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OPTIMIZING THE WAREHOUSE RECEPTION PROCESS LEAD TIME

Master's Thesis
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ABSTRACT:

This research was done around the study aim of optimizing the material flow of goods in a healthcare and laboratory equipment distributor case company warehouse. Since the collection and shipping phases were performing well at the case company warehouse and there was seen to be room of improvement in the reception and inspection phase, the focus was set out to optimize the reception process lead time. This study is limited to focus on the reception and inspection of goods to the point that they are ready at the collection point. The collection of the goods at the warehouse is left out of this study as it is not considered to be an issue inside the case company. The challenges of this study are how to identify points of improvement and what kind of actual changes can be made to tackle them? The research starts with a theoretical part at first, by analysing literature review regarding the subject. After this a more in depth look at the current warehouse operations is done by analysing the operating procedures at the case company warehouse. The data and methodology used in the empirical research consists of open-ended interviews with key personnel inside the case company for gathering qualitative information regarding the optimization and possible changes around the warehouse lead time. The key personnel interviewed were Supply chain manager, Warehouse manager, Quality manager, Logistics coordinator, Supply analyst, Warehouse supervisor and Warehouse inspection worker. Quantitative data is also analysed from the case company regarding the incoming shipments and possible changes to them, by taking a closer look at the item lines received at the warehouse in the year 2020 and how they divided to different days of the week and different months. These combined methods of information highlighted the factors of inefficiency and possible development ideas, which were carried out inside the case company and on to some of the suppliers of larger shipments. This study contributed to results in ways to optimize the inspection of goods and the reception of incoming shipments in a way to further prevent possible bottlenecks at an over-flown inspection area. Conclusions however include future research, that can still be done at the case company by analysing how these changes have affected the turnaround time and how to then optimize the material flow further.

KEYWORDS: Supply chain management, Warehouse management, Lean distribution, Lead time, Inspection, Case study

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TIIVISTELMÄ:

Tämä tutkimus toteutettiin tavoitteena optimoida saapuvien tavaroiden materiaalivirtaa terveydenhuollon ja laboratoriolaitteiden jakelija case-yrityksessä. Painopiste oli vastaanotto prosessin läpimenoajan optimoinnissa, koska keräilyvaiheen katsottiin sujuvan hyvin case-yrityksen varastossa ja vastaanottovaiheessa nähtiin parantamisen varaa. Tästä syystä tutkimus rajoittuu tavaroiden vastaanottoon ja tarkastukseen siihen pisteeseen asti, että ne ovat valmiita keräyspisteessä. Tavaran keräily ja lähettäminen on jätetty pois tutkimuksesta, koska sitä ei pidetä kehityskohteena. Tutkimuksen haasteina ovat, kuinka tunnistaa parannuskohteita ja millaisia muutoksia niissä voidaan saada aikaan. Tutkimus alkaa teoreettisella osuudella, jossa analysoidaan aiheeseen liittyvää kirjallista materiaalia. Tämän jälkeen tarkastellaan case-yrityksen varaston toimintaa tarkemmin analysoimalla nykyisiä toimintatapoja. Empiirisessä tutkimusosiossa käytetty data koostuu avoimista haastatteluista case-yrityksen avainhenkilöiden kanssa laadullisen tiedon keräämiseksi prosessien optimoinnista ja mahdollisista muutoksista varaston läpimenoajan ympärillä. Haastateltavat avainhenkilöt olivat Toimitus-ketjun johtaja, Varastopäällikkö, Laatupäällikkö, Logistiikkakoordinaattori, Tarjonnan analyytikko, Varastovalvoja ja varaston tarkastustyöntekijä. Case-yritykseltä analysoitiin myös kvantitatiivista dataa saapuvista lähetyksistä ja mahdollisista muutoksista niissä tarkastelemalla tarkemmin varastoon vuonna 2020 saapuneita tuoterivejä ja niiden jakautumista eri viikonpäiviin ja kuukausiin. Nämä yhdistetyt tiedonlähteet nostivat esille tehottomuuden kohteita ja mahdollisia kehitysideoita, joita toteutettiin case-yrityksen sisällä ja myös joidenkin toimittaja yritysten sisällä. Tämä tutkimus auttoi case-yritystä saamaan tuloksia tavoissa, joilla voidaan optimoida tavaran tarkastusta ja vastaanottoa, sekä estämään mahdollisia pullonkauloja tarkastusalueella. Johtopäätöksissä mainitaan kuitenkin tapoja tulevaisuuden jatkotutkimuksille, joita yritys voi tehdä analysoimalla, miten nämä muutokset vaikuttavat läpimenoaikaan varastolla ja kuinka materiaalivirtaa voidaan siten optimoida edelleen.

AVAINSANAT: Toimitusketjun hallinta, Varaston hallinta, Lean-jakelu, Läpimenoaika, Tarkastus, Case-tutkimus

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Abbreviations

VSM = value stream mapping

DMAIC = define measure analyse improve control

ERP = enterprise resource planning

LSS = lean six sigma

WMS = warehouse management system

SOP = standard operating procedures

SCM = supply chain management

SCSMP = the council of supply chain management

1 Introduction

1.1 Background

Warehouse management can be described as the control and optimization of complicated warehouse and distribution systems. This also includes the management and organizing of transport means, in addition to the basic inventory management like the management of quantities and storage locations of stock. (Hompel & Schmidt 2007) Warehouse optimization can be defined as the use of time, space and resources in the most efficient way, through careful planning and constant improvement. Companies are constantly aiming to optimize their supply chain processes to minimize waste and increase efficiency.

This research is focused on a case company which is one of the largest providers of healthcare equipment and supplies in Northern Europe. Medical equipment and materials are being bought from all over the world and once arrived at the warehouse in Espoo they are being distributed to different hospitals and healthcare centers around Finland. This case study is focused on the receiving of the goods at the warehouse and the inspection of the goods before they can be transferred to the collection point. Currently the case company needs further optimization in the warehouse since large shipments are creating a bottleneck at the reception and inspection of goods.

This thesis aims to produce information to the case company regarding the processes which affect the warehouse turnaround time. The objective is to share knowledge and information regarding these processes inside the organization and offer concrete changes, suggestions and new insights for improvement.

1.2 Research questions and objectives

This research is based on case company's need for supply chain changes and improvements. The research focus on company's supply chain bottlenecks and lead time of the warehouse material flow. Currently large shipments are coming in at the same time over filling the inspection area and the aim is to create a concrete change in this. To find and generate solutions it is essential to study what kind of spikes are there on the receiving cycle and how to view the prioritization order in which incoming shipments are being inspected. The company will focus on a few key metrics such as how many order lines are being handled within 48 hours and what is the overall turnaround percent. This way it will appear if there is a concrete beneficial change in the meters once the project is running. An optimized warehouse with an efficient lead time will ultimately benefit the end users as well as the company. From these perspectives the paper has two research questions:

Research question 1: *What measures can be taken to reduce the warehouse turnaround time?*

Research question 2: *What are the bottlenecks in the warehouse throughput process?*

This study is centered around the assumption that the current operation method is not the most effective, but rather it could be optimized further. With large volumes of goods coming in daily from a large network of suppliers all around the world it is necessary to not only focus on internal matters, but also try to research if changes with the external framework could be possible and beneficial.

1.3 Research methodology

The research material in this case study is divided into three sections. These are interviews with key personnel inside the organization, material and data obtained from the case company and literature review regarding the subject. The key material is

gathered through different people from whom which the supply chain manager advised to interview, such as warehouse manager, supply analyst, warehouse worker, logistics coordinator and more. This qualitative interview material is processed to gain insight on things to improve, methods for improvement and perceiving the overall picture to access new ways to optimize the workflow.

Quantitative material and data from the case company is used to back up the information that emerges from the interviews and vice versa further developing the different steps in the process. Workflow process charts, measuring meters of logistical operations inside the warehouse and spreadsheets of incoming shipments and items are being studied to see what kind of beneficial changes can be implemented. Materials inside the organization are also studied to understand why different things are working and why some parts are causing bottleneck effects.

Literature review is used on providing a theoretical framework to the study. It introduces and explains some key ideas, tools and methods regarding supply chain management, lean warehouse optimization and process mapping which can be applied in the case company, as well as to compare current methods on existing studies.

1.4 Case company profile

The case has company requested to stay anonymous in this research paper. It is one of the biggest healthcare and laboratory equipment and supply distributors and providers in Finland. The business model is providing equipment, supplies, services and solutions to healthcare providers and professionals.

1.5   Structure of the thesis

The structure of this thesis is divided into seven different chapters. It begins with intro-
duction which gives insight about the topic of the research and the main idea of the
study. This is followed by chapter two which contains basic knowledge about the con-
cepts relating to this research. In chapter three the current reception and inspection
working methods at the case company warehouse are explained. Chapter four explains
the chosen method used in the research and chapter five consists of the actual empirical
research. This includes summaries of the interviews regarding the case study and key
points and development ideas, which rose from these discussions. The sixth chapter is
results which goes more in depth of these development ideas and how they were imple-
mented and what kind of results occurred. The final chapter is conclusions, and it con-
cludes the research by showcasing what ideas, developments and changes this research
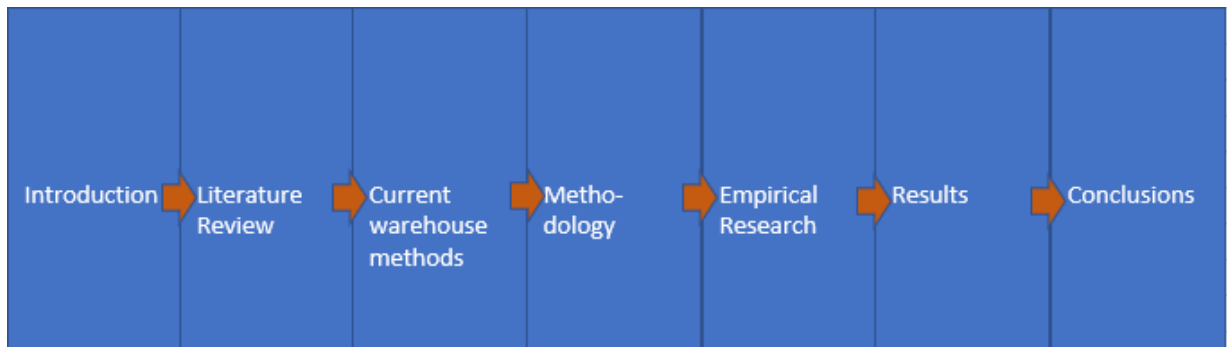initiated at the case company.

Introduction → Literature Review → Current warehouse methods → Metho-dology → Empirical Research → Results → Conclusions

Figure 1. Thesis structure

2 Literature review

The aim of the literature review chapter is to provide a thorough view of the concepts and methodologies used in this research and at the case company. The literature re-view goes through certain concept words and methodologies regarding optimization of warehouse management systems and to give a basic understanding about the topic of this research.

First, warehouse management is explained together with warehouse management system and its challenges. Then a more in depth look on warehouse management and different systems and strategies to handle it, and finally the literature review goes over the ideas of cooperation and relationships of suppliers and distributors and how MDR will affect the distribution of medical devices and equipment.

2.1 Warehouse management

Industrial Distribution magazine describes warehouse management in their 2017 article "What To Know About Lean Warehouse Management" as a system which supports the daily operations in a warehouse. "A modern warehouse today has to manage the flow of material within the facility, as well as the flow of information throughout the supply chain." (Industrial Distribution 2017)

Warehouse management is the process of effectively operating a warehouse and it is one of the key factors in supply chain management. It is important to mention that organizations face substantial challenges in managing warehouses. Furthermore, improving the efficiency of a warehouse requires eliminating any waste from the warehouse by streamlining its operations and improving the efficiency in every part of warehousing processes. These successful efforts of improvement methodologies can lead to significant improvements in a warehouse, such as the elimination of unnecessary or non-

value-adding processes and a development in overall lead-times. Moreover, this will correlate to customer satisfaction and better flow time at the warehouse. (Benmoussa, Benmoussa, De Guio, Dubois, Rasovska 2019)

2.1.1 Warehouse management system

A warehouse management system (WMS) is a software application that improves the monitoring and managing the day-to-day operations in a warehouse. WMS software guides inventory receiving and put-away, optimizes collecting and shipping of orders and advises on inventory replenishment. (IQMS 2016).

WMS is used in the intend to increase the performance of the warehouse by managing efficient managerial implications and in order to develop complete inventory as a result of recording warehouse transactions. WMS can be defined as a system to control the storage of materials and their movement inside the warehouse. However, the role of WMS is expanding to different managerial areas such as the transportation of goods also. These systems include functions for receiving, order picking, packing and shipping, material handling and even customer service activities. As Warehouses must be designed and programmed to achieve high throughput rate and optimal productivity thereby organizations should evaluate their warehouse systems with proper criteria and implement them correctly to increase performance and proficiency. (Apak, Tozan & Vayvay 2016)

 An efficient WMS benefits organisations by:
-Supporting demand for customer orders (pick-and-choose orders)
-Resupplying stock based on the demand of end users
-Tracking inventory from the time it arrives at the warehouse to the time it reaches its destination
-Maintaining the facility to protect goods

2.1.2 Challenges of warehouse management

Since today's warehouses must answer the market demand of pick-and-choose orders made by customers, they can no longer only stockpile products and supplies and wait for end users to purchase them from their predetermined supply. Instead, warehouses must continuously move fresh or updated goods to meet an ever-changing demand. Typical challenges warehouse management might encounter include:

-Weak layout: Locating the right supplies might be difficult if some storage areas are being overfilled whilst others are being underused. Also, too much space between workstations increases the time and labor it takes to move shipments from station to station.

-Unproductive storage and transfer of supplies: Items with a high rate of inbound and outbound should not be stored in space, which is not optimally placed for reach, despite their frequent use.

-Ineffective processes: Suboptimal inventory management can produce frequent defects and missing or damaged goods as well as mislabeled supplies.

-Recurring slow down intervals in the supply chain: Warehouse staff in the collection need to wait for incoming materials to be resupplied before new shipments can be processed. New shipments being inspected and approved can take too long to process which will cause orders to backup. (Industrial Distribution 2017)

Furthermore, to above mentioned challenges warehouse management has focused on three different challenges with today's e-fulfilment warehousing. Seasonality is a crucial factor in almost any industry's warehouse. The demand on staff and equipment can vary largely between seasons, which has impacts on handling and storing goods. Second challenge is the wide range of products warehouses must withhold in today's market, since retailers are also dealing with internet orders. Processing low-cost items at the warehouse consumes the same amount of labour and equipment at the warehouse, but the margin is much smaller compared to higher cost items. (Richards 2017)

The last universal challenge at warehousing is inventory management. Increasing number of product lines puts pressure on the number of collection locations, whilst slow-moving items will take up much needed space at the warehouse. From the collection point of view warehouses need to search for alternative spacing solutions to ground-floor collection such as flow racking and carousel collection points. Furthermore, to release crucial space in the warehouse stock turnover must be managed well and decisions regarding the disposal of non-moving stock must be made swiftly. (Richards 2017)

With today's e-commerce industry warehouses also face a large percentage of returns. This can even be 30 – 40 per cent of outward volume in retail warehouses. Considerably many of these returns are stock that can be resold, although they must go through a comprehensive quality check. The former chief executive of iForce in the United Kingdom Mark Hewitt has talked about the developing interest in returns. According to Hewitt there will be a growing demand for outsourcing e-fulfilment to firms that can also offer returns processing from the same facility, as this will drive down costs by allowing a more effective process for placing returned goods back into the warehouse stock. (Richards 2017)

2.1.3   Benefits of lean warehouse management

When implementing a lean way of working and management style at a warehouse the company will receive multiple benefits. By decreasing errors, maximising the available space for supplies, increasing their efficiency and by pulling supplies based on their customer demand warehouses will be able to meet the altering requirements of their customers. (Industrial Distribution 2017)

Other advantages of a lean warehouse management include:

-Reducing order processing time by standardizing work methods and reducing work-in-progress

-Minimising labour costs related to rework and inefficient handling of materials

-Reducing unnecessary transportation of shipments by storing supplies based on

tracking and knowing their demand

-Decreasing slow periods by pulling materials based on customer needs. (Industrial Distribution 2017)

2.2 Supply chain management

2.2.1 Supply chain

When a consumer places an order, to get the products and services refined into their final form as they move from raw material sources to the end user, it requires several different work steps, companies and individuals to make it happen. The resulting series of interlinked events is called a supply chain. The supply chain covers all material, information and cash flows related in the process. (Inkiläinen 2011)

Companies further develop supply chains in order to reduce their costs and remain competitive in the business landscape (Kenton 2020). Measures to increase the cost-effectiveness and customer orientation of the supply chain were adapted in the early 1990s this process was named supply chain management (Inkiläinen 2011).

2.2.2 Definition of Supply Chain Management

Supply chain management (SCM) has been around approximately 35 years, but the traditional functions of business included in it e.g., procurement, warehousing, transportation, forecasting and order management have been around long before that. Matt Drake defines SCM the same way SCSMP (the council of supply chain management professionals):

"encompassing the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain

Management integrates supply and demand management within and across companies."
(Drake 2011)

2.3 Procurement

Global Competition emphasizes the sourcing of products and materials around the world. An essential part of a company's international supply chain is the searching for and managing the flow of supplies and components. The traditional role of procurement has been achieving the best price possible while ensuring a sufficient flow of materials in to the organisation. This has been shifting now to a new perspective in which the focus on products is changing towards a focus on supplier capabilities. (Skjott-Larsen, Schary, Mikkola, Kotzab 2007)

Procurement has become proactive, managing and designing links of connections. This involves international relationships, utilizing the resources of suppliers, cost management, supplier development and logistics planning for linking and processing. Furthermore, purchasing management has become strategic procurement management shaping the strategic direction of the company. Skjott-Larsen (and others), in their book Managing the Global Supply Chain point to three different decision ranges in the new strategic procurement context:

-Make or buy decision

-Supply-base structure

-Customer-supplier relationships. (Skjott-Larsen, Schary, Mikkola, Kotzab 2007)

These three decision areas pinpoint a distinct break, from past procurement practices by squeezing revenue margins out of suppliers for short-term cost reductions. Numerous factors have played a part prompting this development, but the most notable ones are:

-Increased outsourcing

-Global sourcing

-JIT-purchasing

-Green supply management

-Information technology.

2.4 Value of WMS in supply chain management and procurement

The execution of a well-designed WMS will provide benefits to procurement and overall supply chain management in any organization with warehousing. WMS provides an increase in accuracy, reduction in labor costs, and better service to end user customers by reducing cycle times. WMS will lead to greater storage capacity as well as inventory reduction with an increased accuracy and efficiency of managing a warehouse. While benefiting the cost structure of the company, shortening lead times and improving customer service levels, it can be stated that optimal warehousing influences the performance of an entire supply chain. The implementation of a WMS for a firm requires significant investment and time period (several months to a year) and this time lost must be justified with the benefits acquired in the use it. To rationalize the start of a WMS process involves accurate analysis of the current situation at the warehouse and understanding of the processes applicable for further tuning. (Ramaa, Subramanya & Rangaswamy 2012)

Overall, an automated WMS is an essential replacement for a manual management system in any medium or larger sized warehouse. The main purpose being a manageable control on storing and moving of goods with an enhanced grip on handling the units with a better visibility of security and reliability. (Atieh, Kaylani, Al-abdallat, Qaderi, Ghoul, Jaradat, Hdairis 2016) Therefore a VMS will ultimately increase the reliability and efficiency of the supply chain process.

2.5 Lean

In the supply chain management world often the term Lean presents itself. The history of Lean can be tracked down to the start of Toyota and Ford car manufacturing, which

was operated by a linear system to minimize waste and maximise the workflow output (Hessing 2021).

Kari Tuominen describes Lean in his book "Lean käytännössä" by saying it is not a state to be sought after. It is an ongoing process of learning and development. This journey begins with learning lean techniques and understanding their principles as a living and ever evolving system. (Tuominen 2009)

Lean is a systematic approach which is focused on continuously improving quality, cost, safety, and delivery by pursuing to eliminate waste, create flow and increase the overall swiftness of the organisations ability to meet customer demand. Lean methodologies are applied in organisations to:

-Eliminate waste

-Increase capacity

-Reduce cycle and flow time

-Reduce inventory

-Remove bottlenecks

-Increase customer satisfaction

(Plenert 2006).

The one thing that is consistent in any industry is change. Lean focuses on continuous improvement which can also be described as managed change. Lean requires that the company inspects the goals of the organisation and ways to support the organisation in optimizing those goals by studying the growth opportunities as well as error correction opportunities in current operations. (Plenert 2006)

Warehouse activities affect the to the company's business since these activities are directly related to the arrival of goods at the end user's location. By implementing lean warehousing points of inefficiency and waste can be further optimised, such as maximising storage and inspection space and eliminating floor stock. First the whole process can

be reviewed and visualised using value stream mapping. Then the performance can be measured and inspected to identify point of inefficiency and plan improvement proposals in these points. (Prasetyawan 2020)

2.6 Lean six sigma

Das Näglund (2008) Describes the purpose of six sigma as the way to reduce costs by reducing the variability in the processes, which will lead to decreased defects. He defines six sigma as a method to increase process capability and enhance process throughput. Six sigma is also acknowledged as a method to decrease waste, increase customer satisfaction, and improve financial results.

By using statistical methods, companies are able to understand fluctuations in a process, which will allow them to pinpoint the cause of the problem. This way the whole process can be improved by eliminating root causes and managing the process to make sure defects no longer reappear which will ideally result in long-term benefits to the organization. (Näglund 2008)

Lean Six Sigma (LSS) portrays the systematic and result-oriented development of processes. Above all it is about how we can learn from our current way of doing things and how we can systematically develop what we do to achieve the goals we set and the mission of our organization. Through these development projects, organizations can improve the flow of processes, or more broadly value chains and pursue clear leaps on improvements in their performance. The results of the projects must then be implemented into everyday activities at floor level and furthermore create conditions which enable to question and reform the activities, even in small continuous steps by all (Lintula 2015).

When applying a LSS method on a project like improvement plan the process is guided by a five-step plan called DMAIC (Define, Measure. Analyse, Improve, Control). This will

guide the development of the previously described scientific problem-solving steps. The term DMAIC has solidified its use in a roadmap for project-like development in most languages including Finnish and usually it is no longer translated in scientific papers and documents. (Lintula 2015).
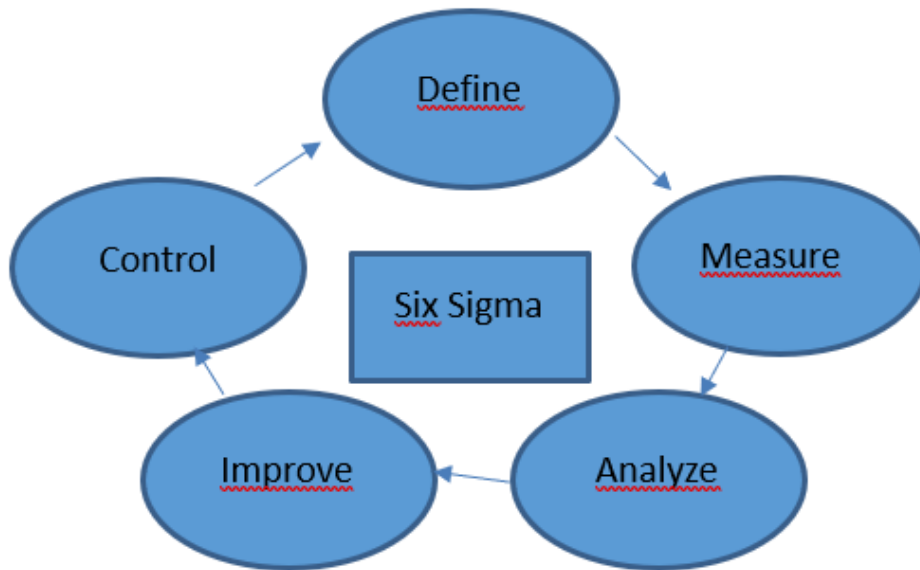
Figure 2. Lean Six Sigma

1. The first step is Define which requires close collaboration with the project manager and the project team. A good delineation and a clear goal at the beginning of the project will support conditions for swift progress. Developing a project plan and milestones as well as defining the resources and a process map are key components of the first step of DMAIC.

2. In the measure phase the company identifies the current mode of operation and performance. In order to ensure a smooth implementation of future improvements, it is important that there is already a comprehensive representation in the working group. Measure phase usually consists of determining current performance, developing a data collection plan, validating the measurement systems, and collecting the data from current processes.

3. In the analysis phase. the process is observed, and data is being collected and examined to identify the root causes of inefficiency. In this phase typically to determine root causes it is optimal to define performance objectives, identify value and non-value-added process steps and identify sources of variation. Typical tools used in analyzing are e.g., histogram, scatter plot, pareto chart and statistical analysis.

4. Improve phase consists of creating new improved policies and action plans. By using tools such as brainstorming, mistake proofing, design of experiments and failure modes and effect analysis (FMEA). With these tools the goal is to develop potential solutions, assess failure modes of potential solutions, validate potential improvement by pilot studies and correct/re-evaluate potential solution.

5. The final phase of DMAIC is control in which conditions are created to incorporate new reforms into day-to-day operations. Once they are included it is crucial to monitor their effectiveness. To control future process performance, companies tend to define and validate monitoring and control systems, develop standards and procedures and verify the benefits of new and improved process. Tools used in control are usually control charts, cost savings calculations and a control plan. (Isixsigma 2021)

2.7 Value stream mapping

Sarah White (2020) describes value stream mapping (VSM) as a lean technique for improving busines processes. Companies are able to eliminate waste and redundancies in their processes and increase customer value by implementing VSM techniques. (White 2020)

VSM is a tool developed to visualize the whole process. The aim is to understand what and how much demand there is in the process, how the individual steps of the process work and how this is being managed. In other words, there is a need for data on operations, information on customer demand, and the flow of information that is used to

manage the process and people (Piirainen 2015). When the process is visualised, it is easier for the people involved to visualize what steps are included in the process, how they are being done and why they are being done. The aim of the information collected and described is to get an idea of where improvements should be made, i.e., what needs to change in the current state (Piirainen 2015).

Piirainen explains in his 2015 article about VSM that it is used to assist people doing improvement and development work to describe the information in a formal and comprehensible way. The description gathers information to help you understand what is preventing you from achieving your goal better. Only the necessary information and the interdependencies of the considered areas are described and organized into the VSM picture. The formal format and knowledge of the activity will help all participants to understand the matter in the same way and draw conclusions. (Piirainen 2015).

VSM has been developed as a tool to identify areas for improvement. If the work stays here, or problem recognizers do not have a vision of how the activity should change, the mapping itself does not move the change forward.

Lewis Yasenchak divides VSM data collection in to six essential methods and processes:
- Collect the information that can be gathered from available systems
- Conduct observations and timings off staff activity
- Conduct observations of the work item itself, such as following it through a manufacturing process.
- Retrospectively review activity. For example, conduct a file review to find typical errors.
- Run workshops with subject-matter experts in order to understand process flows and identify where things might go wrong.
- Conduct deep dives on tasks and activities in a process that employees perform to get the job done
Finally, Yasenchak highlights the importance of knowing specifically when to use each of these data-collection methods, and the researcher should be assured of access to

competent personnel who can use the right approach. These days the journey of data collection does not have to be a long one, given the advancement of modern tools and techniques, but there is still no substitute to good quality information as the basis of successful decision-making. (Yasenchak 2016) Overall value stream mapping can be used for the case company also to recognize the overall activities and processes in the warehouse and identify the parts with waste or problems related to them (Prasetyawan 2020).

2.8 SOP

SOP stands for standard operating procedures which is a set of written instructions that describe the step by step process which is followed in order to perform a routine activity. A functional SOP should be followed every time while doing this said activity in order to guarantee that the procedure remains consistent and in compliance with the organization's regulations and business standards. Standard operating procedures can help an organization by reducing errors, increasing efficiencies and productivity, creating a safe work atmosphere and creating guidelines for how to resolve problems and overcome obstacles. (Brush 2019)

SOP in conclusion sets a clear written direction on how to complete a complex routine task. Still every process does not need to be turned into a SOP. Tasks which are routine, scalable and at the core of what the organization does however need to. Processes look at tasks from a higher level and the general ways to do it. SOP on the other hand dives in deeper and answers the questions; who, when, where, what and how regarding the process. (Ronzio 2020)

2.8.1 How to create a SOP

In order to decide which actions would benefit from an SOP, companies should list their business processes. Managers should discuss employees' day-to-day responsibilities and tasks to ensure all procedures are accounted for. Any tasks that are repeated by multiple

personnel should be considered for SOP creation. Key information a SOP should give out include:

-Who performs what role?

-What does each role do?

-What is the goal/outcome of each persons role?

-Why this task is being done and what it does

First the goal of the process should be identified as well as why it needs a SOP. After this the author needs to decide a format to use for the SOP. Different formats available for SOP include e.g. Flowchart (Displays processes with unpredictable or several outcomes), Simple steps (Numbered/bulleted list of documents. Simple brief list used for short and simple processes.) and Hierarchical steps (Also a numbered/bulleted list but intended for processes with multiple steps and decisions. Includes a numbered list of primary steps followed by a more specific collection). (Brush 2019)

The standard operation procedure should include a title page, a table of contents and a step-by-step list of the actions. This includes explanations of the task's goal, roles and responsibilities, regulatory requirements, terminology, and descriptions of what needs to be done to complete each step, including decisions which have to be made. This part will make up for most of the SOP. (Brush 2019)

2.9 Supplier distributor relationship

A supplier is a company which acts as the source of materials, products or services. It either receives these goods from the manufacturer or manufactures them by itself. Suppliers work with distributors and/or wholesalers by providing them the goods they need. A distributor can be perceived as the contact between the supplier and the wholesaler, retailer or end user. Distributors will often aid with international distribution and shipping for companies. They could be responsible for distribution to a particular country or

region. As well as allocating goods, it is the job of the distributor to replace any products that arrive damaged to the wholesaler or end user and to offer dependable customer service for all the entities that they distribute to. (Product Distribution Strategy 2019.)

The relationship between suppliers and distributors is by nature mutually dependent. As it can be described in the most basic level, suppliers depend on distributors to get their goods in to market and in the other hand distributors would not have a reason to exist without the suppliers and manufacturers who supply them. In the end at the core of each organization they focus on their own objectives and goals. However, for the relationship to blossom and create value to each party they both have a duty to work together to understand the needs of the business. The goal is to look past a simple transactional association, but rather have a symbiotic partnership which provides seamless communication at many levels. (Pulskamp 2019)

The secret of successful businesses resides in the consistent adaptation as well as the high-level satisfaction of the continuously changing consumer demands. According to a present approach in these days we can talk about the competition effort not only of companies and products but also of the supply chains of certain firms. The key to assuring consumer satisfaction is the maximization of the supply chain usually organically independent of participants' performance (suppliers, distributors, and logistics providers) as well as the optimization of operating costs. By supplying information across the supplier and distributor it is possible to optimize and maximize information flow of the logistics and warehousing processes to benefit both parties as well as the end users. (Babics Tamas 2005)

2.10 MDR

The new medical devices Regulation (EU) 2017/745 (MDR) and the in vitro diagnostic medical devices Regulation (EU) 2017/746 (IVDR) bring EU legislation into line with technical advances, changes in medical science, and progress in law making. The new

Regulations create a robust, transparent, and sustainable regulatory framework, recognised internationally, which improves clinical safety and creates fair market access for manufacturers (European Comission 2020). In general, the new MDR and IVDR keep all the existing requirements of the directives while adding some new requirements of their own. Emphasis being on the life-cycle approach to safety, backed up by clinical data. (European Comission 2020)

Since the new MDR inspections are starting this May it is important to further optimize the inspection of incoming goods as far as possible, because MDR will slow it down at least in the beginning of launching it. MDR/IVDR will affect the case company in the following ways.

There will be additional inspections in a large portion of the incoming products. Whenever there is an import product a mandatory inspection is required. Whenever a new product is being received for the first time an inspection is also mandatory. It must be verified that it corresponds to what was expected to be received. There must also be willingness to take samples from time to time, but on what principle has not yet been decided. (Quality manager 2021)

MDR enforces that the importer inspects each arrival shipment, and the distributor determines when to carry out a random inspection on different suppliers' shipments. While performing the MDR inspection warehouse inspectors mainly look at labels and accompanying documents. Since the personnel cannot in any way know thousands of products by memory, there is a quality control level with two different attributes coming from the ERP system. This produces a text for the item that either says import or distributor. When dealing with an import product the inspector uses a checklist to go through that all the required data is filled out and correct.

3 Current warehouse method at the case company

This chapter describe the current working ways and methods at the warehouse regarding the reception of shipments and inspection of the incoming goods. These are the primary focus points of this research, so it is important to understand thoroughly what is being done and why. The case company has a SOP in use with the standardized tasks listed out in instructions. First, we look on a flow chart of the reception of incoming shipments and after that an in depth look on the inspection of incoming goods, which is creating a bottleneck in the material flow at the case company warehouse. This thesis is focused on improving this problem at the warehouse. Information regarding the new warehouse system, which will be launched in the future will also be discussed at the end of this chapter.
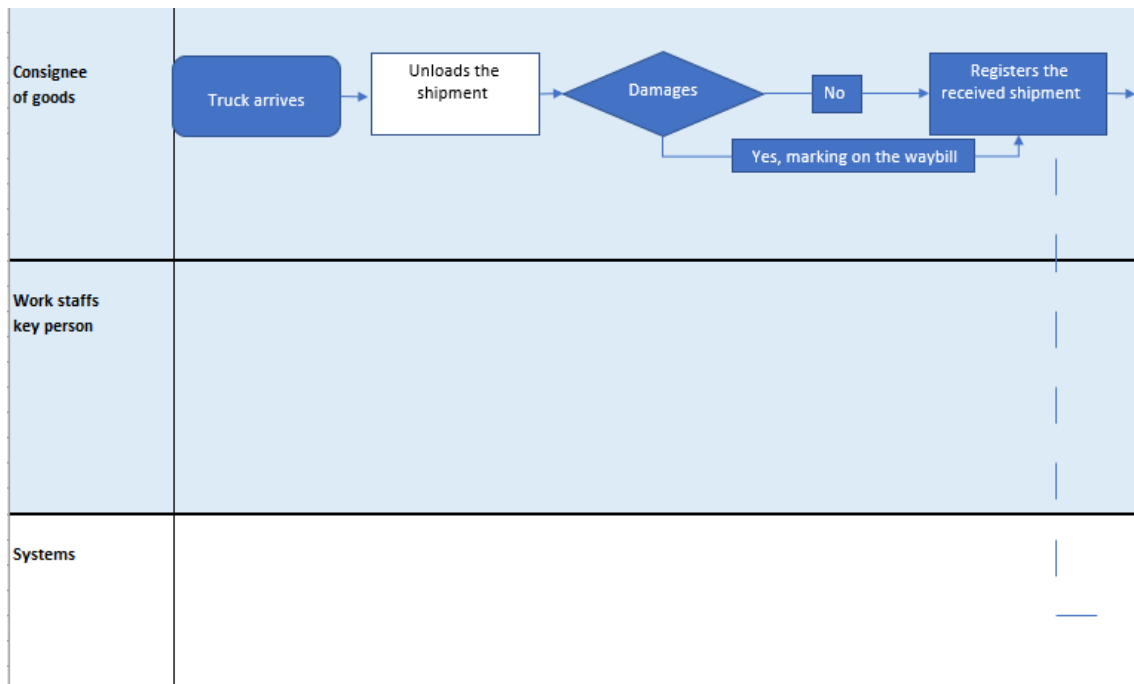
3.1 Reception of incoming shipments

Figure 3. Flowchart of the reception of a shipment at the warehouse part 1

When a new shipment arrives, the consignee checks that the goods belong to the case company, waybill is accurate according to shipment in hand, incoming goods appear to be in good condition and that the number of packages corresponds to the number indicated in the waybill. After this arrival inspection the person marks in the waybill the possible reservation, signs the waybill and marks the time and date of arrival in it. Then he takes the consignee's copy of the waybill and gives the other copy to the carrier. By signing the waybill, the consignee acknowledges that they have completed the receiving of the shipment according to this policy. The incoming shipment is then registered into the ERP-system. If a purchaser has entered the incoming shipment to the ERP with a transport number the receiver prints out the following information:

-Receiver

-Waybill number

-Inspector of goods and the color of the arrival

-Deviation: Indication if a quality deviation report has been made (E=no, K=yes)

-Date and time of arrival

-Origin of the shipment (domestic = K, foreign = U, post = P)

-Number of packages/pallets

-Total weight of the shipment.

The consignee will then print out the shipment's documents in the right color-coded plastic envelope (different colors for different placing such as small materials, cold stored etc.) and places them on the inspection area.
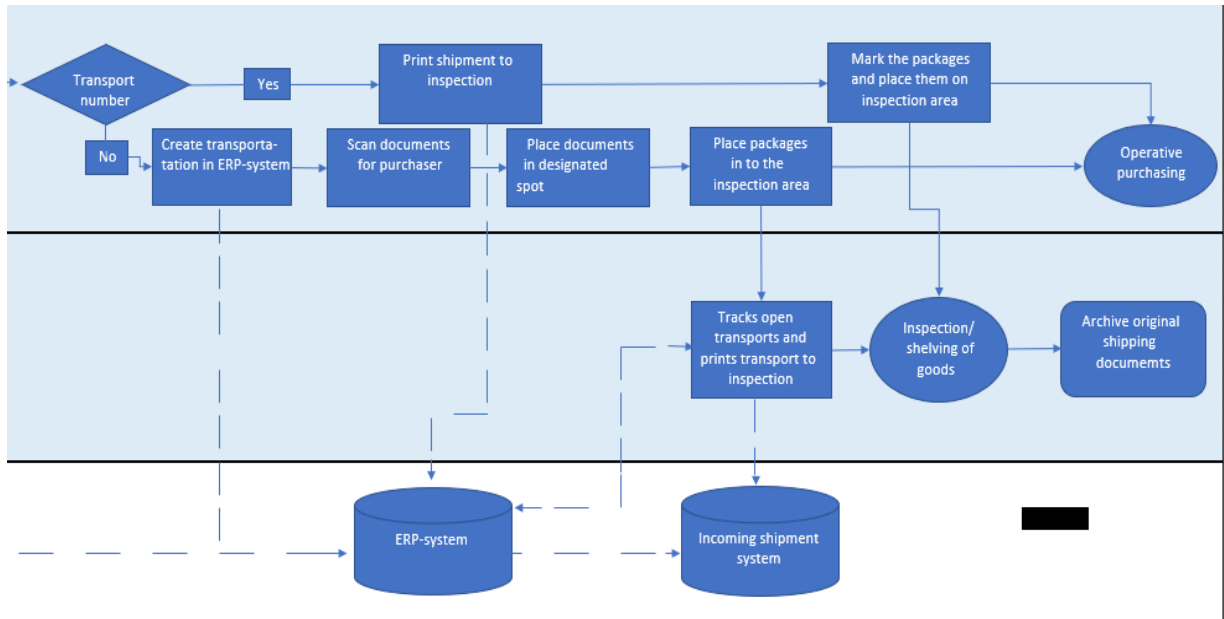
Figure 4. Flowchart of the reception of a shipment at the warehouse part 2

In case a Purchaser has not entered a transport to the ERP-system for the shipment the consignee of goods does it by entering the supplier company and the shipment into the ERP. After this the consignee scans the shipping documents to the correct purchaser of this supplier, so he/she can list the correct orderliness into the transport order. Now the consignee will place the incoming shipments documents on the designated spot which is sorted by date and place the packages/pallets on to the inspection area. The key person of incoming goods will track open transports in the system and print out these transports to be inspected. This concludes the process of receiving incoming shipments and next up comes the inspection of goods.

3.2 Inspection of incoming goods

At this time the inspection of incoming goods has been identified as a problematic area, or even a bottleneck in material flow at the case company warehouse. Currently large shipments are coming in at the same time over filling the inspection area, due to the time-consuming process of inspecting all the items of these shipments. To find and generate solutions it is essential to study what kind of spikes are there on the receiving cycle

and how to view the prioritization order in which incoming shipments are being inspected. Also, possible changes in either the way of working at the case company or possibly at the supplier's end should be contemplated. These points are exported over to conversations within the case company's key personnel interviews in chapter five.

The purpose of the inspection of goods is to ensure that the delivered goods correspond to the order and to make sure they are in an acceptable condition. Inspection requirements also include product name & ref number, packing size, lot number, expiry date, dimensional and weight data, amount, place of storage and external properties such as damages or flaws. These guidelines apply to the case company's warehouse inspectors and describe the procedures for inspecting incoming goods from all suppliers. The current inspection process follows these steps down below:

3.2.1   Inspection prioritization of incoming products

All incoming items are inspected in the order in which they appear on the inspector's handheld PDA-machine. The warehouse monitoring system indicates rules regarding the urgency of the products being inspected and dividing them in to three categories (1, 2 & 3). Products are being inspected and taken into warehouse stock from the earliest arrival date, while considering daily priorities.

A product is urgent when:

-The current stock balance of the product is negative

-It is an order upon customer order product

-The current stock balance is zero

-Product requires cold/freezing storage temperature.

3.2.2   Inspection of goods

The inspection of goods begins when the incoming shipment has been registered in the ERP software. If necessary, the products can be compared with the information in the

consignment note, packing list, invoice copy or the pre-arrival notification that comes with the shipment. The inspection is being done according to the prioritization mentioned above. Products that require cold storage are inspected in the refrigerator room.

The products are being inspected and according to the product requirements entered to the system facts such as name. packing size, lot number, expiry date, dimensional and weight data, amount, place of storage and external properties such as damages or flaws. If an item is flawed or damaged the inspector makes a note in the shipping list/packing list, case company's product number is marked and a "flawed/deleted" document is attached to the shipping list for archiving. If there appears other changes or corrections, they are marked and attached to the shipping list and archived with other incoming shipments documents.

If the products size, wholesale packaging or pallet specifications have been changed, the goods inspector will correct them to match the shipment. The inspector then archives the documents that came with the shipment in a folder specific to the supplier. The archiving period is five years plus the current year.

3.2.3 Shelving of products

After inspecting the products, the products are shelved. Separate shelf labels are being printed to pallets containing the same product and glued to the side of each pallet. After this the shelving person moves these pallets to their storage location.

3.2.3.1 Shelving of small batches

Often products arrive on a mixed pallet, since the order quantities are not always large. These are being shelved as follows;
-Inspection and shelving of a single pallet is being performed simultaneously.
-The mixed pallet is unloaded into a roller and the handheld PDA-machine shows the

mark and place for each product. Then the roller full of different products will be shelved at once.

If the product has several storage locations, the correct balance must be checked from the ERP system. Especially if it is a batch/lot tracked product, the batches must be inspected from both the designated collection- and reserve locations and in practice always shelve the product at its reserve location.

3.2.4 Selection of storage location

3.2.4.1 New product

The storage location is selected according to the size of the device, the size of the arrival batch and the number of incoming pick-ups. When a new product arrives at the warehouse, a collection point is determined for it in the ERP-system. Incoming amounts are checked from the ERP-system and after this empty storage locations will be reviewed. When choosing a storage location, it does not matter which supplier it came from.

A storage space will not be established for order upon customer order products, nor for large products that require one pallet space. A pallet space will be selected if the product is more than 5 kg per unitor over 35 cm in height. Upper-level space will be determined if the product is max 3 kg per unit and under 60 cm height.
A small goods spot is selected if it is certain that there will be no additional stock ups of the product, or all the received items fit well on the shelf.

3.2.4.2 Known product

If the product has an expiration date, the new incoming lot is placed in storage behind the older lot. Empty cartons are removed during shelving. If it appears that the product does not fit on the designated shelf of small items, it must be repositioned. In this case the demand of the product is checked from the ERP-system. The collection points have been named and organized with a lettering system in which A = largest demand and Z =

smallest demand.

- If there are no withdrawals in the last month it will be located to R ->

- If there have been withdrawals approximately once a week, it will be located to H – R

- If there are several withdrawals per week it will be located to A – H

3.2.5 Quality control of private label products

The quality of all Private label products must be ensured. The following guide is primarily intended for gloves but can be extended to other products if necessary. Two boxes of each size of each product are taken from the front, middle and back of the container in random order. First a few gloves are taken off the pack and then about 10 gloves are taken for a closer look. The following areas are inspected of the product:

Packaging:

-It is inspected that the packaging is intact and that the adhesives are in good condition.

-All product and batch markings must be clear and original

-The expiry date as well as date of manufacture must be clearly indicated.

Opening the package:

- The package is opened from the side and it is checked that the gloves inside are straight and fitted in the package instead of being stuffed in skewed.

-The package is smelled, if the smell is oily, strong or unpleasant the package will be placed on the side

-The gloves are taken out of the designated opening whole and it is checked that the gloves come out neatly, one by one and not in clumps.

Gloves

The glove is inspected individually based on the following factors:

-Colour: the colour is even, not particularly glossy or matte and there are no abnormal spots

-Softness: The glove is soft

-Strength: The glove does not tear when placed in the hand.

-Thickness: The thickness of the glove is equal throughout and not for example different thickness material on the fingertips.

3.2.5.1   Deviations in private label products

If any of the above characteristics does not meet the quality requirements, a new sample is taken to ensure the deviation. If the error is random, e.g., only one error in the batch being checked, then this is acceptable. If there are several defective products in the same box, then there is a reason for further consideration.

In this case five packages are taken from the front, middle and back part of the container, so 15 packages in total for the sample of the deviation. The results of the additional inspection such as images of deviating products, batch information and an estimate of the extent of the deviation are forwarded to the product manager. If the same defects are not found in these additional samples as in the first sample, the product can be put up for sale. If there are also some deviations in the additional sample, further inspections can be performed on a case-by-case basis (to be agreed with the product manager).

If the same deviations are observed in the additional sample, the product/size/lot will be transported in the back of the pallet stock in the warehouse and labelled with a red sales ban tag.

3.3 New warehouse system

The current way of working for each arriving shipment is that first it is distributed to the inspection area. After all the item lines have been inspected in the inspection area they are moved to the correct storage locations of each item. The shipment is then acknowledged and only then does the goods appear on the balance and are ready to be shipped to customers.

At the case company there is a new warehouse system on the works, which is scheduled to launch at the end of the year 2022. This system forms a storage unit which is a movable ID element for each lot of each item. These storage units can be progressed individually forward. The principle is that unlike now, before the whole shipment has been inspected, the initially inspected storage units may have already been packaged and sent to the customer. For example, post-deliveries can be sent from the other end when the inspection of the consignment is still in progress. Currently there might be shipments that have been started to be inspected laid out in the inspection area overnight. The new way will be implemented so that each storage unit where the inspection has started will be processed before the day is over.

These storage units will have their own locations for storing even if they are the same product with different lot numbers. This will also change the way items are being stored in the warehouse as dynamic storing positions will start to happen and the locations of goods may vary.

4 Study methodology

The method used in this study was a series of open-ended interviews with key personnel inside the case company. With an overall of eight interviews with seven different people including: supply chain manager, warehouse manager, logistics coordinator, supply analyst, quality manager, warehouse supervisor and warehouse inspector.

4.1 Open ended interview

The main empirical research in this thesis was done with the method of open-ended interviews. This is a way of gathering information by the interviewer by asking open questions which are usually open ended from the participant. These questions can be scripted, but the discussion will still be open ended since the interviewer does not know beforehand what points the answer might involve. Open ended interviews usually aim more for the contributors' experiences, feelings, knowledge, and ideas, but they can also gather basic factual data. (Thibodeaux 2021)

The benefit and importance of asking open ended questions when gathering research material is that they allow you to find out more than you expected. Participants might share motivations that you didn't expect and mention ideas and concerns that you knew nothing about. This is because when people are asked to explain things, they often reveal much more, than with close ended questions, which are more likely to stop the conversation. (Farrell 2016)

4.2 Participants of the interview

When choosing the topic of the thesis and company research I discussed with the supply chain manager and warehouse manager about who to contact regarding interviews and

what possible topics I should discuss with them. In addition to interviewing the supply chain and warehouse managers, it was settled that there should be six individual interviews with key personnel inside the company which could have ideas and valuable talking points regarding the study.

Table 1 indicates who was chosen to be interviewed and what was the reason and main topic of the conversation. Of course, this research was done with open ended questions, so the interviews included much more.

1. Table 1. Interview participants.

Interviewed person	Time worked at case company
Supply chain manager	2 years
Logistics coordinator	9 years
Supply analyst	10+ years
Warehouse manager	2,5 years
Quality manager	7 years
Warehouse supervisor	10+ years
Warehouse inspection worker	9 years

The first interview was conducted with the logistics coordinator since it was already known that large shipments from the beginning of the week slow down the inspection creating a bottle neck. The thought behind it was that it would be interesting to talk about what possibilities of affecting the timing of incoming shipments. Next the case company supply chain manager suggested to contact the supply analyst to provide this research with some data about last year's incoming shipments and talk about it.

Next interview would then be with the warehouse manager to go more depth in to the current challenges the warehouse flow is facing and how they are being handled currently. After this it was time to talk with quality manager about the incoming MDR and how it changes the inspection by adding additional work due to the new regulation. Finally, the warehouse supervisor and inspection worker were interviewed separately to discuss in detail their working experience and talk about what they would change if they could and how. Their look on which processes are working well, and which are sub optimal was also observed in the interviews.

Next chapter consists of summaries of these interviews going through the key topics that were discussed. These summaries also identify the main ideas and propositions that arose from the discussions for further development of optimized material flow in the warehouse.

5 Empirical research

The empirical research focuses on obtaining information and insight on the current warehouse processes as well as inbound logistics through multiple interviews with key personnel inside the company. By doing this qualitative data was gathered and furthermore put to development.

5.1 Logistics Coordinator

This interview focused on looking at whether we could influence the timing of incoming shipments and thus better schedule the timing of receiving and inspecting shipments, so that bottle necks at the inspection area could be avoided. Trucks can hardly be timed, but rather they arrive once the Trucks come to Finland which is usually Monday & Tuesday. Sea freight containers however can now be timed a little bit better since the warehouse is informed about incoming container's and they can directly say which day/time is best for unloading the container. Usually, a time when it is not as busy with the truck shipments and there is slightly more room in the inspection area.

On the general cargo truck shipments with smaller pallet quantities (1-3 pallets) DHL collects shipments from different places such as Germany, France, Denmark etc.. to their terminal in Vantaa. After unloading them they then proceed to deliver all of them on the next morning which is usually Monday or Tuesday. It might be possible to delay this for a couple of days so that the start of the week wouldn't be so busy with most of the shipments coming in then. It is important to note though that there will always be some urgent shipments in the mix and if given the order to bring these smaller quantity pallet shipments on Wednesday, they would also be delayed. It is also not possible to ask the freight forwarder to bring only the urgent pallet and leave the rest to the terminal for a few days, since if this would be the case, they would book their vehicles for different routes. (Logistics Coordinator 18.2.2021)

5.2 Supply Analyst

In this interview first the incoming shipments of last year were inspected by looking at how many item lines overall was received at the warehouse on different days of the week.
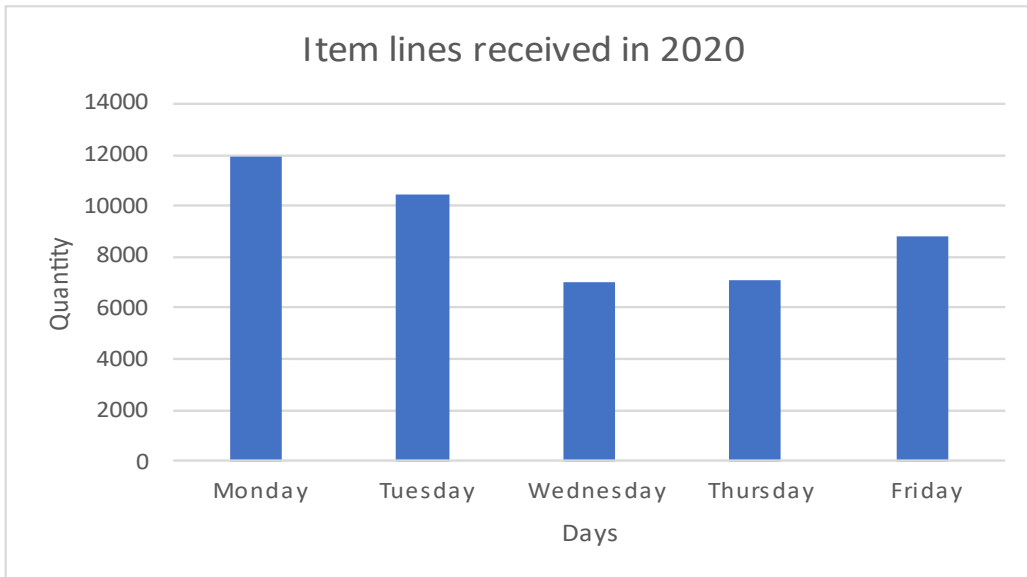

Figure 5. Item lines of incoming shipments

Figure 3 here indicates for many items were received in different days of the week during the year of 2020. Most items were received on Mondays with the number being 11943 and Tuesday being second with 10411 lines. As shown in the graph above these were considerably more than in Wednesdays and Thursdays which were about 7000 lines per day. Also, we speculated if from the data from which I made this graph, would it be possible to inspect if there was variation on a weekly basis and was there differences between the beginning and end of each month.

After this we started to discuss the new warehouse system which is in production and scheduled to launch in 2022. We discussed possible topics for interviewing the warehouse staff. The receiving and inspection area at the warehouse is not getting bigger so what would be an optimal work way in their mind while working at this limited area. Smaller shipments are rather easy to inspect, but what about big shipments with many

pallets packed up with mixed items inside each pallet and a lot of packing lists and shipment documents. As long as for now we are dealing with a complete shipment at a time and not dividing big shipments into smaller units, what could be the best way to unload and inspect these shipments? Could there be a best practice way or is it more of a personal preference.

We talked about the measuring meter of the throughput % of incoming shipments which indicated how many percent of shipments each month were received, inspected, and taken into stock on time. This meter is unstable with a lot of variety between the months. For example, the October was only 36% while the previous month was the best of the year with 95%. Therefore, an assumption can be made that available resources have a huge impact on this meter. Right now, we can assume that there were people absent during the inferior months. (Supply Analyst 19.2.2021)

5.3 Warehouse Manager

This interview started with talk of the overall situation and improvement points at the reception and inspection of goods. The focus has shifted on so that big shipments from different suppliers always come at the start of the week and for one person it might take two to three days for inspection. This way the targeted 48h time window of getting the shipment in to stock will be missed. Manager pointed out it would be nice to know how the inspection workers would speed this up and if they had power to change something in the process, what would it be?

In these cases of big shipments sometimes from the collection side a worker has been borrowed to help inspect the products to speed up things up. This is not that often possible though, since the collection side is busy as well usually, so extra people cannot be loaned that easily. Deceleration and variation in the inspection is caused by large mixed pallet shipments where the same product is on different pallets, which means that inspecting each line of products is time consuming. Differences in inspection methods

could occur here. It is possible that inspectors have developed their own methods for above mentioned cases and there could be potential to exchange information. This leading up to further develop the inspection of more time-consuming shipments, for a possible best practice solution.

As discussed with the logistics coordinator after the weekend, arrives from the DHL terminal a lot of general cargo pallet shipments consisting of 1-3 pallets in addition to all the other shipments. Warehouse manager describes that it would be indeed beneficial if these could be cycled on to Wednesday, because at the moment and as the chart says on Mondays and Tuesdays there is a lot of incoming shipments, and the inspection area gets stuck with overwhelming amount of work.

Then it will be a tough couple of days trying to get things in order and in schedule and maybe at the end of the week the situation starts to be ok, but this cycle will repeat itself next week again. Worst case scenario is that during the overflown inspection area a sea container will be received at the same time and when the big shipments are already there, there will not be enough people to get through them all.

Because of this it would help a lot if it would be possible to even out the incoming shipments during the week. The problem though could be like mentioned by the logistics coordinator that there can always be urgent shipments included in the DHL terminal and sales personnel as well as customers/end users would not like to further delay the transport time. If it could be agreed that the delivery time would be day or two longer, it would even out the large number of shipments coming in the beginning of each week, which would aid the warehouse on applying a process which serves everyone without compromising availability or customer satisfaction.

Warehouse manager confirmed that the meter of throughput % of incoming shipments is heavily affected by resource changes just like we predicted in the previous interview. Furthermore Covid-19 had a big effect on it as well when suddenly many medical

products started to sell on significantly larger quantities than before, while also the incoming shipments and quantities of items grew significantly with no way to prepare for it. On receiving and inspection of goods when things start to turn for the worst it can be quite slow to pick things up again, since it is a challenge which takes a longer time to fix the situation.

When suddenly gloves and masks are being sold at a much higher rate there is a constant hurry in the collection, while simultaneously similar situation in the receiving end with a constant hurry when checking in bigger shipments. Warehouse work is also not possible to do remotely, and it was important to take the pandemic seriously, which meant staff members might have stayed at home with a smaller threshold if there were signs of flu. With three permanent inspection staff members and patching if needed support from collection side things were tight and it shows in the meter. Starting this year there has been four permanent inspectors, although this was justified only by the fact that MDR is coming this May which will further slowdown the inspection. (Warehouse Manager 5.3.2021)

5.4 Quality Manager

First, this interview started with talking about MDR in depth, which was mentioned earlier in the thesis.

Then it was discussed about would it be possible to already do split shipment, meaning not checking in to stock a whole shipment at a time, but rather splitting it into several parts, so that it would be possible to get an item on the shelf before the whole shipment has been inspected. Currently the way of work is that nothing makes it in the stock until the whole shipment has been inspected, which can take a couple of days meaning the goods are sitting at the inspection are overnight. It could be beneficial to study this and see if there is room for change before the new warehouse system ultimately changes it.

The purchaser of each supplier fills out the item lines to the ERP system for incoming shipments. Sometimes though what is filled out in the system and what is received at the warehouse do not match. Furthermore, if there are multiple incoming shipments created to the ERP system for one shipment it could over complicate things. Simple is effective in this case but is it possible to break down some big shipments to some extent, not to end up with goods standing in the inspection area overnight and waiting for each item to be inspected. There are often situations where there is an urgent need to get item X shipped and ready for end user, but it is waiting in line at the inspection area. These inquiries from customer service and sales departments for the warehouse are also excess waste in workflow.

Lastly in this interview how the shipments are placed in the inspection area was discussed. This year laptops were introduced for the inspection staff with designated tables with wheels for easy access in the workspace. All though when the inspection area is full of pallets, the tables cannot move between the shipments and pallets. This brings up the question should there be taped in the floor for designated routes for the laptop tables. This could be done with a lean perspective, but the issue is that when there is limited space it could be hard to be fulfilled.

5.5 Warehouse Supervisor

At the start of the interview, discussion began about how the warehouse monitoring system prioritizes the order of inspection with the 1, 2 & 3 system. If there comes information about an urgent order from purchasing, customer service or sales, the warehouse supervisor can place them to inspection priority.

Supervisor talked about would it be beneficial to do multiple shipments in the ERP system for large shipments and this way split them into multiple smaller segments to swiftly get some of the more urgent goods in to stock. This was deemed to not be helpful to the inspection. It has been already done sometimes when there have been truly urgent

items in a big shipment, but when there is a large shipment and mixed pallets the inspector still must go through each pallet to find the right products. Supervisor described how currently the incoming space at the warehouse is quite small, but it is still necessary to sort the entire shipment in order to find the required products. So, if there are 40 pallets it is still necessary to go through all the pallets when the products are mixed in them. Therefore, dividing the shipment into multiple segments does not really help.

It was interesting to see if the supervisor thought there would be a best practice to inspect these large mixed pallet shipments? The warehouse supervisor informed how inspectors have their own styles of inspecting them. Some put aside the first item on the list and look for the rest and some take everything out of pallets and then sort them out. Supervisor suggested like I had already planned to interview one of the warehouse inspector's and ask him about this.

Since splitting big shipments into smaller segments did not seem helpful, it was interesting to hear was there something that could be communicated towards suppliers end about the packaging of these pallets. For example, suppliers X, R and Y (names concealed) often ship from multiple of our purchase orders at once. If they could pack items from same PO (purchase order) to pallets and mark on top of the pallet the PO number, it would clarify that this pallet would only include goods regarding this PO.

The supervisor also mentioned that it would help if every incoming shipment would have been filled out before handing in to the ERP by a purchaser. This is protocol, but daily there comes a couple of shipments that have not been entered and the receiving warehouse worker must enter it into the system which takes extra time. The supervisor also mentioned how extra staff would be helpful. This year one new inspector was hired, which was justified by the upcoming MDR. Supervisor also pointed out that resources are always displayed on the success meters. If one inspector is on vacation or away, then it will affect and be visible in that month's meter.

Supervisor also thought it would be advantageous if the one to three pallet shipments could arrive on Wednesdays instead of Mondays and Tuesdays. This would allocate more time of the day to inspect the big shipments before these smaller pallet shipments would arrive. We also discussed would the 1–2-day delay be that harmful if often these smaller pallet shipments are inspected on Wednesday anyway. This could be tested out and see beforehand from existing data what would the difference look like as in incoming item lines per day, when switching the general cargo shipments to Wednesday. (Warehouse Supervisor interview 25.3.2021)

5.6   Warehouse Inspector

At the start of this interview, the warehouse inspector was asked about what things are working well, what parts are not so good and what would he change if he could? He described how in the past inspecting was harder while doing it manually, but nowadays with the PDA-device it has been faster and better. What is difficult at inspection right now is the large amounts of shipments and items coming in. For example, shipments with 30+ pallets it is tough for one person to unload and inspect each pallet without help.

For example, suppliers X and Z ship same item codes and lots distributed on different pallets. These suppliers often ship out for example 12 pieces of same item, which are packed in three different pallets, because they are from different lots. If they are from the same lot, they are packed in the same pallet. This is inconvenient for us since these items are lot traceable and need to be inspected together. Especially if supplier Z could pack the same items on same pallet, even though it is from different lot, it would speed up the inspection by a lot. This is because currently so many pallets must be opened and searched to find every pc of the same item. This will be discussed with this supplier if they can pack the same product on the same pallet, even if it is from a different lot.

Another problematic thing is with supplier X when they ship about every two weeks a pallet shipment of medical gloves. Case company warehouse receives a shipment of this

supplier each week, but the glove shipment comes every other week. The problem is that these gloves come in with a different pallet size than a regular euro pallet what we use. A suggestion was made to examine what size we use and indicate to supplier X about this issue and see if some solution/compromise can be made. This takes extra time when unloading and stocking these glove pallets since the height of them is usually too high. This means that they must be repacked on a standard smaller pallet in order to store them on their designated spot. Many suppliers ship according to case company's pallet size, and it would be great if we succeeded to access this with supplier X as well. This would speed up the inspection when you don't have to dismantle all the pallets.

Another thing the inspectors at the warehouse have pointed out is why does the shipment from supplier Y come every other week? There will each time come 100 – 150 item lines of products in this 30-40 pallet shipment. It would be more efficient to inspect this suppliers' shipments if they would come each week like supplier X's shipments, when the shipment would not be so large and clog up the whole inspection area each time, causing a bottleneck effect. If this was changed to half of these pallets coming every week, it could even it out and gain a more balanced workflow.

Inspector also talked about how sometimes ship items with a different REF number than what is in the system, even though the item itself is the same. This also can cause extra work and investigating. Inspector is also on the same page with the idea that smaller DHL pallet shipments would be pushed to Wednesday. Giving more time and space for the large shipments which are coming on Mondays and Tuesdays. Moreover, when inspecting these large shipments from suppliers X and Y there should always be one person helping. When done alone it takes two or three days. Sometimes a consignee worker at the receiving of the goods comes to help the inspector, but not every time. From the beginning of the week when the most lines are arriving to the warehouse, often the consignee is also busy at the reception and nobody from the collection either can aid the inspection. The inspector thinks resourcing staff members at the beginning of the week

vs. the end of the week should help. Mon-Tue when big shipments come it should be mandatory to have one extra worker at the inspection.

Like the warehouse supervisor, the inspector also thinks that if purchasers divide big shipments into multiple incoming shipments in the ERP system, it is not going to help now. We also discussed the laptops that are in use at the inspection currently. These are helpful and even though there is no room to move around with the table and the laptop, the inspector said it is not a problem. The inspection area is not that big and just having a couple of laptops on the side is enough. I asked about having small, designated routes taped on the floor for pathways moving with the laptop tables, but inspector said it would not be necessary or even beneficial. With lots of pallets tightly in the area, there would not be room.

The way this inspector works is, he inspects a certain product and if all of that item is not there on the same pallet, he puts it aside and continues with the next one until it is eventually found. It would be more efficient if the same pallet contained the whole amount of that item. When you must open multiple pallets to find all of that product it takes time. I asked if it would be beneficial in his opinion that every inspector worked this way, but he said that everyone is doing it already like this and usually they start with inspecting the smaller items and moving them together to the stock, and after that moving on to bigger packages.

Overall inspector did not feel that it is necessary to change operating methods or have suggestions for improvement in that regard. The process is a standardized SOP with step-by-step instructions which were looked more closely earlier in this thesis. He also did not see it helpful to go through the inspection process in the warehouse one more time to see if everyone truly inspects the same way. The inspector described that sometimes it might even be good to do it in a different way and it is not a considerable slowdown. However, he had helpful suggestions towards suppliers end which will be pursued forward. (Warehouse Inspector interview 1.4.2021)

5.7 Interview summaries

Table 2 below showcases a short summary of each held interview inside the case company.

1. Table 2. Interview summaries.

Interview participant	Interview summary
Supply chain manager	Decision was made about who to interview inside the case company.
Logistics coordinator	Discussion about the possibility to change the logistics scheduling. Especially the smaller DHL pallet shipments (1-3 pallets) from Mondays and Tuesdays into Wednesdays.
Supply analyst	Discussion about the benefits of changing the DHL pallet shipment schedule and the benefits of the new warehouse system set to launch in the future.
Warehouse manager	Discussion of the problematic areas in the warehouse and possible improvements for them.
Quality manager	Discussion about the MDR and changes it will bring in the warehouse. Possible changes inside the warehouse inspection area and the use of current ERP system were also considered.
Warehouse supervisor	Discussion centered around what changes would bring positive results on the warehouse reception and inspection area, both internal as well as changes at the supplier's end.

Ware-house inspection worker	Discussion about the inspection process, what are the positive and negative portions of the process and why. Conversation about possible beneficial changes regarding different suppliers with large regular shipments.

6 Study results

6.1 Findings of adjusting pallet shipments

In 2020 all incoming item lines in the case company warehouse on different days of the week are shown in Figure 6 below.

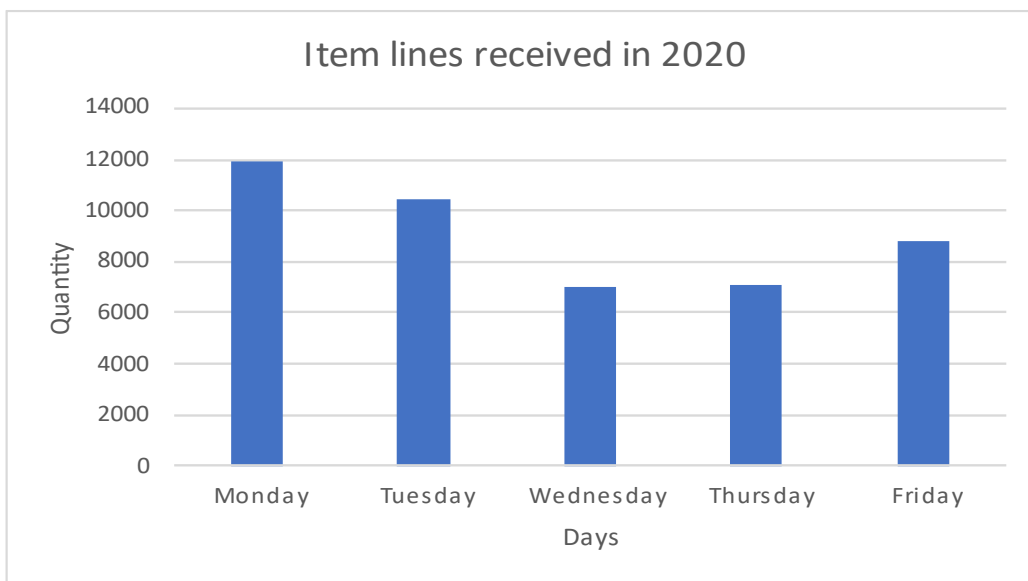
Figure 6. Item lines of incoming shipments

Item lines of 2020

Monday 11943

Tuesday 10411

Wednesday 6989

Thursday 7085

Friday 8826

Figure 6 above showcases how more shipments are being received at the warehouse in the beginning of the week than at the end of the week. After examining data from all incoming item lines and transferring the one to three pallets DHL Freight shipments

received on Monday and Tuesday into Wednesday, the change would have been the following.
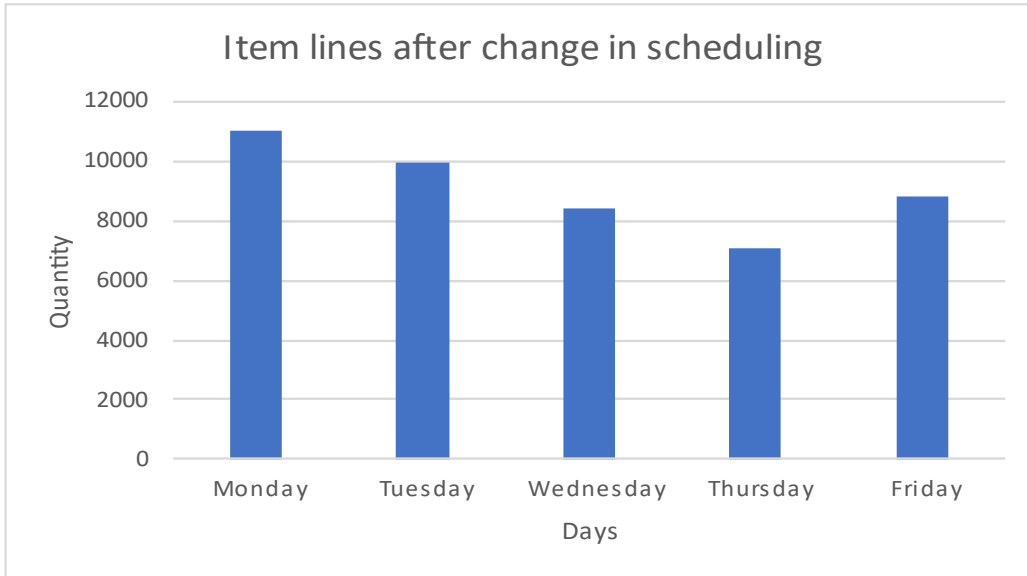
Figure 7. Item lines after change in scheduling

Item lines after change

Monday   11010

Tuesday   9928

Wednesday 8405

Thursday   7085

Friday   8826

How this affects the warehouse is we can see that 1416 item lines have been moved from Monday and Tuesday into Wednesday which before was the day with least shipments received. This does not remove the emphasis of the beginning of the week in incoming shipments, but nonetheless levels it out.

According to the interviews made in this study and looking at the numbers of incoming shipments, the benefits of this change would be:

-Smoother material flow which causes less possibility of clogging the inspection area and making a bottleneck at the warehouse.

-With fewer shipments being received there is more room to work with, which is beneficial when inspecting large shipments.

-The less shipments are received on Mondays and Tuesdays the more time a staff member working at the reception of goods has, to help inspectors with the large shipments from suppliers X and Y, which are received at the beginning of the week. This is a critical aid according to the inspectors working at the warehouse.

-Currently often there is not enough time to inspect these smaller pallet shipments anyway at the beginning of the week, which means this change on the receiving date would not necessary even affect these shipments with a harmful delay.

6.2 Communication of improvement with suppliers

6.2.1 Supplier Z

In a meeting with case company's contact person from supplier Z in Ireland possibilities regarding the raised suggestions at the case company's warehouse was discussed. At the start of the meeting the possibility of supplier Z packing the same items in the same pallets and shipping them like so to the case company was considered. Unfortunately, this idea was turned down. Contact person based this by describing how the supplier utilizes a large third-party warehouse at Germany and the workers there have no product knowledge. Therefore these workers only collect items according to the lines from the picking list of each shipment. The problem is that different lots from the same item might be in totally different places at the warehouse, so that is the reason they are unable collect the same item, to the same pallet. It could be possible if supplier made a picking list for each item, but this would require extra work and is suboptimal in their warehouse.

Also the possibility of having the case company's PO (purchase order) number on top of the pallets was discussed, so that the receiving warehouse workers at the case company

could know just by looking at the pallet what PO it consists of. This change was also not successful, since the employees on the third-party warehouse do not know in detail which customer orders are involved. They were not keen on adding extra labor to staff members since the process is focused on being done as efficient and fast as possible. Furthermore, as warehouses usually intend, their emphasis was on keeping logistics costs at minimum.

The contact person at Supplier Z mentioned the excel table they send out to the case company's purchaser with each shipment. This table contains a list of items included in the shipment and information such as quantities, product names, PO number and pricing. This list was deemed not useful in inspection though, since it does not contain information about which items are packed in which pallets. (Supplier Z interview 29.4.2021)

6.2.2 Supplier Y

Supplier Y ships a large 30 – 40 pallet shipments to the case company's warehouse every other week. Warehouse inspector pointed out that every time at the beginning of the week when this shipment is received it blocks the inspection area, due to its size and the time it takes to inspect it. Warehouse inspector pointed out if it could come every week with half of the pallets, instead of every other week, so the inspection area would not be affected with a bottle neck effect. Unfortunately, this was not possible as the supplier is paying for the freight costs and they want to ship out a full truck to the case company each time, instead of shipping a half full truck with almost the same transportation costs.

The warehouse supervisor and inspector both mentioned in their interviews how it would help if the pallets would have marked on top of them which PO they relate to. Since usually the shipment consists of the latest PO, but also items from backorders which have been ordered in the past. This was discussed with supplier Y's contact person and they agreed to investigate this with their warehouse and come back to the case company with the findings. On 28.4.2021 they reached back with information that from now on they will split the delivery into main order and backorder pallets which will be

marked accordingly. Pallets including items from the latest PO are now marked with "Main order" and the case company's PO number and pallets regarding past orders will be labeled with "Back orders". (Export specialist form supplier Y 28.4.2021)

6.2.3 Supplier R

As a supplier of large shipments Supplier R was also contacted regarding the possibility of marking/labeling pallets with case company's PO number on to them, which would benefit and speed case company's inspection at of the shipment notably. Unfortunately, this was not something supplier R was willing to do. Without further discussion Supplier R ended the topic with: "The way customer should see it is either on the packing list or pallet manifest if they use these". Referring to case company's PO number in that message. (3.5.2021 Supplier R)

6.2.4 Supplier X

Supplier X had been discussed with both the supervisor and inspector's interviews. the issues and suggestions that rose from these interviews were forwarded to the case company's supply chain manager, who had a meeting with Supplier X. These points were discussed with the following results:

Supplier X believed that the case company's PO number should already be always marked at the pallets and that each product should in principle be packed to the same pallet. Exceptions to this are situations where the order does not fit on one pallet or if there has not been enough product at the collection point and the missing quantity is added to the delivery afterwards. Supplier X hopes to receive information if pallets are delivered from them where one product is loaded on several pallets. This was informed to case company's purchaser to add these types of deviations when they occur and report about them in the direction of supplier X. (28.5.2021 Supplier)

Regarding the height of the glove pallets, the supplier informed that they supply 150cm pallets to all countries and changing this to a lower level would practically change the pallet height to all countries. (28.5.2021 Supplier) Therefore the case company's warehouse manager was contacted regarding the possibility to make changes in the stock space so that higher pallets would not have to be re-stacked every time and how laborious would it be to make these changes? This was left for further analyzing still and not yet placed for change.

The case company warehouse had also talked about sometimes getting different quantities of items, than what is in the packing list and invoiced from supplier X. Regarding this issue supplier X informed us, that it is important that the case company reports promptly to the supplier about each case. This is necessary hence they can find out the cause and go through the matter internally. The case company supply chain manager will discuss with the purchaser internally how to handle this optimally.

6.2.5   Results of supplier negotiations

Table 3 indicates the results of discussions with above mentioned suppliers.

3.   Table 3. Supplier negotiations.

Supplier	Discussion results
Z	The supplier turned down the proposal of packing same items into the same pallets. The proposal of marking the pallets with case company's PO number was also turned down.
Y	The proposal of sending a shipment every week, instead of every other week was turned down by the supplier. The supplier however accepted the proposal of marking the pallets with case company's PO number (main order) and backorder labels.

R	The supplier turned down the proposal of marking the pallets with case company's PO number.
X	The supplier promised to reinforce the rule of marking the case company's PO number on pallets and packing the same items in to the same pallets. Supplier X also encouraged the case company to contact them without hesitation if deviations to these promises occur. The supplier turned down the proposal of changing the height of their glove pallets.

7   Research findings and conclusions

The objective of this research was to investigate the material flow at the case company's warehouse and find out possible bottlenecks and solutions to overcome those bottlenecks. Early on it was established that the major bottleneck was located at the inspection area when large shipments incoming at the same time fill up the inspection space. To answer the question "*What measures can be taken to reduce the warehouse turnaround time*" it was crucial to identify development measures for the inspection at the warehouse.

7.1   Key findings

By looking at existing data about incoming shipments in figure 3, it was proven what was thought that the beginning of week is the busiest regarding the reception at the warehouse, since large shipments are coming in at the same time. One measure to even out the incoming shipments was, to delay the smaller pallet shipments with DHL from Mondays and Tuesdays into Wednesdays.

To further reduce turnaround time, other measures were taken to approach the suppliers of the larger regular shipments about beneficial changes for the warehouse inspection, in order to further improve the inspection of shipments. Some suppliers where able to apply these changes and accepted the proposals and some were not. Suppliers R and Y were not able to currently change any measures in their outgoing shipments, but suppliers X and Y started to label their pallets with the case company's purchase order number, which is a useful benefit at the case company's inspection area, when these large shipments are being inspected. Supplier X also encouraged the case company for close cooperation and informing them every time there appears any problems regarding shipments, such as packing lists and orders not matching, or wrong quantities, or markings

at the pallets. This will further develop the cooperation between the two companies and make sure every deviation will be looked in to.

7.2 Conclusions

There were two main objectives for this case company research as well as this thesis. To identify factors creating a bottleneck at the warehouse turnaround time and to find means to overcome that bottleneck and optimize the warehouse inbound process. Between the interviews at the case company and looking at existing data it was clear to identify which factors were creating inefficiencies at the warehouse. This was mainly the overflown inspection area at the beginning of each week, with many shipments incoming on Mondays and Tuesdays, creating a bottleneck in the warehouse material flow. By understanding these points of inefficiency, means were taken into action to reduce the possibilities of overflown inspection area. Communication between suppliers and the rearrangement in DHL shipments were found useful in the optimization of material flow inside the case company warehouse.

For future research the case company could now acquire data regarding the warehouse turnaround time while these changes are made active, and further develop their processes and cooperation between suppliers. Furthermore the case company could do internal development regarding inspection tasks and proposals made from the meeting with supplier X. Due to lack of time there was no opportunity to test out changes in the warehouse's stock space, so that higher glove pallets from supplier X would not have to be re-stacked every time before stocking them. Testing how laborious would it be to make these changes was left for further analysing still and not yet placed for action. Internal development at the warehouse could also be further developed, which was not possible in this study due to lack of time. Value stream mapping was made within the case company regarding the inspection of shipments after MDR was launched in summer of 2020. As a result of going through each step of the inspection phase with the MDR included, together with the warehouse supervisor and inspector, each phase was

marked with a red, yellow or green mark according to its efficiency. This could be further examined to find solutions and points of development inside the case company.

In the time and resources available for this study, I hope this research became beneficial for the case company and even any other company in the field. This study helped the company in supply chain management and planning by optimizing logistics with the timing of incoming shipments at the warehouse, as well as contributing to improve relationships and create beneficial changes with its suppliers. Additionally, internal warehouse processes were examined and revised while keeping the MDR changes in mind, which this study contributed to.

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Supplier X Helsinki, Interviewer Alex Wäck

Supplier Z (29.4.2021) Helsinki, Interviewer Alex Wäck

9   Appendices

Appendix 1. General talking points of the open interviews.

Interviewed person	Talking point
Supply chain manager	Who to interview, what points to ask about
Logistics coordinator	Can the timing of incoming shipments be modified for better flow
Supply analyst	Can we find some beneficial insight by inspecting existing data about incoming shipments
Warehouse manager	What are the current challenges at the warehouse
Quality manager	What changes MDR will bring to the warehouse reception process
Warehouse supervisor	In deph look to the method of receiving and inspecting shipments (what works, what doesn't)
Warehouse inspection worker	Employee's perspective, what changes would benefit the workflow