that they are lucrative and good for business, even though they require extra work and care in their current state. The consolidation can also be considered a value-adding service, as goods will be ready for transport in a single location, decreasing the customer's transport costs. If the process can be defined and streamlined successfully increasing the supply chain's efficiency, it would mean that the consolidation concept could be offered as a service for the customers, even in smaller cases and orders.

The objective of the study is to research the current intercompany shipment consolidation process by examining an ongoing case and provide ideas how the process could be improved. The objective can be reached by dividing it to several smaller objectives. Before

any development ideas can be provided, the current consolidation process must be understood and defined.

The aim is to analyze the current process and its flow and use it as a base to develop a new, streamlined process definition. Other development ideas, including systems viewpoint, for the consolidation process will also be provided. These ideas serve as a framework and guidelines for the future development, and not as complete solutions for implementation. In order to provide development ideas, the current process has to be analyzed thoroughly, which requires understanding the key concepts of supply chain management, and definition of the concept "intercompany shipment consolidation" in terms of this study.

The most important objective is to define the current process, which will be utilized when creating the alternative solutions that serve as the results of the study. The definition of the current process involves investigating the steps taken in the process, which will be modeled to a process flowchart. The knowledge gathered in the analysis of the current process will be utilized to recognize the bottlenecks and other points of development. After recognizing the points of development suggestions and options are provided.

1.2 Research problem and research questions

The main object of the study is to describe and define the intercompany shipment consolidation process in the target company and how it could be improved. The main research question can be directly inducted from the objective to: **How is the intercompany shipment consolidation process executed in the target company and how it could be improved?**

The following sub-questions help to discuss and answer the main problem:

1. What is intercompany shipment consolidation?
2. What are the effects of the intercompany shipment consolidation in the target company?
3. How does the company IT support the intercompany shipment consolidation process?

The aim of the study is to provide insight and suggestions to the problems within the current process, which is why the definition of the current state of the process is the foundation on which the suggestions will be based. The target is to get a comprehensive view of the consolidation process, which requires viewing the problem from different angles. The sub-questions have been developed in this regard.

The answer to the first sub-question will serve as an introductory approach for the main problem, as the objective is to gain insight and understanding of the specific aspect of

supply chain. To understand the concept of intercompany shipment consolidation the basics of supply chain and supply chain management are also covered in the study. The answer to the question will based on a literature review, which will provide an extensive analysis of the concepts.

The answers to the second and third sub-questions will be based on both literature review and empirical study. The literature review allows a general level examination of the subjects and the empirical part enables more specific, target company level analysis of the subjects. The empirical study involves for example interviews and workshops. The findings of both the literature review and the empirical study will be combined to the results of the study.

1.3 Research scope and limitations

The scope of the research is dependent of the target company. The analysis of the process is executed from the viewpoint of the main distribution center, which means that the main focus of the analysis will be on MDC. This will also result in some aspects of the analysis only applicable for the specific company. However, the company's aim is to harmonize the processes throughout the different locations, which emphasizes that the results should be – at least in some extent – applicable in several locations. The target process will be kept on a relatively generic level, as the process definition could possibly be utilized by other distribution centers or company locations. The focus of the study is on the operative level, but the findings could also have an effect on tactical or even strategical level.

The target of the study is to provide a comprehensive review of the process, which involves e.g. examination of the information systems used in the process. However, the idea of the study is to provide more of guidelines and suggestions how the systems involved could be developed, as the more in-depth analysis would require an independent study due to its complicated nature. The focus of the study is in operative functions and their development, but the system aspect has been included due to their importance in the process.

The most important part of the consolidation process examinations is the definition into the flowchart, but it includes also the system approach as well as defining the responsibilities and tasks during the process. The analysis is done on operative level.

The empirical study of the consolidation process is limited to a single case study, which needs to be considered when analyzing the case. Every case is a bit different, as the parties involved differ (e.g. the customer and committed DCs). The target of the case analysis is to be as comprehensive as possible, which is aimed to achieve with interviewing all the main parties in the process. However, the limited material narrows the point of view, which means that every observation on the analysis cannot be generalized into common events or actions in the process.

1.4 Research strategy and the research process

According to Kakkuri-Knuuttila & Heinlahti (2006, p. 131) the selection of research approach, that includes research strategy, research methodologies and philosophies of science, guide the execution and writing of the study throughout the process. Certain combinations of research approaches, philosophies and ways of working have become standards on different sciences. These combinations are called research paradigms or research strategies, and they guide the research processes in certain branches of science. (Kakkuri-Knuuttila & Heinlahti 2006 p. 132; Olkkonen 1994 p. 28) In addition to research paradigms, research philosophical paradigms guide the studies of different branches of science. (Kakkuri-Knuuttila & Heinlahti 2006 p. 132) The researcher must rationalize the selection of the research approach to the reader, especially if the choice is different from the standard paradigms used in the branch of science. (Kakkuri-Knuuttila & Heinlahti 2006 p. 132)

Some established research approaches in business include conceptual approach, nomothetical approach, action-oriented approach, decision-oriented approach and constructive approach. The conceptual approach emphasizes the building of conceptual systems, while nomothetical approach aims to form general laws from the causal connections in the study. The decision-oriented approach is similar to nomothetical, but its objective is to find methods for problem-solving. The action-oriented research approach focuses on the understanding and changing the study subjects by using an explanatory model. Constructive approach emphasizes the problem-solving. (Kasanen et al. 1993) The differences between established research approaches for business have been presented in the figure 1.4.1.

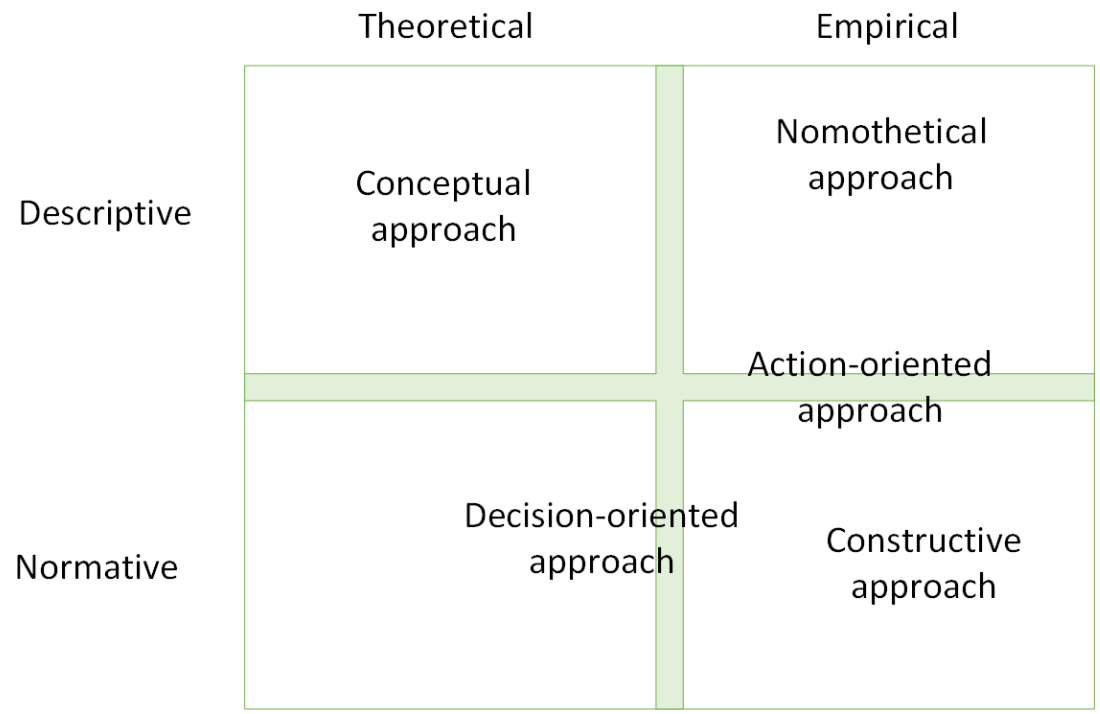


Figure 1.4.1: *Established research approaches in business (adapted from Kasanen et al. 1993).*

According to Kasanen et al. (1993) the most common research approaches in business studies can be divided into three main categories, and juxtapositions inside them:

1. Quantitative vs. qualitative research
2. Positive vs. interpretive and critical research
3. Research based on large vs. small empirical samples.

All of the distinctions above represent the same confrontation between the positivist tradition (the former) and its alternatives (the latter), which mainly reflect the hermeneutical research philosophy (Kasanen et al. 1993). Olkkonen (1994, p. 28) states that the studies in natural science are mostly based on positivism, humanist studies in hermeneutics and business studies apply both approaches.

According to Olkkonen (1994, pp. 26-27) the most used philosophical views of science are positivism and hermeneutics. From these two views the former is based on a more general philosophical approach called realism and the latter on idealism. Positivism relies only to observed facts and eliminates the speculative or hypothetical approach. Positivism can be considered as an aspect of realism and it is considered as the scientific and objective approach. (Olkkonen 1994 pp. 26–27) One of the characteristics of positivism is its quantitativeness, where the emphasis is in collection of and analysis of large samples of values (Kasanen et al. 1993; Pitkäranta 2010 p. 18). The samples are studied with law-like generalizations like the ultimate target of the whole research endeavor. The central

problem in positivist studies derives from the measurement of the samples' variables, which can usually be done only on ordinal or nominal scales. (Kasanen et al. 1993)

Hermeneutics represents an idealistic approach to the research. On the contrary to positivism, hermeneutics emphasizes the interpretation and understanding of the subject, as the objective of qualitative studies is to understand the subject comprehensively. (Hirsjärvi et al. 2009 p. 157; Jyväskylän yliopisto 2010; Olkkonen 1994 pp. 26–27) Per Kasanen et al. (1993) the most significant difference between traditional (positivist) and interpretive (hermeneutic) studies is also the most essential characteristics of interpretive studies – the acceptance of certain level of subjectivity as a legitimate part of science. In hermeneutic studies new knowledge is mostly created from empirical material through induction (Olkkonen 1994 p. 34). Olkkonen (1994, p. 33) states that studies following hermeneutical view aim to understand the research subject's internal connections, processes etc. in situations where a statistical analysis of an extensive research material is not possible. Hermeneutical approach is therefore often used when statistical analysis of the material is not possible due to the novelty of the research subject (Olkkonen 1994, p. 37). This makes hermeneutical approach commonly used in case studies, as one of the characteristics of case studies is the use of small samples (Kasanen et al. 1993).

Per the classification between positivistic and hermeneutic approaches, this study is more strongly based on the hermeneutic and qualitative research approach. The supply chain management processes and shipment consolidation have been widely researched, but due to high specificity of the subject of this study it can be considered a wholly new research subject, where the existing studies cannot be directly applied to. One typical application of hermeneutics is an explorative study, which aim to find new phenomena, explain little-known phenomena, develop hypotheses and find new perspectives. (Hirsjärvi et al. 2009 p. 138; Olkkonen 1994 p. 37). The qualitative research emphasizes the usage of people and the qualitative methods, such as different interviews, in information gathering (Hirsjärvi et al. 2009 p. 160). It is important that the sources have been chosen thoroughly, as the people used as sources should know the subject of the research as well as possible or they will have to have experience from it (Pitkäranta 2010 p. 114). One strategy to perform a qualitative study is by a case study (Hirsjärvi et al. 2009 p. 134). The empirical part of this study is executed by conducting a case study.

As stated, one of the case studies' characteristics is the use of small samples. Usually the aim in case studies is to gain a more comprehensive and profound understanding of the studied subject, which the small samples make possible compared to the large sample sizes collected by e.g. surveys. (Kasanen et al. 1993) In case studies the distance between the researcher, the research object is small and the objective is to gather detailed and intensive data (Hirsjärvi et al. 2009 p. 130; Kasanen et al. 1993). Case studies are very difficult to conduct by a positivist approach, as the making of generalizations is usually impossible. (Kasanen et al. 1993) The primary sources for empirical data in business research case studies is in-depth interviews (Eriksson & Kovalainen 2008). Case studies

often utilize induction instead of deduction, as the collected data is used for generating new findings for current theories. However, the inductive generalizations have always uncertain elements and features, which usually prevent them from being universally agreed by the scientific society (Ojala & Hilmola 2003 p. 46). Stake (1995 p. 7) states that often the result of case study is more refinement of an existing understanding than entirely new understanding of the subject.

There also exists different classifications for case studies. Stake (1995 p. 3) divides the studies by the motivation behind them. In intrinsic studies the case is chosen, because one needs to learn from that particular case. In instrumental studies the case studied to understand something else, e.g. proof for a generalization. (Stake 1995 pp. 3–4) Eriksson & Kovalainen (2008) divide the case study researches into two different types by the scope: intensive case study research and extensive case study research. Intensive case study research aims at understanding a unique case from the inside. This is done by providing a comprehensive, holistic and contextualized description of the case. Extensive case study research aims at generation of generalizable theoretical constructs, elaboration or testing by comparing and replicating several cases. (Eriksson & Kovalainen 2008) However Yin (2003, p. 39) divides the case studies into four different designs using the scope as differentiator. The largest difference between these different classifications by Eriksson & Kovalainen and Yin is that Yin takes divides the studies not only by number of cases and the depth of the study, but also by the number of analyzed units. The classification by Yin is presented in figure 1.4.2.

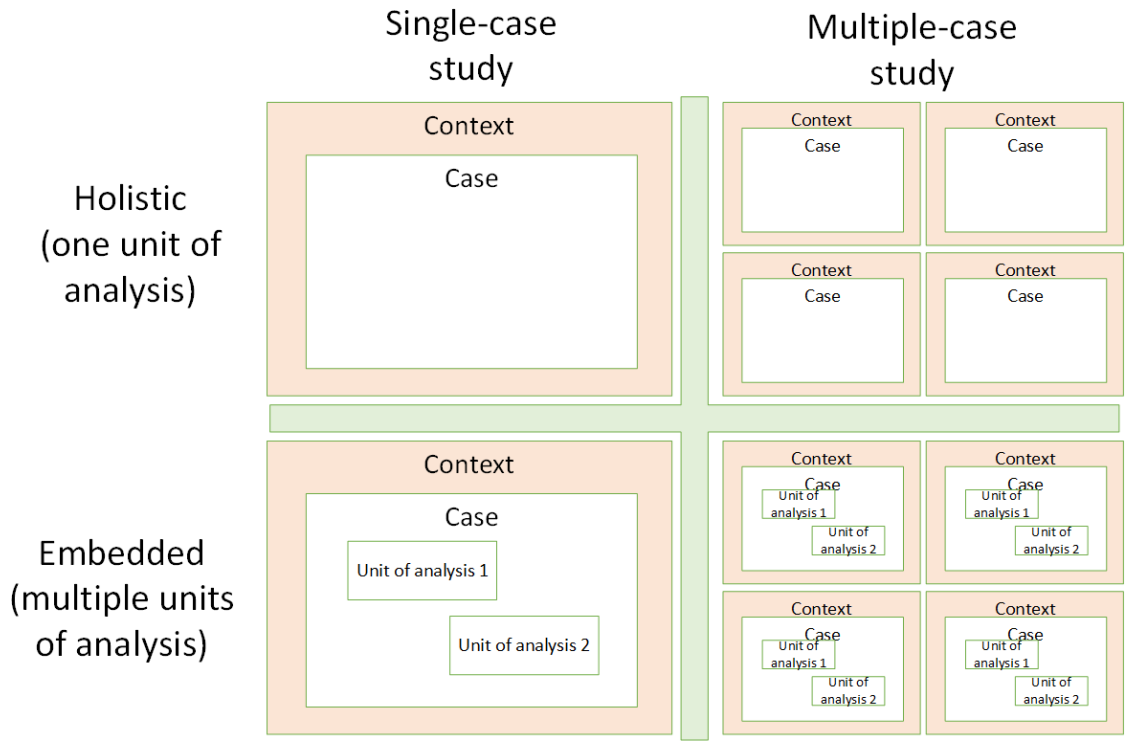


Figure 1.4.2: *Case study research designs (adapted from Yin 2003 p. 42).*

The primary distinction between different case study designs is the number of cases (Yin 2003, p. 39). Per Yin (2003, p. 40-42) a single-case study can be rationaled by five points. Firstly, a single-case study should be used, if the case represents a critical case in well-fomulated theory. Secondly, if the case is an extreme or unique example, single-case study can be used. The third reason for using a single-study case is if it is a representative or a typical case. The fourth rationale for a single-case study is a revelatory case, that exists if the study regards a phenomenon previously inaccessible. The fifth reason for a single case study is a longitudinal case, where the same case is studied at two or more points in time. (Yin 2003, p. 40-42) The selection between a single- and a multiple-case study derives from the available cases. If there are multiple cases available, that are believed to be literal replications of each other, multiple-case study could be beneficial. However, the multiple-case studies are more expensive and time-consuming to conduct. (Yin 2003 pp. 52–53)

The case studies can be further divided into holistic and embedded designs. In holistic design cases there is only one unit of analysis, while in the embedded there are multiple units of analysis (Yin 2003 p. 43). For multiple-case studies the each individual case may be holistic or embedded (Yin 2003, p. 52). Both variants have their pros and cons. The holistic design is preferable when no logical subunits can be identified or when the relevant theory of the case is itself of holistic nature. The cons of holistic design occur if the phenomena is not studied in operational detail. Holistic case studies can also be conducted at abstract level, making them lack any clear measures or data. The changing nature and flexibility of case studies can be seen as a strength or a weakness in terms of a holistic design, as the study can in the end answer to a different research questions that were defined in the beginning of the study. However, the embedded studies have their weaknesses too, as often the study concentrates on the subunits too much, forgetting the larger unit and the entirety of the study, making the original phenomenon of interest the context instead of the target of the study. (Yin 2003 p. 45)

This study follows the single-case study method. The choice was made because a recent case was available for studying, and no further cases were foreseeable. Also, the process for the other cases has been quite similar, making the single-case study viable. Controversely, the single-case decision for this study can be reasoned with the rationales two and three of Yin (2003, p. 40-42) previously presented. The case chosen for this study is unique and represents a process that is not done on a daily basis, and maybe not even on a monthly basis. However, at the same time it is representative of all consolidation cases, as they are similar to each other. The decision between a holistic and an embedded study was easy in terms of this study, as the focus is clearly on MDC, as they are the principal of this study, making the holistic design a natural choice. Nevertheless, an embedded design could have been used if the other distribution centers would have been studied more extensively, but this was not appropriate for the scope of this study. The downsides of the holistic case study design is attempted to be prevented by carefully

researching the case on operational level and presenting measurable units to assess the process.

1.5 Methods of data gathering and analysis

This study includes a theoretical part, which is done by conducting a literature review, and an empirical part, which is done by conducting a case study. The literature review lays the foundation for the case study, as some understanding of the background concepts of the study must be assimilated before the empirical part of the study can be conducted. In general, the literature review is used to build a complete view of the study subject (Salminen 2001, p. 12).

The literature review was conducted by researching numerous written sources, which were retrieved from online-databases and search engines, such as TUT Andor, Google Scholar, Web of Science, Scopus and Emerald, and literature found from the TUT library. The most difficult part in finding the material for literature review was to find the most suitable search statements. Some examples of the used search statements are presented in the table 1.5.1. After the suitable search statements were found, the specificity of the research subject and the different articles presented its challenges. For example, most articles concerning shipment consolidation cover scheduling of replenishment or customer orders through complex mathematical models. The objective then changed to search information of the different aspects separately. For example, there exists vast amounts of material on supply chain management alone, which helped to construct the theoretical part of this study. To gain as comprehensive picture of the research subject as possible the literature was not limited to any specific industries, even though every industry has its own specialties. However, the industry specialties are also discussed during the literature review.

Table 1.5.1: *Examples of the used search statements.*

("supply-chain" AND manag* OR "SCM" AND consolidat*)
("supply chain management" OR "supply chain" OR "SCM") AND consolid* AND "process"
process AND flex* OR agil* AND "supply chain"
("consolidation center" OR (consolid* AND "center"))

The material for the empirical part of the study was gathered mainly by interviews. In-depth interviews are often used as a primary source of information in business studies (Eriksson & Kovalainen 2008). In general, interviews consist of a series of questions and

answers that has been organized into a talk. Usually the interviews take place face to face, but they can be also carried out over telephone or online. The interviews are often conducted between the interviewer and the interviewee, but group interviews that consist of two or more participants are also common in business studies. Most often the interviewers talk first and ask the interviewee a question, to which they respond. However, qualitative interviews can resemble everyday conversations in which the distinction between the interviewer and the interviewee is not so distinct. (Eriksson & Kovalainen 2008) The aim of interviews is to gather data, which can be reliably used for making conclusions of the study subject (Hirsjärvi & Hurme 2008 p. 63).

In the terms of this study, qualitative interviews were conducted. Both semi-structured and unstructured interviews were utilized, depending on the subject of the interview and the interviewee. An unstructured interview resembles an everyday conversation. Its objective is to get the interviewee to reconstruct their experiences on the research subject. Usually the unstructured interview has open questions, that can be modified during the course of the interview. (Hirsjärvi & Hurme 2008 pp. 45–46) A semi-structured interview has different definitions, but the essential part of all definitions is that some part or perspective, but not all, of the interview has been fixed. It could mean, that e.g. every interviewee is presented with the same questions but with different order or that the phrasing of the questions would differ between interviews. (Hirsjärvi & Hurme 2008 pp. 47–48) The questions of the interviews in unstructured and semi-structured interviews are used to initiate the conversation and steer it into different directions if needed (Eriksson & Kovalainen 2008). Structured interviews, which follow the beforehand prepared questions in exactly the same order, were not used in this study (Hirsjärvi & Hurme 2008 p. 42).

Hirsjärvi & Hurme (2008, p. 35) consider interviews as advantageous method if the research subject is unknown or unfamiliar, as it is hard for the researcher to know the directions of the answers of the interviewees. It can be also known, that the subject of the study produces complex and rambling answers from the interviewees. As a pro of the interviews, the researcher can immediately ask further questions from the interviewee, to e.g. clarify or deepen previous responses to the questions. This can be also done to place the interviewees responses to a larger context. However, interviews are considered to include many sources of error. (Hirsjärvi & Hurme 2008 p. 35) According to Eriksson & Kovalainen (2008), because of this sometimes other sources are better than interviews in terms of evidence. In order to decrease the sources of error that derive from the interviews, some parties were interviewed multiple times during the course of the study. In addition to this, the objective was to interview all parties involved in the case to provide the complete overview of the case from the viewpoint of every party. Also, the emails exchanged during the case were studied. An overview of the interviews that were conducted in the study is presented in the table 1.5.2.

Table 1.5.2: *Interviews of the study.*

Interviewee	Type of interview		Times interviewed
MDC personnel	Semi-structured and unstructured	Single and group	6
Other DCs	Semi-structured	Group	2
Customer	Semi-structured	Single	1
3PL	Semi-structured	Single	1
Company supply chain development	Semi-structured and unstructured	Group	4
PLs	Unstructured	Group	1
Reference location	Semi-structured	Single	1

Most interviews took place with the MDC personnel. The interviews with MDC personnel were mostly unstructured, as the objective in the beginning was to gain total understanding of the studied process. The interviews were also repeated during the study, as the case was still underway during the beginning of the study. Semi-structured interviews were also used after better understanding had been achieved from the unstructured interviews. MDC interviews were conducted face to face. The other DCs were interviewed once each via online voice communication. The goal of the interviews with other DCs was to view the process from their perspective. The customer was also interviewed via online voice communication. However, the end-customer was not interviewed, and the customer responded on their behalf. Due to scheduling issues the interview with the 3PL was conducted via email during a two-week period. An unstructured interview with the product line was arranged to better understand their role in the process. The company's supply chain development personnel were face to face interviewed several times in terms of finding solutions and ideas for the recognized problems. Also, a separate company location in the United States was interviewed via telephone, as to gain a reference for the shipment consolidation.

1.6 Outline of the study

Chapters 2 and 3 consist of the literature review that acts as a theoretical foundation to the empirical part of the study. Chapter 2 covers the subject of supply chain management,

starting from the concept of supply chain and moving to more specifics regarding this study. After the concept has been defined, an overview of supply chain management and supply chain integration are presented. The three last subchapters discuss topics that are important in the scope of this study: third-party logistics providers, shipment consolidation and spare part logistics. Chapter 3 offers a general overview of the most common information systems in supply chain management.

Chapter 4 begins the empirical part of the study in the form of a case study. In chapter 4, the data gained from the interviews is put together. The chapter begins with introducing the background of the case. Also, the normal order flow and the information systems used in the process are presented, along with the different parties involved in the case. The subject of the study, intercompany shipment consolidation process in a third-party operated warehouse, is formed into a flowchart with explanatory commentary on the process. The different flaws and bottlenecks of the process are then identified and analyzed.

Chapters 5 and 6 concern the improvement ideas that were come up from the case study's basis. Chapter 5 covers short-term improvement ideas that can be implemented instantly or almost instantly, while the chapter 6 discusses more long-term ideas, that still need more research before they can be implemented.

Chapter 7 is the conclusion chapter. In it, the whole study and its results are analyzed and assessed. A summary of the analysis and results is also provided in the final chapter.

2. SUPPLY CHAIN MANAGEMENT

To understand the subject of the study one should understand some key concepts in logistics and supply chain management. To gain a true understanding of the subject of the research a literature review has been conducted. The literature review also serves as a theoretical framework for the paper. In addition to the previous objectives the aim of the literature review is to provide new viewpoints to the study, that can be utilized in the empirical part of the study.

The aim of the review is to start the examination from top level and progress from the basic concepts to more in-depth concepts along with the literature review. The review flows through introductory examination of supply chains and logistics to supply chain management and finally to the concept of shipment consolidation and the specifics of spare part logistics. The review studies also the notions of third-party logistics providers, as they are usually a significant party in consolidation processes, and the unique traits of spare parts logistics which affect the target company.

2.1 Supply chain

If simplified, a company's business can be described as a series of individual, subsequent processes. In these processes, the company transforms its resources into a finished product or a service for the customer. However, often the company needs other parties, partners, to bring the product or service to the end-customer. These partners could include for example importer, retailer and forwarder. (Sakki 2003, p. 13) This network of partners and their actions to convert the basic commodities into a finished product that the end-customer values is a simple example of a supply chain (Harrison et al. 2014, p. 12). The modern business management emphasizes the role of the supply chain, as the individual businesses can no longer compete as entirely autonomous entities (Lambert & Cooper 2000).

There are several definitions for the term 'supply chain'. According to some definitions, supply chain is defined as a chain composed of three or more entities (organisations or individuals) directly involved in the upstream and downstream flows of materials, finances, services and information (Mentzer et al. 2001; Sakki 2003, p. 14). According to McKeller (2014) the supply chain is a metaphor for representing all individual companies, their personnel and the physical infrastructure needed to create and transport the product to end-customer. The parties are joined together by interconnected processes that enable moving materials, information and finance in order to response to customer needs (McKeller 2014). La Londe and Masters (1994) describe the supply chain as a set of

companies that pass the materials (from raw materials to finished products) forward towards the customer. The "passing" of materials includes co-operation between many parties, which requires also information sharing (La Londe & Masters 1994). Lambert et al. (1998) portray the supply chain as a network of multiple businesses and relationships instead of a chain with one-on-one or business-to-business relationships. Beamon (1999) describes supply chain as an integrated process where raw materials are manufactured into final products and delivered to the customer via retail and/or distribution.

All definitions presented above have slightly different nuances and focuses. However, the basic idea of a supply chain remains the same throughout the definitions. A supply chain describes the process how a base commodity is refined into an end-product and brought to customer. It consists of a chain of different parties, which collectively interact to bring a product to a customer. The supply chain is usually not a chain in real world, but a complex network of interconnected parties (Lambert & Cooper 2000). The chain form is a justified simplification and metaphorization to make the concept more understandable. The dimensions of a supply chain (or a network) vary on the number of suppliers and customer at each level. It is very rare for a company to be part of only one supply chain. For most companies the illustration of the supply chain would resemble more of an uprooted tree, where the roots and branches depict the network of suppliers and customers, instead of a simple pipeline. (Lambert & Cooper 2000)

Supply chain and logistics can be also considered as a system of several different flows (Karrus 1998 p. 72). A supply chain includes three main flows between the parties: material, information and capital (Karrus 1998 p. 214; McKeller 2014). Bagchi & Skjoett-Larsen (2003) take one more flow to consideration, ownership flow, which describes the transfer of ownership rights from the seller to the buyer. However, the ownership flow is not universally recognized as a main flow in the supply chain. All three previously introduced main flows can be considered as key flows from logistics perspective, as Karrus (1998, p. 72) defines material, capital and recycle flow as key flows and Harrison et al. (2014, p. 8) consider material and information as key flows. Despite the small differences in the key flow recognitions, Karrus (1998, p. 72) acknowledges two factors in addition to the flows presented above: information and organization flow, albeit those are considered less flowing than the main flows. Harrison et al. (2014, p. 10) recognizes the importance of reverse logistics and waste, even though not considering them as key flows. Logistical main flows in a simple chain have been presented in figure 2.1.1.

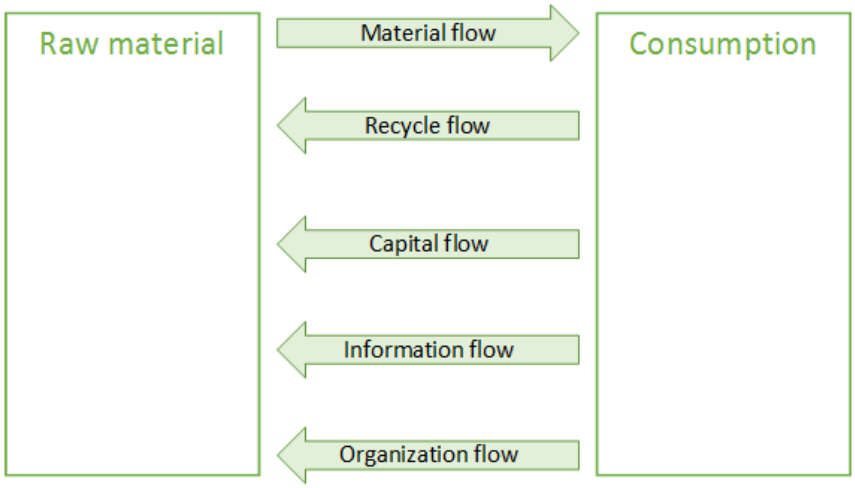


Figure 2.1.1: *Logistical main flows (adapted from Karrus 1998, p. 72).*

The material and information flow are crucial in the supply chain, as the whole chain's performance depends on the two. Logistics' task is managing these two key flows. The flows move in opposite directions. Material flow depicts the movement of physical goods through the supply chain: from the suppliers (upstream of the supply chain) through the distribution centers to the end-customer (downstream of the supply chain). Information flow depicts the demand data that moves from the end-customer through the distribution centers and manufacturing to the suppliers. (Harrison et al. 2014 p. 7) Both flows are tightly tied together (Cheong 2004), as they're constantly interacting. The information flow is needed in order to control and plan the material flow, which means that the information flow makes the whole chain work (Harrison et al. 2014 p. 7, 10). Figure 2.1.2 illustrates the material and information flow in the supply chain. Organization flow portrays the service interface between two organizations and recycling flow the return of the raw materials or products back to production. Capital flow depicts the monetary movement in the supply chain. (Harrison et al. 2014 p. 10; Karrus 1998 p. 72, 306) The efficient control off the flows is a central challenge, as the faster flowing speeds up the capital flow and decreases the invested capital (Karrus 1998 p. 72).

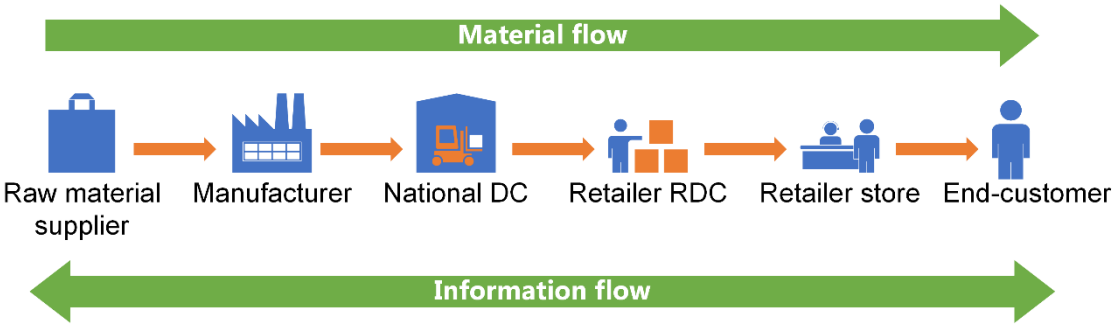


Figure 2.1.2: *Material and information flows in the supply chain (adapted from Harrison et al. 2014 p. 10).*

Supply chains can also be categorized by their complexity. Supply chain usually consist of several echelons, such as the supply, manufacturing, distribution and consumer. The complexity of the supply chain arises from the number of echelons and facilities in each echelon. (Beamon 1999) The number of echelons depends on how many stages the supply chain has. For example, the supply chain with various number of echelons illustrated in the figure 2.1.3 has two or three echelons, depending on the point of view. The left-hand side of the supply chain is considered a "pure" three-echelon supply chain, as materials flow through every echelon. The right-hand side supply chain is considered a supply chain with various number of echelons, as it has features of both two-echelon and three-echelon supply chains. (Kalchschmidt et al. 2003)

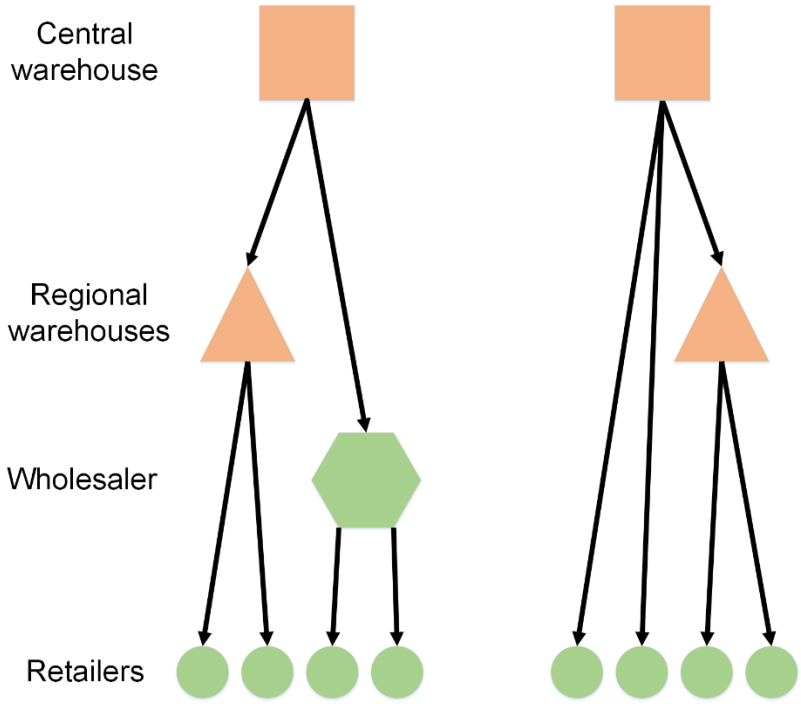


Figure 2.1.3: *A supply chain with various numbers of echelons (adapted from Kalchschmidt et al. 2003).*

Mentzer et al. (2001) have identified three levels of supply chain complexity. The categorization of supply chain complexity takes account into the echelons of the supply chains and illustrates how the complexity increases along with the number of echelons. The different levels of supply chain complexity have been illustrated in the figure 2.1.4.

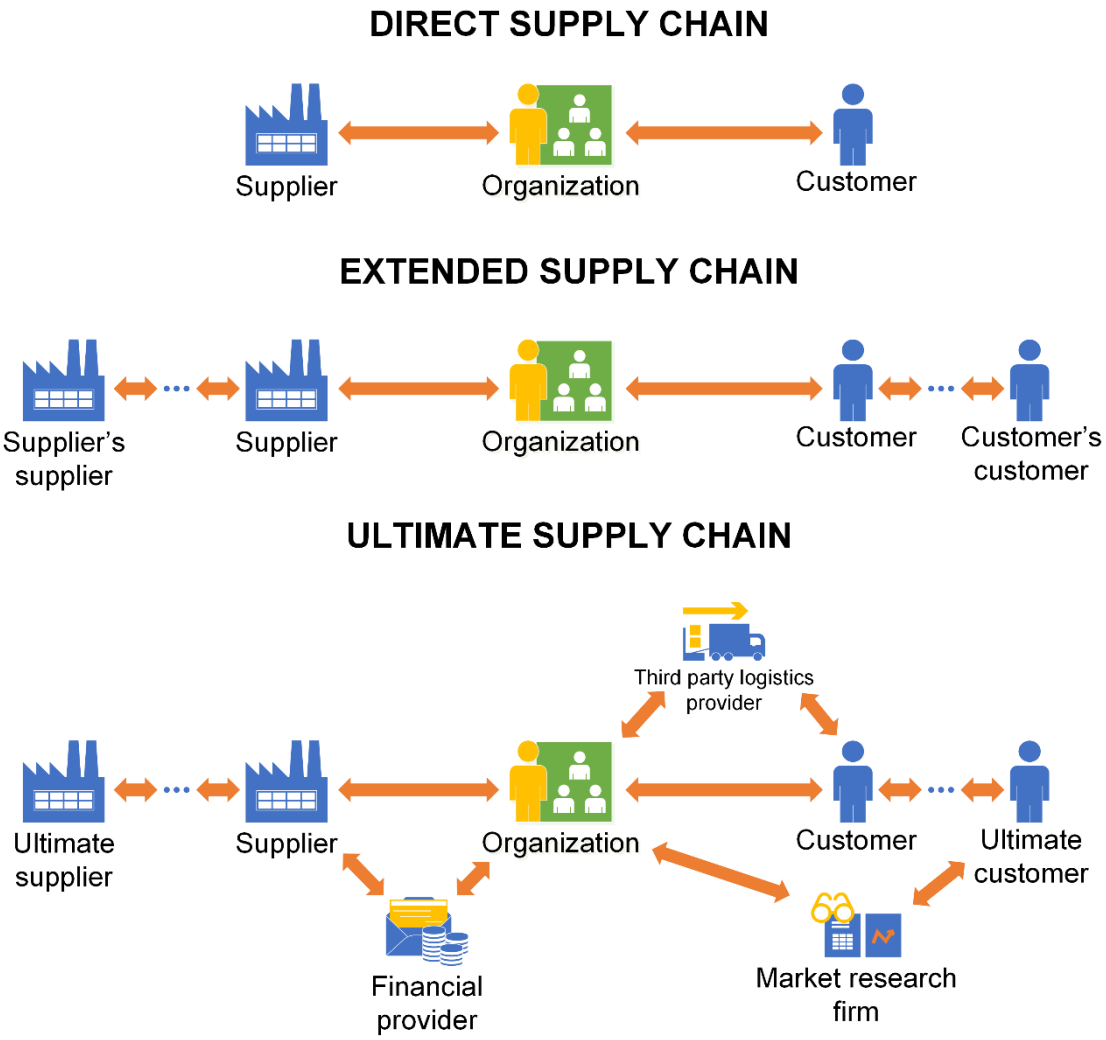


Figure 2.1.4: *Different levels of supply chain complexity (adapted from Mentzer et al. 2001).*

The most concise supply chain is a direct supply chain, that consists only of a company, a supplier and a customer which are involved in the upstream or downstream material, finance and/or information flows. In an extended supply chain the supplier's suppliers and customer's customers are included in the supply chain. An ultimate supply chain includes all of the parties involved in the upstream or downstream flows of material, information or finance from the ultimate supplier to the ultimate customer. (Mentzer et al. 2001)

2.2 Supply chain management and logistics

Some time ago the concepts 'logistics' and 'supply chain management' were, and sometimes still are, used interchangeably (Cooper et al. 1997; Lummus et al. 2001). The two terms are close, yet different as they approach the subject of production and transportation from a bit different perspective. As the concept of supply chain, both terms have multiple

definitions that resemble each other. However, in a way, the term supply chain can be considered as an umbrella concept for logistics.

2.2.1 The definition and purpose

Lambert et al. (1998) defines supply chain management (SCM) as the integration of key business processes from end customer to suppliers, that provide products, services and information that add value to the end customers and other stakeholders. According to CSCMP (2013) SCM guides the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities. SCM also includes coordination and collaboration with channel partners, such as suppliers, intermediaries and customers. SCM is an integrating function that is primary responsible for linking major business functions and processes both inter- and intra-organizationally into a high-performing business model. (CSCMP 2013) The definition of CSCMP is very broad, as it practically covers all activities in the supply chain, but CSCMP's definition is also probably the most universally used and accepted definition of SCM in literature.

A very simplistic definition of logistics depicts logistics as a combination of seven Rs: having the *right product*, in the *right quantity* and the *right condition*, at the *right place*, at the *right time*, for the *right customer*, at the *right price* (Ross 2011 p. 12). The definition grants the general idea of what the concepts includes, but does not take a stand how this is achieved. Other definitions go deeper into the execution of logistics. Logistics (management) is the process of planning, implementing and controlling the efficient and cost-effective flow of raw materials, in-process inventory, finished goods and related information flow from point of origin to the point of consumption (Cooper et al. 1997). Karrus (1998, p. 70) defines logistics as the comprehensive managing and developing of material, information and capital flows, procurement, production, distribution and recycling, maintenance and support services, warehousing, transport and other value-adding services along with customer service and relations. CSCMP (2013) describes logistics management as the part of SCM that plans, implements and controls the efficient and effective forward and reverse flows and storage of goods, services and information between the point of origin and the point of consumption to meet the customer's requirements. The logistics management tasks usually include e.g. outbound and inbound transportation management, logistics network design, supply and demand planning and management of third party logistics services providers. Logistics management is an integrating function that coordinates and optimizes all logistics tasks with other functions, such as sales and marketing. (CSCMP 2013)

Both logistics and supply chain management include function integration within and across companies, but the difference seems to be in the scope of the integration. SCM comprises the integration in a larger scale, including all business functions and processes in the supply chain while logistics usually is considered to cover the view within a company (Cooper et al. 1997; CSCMP 2013; Lambert et al. 1998; Lummus et al. 2001). SCM

also includes elements that are not typically included in the definition of logistics, such as integration of information systems and planning and control activities (Stank et al. 2001). The confusion between the two concepts is probably due to the nature of logistics: it is a functional silo within companies and at the same time a bigger concept that deals with the management of information and material flows across the supply chain (Lambert & Cooper 2000). Figure 2.2.1.1 illustrates the supply chain network structure and the information and material flows through it. It also depicts the functional silos within the companies, and shows how the key supply chain business processes penetrate them throughout the supply chain.

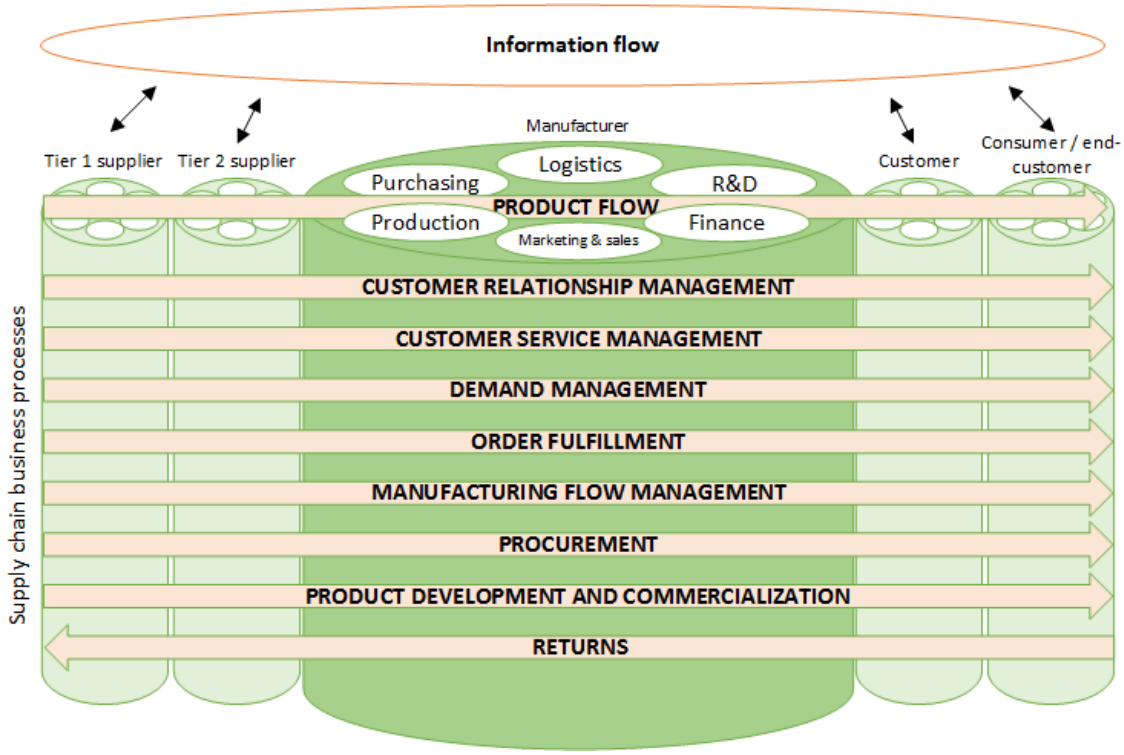


Figure 2.2.1.1: *Supply chain management integrates and manages business processes throughout the supply chain (adapted from Cooper et al. 1997).*

Now that the differences between the two concepts have been established, why does supply chain management matter and what is its objective? Per Lambert & Cooper (2000), the objective of SCM is to create the most value for not only the company, but for the whole supply network. This is achieved by lowering the amount of resources without sacrificing the superior customer service level (Cooper et al. 1997; Stank et al. 2001). According to Stank et al. (2001) an excellent supply chain performance can lower the costs up to 7 % in the supply chain and improve the cash flow by over 30 %. Power (2005) states that the supply chain is responsible for 60 to 80 % of a typical company's cost structure and that a 10 % reduction in its costs can yield a 40 to 50 % improvement in pre-tax profits. To achieve the cost reductions, several sub-objectives have been recognized, such as reducing the inventory investment in the supply chain, synchronizing the

customer's requirements regarding material flow with the suppliers and building competitive advantage for the supply chain. (Cooper et al. 1997) In order to achieve SCM's objectives, collaboration, integration and coordination across the organizations in the supply chain is required (Stank et al. 2001).

In supply chain the importance of individuals decreases, as the parties must work together as partners. Collaboration and coordination between supply chain partners is needed, as Ross (2011 p. 1) states that SCM's importance rises from the fact that the competitive advantage depends nowadays less on the company's internal capabilities and more on the company's ability to recognize and add the correct business partners to their network, in order to assemble the right blend of competencies that resonate with their own organizations and core strategies. Also Acar et al. (2017) and Li et al. (2017) recognize that the competitive edge of the supply chains derives from the whole chain and not the individuals and that the real competition is between the supply chains instead of the individual companies. According to Power (2005) in order to support supply chain efficiency, the redundancies and communication barriers between and within the parties must be eliminated. This is achieved by creating visibility and transparency in the supply chain and identifying the bottlenecks by coordinating, monitoring and controlling the processes. Power (2005) also states that the elimination of these redundancies and communication barriers is the purpose of SCM.

2.2.2 Supply chain integration

The opportunity to integrate processes across functional boundaries is considered a key to competitive success (Birou et al. 1998; Frohlich & Westbrook 2001; Pagell 2004). The definitions of SCM presented above indicate that close, even integrated, relationships between the supply chain parties, are essential in supply chain management. The increasing competition has driven the firms into improving not only their internal operations but has also forced companies to rethink their supply chain partnerships and cooperation, which has increased the importance of joint improvement of inter-organizational processes (Flynn et al. 2010; Prajogo & Olhager 2012). From this need of close relations between the partners the concept of supply chain integration (SCI) has arisen (Flynn et al. 2010).

Several different 'schools' and definitions of SCI exist. Some focus on managing the supply chain as a single system, others optimize the fragmented subsystems. Some emphasize the material flow while others emphasize the information and capital flow. (Flynn et al. 2010) However, the material and information flow are unanimously considered as key factors in SCM and SCI literature (Flynn et al. 2010; Lambert & Cooper 2000; Power 2005; Stank et al. 2001). Most definitions of supply chain integration also explicitly recognize the importance of two flows through the supply chain: the flow of goods and equally important flow of information, which flow into opposite directions (Pagell 2004; Power 2005; Prajogo & Olhager 2012). SCI involves information and material flow inte-

gration, which are referred as information integration and logistics integration. The integration of the two flows reflects the two interrelated forms of supply chain integration, both regularly employed by the manufacturers. (Frohlich & Westbrook 2001; Prajogo & Olhager 2012) Nevertheless, SCI cannot be limited to only other of the flows, but it must comprise of both material and information integration. (Prajogo & Olhager 2012) The basis of supply chain integration has been presented in figure 2.2.2.1.

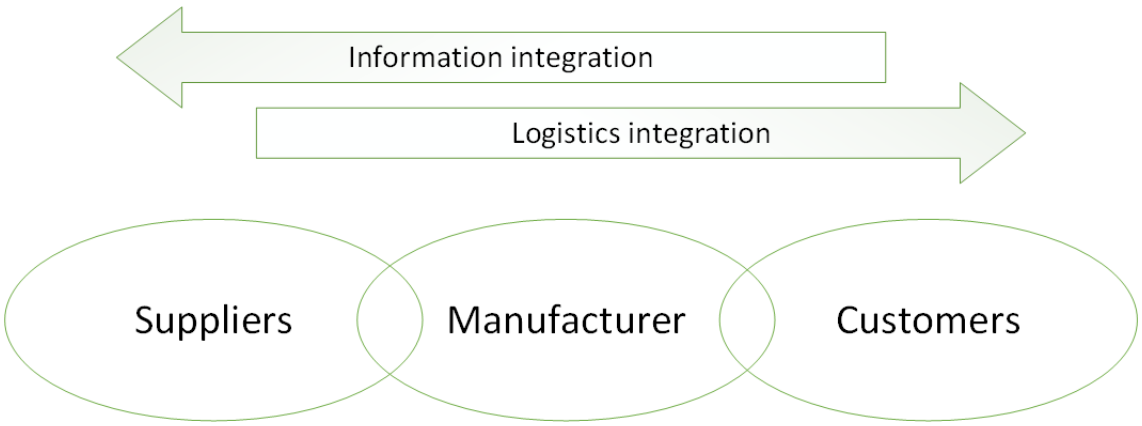


Figure 2.2.2.1: *Integration in the supply chain (adapted from Frohlich & Westbrook 2001).*

Logistics (or delivery) integration involves the coordination and integration of the forward physical flow of deliveries between suppliers, manufacturers and customers (Frohlich & Westbrook 2001). It refers to the specific operational activities and practices that coordinate the material flow from the supplier to the customer. In the optimal theoretical construct, the integration of the material flow is seamless between various supply chain partners. (Prajogo & Olhager 2012; Stock et al. 2000) The importance of logistics integration has been especially noted for example when implementing just-in-time or product mass customization related supply chain strategies. (Frohlich & Westbrook 2001)

Information integration refers to the sharing of key information and inside the supply chain. This is enabled by information technology (IT). (Prajogo & Olhager 2012) The information integration involves backward coordination of the flow of data and information technologies from the customers to the suppliers. Different information technologies allow parties to coordinate their activities as in an effort to truly manage the supply chain. (Frohlich & Westbrook 2001) One of the main purposes of information integration is to support decision-making in real-time. It has been shown that lower costs can be achieved by information integration, e.g. through reductions in inventory sizes and shortages. (Prajogo & Olhager 2012) Today's SCM is technology driven, and several information system solutions have been developed to support the better flow of information in supply chains (Power 2005; Ross 2011 p. 2). However, despite the technology's importance in information integration Prajogo & Olhager (2012) state that the most important factor is the quality, quantity and frequency of the shared information. The information systems in SCM have been discussed in more detail in chapter 3.

Supply chain integration also means the degree to which a manufacturer strategically collaborates with its partners in the supply chain and collaboratively manages the processes within and across organizations, to achieve effective and efficient material, information and capital flows and decisions while providing maximum value to the customer (Flynn et al. 2010). The basis of supply chain integration can be characterized by cooperation, collaboration and coordination, which are more or less used interchangeably when describing the efforts of the supply chain partners to make the chain more efficient overall (Power 2005; Prajogo & Olhager 2012). The implementation of SCM requires the identification of critical links between the parties in the supply chain, which processes need to be linked and what kind of integration is applied to the links. At the same time it should be remembered that the SCI should be designed to increase efficiency and effectiveness for the entire supply chain, and that the benefits gained should be equitably shared. (Lambert & Cooper 2000)

Essential to SCI is the fundamental shift from managing individual processes to the management of integrated chain of processes. This requires for example information sharing, shared technology, trust and partnerships. The extent of integration can cover the whole life-cycle of a product, from the design to the ultimate sales and after-sales services. (Power 2005) According to Power (2005), the foundation of SCI is based on three main principles: information systems, inventory management and supply chain relationships. Higher levels of supply chain integration are characterized by the increasing logistics-related communication, larger coordination of the logistics related tasks in the supply chain and more blurred organizational distinctions between the logistics activities of the firm and its stakeholders. (Prajogo & Olhager 2012; Stock et al. 2000)

When observing the scope of SCI, Flynn et al. (2010) divide the SCI into three different dimensions:

- Customer integration
- Supplier integration
- Internal integration.

Customer and supplier integration mean the external integration in the supply chain, which is the proportion to which the manufacturer and its external partners arrange their cross-organizational processes, strategies and practices into collaborative and synchronized processes (Flynn et al. 2010; Stank et al. 2001). Customer integration emphasizes the core competencies gained from collaboration with critical customers, while supplier integration emphasizes the core competencies related to the collaboration with critical suppliers. Self-evidently, the internal integration focuses on the activities happening within the manufacturer. It means the degree to which the manufacturer has arranged its own organizational practices, strategies and processes into synchronized and collaborative processes to cope with customer requirements and to enable efficient interaction with the suppliers. (Flynn et al. 2010) Also Frohlich & Westbrook (2001) examine the subject

of the scope of the SCI with their concept 'arcs of integration'. However, in their approach internal integration is not considered as supply chain integration, but only the integration with the suppliers and customers. The broadness of the arc defines how extensive SCI is. (Frohlich & Westbrook 2001). The concept of arc of integration is presented in the figure 2.2.2.2.

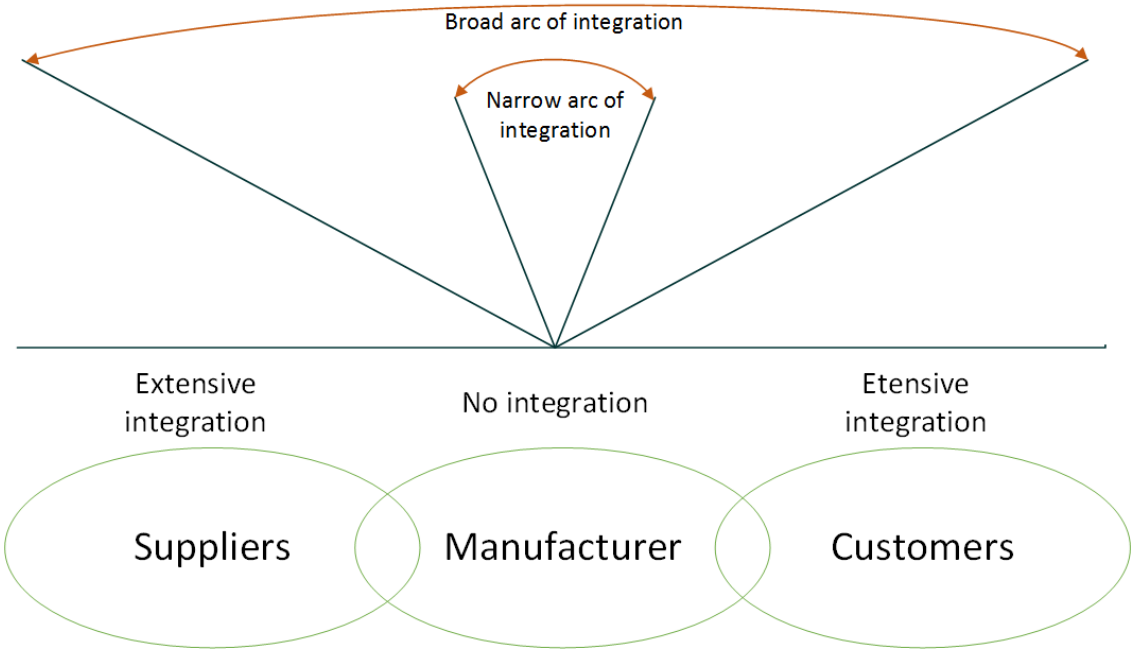


Figure 2.2.2.2: *Arcs of integration (adapted from Frohlich & Westbrook 2001).*

According to Flynn et al. (2010) internal and external integration both have a different role. Internal integration is concentrated on the integration of the departments and processes within the company, external integration emphasizes the meaning of close and personal relationships with the supply chain partners, e.g. customers and suppliers (Flynn et al. 2010). However, Stank et al. (2001) and Kim (2013) acknowledge that companies must first have a fairly high level of internal integration before initiating the external integration, as the internal integration serves as a foundation for future changes. It is also stated, that regardless of their different roles in SCI, both external and internal integration have a positive effect on one another (Stank et al. 2001). Frohlich & Westbrook (2001) state that the scope of the SCI is implicitly decided in the company's strategies. Some companies decide to engage relatively little integration with their customers and suppliers, resulting in a narrow arc of integration, while others extensively integrate their supply chain functions both up and downstream, resulting in a broad arc. (Frohlich & Westbrook 2001) Nevertheless, it has been studied that the higher and broader levels of integration bear the greater potential benefits (Frohlich & Westbrook 2001; Prajogo & Olhager 2012).

Flynn et al. (2010) propose that the internal integration is positively related to both operational and business performance in a supply chain and that the customer and supplier

integration are related positively to the operational and business performance of the manufacturer within the supply chain. Internal collaboration is associated with higher level of logistical service performance (Stank et al. 2001). According to Kim (2013) the shared knowledge and values through the internal integration help the companies to strengthen their cooperation with suppliers and customers. The collaboration between company's different departments helps to generate the partnerships with external partners. Also, the internal integration has an impact on operational or financial performance, although it can be indirect originating from e.g. timely exchange of critical information. In supplier integration, the operational performance of different parties should ameliorate, especially the process performance, but it is highly dependent on the efficiency of information exchange. Per some studies customer integration drives e.g. product innovation and productivity, but per some studies too much focus on customer integration can be harmful. (Kim 2013)

All in all, the benefits of the collaboration between companies are considerable, for example, better quality, reduced resource duplication, greater relevance to customer needs and more flexibility in responding to unique customer needs (Cheong 2004; Prajogo & Olhager 2012; Stank et al. 2001). There are also more tangible and measurable benefits, such as increased operational profits, reductions in costs, lead times and risks (Liu et al. 2005; Prajogo & Olhager 2012). However, even if the integration was 'successful' the collaboration is not always beneficial, as it is dependent of the context, such as the company size, level of uncertainty and the scope of cooperation. (Kim 2013)

There are some barriers in the inter-organizational coordination, the biggest issues being information sharing and trust between the companies (Cheong 2004). This means all participants must be willing to work for the mutual good. However, the will to work together is not enough to ensure effective integration (Stank et al. 2001). Effective integration requires effective implementation, and to achieve that a supply chain wide integration strategy is needed. Without it SCI will produce at best only little tangible benefits and may even be counter-productive and erode competitive advantage. (Power 2005) In addition, the effective integration may require investments in the relationship and possibly resource sharing, and it has been presumed that the successful integrations involve mutual understanding, shared visions and the achievement of collective goals. (Stank et al. 2001)

2.3 Shipment consolidation

The globalization affects companies' supply chains. Global manufacturers need to produce different products which are exported to different countries. However, the manufacturers do not always manufacture enough products in each country to achieve economies of scale. (Cheng & Tsai 2009) The economies of scale are attempted to achieve by consolidating shipments when transporting them. Shipment consolidation is the process where different shipments from suppliers are grouped into a large shipment at a consolidation point (Dondo et al. 2009; Tyan et al. 2003). The idea behind consolidation is to

utilize the vehicle's capacity better that decreases the number of dispatches, which results in lower transportation rates – in other words taking advantage of economies of scale in shipping (Çapar 2013; Hall 1987; Higginson & Bookbinder 1994; Tyan et al. 2003). However, Dondo et al. (2009) consequently state that despite consolidation generally decreases the transportation costs significantly the handling, inventory and facility costs increase within the facilities. The concept of consolidating shipments is not new, but in fact it is centuries old and the practices are widely used in air, ground, rail and sea transport (Tyan et al. 2003). The start of research relating shipment consolidation dates back to the 1970s, but the recent research has focused on utilization of information technology in consolidation (Çapar 2013).

A few policies for shipment consolidation implementation exist. Pure consolidation policies do not require specific coordination. Integrated inventory and shipment consolidation policies aim to coordinate the consolidation with inventory decisions. Pure consolidation policies are mainly concerned in the size of the shipment and dispatching of the vehicle. The size of the consolidated shipment must be large enough to achieve the benefits of economies of scale, but also the frequency of shipments has to be appropriate to meet the service requirements. Integrated consolidation policies treat the supply chain as a whole instead of a group of individual functions. (Çetinkaya 2005, pp. 4–5) The focus on IT in SCM has highlighted consolidation, as it plays a key role in different inventory integrative engagements, such as vendor managed inventory (VMI) (Çetinkaya 2005, p. 5; Cheng & Tsai 2009). In VMI, the supplier is empowered to manage the vendor's inventory of agreed items (Çetinkaya 2005, p. 5).

Cheng & Tsai (2009) introduce the concept of multiple country consolidation (MCC). In MCC consignments to same destination from different countries are combined in an international distribution center. A distribution center can be defined synonymous to a warehouse, as most goods in a warehouse belong to someone's distribution system and they are stored in a DC pending for distribution to appropriate stores (Cheng & Tsai 2009; CSCMP 2013). In distribution channels the warehouses represent storage facilities between the manufacturer and suppliers and the manufacturer and its customers. An international distribution center can be considered a place that integrates manufacturing operations with logistics operations, such as transportation, storage and port and customs operations to achieve efficient distributions of goods. However, the role of distribution centers is changing. In the past, one essential objective for international distribution centers was their cargo throughput, but in future the focus can point more in diversification of the logistics services provided to their customers in order to gain more revenue. This can be done by e.g. developing multiple country consolidation and other value-added logistics services. (Cheng & Tsai 2009)

The consolidation cost is the main variable of the logistics costs affecting the use of MCC in the international consolidation centers. Because of this, a customized consolidation

option should be designed to lower the consolidation costs of the customers. The international consolidation centers could create economies of scale by conducting a number of consolidation services. The reduced costs would serve as an incentive attracting more customers. (Cheng & Tsai 2009)

A traditional way to design the consolidation network is to use hub-and-spoke (HS) structure, which is named after its resemblance the hub and spokes of a wheel (Kurian 2013, p. 151). The design creates a fully interconnected network between any two nodes (spokes) in the network utilizing a central hub. Economies of scale can be achieved by consolidating material flows from and to spoke nodes in the hubs. HS structures rely heavily on the hubs, making them vulnerable to disruptions and degradations of the hubs. (An et al. 2015) HS is widely employed in different industrial applications, such as in airline and trucking industry and telecommunications systems (An et al. 2015; CSCMP 2013) The trend in using HS in logistics is still increasing. This leads to large volumes being transshipped to the main hubs, meaning more and more cargo is consolidated and deconsolidated in these main hubs. (Cheng & Tsai 2009)

Intercompany transactions mean transactions between companies in a group in form of for example charges or transfer of goods (Law 2016). Intercompany shipments can be viewed as a consequence of intercompany transactions, as they are part of the trade between the companies inside the same group. In terms of this study, the intercompany shipment consolidation concerns shipments that are shipped to the main distribution center from other company DCs for consolidation before shipping the goods to the customer. In order to help to gain comprehension of the term intercompany shipment consolidation from the viewpoint of this study two examples are presented. The first, simple example covering unconsolidated shipments in the case company is illustrated in figure 2.3.1.

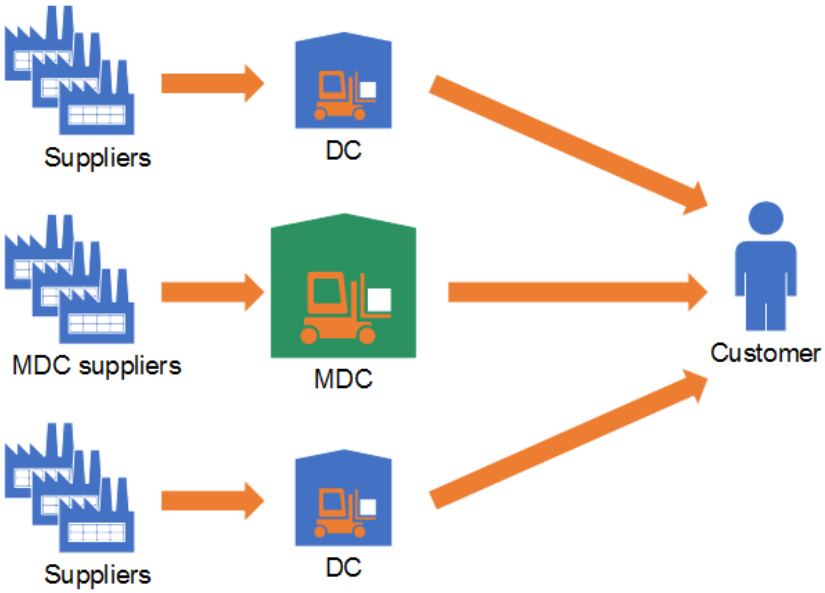


Figure 2.3.1: *An example of unconsolidated shipments.*

In the example, the customer has placed separate purchase orders to three different distribution centers. Each purchase order is fulfilled by the responsible distribution center and each shipment is forwarded directly to the customer from the different warehouses. In the example, each different distribution center acts independently and unaware of the other DCs' orders. In terms of this study, regular order flow at the company resembles the picture above, as customers place separate purchase orders to separate distribution centers without them knowing about it. The second example including shipment consolidation is seen in figure 2.3.2.

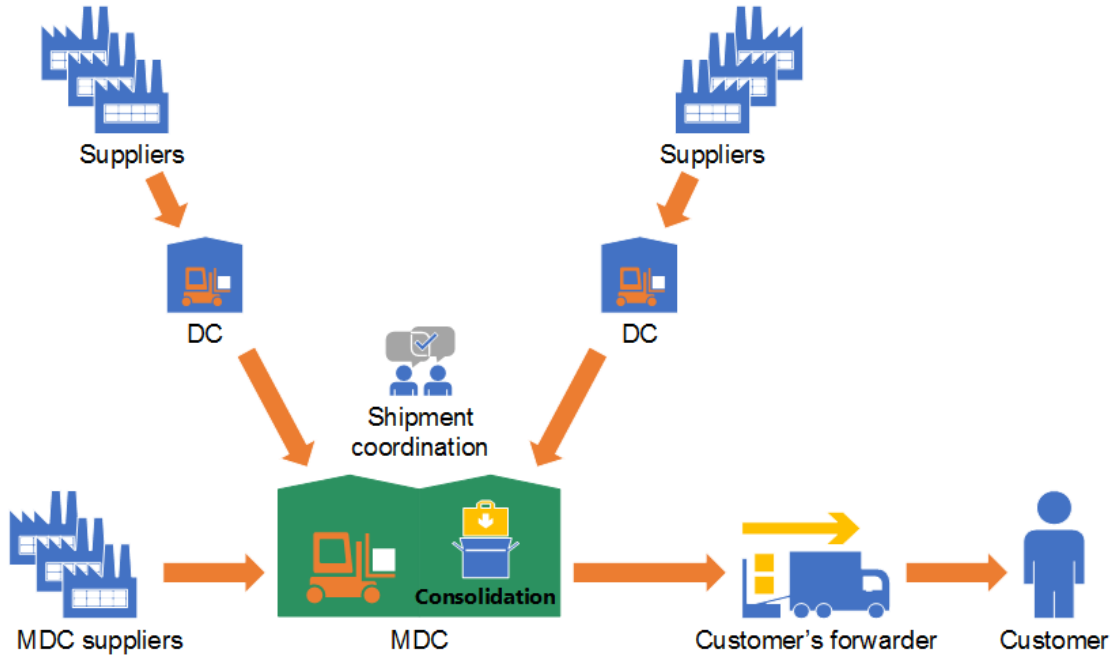


Figure 2.3.2: *An example of shipment consolidation.*

In the example, the customer has placed separate purchase to each distribution center as in previous example, but this time the customer has asked for the shipments to be consolidated at main DC – in other words, the example resembles a hub-and-spoke system, where the main DC acts as the hub. Now the individual distribution centers coordinate their actions to be able to consolidate the shipments at a main DC warehouse, which acts as a consolidation point. The coordination requires communication between the parties in order to achieve fluent consolidation in the timeframe given by the customer, thus meeting the service requirements. The two other DCs dispatch their shipments to the consolidation point, where the three shipments are consolidated. The consolidated goods can be shipped to the customer or the customer's forwarder can pick them up after the consolidation.

2.4 Logistics outsourcing and third-party logistics (3PL/TPL)

The logistics costs average about 12 percent of the world's GDP (Cheong 2004). In Finnish companies, the logistics costs average for 13 to 16 percent of sales. For most companies transportation and warehousing usually present the most important single elements in the logistics costs. (Soinio et al. 2012) The increasingly competitive markets have driven many companies to outsource their logistics functions to third-party logistics providers, as this allows the companies to focus on their core competencies. (Cheong 2004; Marasco 2008) The outsourcing trend is increasing, and the logistics outsourcing markets remain a globally growing business (Cheong 2004; Marasco 2008; Soinio et al. 2012). In addition to the increasing competition, the development of information and communication technologies, increasing customer expectations and the popularity of lean thinking has caused explosive growth of the demand of logistics outsourcing services (Marasco 2008). The trend is moving to two different directions: the number of individual buyers of the services is increasing, and at the same time, the extent of using the logistics services is increasing. (Cheong 2004)

The idea of outsourcing logistics tasks such as transportation and warehousing is not a new phenomenon (Skjoett-Larsen 2000; Soinio et al. 2012). However, the scope and range of the services offered has been broadened immensely from simple transportation and warehousing to comprehensive and advanced supply chain solutions (Soinio et al. 2012). Normally the outsourcing has been done by choosing the cheapest alternative that meets the predefined service requirements. The outsourced services were usually performed by several actors to ensure enough competition, from the outsourcer's viewpoint. The parties were often kept at some distance, with a minimal information change. (Skjoett-Larsen 2000) One could describe the outsourcing as a simple business transaction, as there were no other strings attached. Nowadays, the focus on logistics outsourcing has shifted from simple cost reduction and capital release to a more strategic level, such as increasing the service level, market coverage and flexibility towards the customers' changing requirements. The solutions are tailored to suit the needs of the customer, and

often include value adding services like assembly, quality control and packaging (Skjoett-Larsen 2000; Soinio et al. 2012). The collaboration between the parties has changed too, now the aim is at long, mutually binding partnerships that often require changes in e.g. organization and information systems. (Skjoett-Larsen 2000) In other words, the logistics partnerships usually require supply chain integration.

This transition to more in-depth level of outsourcing is called third-party logistics (3PL or TPL) (Skjoett-Larsen 2000). The term third-party logistics originates from the early 1970s, when intermodal marketing companies started acting as intermediaries between the shipper and forwarder, thus acting as a third party in the logistics chain (CSCMP 2013).

Simultaneously, as the customers' expectations on logistics outsourcing have shifted from price reduction to a more strategic level, low price is not a sure-win strategy for the 3PLs anymore (Cheong 2004; Soinio et al. 2012). According to Cheong (2004), the most important selection criterion for a 3PL are its core competencies. However, Soinio et al. (2012) emphasize the meaning integration and innovation in the services provided.

Like many other terms in supply chain management, the concept of third-party logistics does not have a single, consistent definition as definitions differ from each other quite drastically. Some definitions take a broad approach to the term, while others have a narrower approach. The broad definitions suggest that 3PL include any form of outsourcing of logistics tasks previously performed within a company (Marasco 2008). An example of a broad approach is the definition by Lieb (1996, cited in Marasco 2008), where 3PL is described as the use of external companies to perform logistics functions, which can comprehend the whole logistics process or selected activities within the process, that have traditionally performed within an organization. This kind of broad definition of 3PL suggests that if a company has its own warehouse facilities and decides to use an external warehouse, would be considered as third-party logistics (Skjoett-Larsen 2000). Narrow approaches suggest that 3PL includes many more features than outsourcing of logistics functions, that need to be fulfilled in before the term 3PL can be used. These features include e.g. the long-term duration of the relationship and joint efforts to develop cooperation. (Marasco 2008; Skjoett-Larsen 2000) An example of a narrow approach to 3PL would be the definition by Murphy & Poist (1998), where 3PL is considered as a long-term and mutually beneficial relationship between a shipper and a third party, which has more customized services, broader service functions compared to basic services. The Scandinavian view of 3PLs is often considered narrower from its American and European counterparts (Marasco 2008; Skjoett-Larsen 2000).

According to CSCMP (2013), 3PL requires outsourcing many or all logistics operations of a company to a specialized company. Originally the 3PL meant the companies that accepted the shipments from the shipper and tendered them to the carriers. However, the scope has broadened with the years, and nowadays every company that offers some kind

of logistics services can be considered as a 3PL. (CSCMP 2013) However, Soinio et al. (2012) state that 3PL is usually associated with multiple services as a bundle, but also that different definitions overlap with each other.

In the terms of this study, the relationship between the case company and their logistics partner fulfills both the narrow and broad requirements of 3PL. The outsourced functions include for example value-adding services, such as quality control and packaging, in addition to the more basic functions as warehousing. Their aim is to develop the long-relationship and actions to be more beneficial to both parties, which is pursued by e.g. shared information systems and information sharing. Several other partnerships with e.g. logistics forwarders exist, but not to the same extent.

The relationship between the shipper and a logistics provider can also be illustrated. Bowersox (1989, cited in Skjoett-Larsen 2000) examine the different levels of logistics relationships by analyzing the degree of integration and commitment between the parties. The classification of different levels of logistics relationship can be seen in figure 2.4.1.

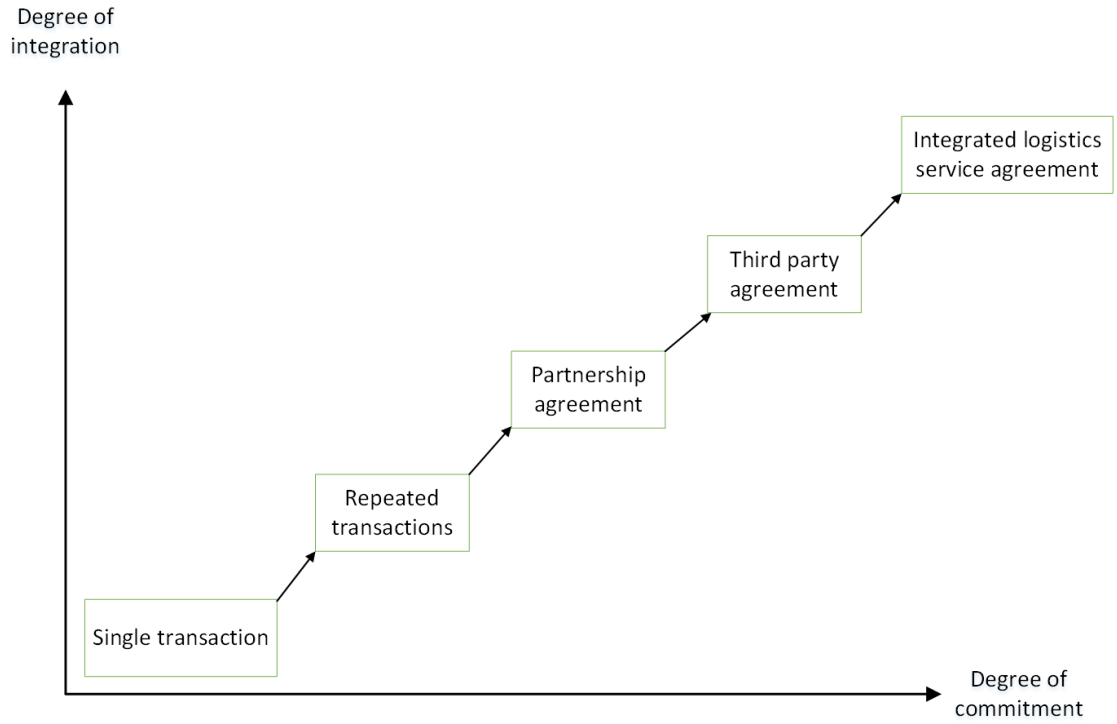


Figure 2.4.1: *Levels of logistics relationship (adapted from Skjoett-Larsen 2000).*

The left part of the scale focuses onto a traditional relationship between the buyer and the seller in the transport market. The agreements are usually short termed, informal and without any commitment except for the specific transaction. In single transactions the price is usually the main leverage. (Skjoett-Larsen 2000) An example of a single transaction would be choosing the most inexpensive freight forwarder for a one-time delivery.

When moving towards right, the style of cooperation changes. As the degrees of commitment and integration increase the agreements become more formal and the mutual obligations increase. (Skjoett-Larsen 2000) The last three forms of cooperation from the right can be considered as forms of strategic alliances, which are preferred by the 3PLs due to the relationships' longevity. (Cheong 2004; Skjoett-Larsen 2000) Cheong (2004) acknowledges that in extensive partnerships and agreements between the client and the supplier the performance of the 3PL is often monitored. It is also not uncommon that several performance-related incentives and penalties have been determined in the contract between the parties (Cheong 2004). The target of these penalties and incentives is to increase the commitment of both parties and thus increase the collaboration.

In a partnership both parties aim to maintain their independence, while collaborating towards more efficient systems and procedures. Usually in partnerships the client maintains the management and planning functions internally, while the logistics functions are externalized to the provider. The provider then tries to create standard solutions for the client's requirements. (Skjoett-Larsen 2000)

Third-party agreements are more demanding than partnerships. The agreements require a certain level of formality and they are more binding than partnerships. In third-party agreements the services provided are much more tailored to the needs of specific clients than the standard solutions provided in partnerships. The agreements often demand investments in equipment, plant or employee training in order to meet the service requirements of the client. The cooperation between the parties is based on free information sharing and mutual trust between the parties. Sometimes the agreements demand the provider to share the responsibility, to some extent, for the personnel, equipment and the plant of the client. (Skjoett-Larsen 2000)

Integrated service agreements require the most extensive cooperation between the parties, both in terms of formality and mutual obligations. In these agreements the provider takes over large parts or the whole logistics process, including such functions as management and control of logistics activities, facility management and personnel administration. The degree of solution tailoring is also the highest, as the solutions are specifically modified to the requirements of the client. The solutions also often include several value-adding services. In addition to these, normally the information systems of the parties are partially integrated and inter-organizational teams of employees are formed for the affected functions. (Skjoett-Larsen 2000)

The cooperation between the target company and its logistics provider can be considered as a third-party agreement, as it fulfills many of the characteristics presented above. For example, many, if not all, of the logistics processes in the warehouse have been tailored to the needs of the target company. Also, several investments to the equipment, plant and training have been made, especially in the beginning of the agreement. Some aspects of

integrated service agreements can also be recognized in the cooperation between the parties. For example, inter-organizational teams and cooperation has been utilized to continually develop the cooperation between the parties and value-adding services, such as quality control and different packing solutions are provided. However, most control on the supply chain management is kept at the MDC office in Finland, as they control e.g. the inventory levels and scheduling of transportation.

2.5 Spare parts logistics

The logistics needs for every commodity are different. For example, perishable foods demand certain temperatures from the transportation and warehousing, which sets certain limitations and requirements for the logistics planning and execution. Then again, for example heavy machinery has very different requirements for its logistics. Spare part logistics has some distinct features. The service level requirements are very high, as the stock-out effects can be financially drastic and the demand for certain parts can fluctuate immensely, making the forecasting difficult. Also, the prices of individual parts can be very high. At the same time the material and time buffers supply chains are decreasing. (Huiskonen 2001) As the requirements for after sales services seem to be ever increasing along with the money involved in spare parts sales, these characteristics set some difficulties and pressure for streamlining the logistics system for spare parts (Cohen & Lee 1990; Huiskonen 2001; Molenaers et al. 2012; Suomala et al. 2002). However, the spare parts business is usually considered to be a very profitable business area. No accurate information is available, but it has been estimated that spare part sales cumulate one third of net sales and two thirds of profit. Sometimes it is even estimated to be the most profitable function of a corporation. (Suomala et al. 2002) If the figures are even remotely close to the estimations, it should provide the companies plenty of incentive to the business development.

Huiskonen (2001) has created a categorization framework for spare parts that includes four key control characteristics of spare parts which affect the logistics system elements. The control characteristics and logistics system elements are presented in the figure 2.5.1. The characteristics help to represent the unique features of spare parts.

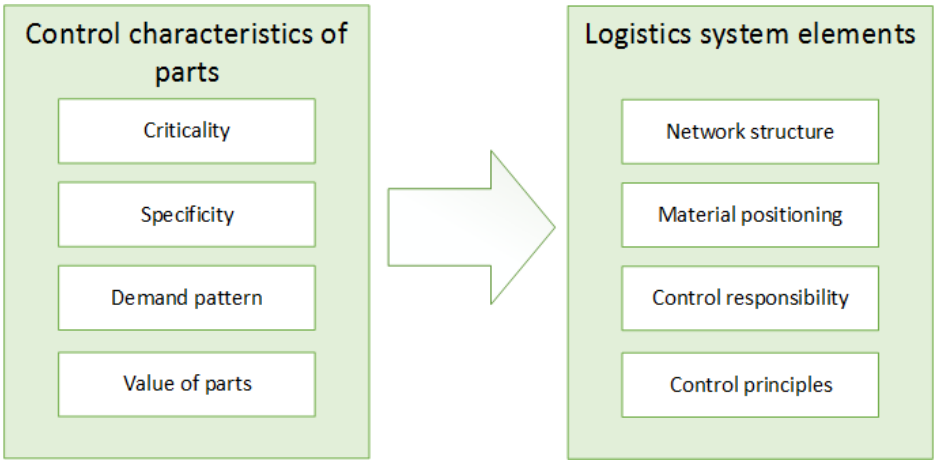


Figure 2.5.1: *The control characteristics and logistics system elements of spare parts (adapted from Huiskonen 2001).*

Huiskonen (2001) divides criticality into two perspectives: process criticality and control criticality. The criticality of a spare part relates to the consequences of a failure of such part. A spare part is considered process critical, if its failure or malfunction will result in process failure and replacement is not immediately available, which can have significant consequences such as production loss or loss of lives. (Huiskonen 2001; Molenaers et al. 2012) If a replacement would be readily available, the spare part is not considered process critical. The impact of the shortage can be multiple times the part's commercial value, which makes it difficult to analyze inventory needs. However, in practice the part criticality is assessed by using several subjective criteria. The "exact" assessment of a part criticality is often not necessary as determining a few categories of criticality is sufficient. A practical view to estimate the criticality is to examine the time the process failure needs to be corrected. (Huiskonen 2001) The case company has classified three different delivery priorities to orders to assess the spare part criticality. The delivery priorities of the target company reflect Huiskonen's (2001) example of categorization of criticality, where first category failures need to be corrected immediately, second category failures can be tolerated for a short period of time and third category failures are not critical for the process. In MDC, the breakdown-priority is used when the customer's equipment has failed and is in stoppage. For breakdown-priority, the aim is to dispatch the needed spare parts as soon as possible (usually during the same day) via forwarders' express services. Express-priority is often used, when for example the customer has a scheduled maintenance stoppage planned in the next week or two from ordering. Standard-priority orders are not urgent and they usually go directly to customer's consignment stock. The delivery priority can be defined independently for every item.

Control criticality is not related to the consequences of the failure and shortage, but more of the possibilities to control and prevent the failures (Huiskonen 2001; Molenaers et al. 2012). The control criticality includes factors like lead time, supplier availability and predictability of failure (Huiskonen 2001). A spare part is considered control critical, if the

possibility of ensuring immediate availability is difficult to control (Molenaers et al. 2012). Huiskonen (2001) states that from the logistics viewpoint the most important is to know how much time there is to react to the situation.

According to Huiskonen (2001) spare part specificity is considered another control characteristic. In the wide array of different spare parts there are broadly used standard parts, which are usually immediately available from multiple suppliers, and specific parts (such as made-to-order parts) that are tailored and used only by a specific user. The standard parts are often stocked in multiple levels of the supply chain, which makes the availability good. The suppliers are also usually willing to cooperate with the user as the volumes are high and offer economies of scale. The situation is the opposite with the specific parts, as the special low-volume parts are not stocked willingly, which emphasizes the responsibility of the user in the control and availability. (Huiskonen 2001)

The demand pattern of the spare parts contains for example the aspects of volume and predictability of demand. Like in every other product, large volumes result in benefits of economies of scale. (Huiskonen 2001) However, distinctive in spare part logistics is the large amount of parts with low and irregular demand. This makes the control more complicated, especially when combined with other features like high criticality and price. The sporadic demand of parts demands larger safety stocks to be able to respond to sudden situations. The fluctuating demand makes the predictability more difficult. (Huiskonen 2001; Suomala et al. 2002) Often the demand uncertainty is created or aggravated inside the supply chain, due to the bullwhip effect, which distorts the actual demand. The bullwhip effect is amplified in multi-echelon supply chains, along with the increasing supply chain complexity. (Kalchschmidt et al. 2003) Usually the demand predicting is done by estimating failure patterns and rates by statistical analyses, which can be facilitated by categorizing the parts e.g. to parts with random failures and parts with predictable wearing patterns. (Huiskonen 2001) One critical effect of fluctuating demand pattern is the simultaneous increase of inventories and decrease of customer service (Kalchschmidt et al. 2003). Paakki et al. (2011) also emphasize that mathematical models are not always applicable to spare parts, due to the complex application environments they provide

The last of the control characteristics is value, which is a common characteristic to all materials. High value makes the stocking of a part undesirable for any party in the supply chain and forces the parties to seek other solutions than stock holding. Nevertheless, if the high value part is not a made-to-order item, the stock must be held somewhere in the supply chain. Usually the high cost of items favors the positioning backwards in the supply chain. With low value items the replenishment must be effective, to avoid unnecessary administration costs especially when compared to the item value. (Huiskonen 2001)

The life cycles of the industrial equipment can exceed 20 years, which can complicate support offered to the customer. For example, in purchasing it can be difficult to find a supplier for a 30-year-old component or a replacement for the component. (Suomala et

al. 2002) From the viewpoint of transportation and warehousing some challenges occur due to the large scale of different parts. The range in size, shape and weight in the parts is immense. For example, a spare part can mean a tiny nut or screw that weighs only some grams and is measured in millimeters, but a spare part can also weigh several tons while being so large that it can’t fit into a 20 feet container. This sets some requirements for warehousing and transportation flexibility.

3. INFORMATION SYSTEMS IN SCM

Different tools used in SCM have come a long way from the paper and pen that were used some decades ago. Nowadays, information technology (IT) is like a nerve system for supply chain management, connecting different parts to each other (Gunasekaran & Ngai 2004). Like a body, SCM is unable to function without IT and the information technologies have become an inseparable part of companies' business strategies, as the progressing information technology has created new possibilities for supply chain management software (Acar et al. 2017; Helo & Szekely 2005). In general, information technology is an important factor for connectivity and transparency across the supply chain (De Koster & Warffemius 2013). The technologies have enabled the convergence of SCM and computerized networking toolsets capable of linking all channel partners into a single trade community (Ross 2011 p. 2). Different information systems are crucial in supply chain management and further in supply chain integration, as it is impossible to achieve an effective supply chain without IT. The supply chains are spread out all over the world, which creates the need for integrating the activities both inside and outside of an organization. Sharing information on different value-adding activities along the supply chain requires an integrated information system (IS). (Gunasekaran & Ngai 2004) However, despite the advanced and evolved information systems used in SCM, the basic objectives of SCM have remained the same: to lower inventory levels and improve the agility of manufacturing, thus enhancing customer service level (Helo & Szekely 2005).

A critical aspect of successful SCM concerns the measuring and monitoring information about the supply chain's key operational and performance parameters (Gunasekaran & Ngai 2004; Qrunfleh & Tarafdar 2014). Because of this it is very important that the company adopts information systems that are aligned to the supply chain and that support the key processes of the chain while providing information about the key parameters measuring the goals of the supply chain strategy (Qrunfleh & Tarafdar 2014). A warning example of not aligning the information systems to the supply chain strategy is when Nike's $100 million IS software could not prevent significant inventory shortages and excess in the company's supply chain. One reason for the lack of alignment is the inadequate analysis of the applications, if they really answer to the information processing and management control needs of the supply chain. (McLaren et al. 2004; Qrunfleh & Tarafdar 2014) For example, the company should consider what kind of applications should be adopted, if the supply chain's key objective is e.g. minimizing inventory or leanness, as the appropriate fit between the supply chain and the IS requires analysis of the true requirements for the applications. (Qrunfleh & Tarafdar 2014)

As mentioned earlier, today's supply chain management is very technology driven, and several information system solutions have been developed to support the better flow of

information in supply chains (Power 2005; Ross 2011 p. 2). Integrating different supply chain processes (i.e. supply chain integration) should provide improved supply performance and it is considered a key factor in gaining competitive edge (Birou et al. 1998; Frohlich & Westbrook 2001; Pagell 2004; Qrunfleh & Tarafdar 2014). Consequently, an important part of SCI is information integration, which is enabled by different information technologies (Prajogo & Olhager 2012). The IT allows the supply parties to coordinate their activities and support the decision-making in the supply chain (Frohlich & Westbrook 2001; Prajogo & Olhager 2012). Helo & Szekely (2005) present several different classifications for the SCM-related software. They can be classified e.g. to intra-firm and inter-firm applications, from data management perspective to transactional (engaged with acquiring, processing and communicating raw data) and analytical (supporting decision-making) software or from process perspective to planning (determines the best way to fulfill and order) and execution (track physical status of goods, materials management and financial information) applications. The transactional and execution software applications are most often used on operational level and short-term scope, while the analytical and planning software support strategic and tactical level and more long-term needs. Different types of software often overlap each other, which means that very different types of applications may compete or even interfere with each other. (Helo & Szekely 2005) Often different information systems, such as ERP, planning systems, manufacturing execution systems (MES) and transportation management systems (TMS) are integrated with each other. The objective of systems integration is to make the decision-making process in the supply chain easier. (Botta-Genoulaz et al. 2005)

As for the actual SCM software applications used in the organizations, Helo & Szekely (2005) divide the systems into four different categories:

1. Warehouse and transportation management systems (WMS/TMS)
2. Enterprise resource planning systems (ERP)
3. Supply chain management software applications
4. Enterprise application integration software.

WMS systems provide real time information about the material flows within the warehouse. TMS systems facilitate the procurement of transportation services (Helo & Szekely 2005). ERP integrates all different business processes of the organization under one system and database (Akkermans et al. 2003; Helo & Szekely 2005). Warehouse and transportation management systems and enterprise resource planning systems will be covered in more detail in the next subchapters. Supply chain management software applications focus on optimization of future planning and scheduling activities of inter-organization material flow. Enterprise application integration software brings interaction between different systems in the organization that are sharing information with organization's external systems, such as information systems of the supply chain partners. (Helo & Szekely 2005) Ross (2011, p. 31) takes a bit broader scope with the classification, as

the classification consider all technologies used in SCM. The first category contains major business systems, such as ERP, the second point technology solutions, such as TMS, and the third execution solutions, such as the Internet or electronic data interchange (EDI) (Ross 2011 p. 31). Although the approach of Ross to the classification is somewhat different from Helo & Szekely's approach the categories resemble each other.

3.1 Enterprise resource planning system (ERP)

Full, effective and integrated execution of a management system becomes a necessity in SCM when multiple criteria, such as speed, high capacity production, high quality, low cost and minimum inventory holding must be met (Acar et al. 2017). An enterprise resource planning system (ERP) is a comprehensive transaction management system that integrates many different information processing abilities and places data into a single database (Akkermans et al. 2003; Helo & Szekely 2005). The different transactions and data were typically spread around several separate information systems before the adoption of ERP systems. Nowadays, the integrated and maintainable ERP systems have replaced a myriad of old legacy systems that were often non-integrated and undocumented. (Akkermans et al. 2003) Enterprise resource planning systems have been implemented in companies since mid-1990s in hopes of leverage productivity, increase efficiency and overall organizational competitiveness (Li et al. 2017). The ERP systems are an evolutionary extension to material requirements planning (MRP) systems of the 1970s and the manufacturing resource planning (MRP II) systems of the 1980s and have been established as a standard in industry (Akkermans et al. 2003). ERP has also been developed as a response to the need of production action coordination across the organizational boundaries in the supply chain (Li et al. 2017). In order to fulfill the coordination between different departments and contractors, ERP provides control of material and information flow by using different modules. These modules include e.g. supply chain, manufacturing, warehouse management and quality. (Acar et al. 2017)

Fragmented information systems cause information delays and distortion, which again causes the bullwhip effect. Therefore there is reason to believe an ERP adoption could provide considerable gains to the supply chain effectiveness, as the system should enhance transparency across the supply chain by eliminating the information distortion and increasing the information velocity by delay reduction, thus reducing the bullwhip effect in the supply chain. (Akkermans et al. 2003) An important role of ERP is to work as a platform for other applications, such as customer relationship management (CRM) and SCM. The ERP system should provide a unified platform for integrating and managing the core business processes (including e.g. SCM and CRM) within a company. Despite this tendency the decision-making between different business functions of a company remains quite disjoint. (Botta-Genoulaz et al. 2005)

IT itself cannot influence the productivity of a company, but the main efficiency factor in IT is how the people use these technologies (Botta-Genoulaz et al. 2005). Akkermans et

al. (2003) acknowledge that ERP has only a modest role in improving future supply chain effectiveness and that there actually exists a clear risk of ERP limiting the progress in SCM. The main limitations of the current were identified as their insufficient extended enterprise functionality in crossing organizational boundaries, their inflexibility for changing supply chain needs, their lack of functionality beyond managing transactions and their closed and non-modular architecture. The limitations originate from the fact that the first generations of ERP were designed to integrate various operations of an individual firm, but in modern SCM the supply chains consist of networks of organizations. (Akkermans et al. 2003)

A typical ERP implementation takes one to three years and the typical budget is between tens to hundreds of millions of dollars (Akkermans et al. 2003). Per Li et al. (2017) the implementation process can take up to six years from the adoption of the system to the point at which organizations report that they would have fully mastered the processes and the technology. The expected outcome of the ERP implementation is an improvement in the operational performance of the company, which leads to financial gains. However, studies have shown that only some companies gain satisfactory benefit from ERP practices. (Acar et al. 2017) For example, the unwillingness to share information can result in failure in SCM IT projects (Prajogo & Olhager 2012). Acar et al. (2017) also state, that probably the most important factor triggering the ERP implementation is supply chain orientation, which can be defined as the motivation of organizations to manage the supply chain relations with their contractors. In other words, the ERP's benefits do not necessarily emerge from the system itself, but from how the system is utilized and supported by other actions in the organization.

The ERP implementation has always risks due to the magnitude of the process. Botta-Genoulaz et al. (2005) propose that the success of the implementation depends on three key factors (strong and committed leadership, open and honest communication and balanced and empowered implementation team), but emphasize the meaning of the strong and committed leadership in the implementation process. Li et al. (2017) state that the implementation of ERP has been complicated and challenging despite the well-documented benefits it bears. While acknowledging that it is not unusual for IT projects to have issues in adoption and implementation, per Li et al. (2017) the ERP projects seem to have disproportionally more problems, such as serious delays, strong employee resistance, substantial budget surpasses and high overall project failure rates. In the implementation process the organization must recognize the critical role of organizational knowledge, that includes both tacit (e.g. understanding end users' perception in response to the employee resistance) and explicit knowledge (e.g. knowledge to customize the software's embedded configurations). Due to the organizational knowledge's importance organizations often turn to their supply partners for ERP implementation related information, when the implementation is relevant. As the current supply chains are interconnected networks that gain their competitive advantages through the whole chain, it is in

the earlier adopters' best interest to share their experiences about ERP to their supply chain partners. (Li et al. 2017) However, despite the immense potential of ERP and the close interactions in supply chains, many supply chain improvement programs and ERP implementation efforts are managed independently by separate groups of people. (Akkermans et al. 2003)

3.2 Warehouse and transportation management systems (WMS/TMS)

A warehouse management system aims to control the movement and storage of materials and the associated transactions (e.g. shipping and receiving) within a warehouse (CSCMP 2013; Myerson 2013, p. 143; Ramaa & Subramanya 2012). Often WMS includes support for radio-frequency communications, which allows real time data transfer between the system and warehouse personnel (CSCMP 2013). WMS is a database driven application. WMS were developed to improve the efficiency of the warehouse and to maintain accurate inventory by recording warehouse transactions. (Ramaa & Subramanya 2012) WMS allow its users to manage the material flows within the warehouse in real time, by e.g. tracking and keeping note of the material movements. The warehouse management system's functions enable the analysis of different performance indicators (such as productivity, shipping and inventory and warehouse order cycle time), which can further be used to pinpoint problem areas in the warehouse, optimize different transactions and recognize shifts in activity levels and patterns. WMS can also be used for e.g. optimizing space, labor and tools in the warehouse. (Helo & Szekely 2005) If warehousing is to be a source of competitive edge, the implementation of a WMS is necessary (Faber et al. 2002). WMS can be standalone applications or they can be modules of ERP. (Faber et al. 2002; Ramaa & Subramanya 2012)

Transportation management systems (TMS) are software that help with the short-term planning and optimization of transportation activities, procurement of transportation services and the execution of transportation plans – in other words TMS helps to manage company's transportation actions (Helo & Szekely 2005; Myerson 2013, p. 144). The systems often provide continuous analysis and advanced reporting tools, route planning, transportation control features and a systematic way to produce documents and labels. (CSCMP 2013; Helo & Szekely 2005) The benefits of TMS include for example decreases in the transportation costs, inventory levels and increases in customer service. TMS should also provide timely and accurate information, which decreases the uncertainty in the whole supply chain. (Myerson 2013, p. 144)

Usually the WMS and TMS are interconnected. Sometimes the WMS can also include route scheduling functions, which are often managed by TMS. (Helo & Szekely 2005) WMS and TMS handle the short-term scope of the SCM planning, while ERP covers more long-term scope (Faber et al. 2002; Helo & Szekely 2005).

4. CASE STUDY: THE INTERCOMPANY SHIPMENT CONSOLIDATION IN A THIRD-PARTY WAREHOUSE

In this chapter the case study of intercompany shipment consolidation at a 3PL operated warehouse is presented. Some background information of the case and the order process at MDC is discussed first. After that, the case process is overviewed in the form of a flowchart. The bottlenecks and issues of the process are assessed in the end of the chapter.

4.1 Background

The outbound delivery process in the case company has been defined very thoroughly, which is why the way of working could be described as a workflow. According to Liu et al. (2005) and Sun et al. (2006) workflow has been defined as whole or partly automation of business processes, during which information, documents or tasks are moved from one participant to another according to a set of procedural rules. Every action in every step in the process has been documented, as the target has been to standardize the workflow to gain stability and predictability. The deviations are coped with the same style which makes the workflow very reliable and stable. The deviations have been recognized beforehand, so that when a problem occurs, the steps to solve it have been defined and can be found from documentation. However, this also makes the process very rigid and inflexible. If, for some reason, an unidentified problem occurs or someone diverges from the workflow solving these issues could be difficult.

The company and the 3PL operating the warehouse have agreed to certain standard operating procedures (SOP). These procedures have been recorded into a 70-page SOP-document, which is used as the basis for daily actions at the warehouse. The document includes detailed process charts and instructions how to proceed in e.g. inbound and outbound delivery processes. The deviations in the processes and solutions to them have been also recognized and documented.

The consolidation process is undefined, which basically makes it a one large deviation. The consolidation process is not included in the SOP-documentation, which is one of the reasons for the confusion in these cases. The problem-solving structure or steps have not been defined, which causes that every case is handled a bit differently and by improvising. The improvisation expands the unpredictability of the problems, which causes even more problems.

The geographical distance between MDC and the 3PL also causes some obstacles in such special cases. MDC personnel are most informed of the situation, but due to the distance communication and cooperation can sometimes be difficult.

The aim of this study is to define the consolidation process and develop the process and its documentation. During the case study it was noticed, that the workload of the consolidation order hindered the efficiency of the employees, as they needed to handle their regular tasks in addition to the special arrangements required by the consolidation order. The aim is also to increase predictability of problems in the process, which should decrease the workload and delay in case of such problems occur.

4.2 Company information systems and normal order process

At MDC, the information systems essential to the intercompany shipment consolidation process are the company's enterprise resource planning system and the company's transport management system. The company also has several other information systems, but they are not relevant in the terms of this study.

The company ERP is used throughout the supply chain and it forms the center of the company's information system network. The company ERP has also been integrated with other modules, such as the business analytics module, that allows easier order follow-up by offering extensive reporting tools. In MDC, most of operational actions are completed through the ERP, which makes it an essential tool in the intercompany shipment consolidation process. The system consolidates automatically orders under the same shipping address and forwarder, but due to the more complex nature of the case this cannot be utilized in the case.

The transport management system (TMS) is a browser-based tool for order transportation management. The transport management system has been integrated to ERP. For example, when a user creates a shipment for an order in ERP, an EDI-message with the order details (including e.g. the forwarder, addresses and package details) is sent to TMS. TMS then sends a booking request automatically for the correct forwarder. However, this can be utilized for nominated forwarders only as the system currently interacts only with nominated forwarders' systems. In this case, the transport management system was mainly used by other DCs for arranging and booking the shipments from Germany and Sweden to Netherlands.

Both ERP and TMS are available at all company locations and at MDC 3PL. They are widely used, as it harmonizes the company processes. The normal order process in MDC follows the usual ERP order process and is presented in figure 4.2.1. There are some discrepancies with the process depending on the customer, forwarder and order size, but most orders follow the process.

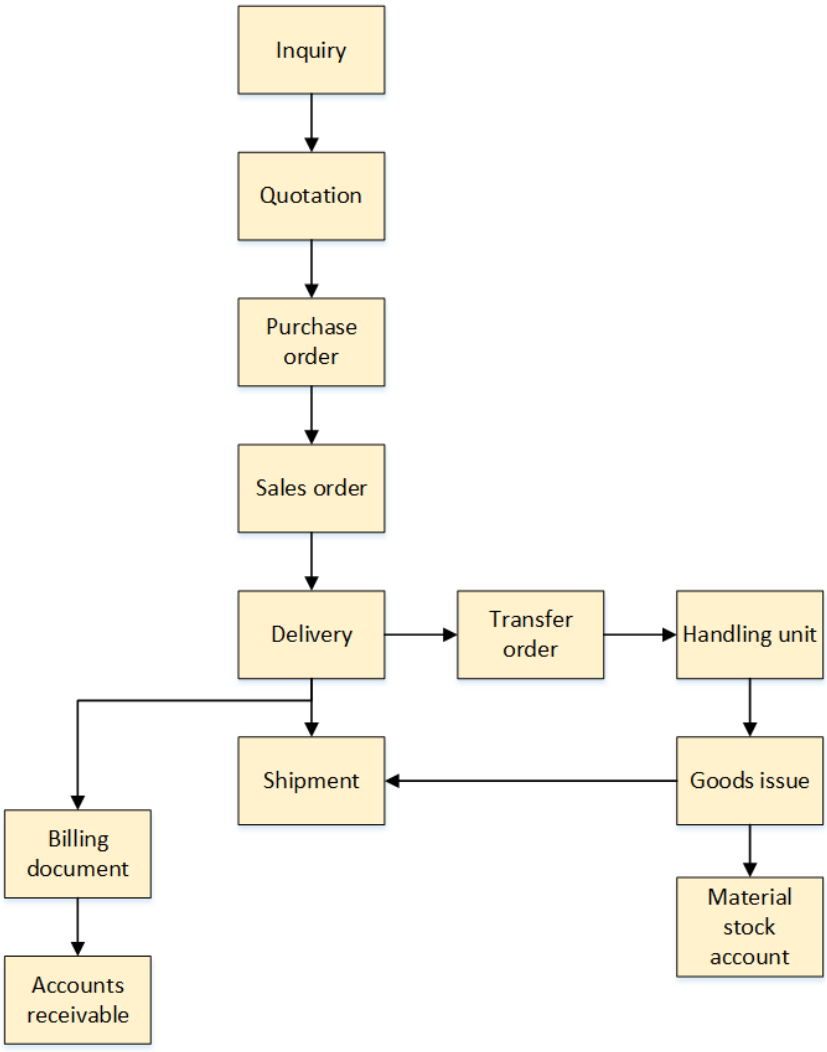


Figure 4.2.1: *ERP order flow (adapted from Kogent Learning Solutions Inc 2011, p. 34).*

The order process starts from the customer inquiry, which is responded with a quotation. In all cases quotations are not needed, e.g. quotation is not needed for a stock order for parts that are on the price list. If a quotation is needed, it is created by MDC technical support team. The customer responds to the quotation with a purchase order, which is sent to the MDC customer service team. Customer service inputs the order to ERP creating a sales order for the parts. Certain customers can also input their own orders to ERP, either directly (some company locations) or via browser-based tool (some distributors).

After the sales order has been created and all needed materials are in stock, the system creates a delivery under the sales order. Also, the transfer order(s), which allow the goods

to be picked and packed at the warehouse, are created. The warehouse personnel prepare the delivery by picking and packing the goods. After every material of a delivery has been packed, a goods issue will be posted. The goods issue removes the count of used materials from the inventory.

When the goods issue is posted the invoice for the order can be created by MDC logistics. However, usually the shipment for the delivery or deliveries is created before the orders are invoiced. The shipment is often created automatically by ERP. If the shipment is for a nominated forwarder, the shipment flows automatically to TMS, which books the transport from the corresponding forwarder. If a non-nominated forwarder is used, MDC logistics creates the shipment manually.

After the shipment has been created, the orders are invoiced. The invoices are created both automatically by ERP and manually by MDC logistics, depending e.g. on the customer and the forwarder used. The system creates accounting documents after the invoices have been created.

Depending on the order, the packages part from the warehouse after they have been booked to a forwarder. The nominated forwarders have fixed collection dates and times, while the collections of non-nominated forwarders must be arranged with MDC logistics and 3PL customer service.

4.3 Parties

Several parties around the world were involved in the analyzed case. In regard of this study the focus is on MDC and its internal parties. MDC acts as an intermediary between all parties in the process and is the only party that contacts all others. In this case study MDC has been divided into four different internal parties depending on their duties and responsibilities. The internal parties of MDC are customer service, logistics, procurement and technical support. Customer service (CS) is responsible for the order entering and monitoring, logistics handles the invoicing and transportation related tasks, procurement handles the inventory and supply and technical support provides solutions and product information to the customers. Most actions regarding MDC in the case are handled by customer service and logistics.

The 3PL operating MDC's warehouse is a critical party in the process, but not considered as an internal party as it is an individual company and geographically separate party from MDC, as MDC operates in Finland and the 3PL in the Netherlands. For clarity, in this study the 3PL is considered as one party, even though it has several internal parties.

The customer in the case operates from Australia. The customer is part of the same group as MDC, but an individual legal entity. In principle, this means that the customer operating from Australia is a sales office, which supports its local customers. In this study, the

ultimate customer is located in Indonesia. The customer's appointed forwarder's role in the process is small, which is why it has not been considered as a relevant party in terms of this study, but included to the customer. The distance and the time difference between the customer and different distribution centers caused some delay in the process.

The other DCs in the case are located in Germany and Sweden. The other distribution centers have smaller volumes than MDC as they support different products. For the other DCs, MDC acts as an intermediary and a consolidation center between the origin and destination of the shipments.

Different product lines operate from different geographic locations, depending on the product. The product line in the case operates from Tampere, from the same site as MDC office.

The communication between the parties is done mainly by using email. Also, Skype is used for instant messaging and voice communication in the process. Some communication between different MDC internal parties and PL could also be done face-to-face.

4.4 Case overview

The grounds for the consolidation process were created when the Australian sales organization sold a comprehensive solution, including capital equipment and spare parts for the equipment, to an end-customer in Indonesia. The technology-based warehousing of the spare parts caused some confusion in the sales organization, as the parts for equipment produced in a specific location are not always supplied from the same plant. For example, in this case the equipment produced in France is supported by the main DC located in Finland. This caused a misunderstanding, that all parts provided in the solution would be shipped from a single place, which lead to errors in contract of sales. The correction of the documents would have caused extra fees which the end-customer or the sales organization were not willing to cover. Together with Indonesia's strict import policies it was decided that the most suitable solution for the problem would be to consolidate the goods in the MDC warehouse in the Netherlands.

The customer placed three purchase orders: one to MDC, one to DC Sweden and one to DC Germany. The PO placed to MDC was largest, containing 93 order items with over 22 tons of net weight in total. The PO to DC Sweden contained 36 order items with the net weight of 1,3 tons. DC Germany PO contained 19 order items with the net weight of 2 tons. The spare parts of the purchase orders are not critical for the end-customer, meaning that they are not needed to be shipped immediately, but they are related to a project relating a new plant. This makes the deadlines strict and inflexible, as the parts must be at the customer on the promised date. Delays could result in financial penalties and the deterioration of the relationship with the customer.

The premise for the consolidation process was not optimal, as the request for consolidation came up when the order process has been already started. However, it was considered that the added value from the consolidation exceeds the costs of extra fees. The end customer's purchase order was also large, meaning that losing the contract would potentially cause lost sales of millions of euros. Consolidation was also considered to add customer value with making all ordered materials to be available at one location at the same time, which makes e.g. arranging the transportation easier and less expensive.

The intercompany shipment consolidation process is illustrated in figure 4.4.1. The process depicts the different steps taken from the customer enquiry to the ready order. The process has been divided into three different phases to make the analysis clearer and more understandable.

The first phase represents the beginning of the process: how the enquiry evolves into a purchase order and what steps need to be taken before the order can be entered into the MDC's information systems. The second phase describes the MDC's internal actions that take place in every order process, such as creating the sales order and examining the product availability. In this case study the steps of the process have some differences to the regular order process, but are mainly the same.

The third phase considers the actual consolidation of the different shipments and what actions need to be done before the complete order is ready for pick-up. The third phase involves most parties and steps in the process.

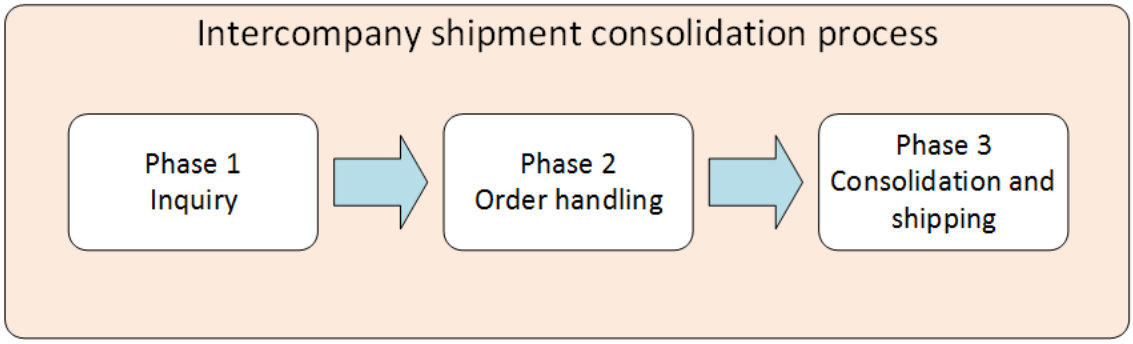


Figure 4.4.1: *Intercompany shipment consolidation process.*

The flowchart of the different phases in the process is presented in the following sections. The uninvolved parties have been removed from the charts illustrating individual phases in terms of readability. The colors and shapes in the flowchart represent different attributes. The orange boxes and arrows of the flowchart describe steps or actions that are done manually (e.g. by using email or Excel). The blue boxes and arrows represent steps or actions done in company's information systems (mainly ERP). The dashed lines represent actions that include both on- and off-system actions. Yellow diamonds illustrate decisions or options in the process and the green shapes represent the documentation involved in the process.

The flowchart does not cover all the steps needed to be done, as some of the steps have been combined in terms of making the chart clearer. For example, all the steps needed to take to create the sales order in phase 2 have been combined under the step "Sales order creation in ERP" as the actions made during that step are not relevant in terms of the consolidation process and the study. The case company has more detailed instructions and process charts of the "normal" process available for the employees if the need would arise.

Similar outbound order process like in MDC is taking place simultaneously with MDC's process in other DCs, but for clarification the processes have been simplified into a few steps in phases 2 and 3 of the process chart. The flow chart does not cover the detailed actions in other distribution centers, as the focus of the study is in MDC process. The order process in different locations should be fairly harmonized, but it is probable that small differences occur in the process in different locations.

4.4.1 Phase 1

Phase 1 is relatively small part of the whole process. It describes the start of the whole process, and all the steps that need to be taken before the customer's order can be entered to the MDC systems. The flowchart of the phase 1 is presented in figure 4.4.1.1.

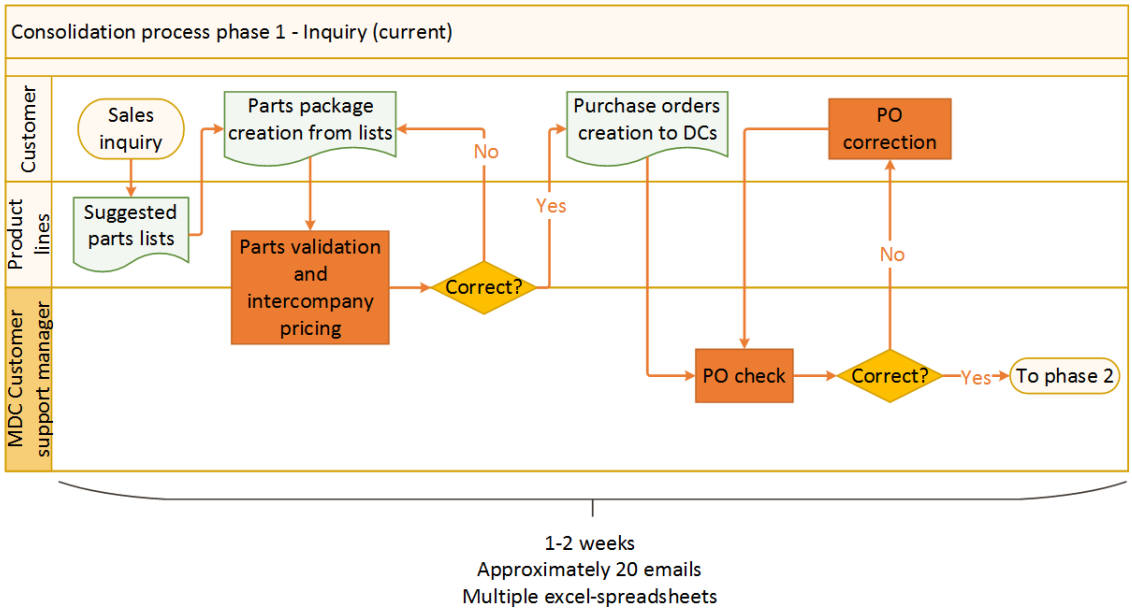


Figure 4.4.1.1: *Phase 1 of the consolidation process.*

The process starts when the end customer makes the inquiry about a solution to the sales organization (MDC's customer). In this case, the end customer's solution included capital equipment and a spare part kit for the equipment. The suggested spare parts for the kit are provided by different product lines (PLs). Each of the product lines are responsible for

different types of equipment and technologies. After receiving specifications of the capital equipment from the sales organization the PLs provide the customer with the suggested spare parts lists. After the customer has received the suggested parts lists they have to combine the lists in order to create the package to be offered to the end customer. Similar to the product lines, different DCs are responsible for supporting different products. Because of this, the customer has to use the PLs' different part lists to create individual lists to every responsible DC. The customer then sends the lists to the DCs for validation and pricing.

The project orders are capital expenditure (CAPEX) driven cases, where the initial parts list is needed in the negotiation phase. CAPEX means a significant expenditure by an organization for the purchase of or improvement of a fixed asset, which is in this case the capital equipment (Law 2015). The spare parts business is usually related to operational expenditure (OPEX), making the project order teams (MDC's customer) unfamiliar with the normal spare parts offering, thus making the validation necessary. In MDC, the validation and pricing is done by Customer support manager in cooperation with the PL. The validation is done to check that the correct (based on the spare parts offering created by the PLs) parts are offered to the end-customer and in order to be able to enter the purchase order to the systems. If the parts are incorrect the product line and customer need to correct them. An incorrect part would be, for example, a part that is not supplied by MDC or if the material number is not on proper level according to the spare parts offering. In this case MDC's customer support manager also has to do the pricing of the spare parts. The validation and pricing cycle continues until the lists are valid from the supplying DC's perspective.

After validating the lists, the purchase orders can be created. Several supplying DCs (depending on the order complexity) mean that the customer must place order to different distribution centers. In this project, the customer places purchase orders to MDC and two other DCs located in Sweden and Germany. Once the customer has created the PO in their system, they send it to MDC via email. MDC has to check and validate the PO once more for errors before inputting it to their system. If any mistakes are found, the PO is sent back to the customer for correction. After correction the PO is rechecked, and if everything is correct, it will be entered to the system and the process will move to phase 2. The PO received from the customer was an excel-sheet instead of a ERP-based purchase order document which are regularly received from the other company locations.

Timewise the phase 1 of the process took approximately 1-2 weeks, as the several validations stall the process. The phase included about 20 emails, as the spare part lists needed corrections and clarifications. Also, multiple excel spreadsheets were utilized in the phase 1.

Problems in phase 1 are mainly related to the creation and pricing of the parts package. In a normal situation, the MDC customer support manager should not have to take part in

the order process. The part list pricing and validation in addition to purchase order validation cause delays to the process, as distribution centers should not participate in the process before receiving the purchase orders. Different material numbers also complicate the process. For example, the customer has been quoted a material that is an assembly (consists of many materials as assembled). However, the quoted assembly may be only sold as a set item from MDC, which means that the parts for the assembly are sold separately. Due to this, one material number can expand into e.g. 20 different material numbers, which complicates things in validating the purchase orders. It also makes material pricing and invoicing more complicated, as often the prices of an assembly versus its components differ. In optimal situation, the PO received is ready to be entered to ERP. This requires that the material numbers are correct and ready for inputting to ERP before a PO is received and the material prices have been already updated in ERP.

4.4.2 Phase 2

The phase 2 of the process describes what steps are taken between the point when the customer's purchase order is input in the MDC system and that the order has been fully packed. The steps in phase 2 mostly take place within MDC. Timewise the phase 2 is the longest, as some of the ordered items were not in stock and they have to be procured from different suppliers. The flowchart of the phase 2 has been presented in figure 4.4.2.1.

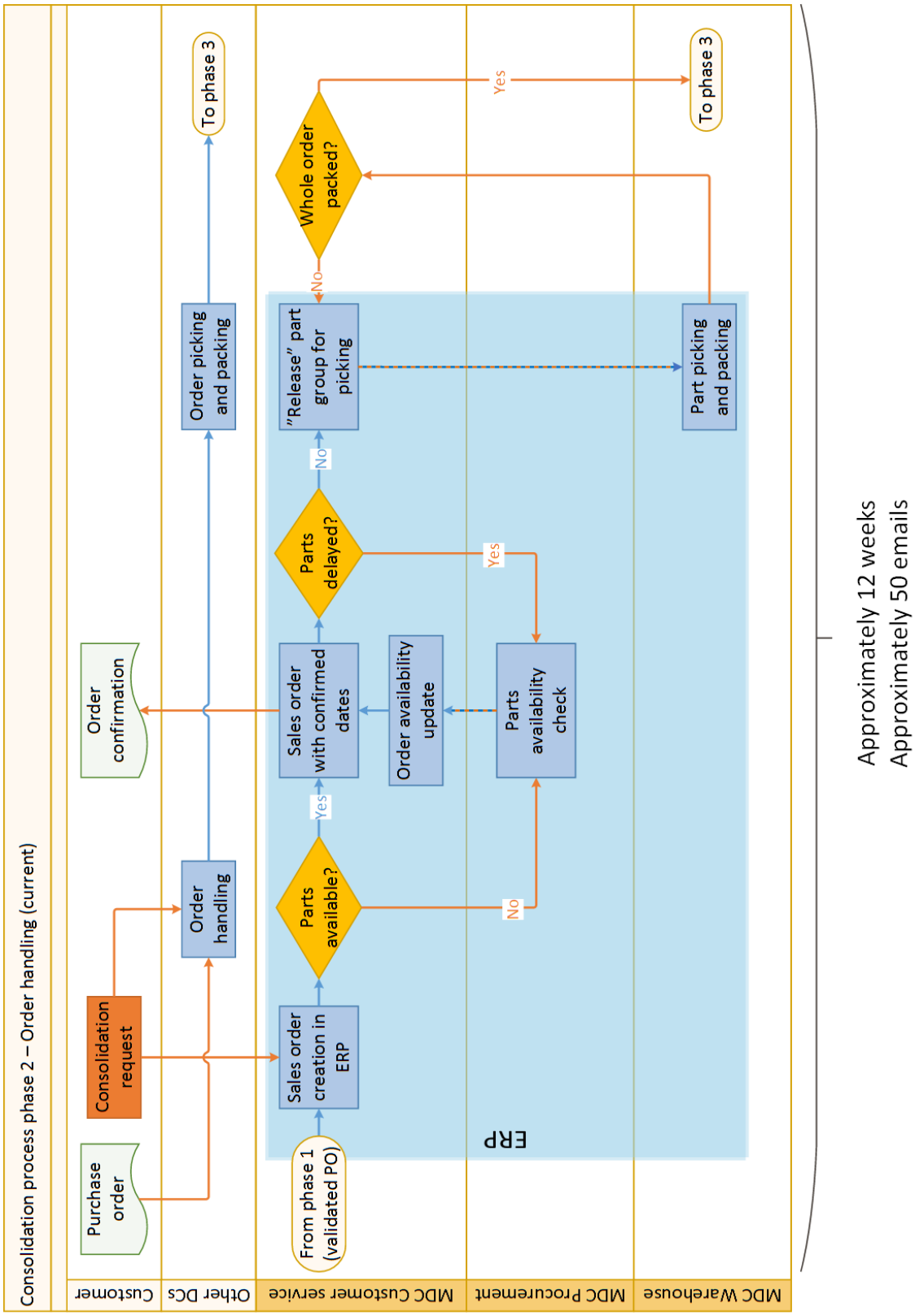


Figure 4.4.2.1: *Phase 2 of the consolidation process.*

After the customer's purchase order has been validated the MDC's customer service can start working on the order in ERP. The phase 2 starts when the sales order is created in ERP. The customer's request to consolidate three different orders in the MDC warehouse

was also introduced at this point of the process. The customer service representative inputs the PO as a normal sales order to ERP. After inputting an item, the availability check is made. If the item is not available, the customer service representative must check the availability from the correspondent purchaser. ERP suggests the estimated lead time for unavailable items, but in special cases (such as this one) the lead time is usually confirmed from the purchaser manually by email. After the purchaser has confirmed the lead time from the supplier he will update the item availability to the system and announce it the to the customer service representative via email. Customer service will then update the items of the sales order with the confirmed availability dates. After the availability of all the items on the sales order has been confirmed, the sales order can be confirmed, printed and sent to the customer.

After the sales order has been confirmed delays to the items can still occur. In case of a delay the actions are similar to availability checking. Usually, when items are delayed, the responsible customer service representative is contacted by the purchaser. The purchaser informs the new availability date after which customer service updates the order with the new dates and informs the customer. Customer service representatives and purchasers monitor open orders from an order follow-up report on a daily basis. The reports list critical order lines, which are in danger to be delayed, and already delayed order lines. Sometimes the customer service representatives detect the upcoming delays from the reports before the purchasing informs of the delay. In this case the customer service representative takes contact with the correspondent purchaser for a fast reaction to the situation. Proactive monitoring of the reports helps to avoid the delays, as the critical order lines' delays can often be influenced. Project orders like in the case in examination are quite delicate in terms of delays as they are not tolerated, which means that the purchaser needs to double check the item availability from the supplier or inquire about the availability from alternative suppliers.

One of the characteristics of a project order is that they are usually larger than normal orders. Because of this MDC does not wait until all of order's items are in stock, but they release groups of items to picking and packing as soon as they are available. This procedure ensures that the items are reserved to the project order, as sometimes items can be prioritized for critical orders, even despite the reservation. The items were grouped in ERP according to their stock-date. The system created the deliveries once all the parts in the grouped were in stock. The delivery is required before any transfer orders can be created and the picking can commence. If the grouping is not done, the system could create hundreds of deliveries against one sales order, but the grouping allows control on the number of deliveries on the order. The delivery grouping is done due to the traceability and clarity of the parts on the order, as the customer service must inform the 3PL customer service about each of the deliveries separately. The informing is not done with normal orders. In this order, the creation of the deliveries was confirmed to the warehouse via email. The email notification was used to make sure that the picked and packed goods

would be stored in the same place as the rest of the order as the storing location was different from normal order flow. The “release” and picking and packing cycle continues between MDC CS and 3PL CS until all the order lines have been packed.

The customer has placed several purchase orders to different distribution centers. The other DCs’ order process flows simultaneously with the MDC’s process. The other DCs’ processes are similar to MDC’s process and they have been simplified into few steps.

After every item of the MDC sales order and other DCs sales orders have been picked and packed the process moves to phase 3, in which the consolidation with the other distribution centers’ orders is done.

There are two main issues in phase two of the process. First one is in internal communication at MDC about the material delays. The case’s project order hasn’t been marked into the systems, but the special nature of the order has been communicated from order desk to purchasing via email, which means that the monitoring relies on purchasers’ memory and possible notes. However, delays occurred and order desk had to ask the corresponding purchasers for availability check, which causes redundant work and emails.

The second problem is due to the size of the order. Because of the large number of items on the order, the parts were released to picking and packing in groups. This was done to ensure that the items would not be reserved to other orders. The warehouse and MDC CS had to be very careful in storing the packed goods, as they needed to be kept together to avoid any parts to get lost. However, one large part went missing in the process and needed to be delivered with a back order. The only indication of the special nature of the order was conveyed to the warehouse via email, as there was not time for investigating an ERP solution for “marking” the consolidation order. The “releasing” of the deliveries for picking and packing also required tens of emails.

4.4.3 Phase 3

The final phase of the process describes how the different shipments are consolidated to one shipment and what steps need to be taken before the shipment can be delivered or picked-up. Phase 3 includes the most steps in the process, and requires the most communication and coordination between the parties. The flowchart of phase 3 has been presented in the figure 4.4.3.1.

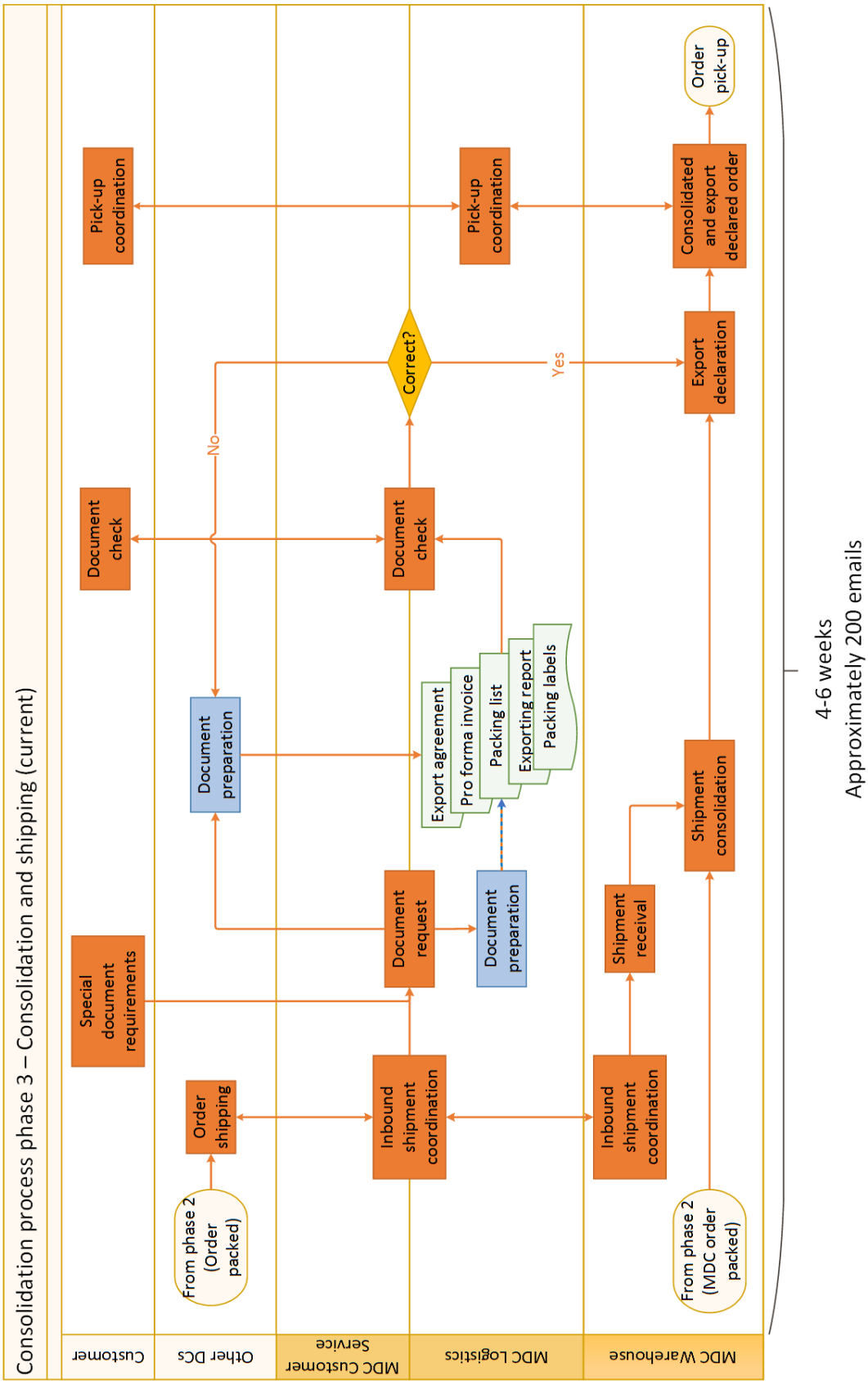


Figure 4.4.3.1: *Phase 3 of the consolidation process.*

The phase starts after the shipments have been packed completely. As the request for consolidating all the shipments in the MDC warehouse has been informed to all parties the other DCs prepare to ship their shipments to the MDC warehouse. The inbound shipments from other DCs must be coordinated carefully between MDC and the sending DC, as otherwise the margin of error at the MDC warehouse rises significantly. At current state, the inbound intercompany orders are not trackable in MDC's systems, which makes the consolidation task much more difficult. MDC acts currently as a link between the parties, trying to ensure the sufficient communication between the parties.

The coordination between the DCs is done by email conversations. The sending DC has to provide MDC the details about the shipment, which include the reference number, estimated time of delivery, delivery truck company and license plate number and pictures of the packages. It was also advised to mark the CMR-document (Convention relative au contrat de transport international de Marchandises par route, a consignment note) with the project name (Logistiikan maailma 2017). After the sending DC has provided MDC the details, MDC will convey the information to their warehouse to prepare them for the incoming shipment. With the information provided the warehouse operator should be able to recognize the correct shipment and store it to their cross-docking area. However, the warehouse's internal communication failed with the other inbound orders, which caused ODRs (order discrepancy report). This means a deviation process that starts when a discrepancy is identified. In this case the warehouse receiving could not identify the inbound intercompany shipments. The warehouse posted the discrepancy report to MDC procurement which conveyed the message to the responsible customer service representative. The customer service representative then contacted the warehouse to resolve the issue. A reminder of the intercompany shipment was required to solve the problem. After the shipment had been identified, the goods were separated from other shipments and marked. Because the shipment was not actually MDC's inbound shipment (like for example a stock transfer order or a supplier shipment) it could not be received in ERP. This causes that the warehouse personnel must manually track and keep record of the shipments. The same process repeated with both intercompany shipments. The consolidation of all shipments itself was simple, as the shipments were gathered and packed together.

Simultaneously with the shipment coordination the preparation of the required documentation started. Several documents were required in order to make the export declaration possible. The declaration needed to be done separately for all three shipments, therefore all the parties needed to provide their own documentation, as regular users (such as logistics coordinators at MDC) do not have rights in ERP to create e.g. invoices for different locations than their own.

The information of required documents was passed to DCs in the same emails with the discussion about shipment coordination. The DCs had to provide MDC the invoice used for export declaration (with the end-customer prices), packing lists of the shipments and an agreement which authorized the 3PL to conduct the export declaration. To create the

invoices with the end-customer prices all DCs had to modify the prices on the orders in ERP using a specific pricing category on the sales order. How to achieve this was instructed by MDC customer service. Otherwise the invoices would have had the intercompany prices, which cannot be used in export declaration. After the documents have been created, they are sent to MDC where they are inspected in cooperation with the customer. If the documents have deficiencies (e.g. in pricing), they are sent back to DCs for correction. After the documents have been approved by MDC and the customer, they are sent to the 3PL for the customs declaration. MDC logistics created also additional exporting reports to smoothen the customs clearance. The reports combine the needed details for each purchase order to an excel-sheet, that can be used instead of using the separate packing lists. The report can be output from ERP with the order reference number, but MDC logistics had to modify manually the prices of the report to match the end-customer prices. The price adjustment had some problems due to different policies in material pricing. For example, in the original purchase order the set items (items consisting of numerous materials) had only been priced by the parent item, whereas in the actual sales order in MDC every individual item had a price. Also, the report creation is quite laborious due to material data issues in the net weights of the materials. Sometimes, the material net weight on the invoice is different from the net weight on the report. MDC logistics have to manually adjust the net weights of the report to reflect the net weights of the invoices, which can take hours in case of long sales orders like the case order. In addition, it was discovered that the end customer had placed three different purchase orders to MDC customer, but the MDC customer had combined the POs into one that was sent to MDC. This meant the MDC invoices had to be split manually to represent the original three purchase orders instead of the one, combined PO that was placed to MDC, which caused some extra work for MDC logistics

The customer also provided commercial invoices for the orders, but those could not be used in the case as the export invoices must contain the sending organization's information. The end-customer had also some special requirements to the documentation, such as the usage of special packing labels. The special labels were provided by the end customer and attached at the MDC warehouse.

After the documentation and export clearance had been done, the order was ready for pick-up. The customer directed their forwarder to MDC logistics. The last steps caused some delay as the customer only started to choose the forwarder when the order was ready for delivery. The forwarder informed when they would pick-up the order. MDC logistics then conveyed the information to the warehouse operator. After the pick-up date and time was agreed, the forwarder picked up the order and the process ends.

In total, the phase 3 of the process took approximately 4-6 weeks. Approximately 200 emails were changed in the phase 3. The phase also included several different documents because of the customs clearances.

There were several problems in phase three of the process. First problem was that the inbound shipments from Germany and Sweden were not visible in the warehouse systems, but MDC and the warehouse had to rely on email communication. This caused the uncertainty and inbound order discrepancies when receiving the shipments, which caused several delays and extra work.

Another issue in phase three appears to be in gathering the correct documentation for each shipment. It was not clear for all parties what documentation and in what kind of form was needed in order for the 3PL to be able to customs clear the shipments. Arranging the documents took approximately one week.

A problem in phase three was also that the customer had not contacted the forwarder before all goods were ready for collection. This caused that the packed and cleared order waited at the MDC warehouse for several weeks before the customer's forwarder collected the goods, as the customer and the forwarder had to agree to the terms of the transport before the collection could be arranged.

4.5 Process issue analysis

Different problems in the process have been collected to the table 4.5.1 below. In the table, the problems, the affected party or location and the affected phase or action have been marked. In addition, the impact of the problem has been assessed with a three-level scale (low, medium, high) and in two categories, workload and time. Low impact problems delay the process for two workdays or less and increase workload up to a total of one hour of work time. Medium impact problems can delay the process two to five workdays and add workload up to total of five hours of working time. High impact problems delay the process more than five workdays and increase workload more than five hours in total. The observed problems have been gathered and the assessment scale developed by the researcher, based on the process analysis and the interviews. The problems and their impact were mostly examined in the interviews by asking each party e.g. how much time was used in a phase, how many emails were involved in a phase, which was the most laborious step of a phase and what could have been done differently. The findings are MDC-centric, as they are under the heaviest workload in the process.

Table 4.5.1: *Observed problems in the consolidation process.*

Problem	Affected party	Affected phase	Time impact	Workload impact
Communication	All	Whole process	High	High
Systems rigidness	MDC, DCs, 3PL	Whole process	High	High
Incorrect or incomplete material data	MDC, PL	Phase 1 and 3	Medium	Medium
Response for material availability and delay	MDC, customer	Phase 2	Medium	Low
Picking and packing	MDC, 3PL	Phase 2	Low	Medium
Insufficient warehouse space	3PL, Customer	Phase 2 and 3	Low	Medium
Inbound ODRs	MDC, DCs, 3PL	Phase 3	Medium	Medium
Document preparation	MDC, DCs, customer	Phase 3	High	High
Order collection by forwarder	Customer, MDC, 3PL	Phase 3	High	Low

The whole process is labeled by the problems in communication. The issue is mostly in the number of emails in the process, as the conversations are responsible for a majority of the workload in the process. The sheer volume of the emails consumes time of the parties, as the mails must be at least skimmed through in case of any important information. As the email conversations grow and expand the time to go through them increases, especially if one has not had to take part into the process recently. The timeframe of the process expands to several months, which causes that things can also be simply forgotten. The workload caused by the large number of emails was also recognized in the

interviews with the MDC and other DCs' personnel, as it was considered as one of the main problems in the process and it was brought up as one of the first things concerning the process.

The number of emails in the process is humongous, while a large portion of them are redundant or even unnecessary and address topics that have already been discussed. There are several reasons for the issues. The communication problems can be considered as consequences to other problems and not as actual problems per se. Several factors bloat the amount of emails in the process. Firstly, the consolidation orders are somewhat new in the current organization structure, and therefore it is still unclear how they should be handled. The responsibilities and steps are unclear at times, as the special needs of the consolidation orders occasionally require different steps from normal orders. As there are no instructions for these, it requires improvisation which often causes that the work is not optimized. Also, as the steps are not clear to each party, steps need to be double-checked and sometimes corrected.

Communication problems also derive from the information systems, as currently the systems do not provide enough support for the consolidation orders of this type and size. Due to the incompatible systems, the traceability and transparency of the process is poor. This also creates the need of communication, especially between the MDC CS and 3PL CS in phases 2 and 3, as the poor visibility in systems forces them to verify the actions by email, e.g. when releasing the goods for picking and packing.

Communication between the parties is also hampered by the distances between them, that causes some delays. The time difference between the European parties is only an hour or two, but the time difference with the customer is several hours. This caused that often a reply would not be received before the next business day. The communication between parties also failed for some parts of the process, as necessary requirements were not always clear to all parties. For example, the need for consolidation was not known in the beginning of the process, due to a misunderstanding. Some requirements also came up during the process (e.g. the invoice splitting), which required quick actions and flexibility from the parties.

Despite the problems in communication all parties remained active and reachable throughout the process. This alleviated e.g. the delays to the process in case of unforeseen problems, such as the inbound ODRs. In a way, the active communication increases the number of emails, but decreases the possibility of misunderstandings and the delay effect, as the parties do not have to wait for long times for responses.

Also, the information systems do not support the consolidation in the way done in the process, which reflects to the whole process hindering it. The consolidation is problematic from the system viewpoint, due to the different parties included in the process. The special characteristics of the consolidation process were also recognized by the company supply

chain development team during the interviews. The fast schedule did not allow a thorough research of ERP features that could help, as the order process was already underway when the consolidation request was revealed.

Especially inbound shipments suffer from poor visibility and traceability, as they are not visible in MDC or 3PL systems. The traceability relies on emails between the sending location, MDC and 3PL, as the systems support is weak. The sales order to DC Sweden can be taken as an example of poor visibility and rigidness of the system. In ERP, the sold-to party is the company sales office in Australia, ship-to party is the end-customer in Indonesia, but the transportation is booked to MDC warehouse in the Netherlands operated by the 3PL. MDC did not have visibility for the inbound shipment and the 3PL could not receive them in ERP, as MDC had not placed a purchase order for the goods. A purchase order could not be placed due to the schedule and because the material numbers were not open on the MDC plant due to the technology-based support of products. As a result, there were two different inbound shipments with multiple packages at the warehouse, which were not visible in any system. This makes it difficult to e.g. identify the packages. The problems with e.g. the inbound shipments were identified in the interviews with MDC and 3PL personnel, as the lack of traceability resulted in a lot of extra work in the process.

The system issues came up also in the phase two of the process, reflecting to the availability and delays of materials and the rigidness of the picking and packing process at the warehouse. In the current process, there does not exist an easy way of marking special orders to follow-up report in ERP so that MDC procurement can prioritize those orders in case of delays. The delays cannot be always avoided, but the response time and actions to the delays could be improved. The size of the order required some special actions, which complicated the picking and packing of the order, such as releasing the materials in groups. The parts could not be picked normally (when they are available), as a way to mark the order significance to the 3PL employees in ERP was not found. If grouping would not have been done, the project order's packages would have ended up to the same ship lanes as normal orders that the customers' forwarders will pick-up. The delivery grouping and the follow-up were considered as very time consuming by MDC CS.

The project order's size also complicated the warehouse's actions, as they were not completely prepared to store a large amount of ready-to-ship goods for a long period. This presented the issue that all goods for the order could not be stored into same place, even though it was requested. This also caused that one large part went missing during the process and the order could not be shipped fully. The missing part had to be post-delivered to the customer.

In phase one, the issues with material data resulted in some delays unnecessary work, as the part list's material numbers and prices had to be individually checked. The checking was done cooperatively by the product line and MDC customer support manager. The

material data issues continued in phase 3, when MDC logistics prepared the documents for the export declaration. The differences in pricing of set materials caused some irregularities in the document preparation, and the pricing had to be corrected manually to the documents. Also, the differences in material net weights on invoices and exporting report caused some unnecessary workload on the MDC logistics. However, the structure of the project orders hinders the possibilities of changes. The case order is supportive to a sales of capital equipment. The exact type and model of the equipment is not known until the final stage of the sales, meaning that the structure of the parts package cannot be finalized before that. After the specifications of the equipment is finalized the product lines have about two weeks to finalize the structure of the parts. The PL and MDC logistics brought up the difficulties caused by the material data.

In phase three, the problems are mainly related to the receiving of inbound shipments from other DCs and arranging the documentation for the export clearance. The documentation issues are largely due the new process and unfamiliarity to it. For sending DCs, it was not always clear what kind of documents were needed and in what form. A slight delay in phase three was also due to the transportation booking of the customer, as the consolidated order waited at the MDC warehouse for weeks for the forwarder's collection. The problems were recognized from the analysis of the case order's email conversations and the interviews with the MDC personnel.

5. SHORT-TERM IMPROVEMENT IDEAS TO THE CONSOLIDATION PROCESS

Even though the studied intercompany shipment consolidation process covers a fairly small part of the company's supply chain and its functions, it involves a network of parties and a complex system of several interdependent actions. SCM aims to create more value for the whole supply chain by reducing the resources used in it (Cooper et al. 1997; Stank et al. 2001). This often means that the supply chain processes should be honed to eliminate the excessive resource usage in them. As the intercompany consolidation process was analyzed in the previous chapter, several bottlenecks and problems were recognized in it. In order to truly follow the objectives of SCM, some changes to the process are required.

The development ideas presented in this chapter represent the "quick wins" that can be achieved in the intercompany shipment consolidation process. The improvements require little to none capital, as the aim is to rationalize the current process using the tools available in order to solve the most obvious and blunt problems in the process. The presented improvements may not be sustainable solutions to the problems, but should be implemented while more sustainable improvements can be taken into use. Most of the improvements can be implemented instantaneously or almost instantaneously.

Different means and tools for the improvements are first presented. The main focus of the short-term improvements is on the consolidation process flow. Several redundant actions were recognized in the original process. These steps have been removed or combined to clarify the process and the different responsibilities of parties.

The improvement ideas were developed from the process analysis presented in the previous chapter. Most improvement ideas were discovered in the interviews conducted in the study, after which they were researched more thoroughly and complemented by the researcher. Also, a company location in the United States was interviewed for reference, as the location has had similar project orders than in the case study. However, the interview did not present notable development ideas for this study, as the consolidation process at United States differed noticeably from MDC's process. The effects of the improvement ideas have been assessed by the researcher, based on the research data and interviews.

5.1 Consolidation order instructions

The interviews implicated that many issues of the process are a result of the process being undefined. This causes confusion in the responsibilities and actions in the process. It is important that each party is aware of the process flow and its steps, as the competitiveness

of the supply chain derives from the whole chain instead of individual parties (Acar et al. 2017; Li et al. 2017; Ross 2011 p. 1). Any written instructions of these specific consolidation cases have not been available making the improvisation on the go only option to handle such cases. To solve this, a comprehensive instructions guide will be written based on this study. The idea of the instructions did not directly come up in the interviews with the different parties, but documenting the process appears as a simple way to convert the tacit knowledge of the process into an explicit form. The instructions describe the process and its different phases including the steps needed to take. The guide should decrease the emailing between the parties, as it should respond to the most frequently asked questions of the consolidation orders.

The idea of the instructions is to guide and support the different parties involved in the cases throughout the process. The instructions will define clearly which actions are needed in different phases of the process. Separate instructions for different parties will be written, in order to make the instructions approachable and understandable. The instructions will be utilized in the order process, as they will be sent to the different parties in the beginning of the process.

The instructions should not be considered as a "silver bullet" that resolves all issues related to the intercompany consolidation orders. Every case is different from other, which means that sometimes the parties need to adapt to different situations instead of blindly relying on the guide. The consolidation order instructions also pose a threat to the process. If the instructions contain errors, it could be harmful for the process causing more problems and issues than without the instructions. Because of this writing the instructions should be an iterative process and the instructions should develop along with the process. The guidelines should also be updated from time to time, if changes to the process apply.

5.2 Material data verification

The conflicted, missing or incorrect material data slows down the phases 1 and 3 of the process. The data issues require the material codes and prices to be verified by both the PLs and the MDC customer support manager in phase 1. In phase 3, the documentation arranging gets more consuming as the net weights and customs codes of the materials must be checked and corrected if wrong. Also, the prices of the materials needed to be checked when creating the exporting report. The exporting reports for export clearances are done at MDC on a daily basis, making it an excellent target for improving the lean-mentality in the case company, as the resources consumed in correcting the documents cumulate. The benefits of such improvement should overcome the resources used in the data verification in reasonable schedule.

In order to avoid such problems, material data verification should be executed. The material data is mostly maintained by each plant, but some data, such as net weight of the material, is maintained globally. The globally maintained data flows to company ERP

from a product data management (PDM) software. Local material data is maintained in ERP. Currently, the PDM's data overwrites the ERP data, which makes the local modification of globally maintained data impossible, as the PDM's data overwrites every change. This makes the data maintenance a very rigid process in some aspect, as some attributes cannot be modified locally.

The material data verification is the most demanding of the short-term improvement ideas. It is also debatable if it is even a short-term improvement idea, as there are several ways to realize it. It is questionable if it can even be considered an improvement idea, as further discussion in the company revealed that the problems with the material data have been already recognized in the company and actions for improving the current situation are on the way. For example, a global project for a new PDM-system is in progress. The system should provide flexibility to the product data management. Actions for updating, maintaining and correcting material data attributes have been also implemented in the company. For example, a project for maintaining the material net weights has been started. In future, e.g. the missing or incorrect material net weights will be added to the company ERP when receiving of such goods. The warehouse employee will get a notification of the missing or incorrect net weight before the put-away of the materials. In such case, the employee will measure the net weight of the material (separate training for the measuring is offered) with a calibrated scale and add it to the ERP. The material data for such material will then update globally to all company plants. Also steps for harmonizing the customs tariff codes are underway. These actions altogether should increase the reliability and validity of the material data, which should reflect not only to the workload of intercompany shipment consolidation process, but to everyday actions taken at MDC, by decreasing required the time and effort used in e.g. invoicing.

5.3 Dedicated consolidation area at the warehouse

The 3PL partner advertises its flexible solutions for different needs. One solution offered is a quick and flexible warehouse area, which can be utilized for many needs, such as project orders. The area will be separated from others with sealing-off line, meaning the areas are visually outlined, which decreases the possibility of mistakes in warehouse operations.

In the interviews with MDC management a dedicated consolidation area for project orders appeared as a solution to make the cases clearer and more manageable at the warehouse. To utilize the areas the need for one should be clearly indicated to the 3PL before the order process. For example, the MDC warehouse manager could inform the 3PL of the need as soon as the information of the consolidation request is forwarded from the customer.

A separate consolidation area for the project order should decrease the problems in phases 2 and 3. Along with work instructions, the issues with picking and packing the parts and

lost parts should be eliminated or at least diminish. In picking, the parts would be collected to the consolidation area. The consolidation area for smaller parts, that are stored inside the warehouse, could be implemented inside the warehouse. A separate area for large parts, that are stored in the yard, could also be arranged to the yard. All MDC goods of the order would be packed when everything has been collected, allowing further optimization to the packing process. Compared to the case process, the goods are picked and packed in delivery groups, which may not always result in ideal packages.

The dedicated warehouse area should benefit both MDC and the 3PL. The workload for both parties decreases, as the problems with missing items should decrease. The area should also clarify the situation at the warehouse, as the project order parts are clearly separated from other orders. In addition to these, the packaging optimization could present some small decreases in packing material and transportation costs.

However, there are some limitations to the consolidation area. Firstly, the information about the consolidation must be passed to MDC before the order process is started in order to gain the most benefit of the area. Secondly, the space at the warehouse is limited. Several simultaneous consolidation areas could fill the current warehouse, meaning that MDC should rent more space from the 3PL. At current situation, however, this scenario is highly unlikely.

5.4 Information systems support

Information technologies and systems support the supply chain management and integration by offering better connectivity and transparency across the supply chain, making the chain more of an interlinked network (De Koster & Warffemius 2013; Ross 2011 p. 2). A significant aspect of the SCI is the information flow in the supply chain and how this flow can be enhanced (Gunasekaran & Ngai 2004; Power 2005). From the supply chain management's perspective, it is crucial that the information systems that are used in the supply chain are aligned to the chain and support the key processes of it, thus supporting the decision-making and task coordination in the chain (Frohlich & Westbrook 2001; Prajogo & Olhager 2012; Qrunfleh & Tarafdar 2014). The study of the consolidation process revealed that the information systems used do not support the consolidation process very well, or at least all the functions of the systems that support the process have not been implemented. However, the consolidation process can be hardly seen as a key process, as it is a very specific and quite rarely needed process in the company.

Interviews with the company supply chain development team revealed that the uncommon nature of the consolidation process presents problems to the systems support, making quick and easy out-of-the-box solutions to the company ERP difficult or even impossible. However, several ideas were identified how the information systems support in the consolidation process could be improved in a short-term scope. The improvement ideas focus

on enhancing the information integration between the parties, as the communication problems was recognized as one of the problems in the process. The issues were partly due to poor order and shipment visibility and traceability in the systems. The information integration aims to enhance the key-information sharing and decision-making supporting in the supply chain. It has been also proven helpful in reducing the supply chain costs. (Prajogo & Olhager 2012) However, the concept of logistics integration is also present in the information systems related improvement ideas, as the objective of the systems is to support the creation of as seamless material flow as possible. (Prajogo & Olhager 2012; Stock et al. 2000)

The short-term improvement ideas on information system level require little to none configuration to the information systems. The ideas concentrate on utilizing the existing features in the information systems instead of needing to develop new features or systems. Partly due to this, the improvement ideas are focused on alleviating the problems instead of solving them completely.

5.4.1 Consolidation order reference

One problem identified in the study results from the fact that the consolidation orders cannot be easily recognized from the other orders, which causes various nuisances in the process, e.g. with the handling of delayed materials. In order to specify the consolidation orders from regular orders a new kind of reference could be used. This “consolidation order reference” offers a way in MDC to separate special orders. In the interviews, the company supply chain development team hinted that the company ERP includes a way to mark orders with a reference number that is visible only in the company ERP and its applications. An identifying reference number or code can be given to each order. Sales order header contains a “your reference” field in ERP, to which an identifying internal reference can be inputted. The reference can be input to the sales order header when creating the order. A picture where the reference is input in ERP interface is presented in figure 5.4.1.1.

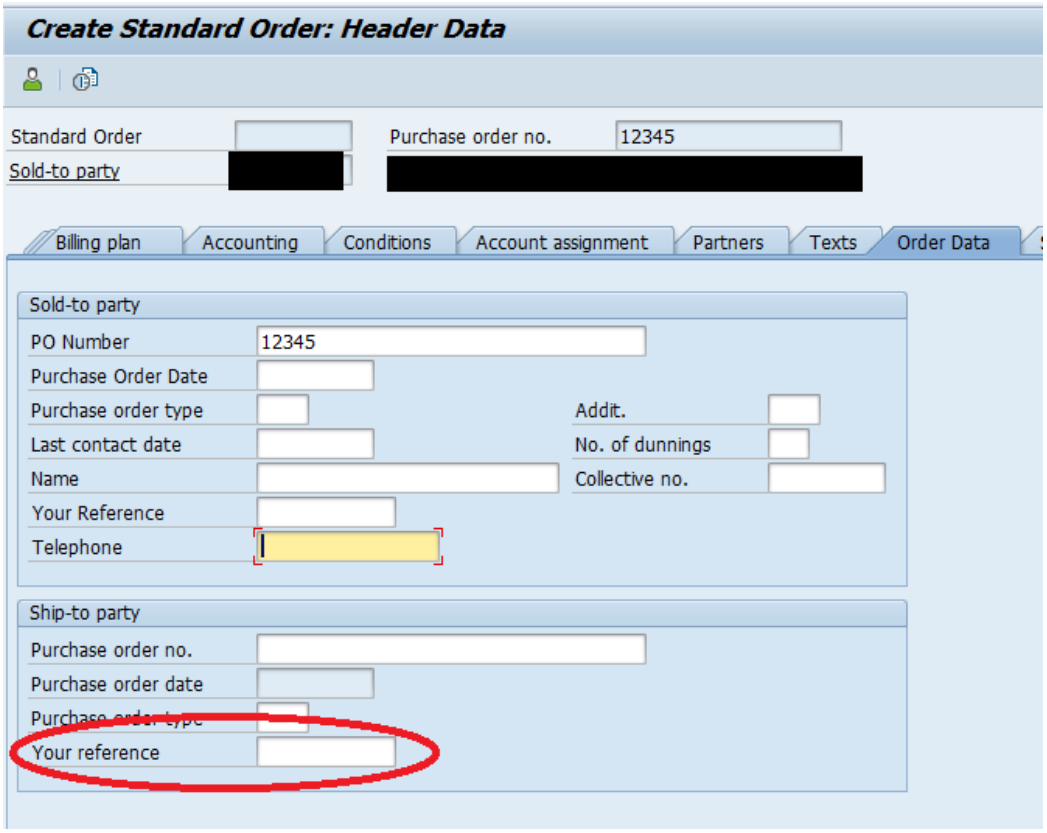


Figure 5.4.1.1: *Your reference on ERP sales order header.*

The usage of "your reference" should decrease the need for internal communication between MDC employees. The utilization should minimize the emailing between MDC customer service and procurement in case of a material delay, as the identifying reference is visible on the order follow-up reports of both teams. The schedules and deadlines in consolidation orders are relatively strict, which means that delays can result in even financial penalties or even the loss of sales. With the reference number the MDC employees recognize the consolidation orders directly from the reports. Thus, the procurement can enquire the part supplier for a better lead time directly for the parts, instead of first informing the customer service of the delay and their request for expediting.

However, ERP does not automatically create the reference number, but the customer service representative must add it manually. As the "your reference" field may be utilized also for other purposes than identifying consolidation orders, a rule for the reference creation must be considered to separate the consolidation orders from each other and from other orders. One way to execute this would be a two-part reference, where the first part would specify the order type and the latter order identifying reference, such as purchase order number. An example of the reference is "ICC-123456", where "ICC" stands for intercompany consolidation and "123456" is the identifying reference number. The identifying number part could be, for example, the customer PO's reference number. The reference could also include the required ready time for the order's parts, making the information directly visible on different teams' follow-up reports.

This reference could also be further utilized when coordinating the inbound intercompany shipments with the warehouse. One problem that arose during the case study was how the incoming shipments from other distribution centers were handled and communicated. The study's sample size is very small, but the problem was consistent. In the case, the inbound shipments were not recognized, as they were "outside" the information systems. The inbound department did not have visibility for these shipments, so they were handled as any other unrecognized shipment. The handling caused unnecessary work for both the warehouse and MDC staff.

The MDC customer service could give the created reference to the other DCs involved when instructing them in the process. The DCs would mark the packages of their shipments with the reference and for example text "More information available at 3PL customer service", which would direct the inbound warehouse personnel to the customer service, who could further instruct the workers how to proceed with the inbound shipments. The 3PL customer service is responsible for the communication between the MDC and the 3PL. The 3PL should not need the markings, but they work as precautionary measures if others fail. The reference could be used to identify the different consolidation orders, if there are several at the same time.

The benefits of the new reference relate to the communication and duration of the process. The usage of the consolidation order reference reduces the amount of email between the MDC customer service and procurement in the phase 2 and the email between MDC customer service and the 3PL customer service in phase 3. It also decreases the workload of customer service and the warehouse, as the sufficiently marked inbound shipments would not require ODRs, but the required actions would be clear at both ends. The implementation should also decrease the response time needed in case of anomalies or defects in the process, i.e. in case of delays in the supplier's shipments.

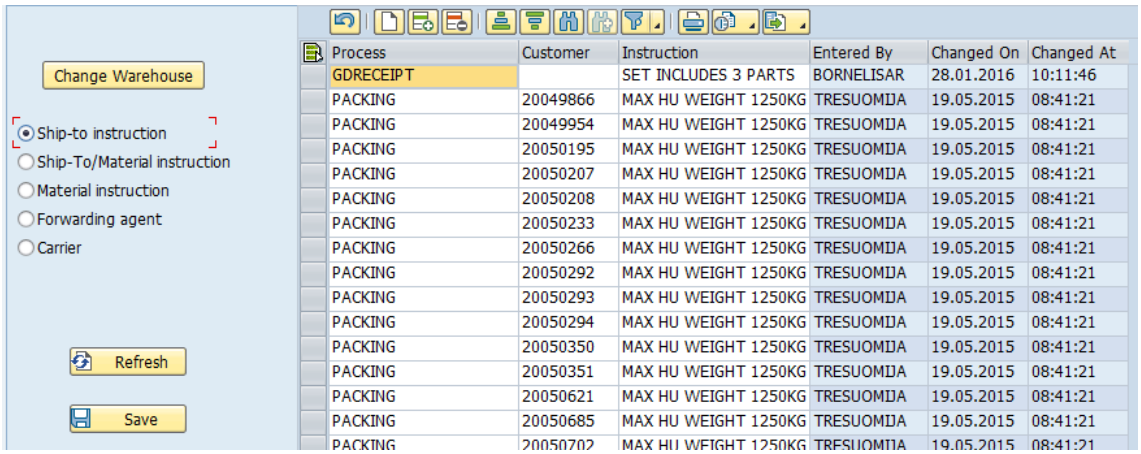
The downside of using the reference is that it is not automatically created by the system. Because of this the MDC CS must remember to create and input the reference when creating the order. If the reference is not input, the MDC procurement will handle the delays with normal priority. The reference is also needed when coordinating the inbound shipments of the other DCs. If the inbound shipments are not marked sufficiently, the shipments could cause an ODR at the warehouse, which will result in unnecessary delays and workload. A specific structure to the reference could also be needed, if the reference would be used to different purposes in future.

5.4.2 3PL work instructions

The delivery releasing and thus picking and packing coordination of the order requires a lot of work from MDC customer service, as they need to monitor the orders carefully and inform the 3PL about every delivery. The problem originates from the fact that the case order looks like any other order to the 3PL. An idea how to resolve the problem came up

in the interview with the 3PL staff. The information system level solution for the visibility seems to be out of reach in short-term schedule, but the problem could possibly be alleviated with different markings, such as further utilizing the "your reference" presented previously. However, the company ERP includes a transaction which allows the input of different kinds of work instructions to different kinds of tasks. For example, work instructions can be input to material numbers, if the handling of the material requires special attention. Then, the warehouse workers receive the instruction to the screen of their RF-device when e.g. picking the specific material.

At current state the system supports work instructions on material number, ship-to-party, combination of material number and ship-to-party, forwarding agent and carrier. The instructions can also be directed to certain actions, such as picking, packing, goods receipt and put-away. Inputting the instructions is simple, as the users only have to create a new instruction item, select the level and action, input the target party or material and the instructions. The actions can be assigned to a certain warehouse location. After saving the instructions they are activated. A picture of the transaction's user interface is presented in figure 5.4.2.1.



Process	Customer	Instruction	Entered By	Changed On	Changed At
GDRECEIPT		SET INCLUDES 3 PARTS	BORNELISAR	28.01.2016	10:11:46
PACKING	20049866	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20049954	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050195	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050207	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050208	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050233	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050266	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050292	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050293	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050294	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050350	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050351	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050621	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050685	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21
PACKING	20050702	MAX HU WEIGHT 1250KG	TRESUOMIJA	19.05.2015	08:41:21

Figure 5.4.2.1: *Work instructions input interface in ERP.*

The optimal solution for the process would be adding the instructions to the sales order-level, but unfortunately the system does not currently support that. Even though the work instructions do not work currently on sales order-level, the instructions can be utilized in the process. One possible workaround would be using the work instructions on the ship-to-address-level. Using the instructions would solve the problem of manual "release" for the deliveries, as the warehouse workers would get the instructions when starting to pick the deliveries of the order. While not being an optimal solution, it allows the immediate implementation of the work instructions, granted that there are not several different orders to the same ship-to-party. If the ship-to-party has regularly normal sales orders, the ship-to-party-level work instructions are not a viable option, as the instructions would pop-up to every sales order that has the ship-to party to which the instructions have been input.

The consolidation orders are rare and often not to regular customers, making the workaround worth considering.

The usage of the work instructions is simple, as the only required step is that the MDC customer service adds the work instruction to ERP after the sales order or ship-to-address has been created. If the instructions have been created on the address-level, the MDC CS should create the address in ERP before entering the sales order and remove the instructions after the sales order has been shipped, as otherwise there is risk that the instructions will interfere with future orders.

The instructions could be simple, such as the "your reference" and a remark that the materials or packages should be stored together to a specific location, if that has been agreed beforehand with the 3PL, a consolidation area. In the instructions, the 3PL employees could also be instructed in that the materials do not need to be packed until all goods have been picked. If the materials are packed all together, it allows further optimization in packing contrary to the current situation, where all the deliveries of the consolidation order were packed separately. The instructions could be different for materials that are stored inside and to the materials stored in the yard, as due to their size the yard-materials should be stored to the consolidation location in the yard instead of inside the warehouse.

The implementation work instructions would have a medium impact on the workload and communication in the phase 2 of the process. The usage of work instructions requires one or two extra steps from the customer service representatives when creating the order, but decreases the amount of email needed in the process, as the deliveries do not have to be communicated to the warehouse individually. The MDC customer service's workload during the process derives from mainly the humongous amount of email and communication needed to which this improvement would answer. In the scope of the case study, the amount of email in the phase 2 would have decreased by approximately 20 messages if the work instructions could have been used. The MDC CS would also not need to follow up the sales order as intensively, as the delivery blocks and grouping would not be needed on the order, as the materials could be freely picked for the order as soon as they are stocked. This would further decrease the workload. The impact on process lead time would be small, as the time benefits would only come from the reductions in time used in communication and delivery releasing.

5.4.3 Dock Scheduling Tool (DST)

The 3PL uses a Microsoft Excel-based tool called "Dock Scheduling Tool" (DST) for monitoring the truck movement at the warehouse. The warehouse has tens of inbound and outbound truck shipments every day, because of which a tool has been developed. The tool helps to keep track of the different shipments. It has several different information columns, such as date and time of arrival and departure, forwarder, shipper or receiver, truck license plate, reference number, number of packages, total weight, country of origin

or destination and the correct dock. Also, a comment section is available, where different kinds of miscellaneous information of the shipments can be added.

As the name suggests, DST works as a schedule of incoming vehicles and usage of docks, as it keeps track of them. The use of the tool is simple. 3PL customer service inserts data to the sheet, when they receive a pre-alert of a vehicle from e.g. a forwarder. When the vehicle arrives at the warehouse, it first goes through the customer service, in which the vehicle is identified and forwarded to the correct dock. The customer service then informs the inbound or outbound team that the vehicle is arriving. Then the operational teams load or unload the vehicle and give the driver a permission to leave after everything has been checked. An example picture of the DST is presented in figure 5.4.3.1.

LOADING	UNLOADING	DATE	ARRIVAL	DEPARTURE	T1	Container	FORWARDER	SHIPPER/RECEIVER	License Plate	Reference number	COLLOW pallet	Weight	Country	Door	COMMENT
N	Y	08.05.17	10:00	11:55	Y	Y	xxxx	yyyy	03 BFD 8		12	22281	TR	Yard	ARMU981610-5 Geen PO nummer; Alleen CMR ; Leverancier
N	Y	06.06.17	9:55	12:55	Y	Y	xxxx	yyyy	01 BFD 8	54357454	17		TR	Yard	ARMU981612-9 ; geen gewichten
N	Y	06.06.17	11:00	13:40	Y	Y	xxxx	yyyy	17 BHG 7	12346876	10	23123	TR	Yard	ARMU98161-8
N	Y	25.04.17	12:20	14:15	Y	Y	xxxx	yyyy	39 BGT 8	345346363	15	21775	TR	Yard	ARMU981623-4 ; 8:15 aanwezig; had een hangslot aan de container
N	Y	03.05.17	8:25	11:50	Y	Y	xxxx	yyyy	01 BFD 8		17	22183	TR	Yard	EXPU983002-0;Geen PO nummer ; Alleen CMR ; Leverancier AS
N	Y	07.06.17	9:30	13:50	Y	Y	xxxx	yyyy	18 BHG 1	234134523	16	21791	TR	Yard	expu983019-0

Figure 5.4.3.1: *DST in use.*

As the inbound shipments in the consolidation cases have been proven problematic and they have been ended up unidentified delaying the process, the tool could possibly be utilized to achieve better success rate at reception of these shipments. As in the case study, MDC customer service gets all the necessary information of the shipments from other DCs after they have booked the transportation. MDC CS then conveys the information to 3PL CS, where they would now mark down the information to DST. This way the 3PL CS does not have to rely solely on email information of the special shipment, as the emails can get lost or simply be forgotten. For further information, the comment-section of DST could be used to input specific information regarding the consolidation shipments, e.g. if all the items of a consolidation order have been agreed to be collected to a certain ship lane, the 3PL customer service could direct the vehicle directly there. Using DST should improve the traceability of inbound consolidation shipments at little to none increase in needed resources. The only difference to the previous procedure is that 3PL CS inputs the vehicle information to DST when getting the pre-alert from MDC CS. All in all, the total resources needed in the consolidation process should decrease, as the shipments can be identified better, which decreases the amount of inbound ODRs that cause unnecessary workload. This should also reflect decreasingly to the communication needed in the process and the duration of phase 3 of the process.

DST could be implemented immediately without additional costs. Together with the package markings, work instructions and sufficient communication DST should form an overlapping network of different tools and markings that should ease the inbound shipment process. The overlapping tools and markings provide some failsafe in case of some of them fail in the process. However, these should not be considered as long-term options for the process as the tools do not provide a sustainable solution for the problems, but as more of a quick fix.

5.5 Updated intercompany shipment consolidation process flow

The original process contains a lot of redundant steps and work. The new, improved process has been streamlined in order to avoid most of the redundancy. The new process flowchart describes the ideal situation, which may not be always the flow the process follows.

5.5.1 Phase 1

The changes in updated phase 1 are targeted mostly outside MDC. In the optimal situation MDC personnel should not be involved in the whole process before the customer places a purchase order for the goods. The need for consolidation should also be known before any purchase orders are placed to different DCs. The updated flowchart for the phase 1 has been presented in figure 5.5.1.1.

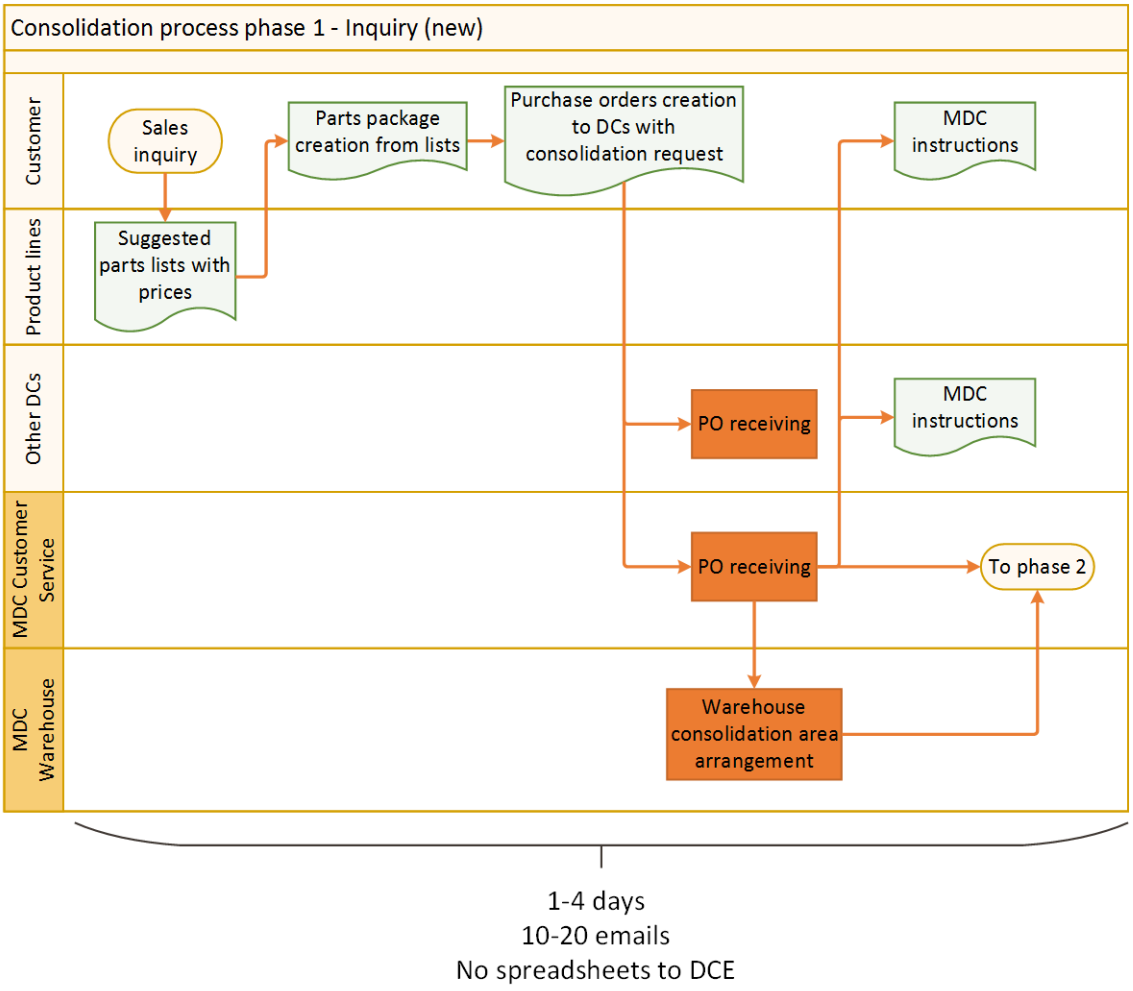


Figure 5.5.1.1: *The updated phase 1 of the process.*

The updated phase 1 relies heavily on order and material data being correct. The process starts when the customer places a sales inquiry to the product lines. This is preferably done before any final agreements with the end-customer have been done, to avoid any unnecessary corrections to the sales and to keep the end-customer satisfaction at high level. The product lines create the suggested part lists suited to the situation. The suggested lists include the correct prices and material numbers. The validation should not be needed, as the product data should be accurate. However, most likely the validation of the parts lists and purchase orders is still needed in the beginning. After that the customer combines the different lists as the part package to the customer, presents it and if approved creates the purchase orders and sends them to the corresponding distribution centers. The need for consolidation is informed already at this point, which allows better preparations further in the process.

After receiving the PO and the request for consolidation, MDC and 3PL arrange a consolidation area for the order at the warehouse. The area is used to store the goods of the order throughout the process. The 3PL must also give a specific name for the consolidation area, which MDC can use later in the process. MDC's instructions for intercompany shipment consolidation will also be sent to the customer and participating DCs at this point. The instructions should be helpful to avoid problems further in the process. After the invoices have been sent to the parties the process advances to phase 2.

The time used in phase 1 is shortened considerably, as in the streamlined process the phase 1 should take only 1 to 4 working days instead of the 1 to 2 weeks in the current process. The continuous emailing and validation between the parties has been decreased, which shortens the time needed. However, the estimated email count does not necessarily decrease significantly, as the steps increase. Estimated count is to 10 to 20 emails, which still can be about 50 percent less than in the current process. No spreadsheets are sent to MDC, as the part lists should be handled completely between the product lines and the customer. In the improved phase 1 any actions from the MDC customer service manager should not be required. One of the key differences compared to the case process is that the customer informs the consolidation request to the different distribution centers already when the purchase orders are placed. This eases the consolidation task, as the preparations can be started immediately.

The updated phase requires better coordination and communication between the product lines and the customer. The schedule for the spare parts package is tight, as the product lines have about two weeks to work on structure of the package. Conversation with the product lines revealed that they would need more time, so the deadline needs to be longer or the equipment structure needs to be informed earlier to the product line. The optimal solution would be that the customer would include the product lines to the cases already when they are creating the quotation for the end-customer. This would ensure that the correct parts with correct prices will be quoted to the end-customer. This would decrease the need and workload of validation in the parts list and package creation. Also, the part

lists formatting should be harmonized, in order to optimize the part package creation. At current state the different part lists can have different layouts, which leads to excess work when the lists are validated and combined.

The problems of the phase can lie in the accuracy of product data and communication. The improved phase 1 requires that the data used in the process is reliable to get rid of several different validations required in current process. The communication is also in crucial role, even though the amount of it (from MDC perspective) is decreased. The PLs and the customer are responsible for the part lists, which emphasizes the communication between these two parties in the phase 1.

5.5.2 Phase 2

The problems in phase 2 of the process were mainly related to the internal actions of MDC and the arranging of picking and packing of the parts. The updated phase 2 in fact has more steps than the original one, but the process should require less interaction between different parties thus making it more fluent. The flowchart of phase 2 is presented in figure 5.5.2.1.

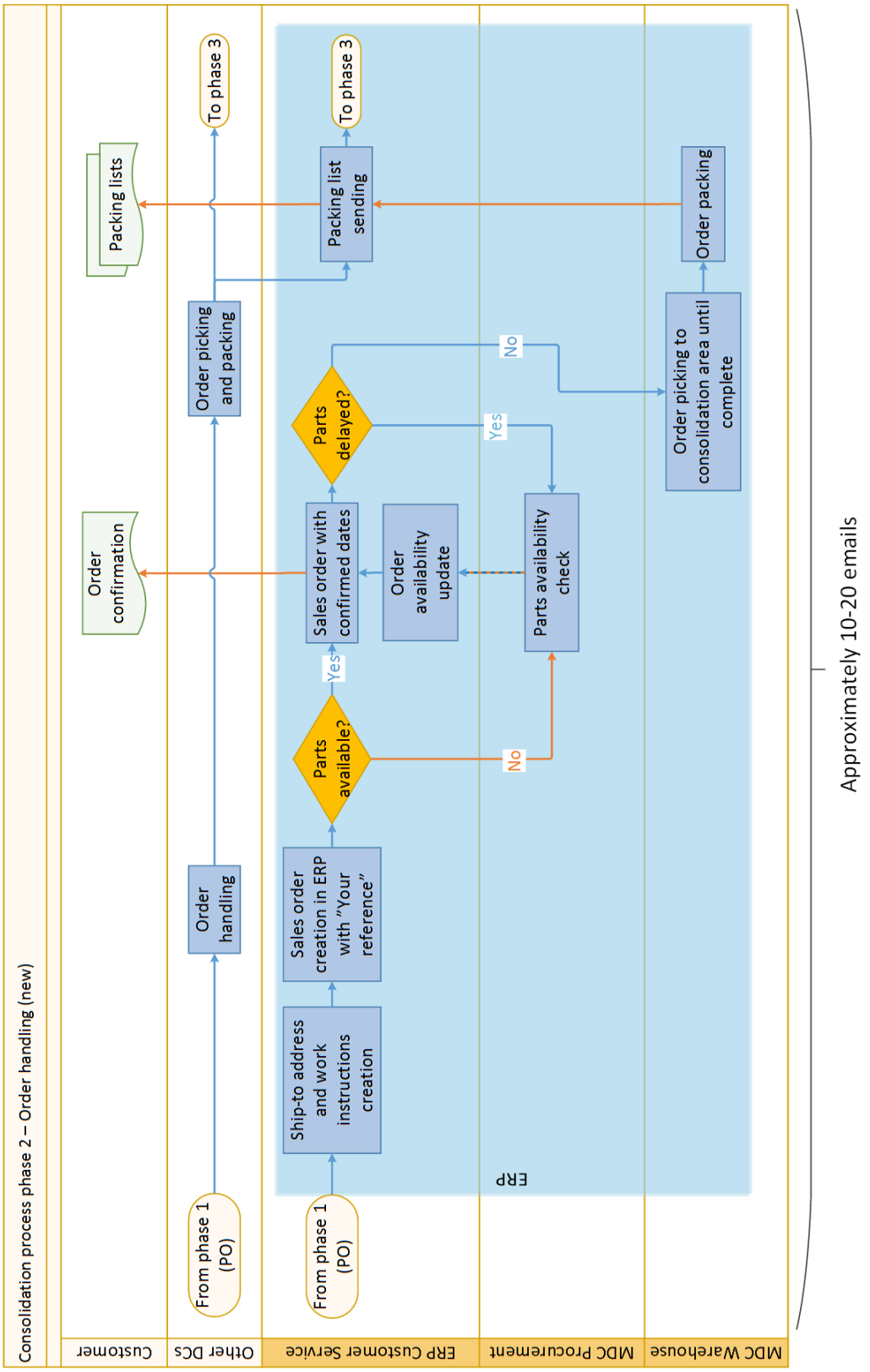


Figure 5.5.2.1: *The updated phase 2 of the process.*

First change in the phase 2 is that the ERP transaction for 3PL work instructions is utilized when the order is being created. At current state of the transaction the instructions should

be added to the ship-to-address -level, as the system does not currently support the instructions on sales order -level. If the sales order instructions were supported, the step would move forward in the process, as it would be executed after the sales order has been entered to ERP. Before creating the sales order the MDC customer service must also create a new ship-to-address against the consolidation order's recipient. This address is used for adding the instructions. The instructions can be simple, including the information about the consolidation and the consolidation area given by the 3PL in phase 1.

The work instructions affect mostly to the picking and packing of the order, allowing some changes to it. The instructions allow MDC to get rid of the grouping of materials, as the 3PL employees will know from the instructions where the picked parts should be stored. Allowing the system to automatically create deliveries for the parts as they are stocked streamlines the communication between MDC and 3PL, as the releasing of the deliveries is not needed anymore. On the downside, this will increase the number of deliveries on the sales order, which will make invoicing more complex, as the invoicing system works on delivery-level. MDC customer service also cannot entirely disregard monitoring of the order. They should monitor the sales order progress until the order has been completely picked and ultimately packed. The automatic delivery creation also increases the importance of the communication between MDC customer service and logistics, as customer service must inform logistics when the sales order is fully packed.

Another change in phase 2 is also related to the sales order creation. When creating the sales order in company ERP the customer service representative inserts the "your reference" to the sales order header. This reference is used in MDC's internal actions, as it is a signal to the MDC procurement of the importance of the order. The reference is included in the follow-up report both MDC customer service and procurement use. In case of delays, the added reference should indicate MDC procurement that the materials cannot be delayed, and thus procurement can begin corrective actions immediately. This should decrease the emailing between MDC customer service and procurement, as before the delays were informed by email, to which customer service responded that the materials cannot be delayed. This should also decrease the response time to the delays, as the procurement can immediately consider the materials of orders including the reference as critical materials. However, some communication between customer service and procurement is needed, as procurement should inform customer service if delays or other changes of schedule occur. Also, when creating the order customer service should inquiry the schedule for non-stock items, if any exist.

Sometimes the delays and availability issues for parts are unavoidable due to problems at the supplier, but the aim of the change is to approve the reaction time for such events. Although the lead time for the project order was long, in other cases days or even hours can be critical. For example, the machine breakdown situations can cost the customer thousands of euros per hour if the whole plant stalls. In the context of the case, the

timeframe was inflexible, meaning delays were not tolerated, which makes the quick response for delays important. The time won in faster reaction can be used for finding alternative solutions.

After the whole sales order has been packed, the packing lists should be provided to the customer. This allows the customer to start the negotiations about the collection with different forwarders. The packing lists should be provided by all participating distribution centers, as otherwise the size and count of all the packages in the consolidation order is not conveyed to the forwarder. The other DCs should send their packing lists to MDC customer service after the goods are packed. MDC will then send all packing lists at once to the customer after every packing list has been received. Often an estimate of the ready date of the whole consolidation order can also be given at this point. The sending of packing lists should reflect to the phase 3 of the process shortening it. After the packing lists have been sent the process proceeds to the final phase. The different sales orders are not necessarily ready simultaneously in all locations, due to e.g. material delays. In these cases, the process proceeds normally and for example, the other DCs can ship their sales orders to MDC without having to wait that the MDC sales order is completely packed.

The changes in the phase 2 should decrease the amount of emails considerably. From communications perspective, the bottlenecks of phase 2 were in the availability of the materials and the picking and packing of materials. The changes should minimize the emailing, although in order to achieve this some extra steps need to be taken when creating the orders. The number of emails in phase 2 is difficult to estimate, as it is very dependent of the duration of the phase. The duration is also impossible to estimate, because it varies heavily case by case, depending mostly on material availability. However, the number of emails should be at least halved if the changes are implemented successfully. The changes made also reflect further to the process. For example, the packing list forwarding should also alleviate the collection issues previously encountered in phase 3.

5.5.3 Phase 3

In the case study the issues in phase 3 were related to the coordination of the inbound shipments from other DCs, documentation creation and handling and the collection of the order. The changes suggested to the phase 3 of the process aim to alleviate the recognized problems. The flowchart of the improved phase 3 is presented in figure 5.5.3.1. The updated process follows the case process mostly, but minor changes have been made.

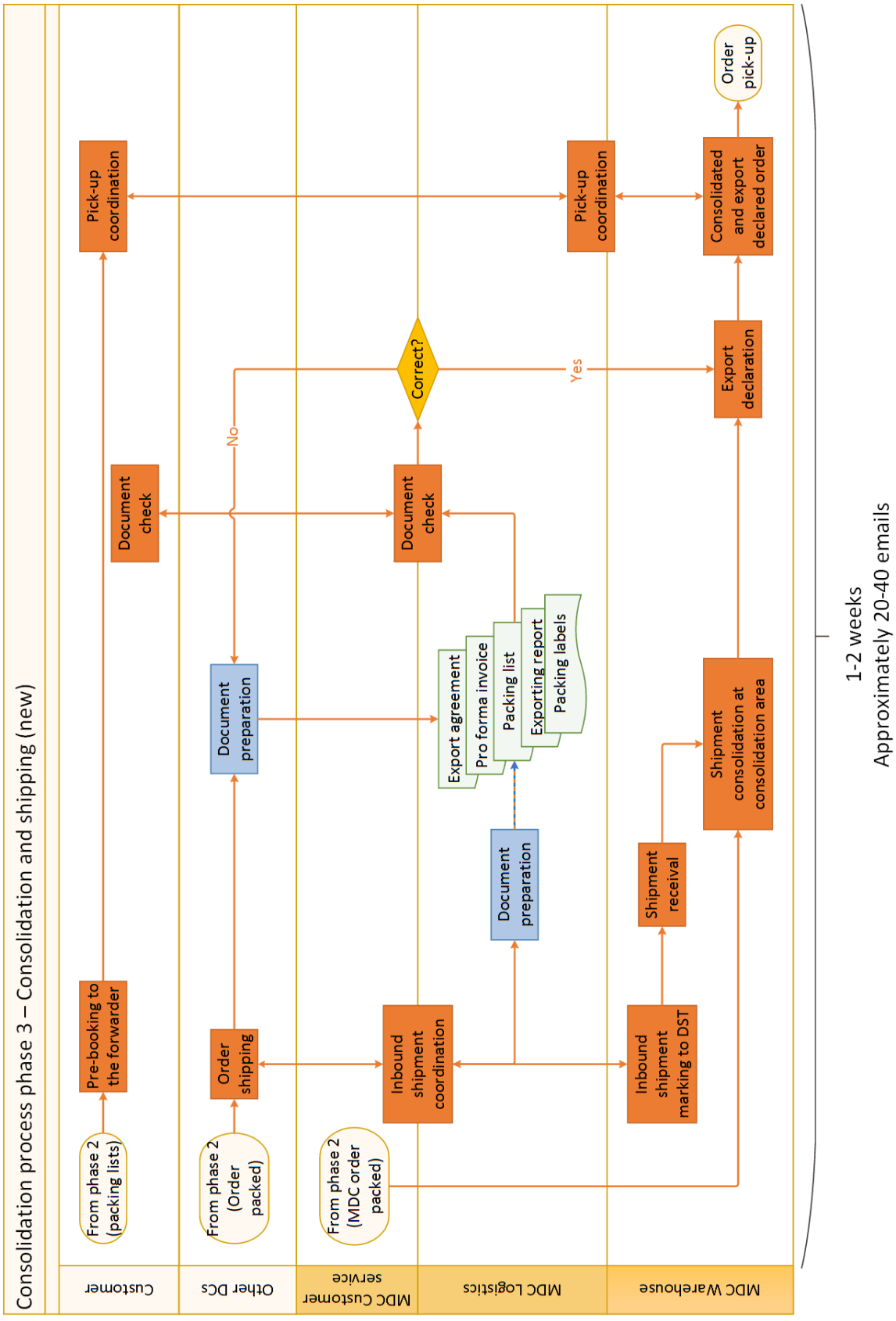


Figure 5.5.3.1: *The updated phase 3 of the process.*

The phase 3 starts after all goods in MDC and other DCs have been packed and the packing lists have been sent to the customer. Other DCs' sales orders are ready for shipping to MDC warehouse and the transport booking can be done. The booking is preferably done to a company nominated forwarder in TMS, as it allows better visibility to the shipments, as the TMS is available in every company location. After the booking has been done, the DC informs MDC customer service the details of the shipment, such as the ETA, forwarder, vehicle license plate number and preferably photos of the packages that will be shipped. The sending DCs should also mark the packages with the consolidation order reference and preferably with the consolidation area name. Also, it would be good to indicate via markings that the 3PL CS knows more about the shipment. The sending DCs should read the details about information to be sent from the instructions given to them in phase 1 of the process. The package details can be seen from the packing lists that the DCs have sent already in phase 2. When all necessary information has been sent to MDC customer service, they will forward it to the 3PL customer service in a pre-alert. When pre-alerting the 3PL, MDC customer service should emphasize that the inbound shipments are related to a consolidation case, as well as informing the references used and the consolidation area where the shipments should be stored. The 3PL customer service will update the information to their Dock Scheduling Tool (DST), which is used to keep track of inbound and outbound vehicle traffic at the warehouse. DST should support the 3PL personnel when they receive the inbound shipments, as all relevant information about the consolidation should be included in DST and thus available when the vehicles arrive at the warehouse and are identified. Using this information the shipments can be instantaneously directed to the assigned consolidation area, decreasing the issues in e.g. not being able to identify the shipments and therefore delaying the process.

At the same time as the shipping to MDC warehouse is being coordinated the sending DCs should start working on the documentation needed in the export clearance. In optimal scenario MDC should not have to ask for the documents separately, but the other DCs would send them automatically as instructed. In the case process the documentation caused some confusion in DCs, as it was not explicitly clear what documents were needed and how they were created. The documentation preparation should be clearer due the instructions provided by MDC in phase 1. The instructions include e.g. how the DCs can create the invoices with end-customer prices in ERP and how the exporting report can be output from ERP. After the DCs have prepared the needed documents (invoice, export agreement, exporting report, packing lists) the documents will be sent to MDC. MDC and the customer will check that the documents are valid (e.g. that the prices match to the POs prices). If everything is correct, the 3PL can start the export clearance process. If corrections are needed, it is informed to the DC. The cycle continues until correct documents are received. The customer should also provide MDC the end-customer's special documents (e.g. package labels) if there exists any.

Simultaneously to the shipping and reception of the different sales orders at MDC, the customer can already start working on the transportation for the whole consolidation order. The packing lists were sent to them in phase 2 meaning that the (end-)customer can start their booking process, as the package details (such as weights and in optimal case the dimensions) are known. Usually the exact ready date for the orders is not yet known, but estimations can be used when pre-booking the transportation. The transportation booking process in the case process did not start before everything was ready for collection at MDC warehouse. Because of this the ready goods waited for the transportation for several weeks at the warehouse. The pre-booking should minimize the waiting time of the consolidated goods, as the (end-)customer can invite tenders from different forwarders well before the goods are ready. After all goods have been gathered to MDC warehouse the export clearance has been done, the (end-)customer can place the actual booking to the freight forwarder. After the booking has been done, the collection is coordinated normally between the forwarder, MDC logistics and 3PL customer service.

The consolidation order instructions have a significant role in the process. In the last phase the instructions should decrease especially MDC's workload regarding the document preparation and handling. Most of the exchanged emails in case process' phase 3 were related to the documentation, as the other DCs needed help with them. The email count should decrease considerably if the consolidation order instructions are functional, as the DCs should not need to ask MDC personnel for advice in every problematic situation. In optimal situation, the email count could decrease as much as 90 percent from the case study. However, this is highly variable on the order, as e.g. the number of inbound shipments affect to the communication.

The biggest benefit timewise comes from improvement in inbound shipment handling and the forwarder booking. The forwarder booking alone should decrease the timeframe of phase 3 by at least one to two weeks, as preferably the order will be collected almost immediately after it has been completed. The improved inbound shipment handling and tracking should shorten the timeframe at least by a week, depending on the number of inbound shipments. Every "lost" inbound shipment delays the process by two to five days, but DST and consolidation area should eliminate or at least minimize the risk of the lost or unidentified shipments.

5.6 Improvement analysis

Several different improvement ideas for short-term implementation were discovered during the study. Most ideas aim to make the bottlenecks of the process smoother and more fluent. The ideas regarding information systems utilize tools or features that already exist in the systems, as the larger development of the systems would require much more resources that can be provided in short-term.

The effects of the improvement ideas have been already discussed earlier in this chapter, when presenting the ideas. Exact measuring of the impact of the improvement ideas is currently impossible, as similar project orders have not come up during the study. Because of this, the improvements have not been able to be implemented and tested. However, the impact of the improvement ideas has been estimated by comparing a process that would include the improvements to the case order's process. The comparison is done by concentrating to the bottlenecks and issues recognized in the process previously in the study by assessing the problems' impacts after the improvement implementation.

The assessment results are presented in the table 5.6.1. The table consists of six columns: the problems, the improvements that effect the problem, and the estimate of problems' impacts to the timeframe and workload of the process before and after the improvements have been implemented. As in chapter 4, the impact of the problem has been assessed with a three-level scale (low, medium, high) and in two categories, workload and time. Low impact problems delay the process for two workdays or less and increase workload up to a total of one hour of work time. Medium impact problems can be delay the process two to five workdays and add workload up to total of five hours of working time. High impact problems delay the process more than five workdays and increase workload more than five hours in total. The impact of the improvements is an estimate assessed by the researcher, based on the data and interviews used in the case study and the researcher's previous experience on the company's supply chain processes. The estimate presented is not exact due to the changing nature of the cases, but it does give a hint of the effects of the improvement ideas and their impact of the bottlenecks and issues of the case process.

Table 5.6.1: *Improvements' effects to the problems of the process.*

Problem	Improvement(s)	Impact before the improvements		Impact after the improvements	
		Time	Workload	Time	Workload
Communication	All, but especially consolidation order instructions	High	High	Medium	Medium
Systems rigidness	Consolidation order instructions Consolidation area Consolidation order reference DST	High	High	Medium to high	Medium

	Work instructions Updated process				
Incorrect or incomplete material data	Updated process Material data verification	Medium	Medium	None to low	None to low
Response for material availability and delay	Consolidation order reference	Medium	Low	Low	Low
Picking and packing coordination	Consolidation area Work instructions Updated process	Low	Medium	None to low	None to low
Insufficient warehouse space	Consolidation area Updated process	Low	Medium	None	None
Inbound ODRs	DST Consolidation area Consolidation order reference	Medium	Medium	None	None
Document preparation	Consolidation order instructions Material data verification	Medium	High	Low	Medium
Order collection by forwarder	Consolidation order instructions Updated process	High	Low	Low	Low

The communication issues were mostly a consequence of other problems. One main reason for the large number of emails in the process was that the process itself was new and unfamiliar. Practically all improvements aim to decrease the workload of different parties. The consolidation order instructions should support and guide different parties throughout the process thus decreasing the workload especially on MDC (mostly customer service), which acts as an intermediary between the parties. However, it is very probable that

even with the instructions the future cases will include large numbers of emails. Unexpected issues occur and they are sometimes unavoidable. The larger and more important the case is, the more double and triple-checking is needed, which increases the communication and thus the time and workload impact on the process. Because of this, the benefits of the changes are not considered as remarkable as they could be and both the time and workload impact are estimated to decrease to medium.

The information systems do not currently support the consolidation cases very well and it shadows the whole process. An out-of-the-box solution could not be found for the special needs, which is why several separate improvements were considered to decrease the effect of rigid information systems. Nevertheless, the improvements cannot be considered as sustainable solutions to the problems, as they are more of workarounds to the problems instead of actual solutions. The improvements ameliorate the process and its bottlenecks, but require often manual extra steps. Despite the extra steps, the improvements should decrease the total workload caused by the rigid systems. The workarounds should e.g. significantly decrease the number of inbound-ODRs and the MDC customer service's workload in picking and packing. It is not known how well the improvements will work in practice. The consolidation order cases are quite rare, which could result in that the parties are not familiar with the use of the tools suggested, as they are often not required in daily tasks. However, the consolidation order instructions should support the parties in using the tools, making the potential problem less severe.

The issues and inconsistency of material data is a quite complicated problem from MDC perspective. The actions that can be done to solve the material data issues in the process do not directly concern MDC, but the customer and especially the product lines which makes the actions out of this study's scope. Of course, the MDC technical support maintains the MDC's material data with the help of the product lines. The complete check of the material data would be very laborious, but the updated process can be considered as an improvement, as it allows the product lines to get involved with the process earlier. This could allow the checking of the materials needed in the case more thoroughly and with more time. If the inconsistencies can be solved already before MDC is involved in the process, it should directly reflect to the later phases of the project decreasing the issues.

Response time to the delays and material availability should decrease with the utilization of the consolidation reference. The feature is readily supported by the MDC systems, but it has not been adopted. With the use of the reference both MDC customer service and procurement should notice the special orders directly from their order follow-up reports. This eliminates the need for double-checking if e.g. the material delays are acceptable, and the procurement can start working on the replacements or alternative solutions. Timewise the impact may either substantial or insignificant, as it changes heavily case by case. From workload-perspective, it does not rid of all work, as the changed schedules should be informed to all relevant parties. However, the double-checking is wasted work, which

should be eliminated. The consolidation reference can possibly be utilized in other special cases too, e.g. breakdown-situations, where material delays are unacceptable.

The picking and packing coordination and the insufficient warehouse space should ease with the implementation of consolidation areas and work instructions. Together the two improvements the materials can be released to picking as they are stocked, meaning that separate delivery groups and their releasing is not needed anymore. With the updated process the goods are not packed immediately after picking, but the whole order will be packed completely at once. The separate consolidation area should eliminate the possibility of losing parts during the process, as the area is clearly separated from other packing areas. The improvements should decrease the workload considerably by remove the need of close communication and coordination for picking and packing, as the process flows in the systems automatically. The time impact should also decrease as the 3PL and MDC customer service should not have to investigate the missing pieces. However, more workload is needed in the preparations of such cases, as MDC and 3PL have to agree to the terms on the consolidation areas before the order process is started.

Inbound-ODR cases should cease with the use of DST, consolidation area and consolidation order reference. The idea is to add the support of DST to the email coordination of the intercompany inbound shipments, as the tool is in daily use at 3PL. If the DST should fail and the shipment is not identified when it arrives at the warehouse the emails and package markings should act as a backup technique that can be used for identifications. The responsibility is 3PL's internal tool, so the utilization of it depends highly on the 3PL. However, due to the daily use of that tool, it is assumable that the implementation for such cases should not provide any obstacles. The consolidation area allows the shipments to be stored directly to the correct place at the warehouse, along with the other goods of the consolidation order. However, there is a risk that the inbound shipments end up as ODRs, if the DST is not used and the marking of the packages is lackluster. In optimal situation, though, the ODRs do not occur removing the time and workload impact completely.

The improvements do not solve completely the problem with the documentation. The documents have to be created manually, which means that some workload is always present. Some documents also have to be modified manually, which increases the workload significantly. However, the need for manual modifying of the documents should decrease significantly with if the material data quality and relevance improves. The documentation-related time and workload impacts of all parties can also be decreased via the consolidation order instructions. The instructions should indicate which documents, in which form and at what time are needed decreasing the need of constant instruction of the parties. The gain is nevertheless quite small, if the material data issues persist. The optimal solution in terms of documentation would be, if there would exist only one invoice and export declaration. This would, however, require change of ownership of the goods (e.g.

MDC would purchase the goods from other DCs). The matter will be further discussed in the next chapter.

The time impact of the delay in customer's forwarder collection should decrease significantly with the help of the updated process. In the updated process the packing lists of the different sales orders are sent already when the goods have been packed, allowing the customer to pre-book the collection. The pre-booking is done simultaneously to the rest of the phase 3, which provides the customer more time to arrange the transport. Some risk of misunderstanding is also involved, as the customer must be made clear that the goods are not ready for collection until all goods have been consolidated at the MDC warehouse and export cleared by the 3PL, because of which the customer's forwarder should contact MDC logistics and the 3PL customer service before attempting the collection.

With all the improvement ideas, the intercompany consolidation order process can be considered reasonable if the frequency of such orders remains at current level. However, if the frequency of such special cases would rise or if the consolidation service would begin to be offered to other orders as well, more radical improvements and changes to the process will be needed. Especially the information systems solutions should be researched in this kind of situation, as currently a direct and a focused solution for such cases does not exist, making the proposed improvements a collection of independent solutions. Therefore, some long-term ideas for the process improvement are considered in the next chapter.

6. LONG-TERM IMPROVEMENT IDEAS AND VISIONS TO THE CONSOLIDATION PROCESS

In this chapter, more solutions and improvements for a long-term approach are presented. The implementation of the ideas requires time and investments, because of which they should be further investigated before implementing. The ideas provide more of an aspiration of the state of the process and aim to raise conversation of future decisions.

6.1 Information systems support

Many of the intercompany shipment consolidation process' problems root from the unsupportive information systems. Several ideas how to develop the information systems of MDC to support the special needs of intercompany shipment consolidation orders were considered in the interviews with the company supply chain development manager and the development team. The discussions resembled brainstorming, where different ideas were brought up and then discussed more thoroughly. Some of the discussed ideas are presented in this chapter. However, the systems renewal and modification in such large company is a complex and long process. Large developments to ERP are also often very expensive (Akkermans et al. 2003). Small changes and fixes to the existing system can be implemented in monthly client releases, but adjustments of this magnitude require several months, or even a year to be developed and implemented as the changes are done on global level.

All in all, with the current frequency of the intercompany consolidation orders extensive investments for information systems modifications and reshaping is not considered feasible. At the moment, the consolidation process cannot be considered as one of the key processes to the supply chain making the large-scale modifications to the information systems questionable, as per Qrunfleh & Tarafdar (2014) the systems have to be aligned to the key processes. However, the situation could change if the consolidation service would be offered and utilized more frequently. The consolidation process would in this case require more information systems support, which is not on satisfactory level even with the short-term improvement ideas implemented. If such changes are considered, the information systems improvements must be more thoroughly researched. However, as the scope of the study is concentrated more on the short-term improvement ideas, the long-term ideas were not intensively researched and remain more as aspirational ideas for future.

6.1.1 New order type

The first idea how to alleviate the problems in the consolidation process on the information system-level was a new order type to ERP. There already exist multiple different order types for different needs, such as sales orders, return material authorizations, debit notes and credit notes. The different order types have different features. Different types are also easily recognizable from each other in ERP and the tools used. For example, in ERP the user can identify the order type from e.g. order document flow or from the order header.

The new order type would solve at least the MDC's internal issues with the consolidation. For example, the procurement would recognize the consolidation orders directly from the system and reports and the consolidation order reference would not be needed. A specific requirement type for the material demand could be defined, from which the procurement would recognize that the demand originates from a special order which are urgent. The new order type would require the consolidation order process to be redefined from the beginning. This can also be considered as a benefit, as it would allow to start the process from a clean slate. The order type and its process could be designed in cooperation with the 3PL. The collectively created order process could also take the interaction between MDC and 3PL into consideration. For example, the agile implementation of consolidation areas that would not require actions from MDC would streamline the process.

The new order type could possibly resolve the visibility issues with the inbound intercompany shipments. The system already currently supports sales orders that include materials from different plants. Perhaps this could be taken a step further in the new order type, so that a centralized sales order, that included all materials from different DCs would be created and the order process would be completed with a single sales order. An ERP cross-docking feature could also possibly be utilized in the new process, so that the shipments would remain visible to all parties throughout the process. However, if the ERP cross-docking feature is wanted to be utilized, it requires that the goods receipt for the intercompany shipments must be done in MDC warehouse. The receipt can be done either on material or handling unit-level, but the handling unit-level would be preferable, as the material-level would require extension of all materials to MDC. (SAP 2017) How the actual cross-docking and thus consolidation would be done remains a question, as because of the scope of this study further research was not made.

6.1.2 Virtual plants

The second idea to enhance the process was somewhat more complex than the previously presented idea of new order type. In this solution, virtual ERP-plants (in other words, warehouses) for other locations would be created under MDC warehouse in the Netherlands. The plants would be warehouses, but they would not have any stock per se, as they

would only be used for physically moving the other DCs' goods from their warehouses to MDC warehouse.

The goods would be moved to the virtual plant by stock-transfer-orders (STO), which the sending DC would create. Under the STOs, the goods would be transferred to MDC warehouse in the Netherlands. The sending DCs could then create the sales for the goods, while the sending plant would be that DC's virtual plant. This way the goods will be physically at the same location and the visibility in the systems is gained.

The virtual plants would allow the transfer of the goods to the MDC warehouse in the Netherlands without MDC having to purchase the goods from other DCs. The goods would be owned by the sending DCs until the final sales is made to the customer. This would be beneficial to the case company, as they would not have to concern about the VAT (value-added tax) as the STO is an internal transfer between two storage locations and the ownership of the goods does not change. The virtual plant also allows the system-visibility for the inbound shipments, as system-wise the 3PL could handle the inbound shipments as any inbound shipments. However, the configuration and setup, where e.g. inventory and warehouse management are considered, and VAT registration for the virtual plant must be made before implementation, but they only need to be done once per each virtual plant. On the downside of the virtual plants, there would exist several sales orders, meaning that the documentation stage would most likely resemble the current process, as each order would require individual documentation.

Similar solution has been already utilized in other company locations for different reasons. However, they have used virtual stock locations, which do not allow the VAT-registration making them unsuitable for the consolidation needs. The locations using the virtual solutions and the responsible project teams should be heard before further decisions and actions should be made. They know the pros and cons of the virtual locations and their implementation.

6.1.3 A new plant for MDC

The third idea how to alleviate problems in the process regards opening a completely new plant under MDC. The plant would be used solely for special cases, such as the project orders that require consolidation.

The new plant would relieve MDC's internal issues in consolidation cases. Especially the material availability and delays would be affected by the new plant. If the material demand would be at an entirely different plant than regular orders MDC procurement would know that the demand is urgent. The sales orders would also reserve the available stock, and the problem that other, standard orders would reserve the required materials should not exist.

However, the entirely new plant requires extensive order volume in order to be feasible, as the upkeep of the plant and its materials requires a great deal of resources. The idea of a new plant was considered as too burdensome solution at least at current order frequencies.

6.2 Material extension to MDC and central warehousing

Currently, the intercompany shipment consolidation process at MDC appears to consume more of the company's resources than it produces. The consolidation process creates value for the customer and increases the service level, which are difficult to directly measure. Alternative solutions to the consolidation process should be considered, as controversially the most common objective of shipment consolidation is to reduce costs, e.g. by utilizing the economies of scale (Çapar 2013; Hall 1987; Higginson & Bookbinder 1994; Tyan et al. 2003). However, it should be acknowledged that Cheng & Tsai (2009) state that in future the focus of distribution centers could lean into more diversification of the provided logistics services to increase the customer revenue, instead of cargo throughput which was the essential objective of DCs in the past. The service diversification could, for example, include development of multiple country consolidation (Cheng & Tsai 2009). Nevertheless, one solution to avoid the need for consolidation is that all customer POs would be directed to MDC. This would require some bending and changes to the company policy, where different distribution centers support different technologies and products. It would also require that all different material numbers would be extended to main DC's systems.

There are a few different ways to manage this kind of arrangement. Two different ways were considered in the interviews with MDC management. In the first way, different distribution centers would still support different technologies and products. After getting the PO(s) from the customer, MDC would extend the new material numbers to their systems. New materials numbers, in this regard refer to the materials supported by other DCs. After the extension, MDC would purchase the required materials from the other DCs. The customer POs could be handled like any other POs at MDC customer service, but the order monitoring and MDC internal communication would have greater impact. The purchasing of the materials would allow a single sales order for each case, which would streamline especially the documentation stage of the process, as only MDC would be responsible for the documentation.

This way of working would make the other DCs MDC's suppliers and remove them from the active parties of the current consolidation process. It would make the inbound logistics process much easier at the MDC warehouse, as the other DC materials would be purchased and delivered as any other replenishment order from suppliers, which means that the orders would be visible in MDC systems thus making the inbound process easier and more trackable. There should not be problems with receiving the goods, which would probably make the process faster as the shipments would not be stuck as ODRs at MDC

warehouse. The warehouse process would require more time compared to the current process where other DC shipments can be directly consolidated, as the inbound shipments would need to be inspected and taken into stock, before they could be prepared for the order. This could have a positive upside, because the packing and containerization of the order could be more optimized. On the downside, the workload of the warehouse inbound, picking and packing would increase, although the workload of inbound could remain relatively same, as there would be no need to solve ODR cases as in current consolidation process.

Also, the coordination between MDC and other DC's order desks would be removed, but the responsibility would transfer more to MDC procurement, as they would have to make sure their POs would be delivered in the agreed schedule. The required coordination between MDC and their warehouse would also decrease, because currently a lot of the communication was related to the inbound shipments from the other distribution centers. However, the way of working would put much more pressure to the MDC product support and item opening teams, as the materials would have to be extended in a tight schedule, as the process can't proceed before that. Probably the number of the materials requiring extension would be high, especially in the beginning. As time passes, more materials would be already open, decreasing the workload of the product support and item opening. One question would also be how the other DCs would react to this kind of policy. They would lose the profit gained from selling their goods to the end customer, as the MDC purchasing prices for the goods would be lower. Of course, the capital gained from the customer orders would remain inside the company, so the question would probably be more related to how the capital flow is wanted to be directed in global scale. On the downside, the purchasing is also an extra commerce between MDC and other DCs, which can result in decreased profit due to VAT, unless some special processes that would allow VAT-free sales between EU-countries are taken into use.

The extension of materials and purchase of them to MDC has been already used case by case. Usually, in the cases the number of extended materials is low, so it has been easier to extend the materials than coordinate different orders off-system to MDC. Sometimes the extensions have been made because of specific customer requests and needs. If the extension would be used in a larger scale probably more resources would be needed in material number management.

The second way of working is more radical and requires extensive changes. Currently the distribution and warehousing of the spare parts is done by dividing the different distribution centers to support different technologies and products. However, there has been some consideration of movement more towards a central warehousing system, where MDC would act as the central warehouse and the other distribution centers as its satellites operating on the regional level. In a way, the change in distribution would similar to the previously explained material number extension from MDC's point of view, but in larger scale, as practically all spare parts would flow through MDC. The change would require

large changes in the global company supply chain structure. The increased materials and order count would impact whole MDC personnel, but especially MDC procuring and product support due to the ample increase in materials supported by MDC. The increase of parts increases the number of suppliers and replenishment orders, which increases the workload of procurement. Product support would have to study the new materials to be able to provide support to the customers.

The central warehousing would undoubtedly solve the questions regarding the subject of this study, as the intercompany shipments in the context of this study would cease to exist. The customer's purchase orders could be directed to MDC, which would procure the needed materials from their suppliers. A change of this side would surely raise some questions, as the role of MDC would grow immensely, but the role of other distribution centers would decrease at similar scale.

The central warehousing has been considered at high level as a possible way of working in future. The possible outcomes and consequences have not been yet investigated sufficiently, so that any estimates cannot be given, as the changes are out of the scope of this study. Therefore, a thorough research of the subject must be done before any actions should take place. Also, the questions recognized in investigation need to be taken into consideration before any changes can be made. In addition, due to the large scale of the changes required to the process the timeframe for the improvement is measured in years.

6.3 Consolidation at forwarder depot

One of the easiest solutions to the consolidation (from the case company perspective) would be, if the freight forwarder would consolidate the different shipments at their depot. Forwarders do consolidation on a daily basis and they should have the facilities and resources for it. The price for the freight would probably be a bit higher, as the consolidation can be viewed as a special service from the forwarder. The cases requiring intercompany shipment consolidation are all unique and different from the normal sales order process at case company.

In normal sales order process, the shipments are transported via case company's nominated forwarders. The company has agreed to contracts and operating rules with these forwarders, which makes them logistics partners. The freight prices are predictable due to the contracts and the interactions between the companies are clear because of the agreed rules. However, often in special cases the end customer wants to arrange the forwarding themselves, using their logistics partner because of e.g. a shorter transport time or a more economical rate.

The use of the customers' forwarders sets some limitations, if the orders would be to be consolidated at the forwarders' premises. Firstly, the transport is fully paid and organized by the customer and the case company does not have any interaction with the forwarder

before the process has advanced to the point where the collection of the orders becomes relevant. If the consolidation would be done by the freight forwarder, they could charge extra costs from the customer, as the consolidation can be considered as a special service (the forwarder must hold the goods at their depot or warehouse until all shipments have arrived). The price is often the reason why the customer and/or the forwarder is not willing to arrange the consolidation. To solve the issue with the price and encourage to the forwarder consolidation, the case company could provide the customer a small discount if the customer's forwarder would arrange the consolidation. The discount should be comparable with the expenses the consolidation process produces at the distribution centers and their warehouses (that are mostly staff expenses). However, the discount is not an ideal solution, as it could be exploited, and one of the objectives of MDC was that the consolidation service could be offered to the customers.

If the case company would arrange the transportation, the shipment consolidation at the forwarders' depots would seem as more viable option. The consolidation option could be included in the contracts between the forwarder and the company, which could reduce the price for the service, especially if the usage of the service would be high. If the case company could encourage the customer to use a nominated forwarder, the case company could still advertise the consolidation service to their customers, but the consolidation would be outsourced to the forwarder. This way the customer POs could be handled normally at all locations, but all locations would have to use the same forwarder and arrange the consolidation with the forwarder. The procedure would have more tangible costs than the current process, as the forwarder would have to be compensated, but the intangible costs should decrease, as the workload of the distribution centers and warehouses would decrease.

The consolidation at the forwarder's premises could benefit from an ongoing project at the case company, which aims to implement a new address to the sales order header. This new address is called a Y8-address, and it is an address between the MDC warehouse and the end-customer address, in other words an intermediary address. It allows more transparency to the order process, as the actual shipping location can be seen directly from ERP. It possibly could also be utilized in the transportation booking process, as the transportation could be automatically booked to the Y8-address in case of such exists on the order.

The outsourcing of the consolidation would follow the basic principles of logistics outsourcing, where the companies should concentrate on the processes that include their core competencies (Cheong 2004; Marasco 2008). The implementation of the outsourcing could take place in a fairly fast schedule, as no structural changes are required to the case company supply chain. The change could also be piloted with a few test cases before further agreements or implementation is done. The full-scale implementation of the process could take months or even years, as before that the process must be refined with the forwarders and the agreements should be done with them. However, the exact influence

of the change is impossible to estimate with current knowledge, which means further research should be made before decision-making.

6.4 Global project model

Most development ideas have been for understandable reasons very concentrated to MDC. However, a somewhat different type of suggestion arose in the discussions, as it was proposed that the whole project model and organization, that is responsible for the special orders, would be rebuilt. Currently the projects are handled from and owned by a specific country and their sales office. It has been considered already for years, that a global project model would be formed, with which projects including several locations and countries could be handled.

For accounting reasons if a project requires materials from e.g. three different locations, the location responsible for the project should purchase the materials from those locations first take them into stock, and then deliver them to the customer. In the global model, each of the involved countries and sales organizations would be responsible for their materials and deliveries, contrary to the current model where everything flows through the project owner location.

The idea of global projects steers away from the consolidation, as in the global projects each location would probably ship their goods directly to the customer. However, it would rid of one internal sales, as the locations could sell their goods directly to the customer, instead of using the project owner as an intermediary. This would reduce the accounting dilemma, as internal sales would not be needed. It would also streamline the documentation process of such projects, as each party could handle their own documents and exporting.

The global projects do not solve the problems with the consolidation process, but they remove the consolidation from the equation. However, the change to global project model is substantial and requires a lot of further work and research. Due to this, any comments on its feasibility and rationality cannot be made in this study.

7. CONCLUSIONS AND DISCUSSION

This study focused on case company's special project order, that required intercompany shipment consolidation at a third-party operated warehouse. The study emphasized on a case study, where the intercompany consolidation process was analyzed. From the analysis, several improvement ideas were presented both for short and long-term scopes. The focus in the study was on the short-term improvement ideas, which would allow rapid improvements to the process.

The consolidation does not result in any cost reductions for the case company, but on the contrary the costs increase as more work is required from the sales organizations. However, it does increase the customer service level and customer satisfaction, and the customer should gain reductions in transport costs due to the scale of economies. The objective of this study is to research how the consolidation would be as lean and efficient as possible for the case company, so that the workload and required resources would decrease.

7.1 Answering to the research questions

The research problem and the research questions were presented in the chapter 1.2. The research questions derive from the research problem. The main research question was formed to answer the most important questions in the research. The main research questions was: "**How is the intercompany shipment consolidation process executed in the target company and how it could be improved?"**

In the terms of this study, the intercompany shipment consolidation process is the process, MDC warehouse acts as a consolidation point, where several different are consolidated. The consolidation is done quite rarely, but it is a possibility that it could be utilized more often and offered as a service. The intercompany shipment consolidation process itself was examined in chapter 4. The improvement ideas to the process were introduced in chapters 5 and 6.

Three sub-questions were created to help to discuss and answer the main problem:

1. What is intercompany shipment consolidation?

Intercompany transactions mean transactions between companies in a group in form of for example charges or transfer of goods (Law 2016). Intercompany shipments can be viewed as a consequence of intercompany transactions, as they are part of the trade between the companies inside the same group. Shipment consolidation is the process where different shipments from suppliers are grouped into a large shipment at a consolidation

point (Dondo et al. 2009; Tyan et al. 2003). The idea behind consolidation is to utilize the vehicle's capacity better that decreases the number of dispatches, which results in lower transportation rates – in other words taking advantage of economies of scale in shipping (Çapar 2013; Hall 1987; Higginson & Bookbinder 1994; Tyan et al. 2003).

2. What are the effects of the intercompany shipment consolidation in the target company?

The sub-question could be rephrased to "What are the issues in the intercompany shipment consolidation process in the case company". Several issues were discovered in the process, the most explicit being related to the communications and the information systems support in the process. However, as a positive effect, the customer was pleased about the consolidation opportunity and the service level of MDC.

3. How does the company IT support the intercompany shipment consolidation process?

In short, currently the company ERP does not directly support the special process that the intercompany shipment consolidation requires. However, several features of the IT can be utilized when battling the issues in the process. Gaining a direct support will require more extensive changes and modifications to the existing systems. The decision if such modifications should be made depends on the frequency of the consolidation cases.

7.2 Recommendations

Several improvement ideas were discovered and assessed in the study. The short-term improvement ideas were observed more rigorously than the long-term ideas, as the short-term ideas are possible to implement rapidly allowing the most obvious flaws in the process to be corrected quickly. The long-term ideas are more of aspirational ideas for the future and provide a brief overview of the possible directions that could be taken in terms of consolidation. The following short-term improvement ideas to the intercompany shipment consolidation process at a third-party operated warehouse were covered in this study:

- Consolidation order instructions
- Material data verification
- Dedicated consolidation area
- Consolidation reference
- Work instructions
- DST
- Updated process flow.

The main emphasis on the short-term improvement ideas concerns the analysis of the bottlenecks and problems of the case process. The most substantial of the improvement ideas is the updated process flow, which redefines the whole intercompany shipment consolidation process at MDC. The other short-term improvement ideas are supportive to the updated process flow, which does not function properly without the other improvement ideas. The improvement ideas should form a synergy, making the benefits of the combined improvements greater than the benefits of individual benefits. This implicates that to get the most benefit of the improvements they all should be implemented. The implementation of the short-term improvement ideas can be done at none to low cost and at a fast schedule. In general, they do not offer long-lasting and sustainable solutions for the problems, but quick reliefs to the problems.

The following long-term improvement ideas were presented in this study:

- Material extension to MDC
- Central warehousing
- Consolidation at forwarder depot
- Global project model
- New order type
- Virtual plants
- New plant for MDC.

The presented long-term improvement ideas need extensive research before they can be implemented into use. Some ideas seem more plausible than others, as e.g. system-wise virtual plants appear to be much more agile and feasible than a new plant for MDC. Some ideas are also quite radical in terms of case company's supply chain, such as the centralized warehousing. The long-term ideas need to be researched much more in-depth before decisions of them can be made.

In addition, some improvements that could be utilized in daily tasks were also discovered in the study. For example, the use of "your reference" could benefit MDC in e.g. breakdown-orders, as it should decrease the response time for material delays in urgent cases. The material data verification should also be helpful to the case company in long-term, as the employee hours consumed in correcting the documentation cumulate.

One essential question regarding the improvements lies on the frequency of the project orders that would require consolidation. During the study, no such orders were appointed to MDC. The project order frequency is hard to forecast, which poses a dilemma for the case company. At the current frequency, it does not seem feasible to invest in large development projects regarding intercompany shipment consolidation. However, the developments should decrease the workload and lead time of such cases, making them more efficient and less resource consuming. This could attract more use for the consolidation, especially if it would be implemented as a value-adding service that would be offered to

the customers. In this case, more emphasis should be put to the information systems development if the consolidation service will be offered also to other than special case orders. Nevertheless, the research provides ideas and directions what could be done, should the frequency increase.

Another focal question regarding the consolidation process and its improvements concerns the actual benefit of the consolidation process. Is the consolidation service beneficial enough for the customer and MDC to be feasible? Are the increases in customer service level and customer satisfaction beneficial enough from the case company perspective compared to the costs the consolidation process is responsible for?

All in all, it seems like the intercompany shipment consolidation is just a stepping stone towards bigger changes in spare part distribution in MDC and the company in general. The consolidation can be seen as an interphase between the current way of working and complete overhaul of the distribution strategies and tactics in project orders, which requires a great deal of actions in the whole corporation.

7.3 Assessment of the study and discussion

A hermeneutic approach to the study was selected due to the specificity of the subject. In general, the idea of consolidating different shipments is not new, but the unique traits of the process in study contributed in the selection of a hermeneutic research approach. Because of the hermeneutic approach a lot of qualitative material was used in the study. Due to the hermeneutic nature of the study, the researcher's interpretations are taken into account, because of which the objectivity of the study cannot be guaranteed. The researcher also has some previous experience from the field of spare part business, which may have affected the study. The researcher's previous experience and understanding has affected the interpretations made in the study. It is possible, that e.g. a researcher that does not have any previous knowledge and experience on the spare part business would have carried out the research differently. The research is poorly reproducible, as each case is unique and the study is affected by the interpretations of the researcher. However, the improvement ideas that are presented as the results of the study have been gathered from several different parties involved in the process in study, which should make the results of the study reproducible at least to some extent.

The theory base founded in the literature review provided useful theory background for the empirical part. The subject of the study is quite broad and specified, which made finding theory used in the study more difficult. Because of the high specificity of the study subject, the literature review does not offer a very in-depth view of the subject, but a general overview that is needed to provide understanding of the empirical part of the study. Also, due to the high specificity of the subject of the case study the findings of the literature review were not directly applicable, making the empirical part rely highly on

the data and information gathered from the interviews. Interviews are considered to contain many sources of errors (Hirsjärvi & Hurme 2008 p. 35). In this study, the effect of erroneous interviews was attempted to decrease by interviewing different parties involved in the process multiple times if possible, and utilizing the data gained from email conversations of the process.

The empirical part of the study suffered partly from the downside of a holistic case study recognized by Yin (2003 p. 45). The somewhat abstract level of the study caused that the data was scarce or open for interpretation. Some numeric data, which could be used to analyze the process and measuring, could be gotten directly from the company information systems, but the interviews were required to be used for the source of most data. For example, the working hours used in the process are estimates of the participants, meaning the figures should not be blindly accepted. In absence of tangible data, it was difficult to assess the problems discovered in the process. This affected the measuring of the results too. The actual testing of the improvement ideas could not be executed, as during the study no relevant cases came up. Because of this, the analysis of the effects is done by estimating how would the improvements effect to the different problems in the process identified during the study. Therefore, the results of the study should be treated as approximates and not as absolute results.

However, the study provides a definition and a representation of the intercompany shipment consolidation process at a third-party operated warehouse. The definition created should provide a detailed description how the process case proceeded and what were the bottlenecks in the process. The improvement ideas could not be tested in practice, but they provide at least ideas how the process could be developed, in case they prove out to be incompatible in practice. Nevertheless, the short-term improvement ideas should be applicable to the process.

REFERENCES

Acar, M. F., Zaim, S., Isik, M., & Calisir, F. (2017). Relationships among ERP, supply chain orientation and operational performance. Benchmarking: An International Journal, Vol. 24(5), pp. 1291–1308.

Akkermans, H. A., Bogerd, P., Yücesan, E., & van Wassenhove, L. N. (2003). The impact of ERP on supply chain management: Exploratory findings from a European Delphi study. European Journal of Operational Research, Vol. 146(2), pp. 284–301.

An, Y., Zhang, Y., & Zeng, B. (2015). The reliable hub-and-spoke design problem: Models and algorithms. Transportation Research Part B: Methodological, Vol. 77, pp. 103–122.

Bagchi, P. K., & Skjoett-Larsen, T. (2003). Integration of Information Technology and Organizations in a Supply Chain. The International Journal of Logistics Management The International Journal of Logistics Management Iss The International Journal of Logistics Management, Vol. 14(1), pp. 89–108.

Beamon, B. M. (1999). Measuring supply chain performance. International Journal of Operations & Production Management, Vol. 19(3), pp. 275–292.

Birou, L. M., Fawcett, S. E., & Magnan, G. M. (1998). The Product Life Cycle: A Tool for Functional Strategic Alignment. The Journal of Supply Chain Management, Vol. 34(2), pp. 37–52.

Botta-Genoulaz, V., Millet, P.-A., & Grabot, B. (2005). A survey on the recent research literature on ERP systems. Computers in Industry, Vol. 56(6), pp. 510–522.

Bowersox, D. J. (1989). Leading edge logistics competetive positioning for the 1990s: comprehensive research on logistics organization strategy and behavior in North America. Council of Logistics Management.

Çapar, İ. (2013). Joint shipment consolidation and inventory decisions in a two-stage distribution system. Computers & Industrial Engineering, Vol. 66(4), pp. 1025–1035.

Çetinkaya, S. (2005). Coordination of Inventory and Shipment Consolidation Decisions: A Review of Premises, Models, and Justification. In: J. Geunes, E. Akçali, P. M. Pardalos, H. E. Romeijn, & Z.-J. M. Shen (eds.), Applications of Supply Chain Management and E-Commerce Research. Springer, Boston, MA. Pp. 3–51.

Cheng, J.-H., Chen, S.-S., & Chuang, Y.-W. (2008). An Application of Fuzzy Delphi and Fuzzy AHP for Multi-criteria Evaluation Model of Fourth Party Logistics. WSEAS TRANSACTIONS on SYSTEMS, Vol. 7(5), pp. 466–478.

Cheng, Y.-H., & Tsai, Y.-L. (2009). Factors influencing shippers to use multiple country consolidation services in international distribution centers. International Journal of Production Economics, Vol. 122(1), pp. 78–88.

Cheong, M. L. F. (2004). Logistics Outsourcing and 3PL Challenges. Singapore-MIT

Alliance, Innovation in Manufacturing Systems and Technology (IMST), pp. 1–8.

Cohen, M. A., & Lee, H. L. (1990). Out of Touch with Customer Needs? Spare Parts and After Sales Service. Sloan Management Review; Cambridge, Vol. 31(2), pp. 55.

Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply Chain Management: More Than a New Name for Logistics, Vol. 8(1), pp. 1–14.

CSCMP. (2013). Supply Chain Management Terms and Glossary. CSCMP Glossary.

De Koster, M. B. M., & Warffemius, P. M. J. (2013). American, Asian and third-party international warehouse operations in Europe: A performance comparison. IInternational Journal of Operations & Production Management, Vol. 25(5), pp. 762–780.

Dondo, R., Méndez, C. A., & Cerdá, J. (2009). Managing Distribution in Supply Chain Networks. Industrial & Engineering Chemistry Research, Vol. 48(22), pp. 9961–9978.

Eriksson, P., & Kovalainen, A. (2008). Qualitative Methods in Business Research. SAGE Publications Ltd, London, United Kingdom.

Faber, N., De Koster, R. Â. M., & Van De Velde, S. L. (2002). Linking warehouse complexity to warehouse planning and control structure An exploratory study of the use of warehouse management information systems. International Journal of Physical Distribution & Logistics Management, Vol. 32(5), pp. 381–395.

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. Journal of Operations Management, Vol. 28(1), pp. 58–71.

Frohlich, M. T., & Westbrook, R. (2001). Arcs of integration: an international study of supply chain strategies. Journal of Operations Management, Vol. 19, pp. 185–200.

Gunasekaran, A., & Ngai, E. W. . (2004). Information systems in supply chain integration and management. European Journal of Operational Research, Vol. 159(2), pp. 269–295.

Hall, R. W. (1987). Consolidation Strategy: Inventory, Vehicles And Terminals. Journal of Business Logistics, Vol. 8(2), pp. 57–73.

Harrison, A., van Hoek, R. I., & Skipworth, H. (2014). Logistics management and strategy: competing through the supply chain. 5th edition. Pearson, Harlow, United Kingdom. 427 p.

Helo, P., & Szekely, B. (2005). Logistics information systems: An analysis of software solutions for supply chain co-ordination. Industrial Management & Data Systems, Vol. 105(1), pp. 5–18.

Higginson, J. K., & Bookbinder, J. H. (1994). Policy recommendations for a shipment-consolidation program. Journal of Business Logistics, Vol. 15(1), pp. 87–112.

Hirsjärvi, S., & Hurme, H. (2008). Tutkimushaastattelu: teemahaastattelun teoria ja käytäntö. Gaudeamus Helsinki University Press, Helsinki, Finland. 213 p.

Hirsjärvi, S., Remes, P., Sajavaara, P., & Sinivuori, E. (2009). Tutki ja kirjoita. 15th edition. Tammi, Helsinki, Finland. 464 p.

Huiskonen, J. (2001). Maintenance spare parts logistics: Special characteristics and strategic choices. International Journal of Production Economics, Vol. 71(1–3), pp. 125–133.

Kogent Learning Solutions, Inc. (2011). SAP SD handbook. Jones and Bartlett Publishers, Sudbury, MA.

Jyväskylän yliopisto. (2010). Hermeneutics — Jyväskylän yliopiston Koppa. Available (referred on: 4.5.2017): https://koppa.jyu.fi/avoimet/hum/menetelmapolkuja/en/methodmap/philosophy-of-science/hermeneutics.

Kakkuri-Knuuttila, M.-L., & Heinlahti, K. (2006). Mitä on tutkimus? Argumentaatio ja tieteenfilosofia. Gaudeamus, Helsinki, Finland. 230 p.

Kalchschmidt, M., Zotteri, G., & Verganti, R. (2003). Inventory management in a multi-echelon spare parts supply chain. International Journal of Production Economics, Vol. 81, pp. 397–413.

Karrus, K. (1998). Logistiikka. WSOY, Helsinki, Finland. 319 p.

Kasanen, E., Lukka, K., & Siitonen, A. (1993). The constructive approach in management accounting research. Journal of Management Accounting Research, Vol. 5, pp. 243.

Kim, D. Y. (2013). Relationship between supply chain integration and performance. Operations Management Research, Vol. 6(1–2), pp. 74–90.

Kurian, G. T. (Ed.). (2013). Hub and spoke. In: The AMA Dictionary of Business and Management. 1st edition. AMACON.

La Londe, B. J., & Masters, J. M. (1994). Emerging Logistics Strategies. International Journal of Physical Distribution & Logistics Management, Vol. 24(7), pp. 35–47.

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

Lambert, D. M., Cooper, M. C., & Pagh, J. D. (1998). Supply Chain Management: Implementation Issues and Research Opportunities. The International Journal of Logistics Management, Vol. 9(1), pp. 232–241.

Law, J. (Ed.). (2015). Capital expenditure. In: A Dictionary of Finance and Banking. 5th edition. Oxford University Press.

Law, J. (Ed.). (2016). Intercompany transactions. In: A Dictionary of Business and Management. 6th edition. Oxford University Press.

Li, Y., Wu, F., Zong, W., & Li, B. (2017). Supply chain collaboration for ERP implementation. International Journal of Operations & Production Management, Vol. 37(10), pp. 1327–1347.

Liu, J., Zhang, S., & Hu, J. (2005). A case study of an inter-enterprise workflow-supported supply chain management system. Information & Management, Vol. 42(3), pp. 441–454.

Logistiikan maailma. (2017). Kansainvälinen autorahtikirja (CMR) – Logistiikan Maailma. Available (referred on: 1.11.2017): http://www.logistiikanmaailma.fi/wiki/Kansainvälinen_autorahtikirja_(CMR).

Lummus, R. R., Krumwiede, D. W., & Vokurka, R. J. (2001). The relationship of logistics to supply chain management: developing a common industry definition. Industrial Management & Data Systems, Vol. 101(8), pp. 426–432.

Marasco, A. (2008). Third-party logistics: A literature review. International Journal of Production Economics, Vol. 113(1), pp. 127–147.

McKeller, J. M. (2014). Supply chain management demystified. McGraw-Hill Education LLC, New York, NY.

McLaren, T. S., Head, M. M., & Yuan, Y. (2004). Supply chain management information systems capabilities. An exploratory study of electronics manufacturers. Information Systems and E-Business Management, Vol. 2(2–3), pp. 207–222.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., & et al. (2001). Defining supply chain management. Journal of Business Logistics, Vol. 22(2), pp. 1–26.

Molenaers, A., Baets, H., Pintelon, L., & Waeyenbergh, G. (2012). Criticality classification of spare parts: A case study. International Journal of Production Economics, Vol. 140(2), pp. 570–578.

Murphy, P. R., & Poist, R. F. (1998). Third-party logistics usage: An assessment of propositions based on previous research. Transportation Journal; Lock Haven, Vol. 37(4), pp. 26–35.

Myerson, P. (2013). Lean Supply Chain and Logistics Management. McGraw-Hill Professional, New York, NY. 270 p.

Ojala, L., & Hilmola, O.-P. (2003). Case study research in logistics. Turun kauppakorkeakoulu, Turku, Finland. 190 p.

Olkkonen, T. (1994). Johdatus teollisuustalouden tutkimustyöhön. 2nd edition. Teknillinen korkeakoulu, Espoo, Finland. 143 p.

Paakki, J., Huiskonen, J., & Pirttilä, T. (2011). Improving global spare parts distribution chain performance through part categorization: A case study. International Journal of Production Economics, Vol. 133(1), pp. 164–171.

Pagell, M. (2004). Understanding the factors that enable and inhibit the integration of operations, purchasing and logistics. Journal of Operations Management, Vol. 22(5),

pp. 459–487.

Pitkäranta, A. (2010). Laadullisen tutkimuksen tekijälle - työkirja. Satakunnan AMK. 168 p.

Power, D. (2005). Supply chain management integration and implementation: a literature review. Supply Chain Management: An International Journal, Vol. 10(4), pp. 252–263.

Prajogo, D., & Olhager, J. (2012). Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration. International Journal of Production Economics, Vol. 135(1), pp. 514–522.

Qrunfleh, S., & Tarafdar, M. (2014). Supply chain information systems strategy: Impacts on supply chain performance and firm performance. International Journal of Production Economics, Vol. 147, pp. 340–350.

Ramaa, A., & Subramanya, K. N. (2012). Impact of Warehouse Management System in a Supply Chain. International Journal of Computer Applications, Vol. 54(1), pp. 14–20.

Ross, D. F. (2011). Introduction to supply chain management technologies. Taylor & Francis, Boca Raton. 410 p.

Sakki, J. (2003). Tilaus-toimitusketjun hallinta: logistinen B-to-B -prosessi. 6th edition. Jouni Sakki oy, Espoo, Finland. 216 p.

Salminen, A. (2001). Mikä kirjallisuuskatsaus? Johdatus kirjallisuuskatsauksen tyyppeihin ja hallintotieteellisiin sovelluksiin. Vaasan yliopisto, Vaasa. 50 p.

SAP. (2017). SAP Documentation: Cross-docking (CD). Available (referred on 25.9.2017): https://help.sap.com/saphelp_scm2007/helpdata/en/eb/aee641fb6e3f5de10000000a1550b0/frameset.htm.

Skjoett-Larsen, T. (2000). Third party logistics – from an interorganizational point of view. International Journal of Physical Distribution & Logistics Management, Vol. 30(2), pp. 112–127.

Soinio, J., Tanskanen, K., & Finne, M. (2012). How logistics-service providers can develop value-added services for SMEs: a dyadic perspective. International Journal of Logistics Management; Ponte Vedra Beach, Vol. 23(1), pp. 31–49.

Stake, R. E. (1995). The art of case study research. SAGE, Thousand Oaks, CA. 175 p.

Stank, T. P., Keller, S. B., & Daugherty, P. J. (2001). Supply Chain Collaboration and Logistical Service Performance. Journal of Business Logistics, Vol. 22(1), pp. 29–48.

Stock, G. N., Greis, N. P., & Kasarda, J. D. (2000). Enterprise logistics and supply chain structure: the role of fit. Journal of Operations Management, Vol. 18(5), pp. 531–

547.

Suomala, P., Sievänen, M., & Paranko, J. (2002). The effects of customization on spare part business: A case study in the metal industry. International Journal of Production Economics, Vol. 79(1), pp. 57–66.

Tyan, J. C., Wang, F.-K., & Du, T. C. (2003). An evaluation of freight consolidation policies in global third party logistics. Omega, Vol. 31(1), pp. 55–62.

Yin, R. K. (2003). Case study research: design and methods. 3rd edition. SAGE, Los Angeles, CA. 181 p.