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Managing operational risks during warehouse relocation project

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Abstract

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The objective of this thesis was to find out how case company Outotec could relocate their principal spare parts warehouse with minimal disruption for business. In order to find out the answer to the main research question above, the current status of the inbound and outbound materials flows to the warehouse as well as the risks involved in the relocation needed to be researched.

This thesis concentrated on the planning of the warehouse relocation. Choosing the new location of the warehouse and the logistics service provider to partner with were limited out of the thesis because they were handled separately in the case company. Also warehouse layout planning was limited out of the thesis due to the fact that the warehouse operator is responsible for it.

The analyses were conducted by gathering data through case company ERP system, reviewing actual warehousing costs, interviewing case company and warehouse personnel and observing the warehouse daily operations. Freight calculator provided by case company's domestic carrier was used to simulate freight costs between different locations.

Based on the analyses, a risk assessment and a project plan were put together. They concentrated on the operational side and for example contractual risks were not considered, although they were recognized as a major factor in any project.

Keywords: warehouse, risk management, supply chain management

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1 Introduction

Planning a warehouse relocation carefully is extremely important, as companies can't afford to be out of business for weeks. Detailed planning and preparation helps to avoid biggest issues. However, it's clear that there may still be surprises during the move. Expecting the unexpected is a good attitude for this kind of project. The optimization of supply chains and logistics can have immense effects on the performance of the whole company when successful. However, the task is not easy, because supply chains usually involve several parties who need to work together for the best results.

1.1 Case company and background for the study

The topic of this thesis is managing risks in a warehouse relocation project. Case company Outotec is a Finnish technology company. The company employs over 4000 people globally on six continents. Outotec has divided its operations into three business units: minerals processing, metals energy & water and services. Minerals processing unit offers equipment and process optimization for processing different types of ore. Metals, energy & water unit offers solutions for metals processing, industrial water treatment and renewable energy production. Services business unit handles spare part deliveries as well as operations and maintenance services. (Outotec 2017.)

Outotec spare and wear parts are a part of the services business unit. Spare parts are needed for all equipment and the number of unique parts is calculated in thousands. A spare part can be anything from a small bearing to a large piece of equipment and all of them need to be stored, packed and transported safely and efficiently. Around 80 percent of Outotec's manufacturing is sourced from external suppliers (Outotec 2017). Spare parts are being delivered from suppliers around the world to a few principal warehouses and local warehouses from where they are sent out to Outotec customers. This kind of operating model requires strong supply chain manage-ment through the whole process.

The need for this study came from the case company. Outotec spare parts principal warehouse that is currently located in Vantaa Finland, needs to be relocated by February 2018, because the lease has been terminated. The warehouse is

operated by a third party logistics service provider. Outotec has chosen to partner with a logistics service provider to ensure the company's resources are used in its core expertise. Warehousing and material handling are a crucial part of the total supply chain management but something that specialized logistics service providers can often do better than companies that work in other fields.

Vantaa principal warehouse is Outotec's largest spare parts warehouse. Volumes that go through this warehouse make up over a half of the total spare parts volume of the company. The relocation is a challenge in any case, but especially because the spare parts stored in this warehouse are needed all around the world and the deliveries can't be put on hold for long. This study attempts to analyse the risks involved and create an action plan so the relocation can be done with minimal disruption for Outotec customers and as efficiently as possible.

1.2 Objectives of the study and research questions

The objective of this thesis is to create a plan for relocation of Outotec's principal spare parts warehouse. In order to create the plan an analysis of the risks involved needs to be made. The warehouse and its main inbound and outbound flows also need to be analysed. The intention of the thesis is to find an answer to the main research question:

- How can Outotec's principal spare parts warehouse be relocated with minimal disruption for business?

In order to be able to answer the main research question, the current material flows and the risks involved in the relocation need to be examined. The sub questions therefore are:

- What are the current inbound and outbound material flows of Outotec's principal spare parts warehouse like?

- What are the risks involved in Outotec's principal spare parts warehouse relocation?

1.3 Limitations of the study

This thesis concentrates on the planning of the warehouse move. Choosing the new location of the warehouse and the logistics service provider to partner with are limited out of the thesis. These decisions are extremely important and they create the foundation for the relocation planning. However, they require extensive research and could be topics for their own studies.

Another reason for this limitation is the schedule of the whole process. Choosing the new location and the logistics partner is being done simultaneously to this thesis in the case company. This information was not yet available at the time of writing this thesis. However, the case company wanted to start planning the relocation already so there would be enough time for the preparations. The actual moving and assessing the process are also limited from the thesis due to the schedule. This thesis will be completed before the warehouse is relocated.

Because the new warehouse will be operated by a third party logistics service provider, warehouse layout planning and operations are also limited from this thesis. The warehouse operator will be responsible for the detailed planning of creating the warehouse layout and how the daily functions are executed. Outotec will provide their requirements, but the way the work is arranged will be up to the warehouse operator.

1.4 Theoretical framework and study structure

Theoretical framework of this thesis will focus on supply chain management, risk management as well as transport need and cost planning and calculating. These topics will be handled with the relocation in mind. In other words, these topics have been chosen after considering what the key elements are for the case company in this kind of a project.

Supply chain management will be discussed in chapter 2 of this thesis. It’s the foundation for the case company's daily spare parts business as well as the warehouse relocation. Thorough understanding of all the components of a supply chain are key to making sure everything is considered when planning the relocation.

Recognizing and assessing risks, risk management, is another crucial element of the relocation project. Risks are easier to manage when they are known to exist and a plan for managing them has been put together. Something unexpected is bound to happen and small delays may escalate and turn into roadblocks. Going through the processes in advance and analysing which risks are most likely, means less stress at the time of executing the move. Chapter 3 of the thesis will focus on this topic.

Third section of the theoretical framework will handle transport need and cost planning and calculating. This is a topic that the case company has little resources in and it has been chosen because of this. The current warehouse is operated by a logistics service provider. That will also be the case with the new warehouse. Case company doesn't have any people at the warehouse and the daily operations are run by the logistic service provider. Logistics service provider will also handle resourcing the relocation, because case company doesn't have the people or needed skills available. The purpose of this section is to provide a basic understanding of how the relocation transport need is calculated. Aim is also to get tools through literature to help with the analyses in this thesis. This topic is discussed further in chapter 4.

Chapter 5 will discuss in detail how the study was conducted. The relocation of Outotec's principal spare parts warehouse needs to happen by February 2018 because the lease in the current warehouse has been terminated. First objective of the thesis is to determine the time for the move that would cause the least amount of disruption for business. This will be done by analysing the warehouse statistics of inbound and outbound material flows. As mentioned earlier, the process of selecting the new warehouse location as well as the logistics service provider to operate the warehouse is ongoing simultaneously to this thesis during 2017. Therefore, the earliest realistic timeframe for the move is January 2018. The material flows of January in previous years will be analysed in order to give a recommendation of the best time for the warehouse move.

Second step for this thesis is to determine how long the moving is estimated to take if the warehouse is open during the move or if it can be closed. This will be done by analysing the warehouse stock-keeping units and how much storage

space they require and calculating the needed transport space based on the analysis. Interviews with the warehouse personnel as well as case company personnel are also required in order to form a picture of the human resources needed for the move. To help the analysis, warehouse daily actions will also be observed.

Case company has had some previous experience on moving warehouses so any existing materials will be checked and utilized if possible. Based on the findings, an estimate can be formed of the length and the costs of the move. The data will also be the base for the suggestion of the possibly needed warehouse down time, although the case company will do the final decision on the warehouse closure.

Based on a preliminary analysis, most of the outbound deliveries that are handled at the warehouse will be delivered to Outotec units around the world. Deliveries are made directly to external customers as well, but the largest amount of outbound deliveries is being moved between Outotec locations. The third thing that is being researched through the analysis of the warehouse statistics, is the outbound material flow and the portion of external customer deliveries. The aim is to understand the process and find out what the expected ratio between Outotec internal deliveries and external customer deliveries is during the move. This is being checked because external customer deliveries are often more time-restricted or complicated than internal deliveries between Outotec locations. The orders may be required to be delivered in full at once or they may have complicated payment terms or other conditions.

As a fourth step, the inbound material flows to the warehouse, the purchasing process, needs to be analysed. As previously mentioned materials are received from a large number of suppliers all around the world. The current process of how and when the purchased materials are delivered to the warehouse will be checked by interviewing Outotec and warehouse personnel in order to get a clear view on the process. Lead times for certain items are months. This means that backlog management of purchase orders will be important so that it can be ensured all purchase orders are received to the correct location and that the change is communicated to all suppliers in time.

Case company currently has another principal warehouse in Central Europe. Final analysis step for the thesis is to consider if this warehouse can be utilized during the relocation of the Vantaa warehouse. The volumes currently handled in the Central Europe warehouse are significantly lower than at the Vantaa warehouse. Otherwise the operating system is the same. This warehouse is also operated by a logistics service provider. This analysis will be conducted by interviewing Outotec and warehouse personnel and comparing the transport times and costs data available between the warehouse locations.

The data acquired from these analyses and literature will be the base for risk analysis and project plan for the relocation. The aim of these analyses is to give detailed information on the whole spare parts supply chain and offer support for the relocation planning and communicating the move to the organization, customers and suppliers. Findings of the study will be discussed in chapter 6. In chapters 7 and 8 the risk analysis and project plan will be explained in detail. Actual risk analysis and project plan documents can be found in appendices 1 and 2.

Finally, in chapter 9 of the thesis, the whole study process will be reviewed and analysed. Results and the successes and shortcomings of the study are discussed. Recommendations for similar projects are given based on the things noticed during this project.

2 Managing supply chains

2.1 Definition of a supply chain

A supply chain can be defined as a network of resources that supports fulfilment and satisfaction of customers. Supply chain links a company to its suppliers, distribution channels and customers. Supply chain as a term is broader than any of its components by itself. Logistics, manufacturing and material acquisition are the key components of a supply chain. The role of a supply chain is to deliver the right products, in the correct quantity, to the right customer, at the right place and time and in a correct condition and with a correct price. (Ayers 2004, 10.; Richards 2011, 7; Huuhka 2016, 14.)

In other words, a supply chain is a network of organisations that are linked to each other in the different processes that produce value in the form of products and services to the end customer. The organisations link together in upstream and downstream linkages, meaning an organisation can be a customer to one partner and a supplier to another. The organisations depend upon each other to create the final product or service to the ultimate consumer. (Christopher 2011, 13.)

2.2 Supply chain management

Supply chain management covers all the functions in the supply chain such as the flow of materials as well as information and financial transactions between the parties. The aim of supply chain management is to fulfill customer needs as efficiently as possible. Key aspect is the co-operation between the supply chain parties. (Huuhka 2016, 14.)

Three major activities make up supply chain management: coordination, information sharing and collaboration. Coordination is the movement of funds and goods or services through the supply chain in both directions. This may also include possible return flows, reverse logistics. Information sharing between the members of the supply chain is crucial, in order for the processes to run smoothly. Collaboration between the members is essential, because each individual link in the supply chain depends on the others to operate. None of the supply chain members could achieve the same performance on its own. (Sanders 2012, 6-7.)

In the modern world supply chains are global and companies must work together in order to survive. Even in the smallest businesses, there is a chance that some materials or resources are sourced through a global supply chain. Big companies have a global presence and an item ordered from for example a Finnish company might very well be delivered to customer from overseas. Modern supply chains are often quite long, when original suppliers use subcontracting for the manufacturing or purchase the needed parts from another supplier.

The purpose of supply chain management is to balance supply and demand. In an ideal situation, nothing is assembled, configured or packaged, until the customer's order requirements are clear. This is however rarely the case, because it

requires a high level of agility in the supply chain. Forecasting customer needs would also need to be accurate to be able to have the needed inventory of components or raw materials available somewhere in the complex supply chain. (Christopher 2011, 92.)

The term logistics is sometimes confused with supply chain management. Logistics is a key element in supply chain management but still only a part of the whole concept. Logistics can be defined as the part of supply chain process that plans, implements and controls the flow and storage of goods, services or information in an efficient manner from the point of origin to the point of consumption in order to meet customer requirements (Ayers, 2004, 9). Another way of defining logistics is to say that logistics is responsible for transporting and delivering products to the right place at the right time throughout the whole supply chain (Sanders 2012, 15). Multimodal supply chains are international transport systems that combine different modes of transport such as sea freight, truck freight or air freight (Vilko 2012, 25).

Supply chain management is increasingly important in the modern world. Outsourcing and best-cost country acquisitions are seen as ways to reduce costs and add flexibility to the supply chain. While the immediate costs may be lower, it is important to try to assess the full costs of the supply chain. Best-cost country supply may in some cases lead to unexpected delays or costs in the form of airfreight or duties. Risk and cost management's value in companies has grown with the emergence global supply chains. Especially in project type business the success of the supply chain may be a huge factor in the total profitability of the project. (Lintukangas, Hallikas, Kähkönen, Bolander & Multaharju 2014, 9.) Risk managent and supply chain risks are discussed in more detail in chapter 3 of this thesis.

2.3 Warehouse as a part of the supply chain

In a supply chain, the importance of warehouses is not always seen even though they could offer significant competitive advantage when optimized. Warehousing is a substantial part of the total supply chain cost. However, if it's able to deliver products customers want, when they want it and most of all in a cost effective

manner, it can make a big difference in the overall customer experience and satisfaction. (Alicke, Leopoldseder, Mishra & Schultz 2008.)

Warehouses are an essential part of the supply chain. There are several different types of warehouses, which serve different needs. Different warehouse types are for example: raw materials storage, finished goods storage, consolidation centers and transit warehouses, reverse logistics centers and transshipment or break-bulk centers. In recent years, warehouses have evolved from traditional warehouses more into distribution centers. Today warehouses are also very often outsourced and operated by logistics service providers. (Richards 2011, 9-12.)

It is however important to note, that bad warehouse practise is not solved by outsourcing. Outsourcing inefficient processes only provides service providers a chance to bill higher margins. A warehouse is often inefficient due to reasons beyond its control. The reasons behind the inefficiency could be volatile demand patterns or undisciplined ordering. This could lead to a situation where an outsourced warehouse is not able to provide significant cost advantages compared to the company's own previous warehouse. (Alicke et al., 2008.) This again highlights the complex nature of supply chains, where one part of the chain is unable to solve the occurring issues by itself. Optimizing a part of the supply chain may lead to issues in another part of the chain if the supply chain is not viewed as a whole when making changes.

Items that a company has in its inventory, warehouse, tie up capital, which is why the warehouse is often viewed as a cost rather than an asset. The company has already paid for the cost of manufacturing of the items such as raw materials, energy and personnel costs. Capital is also at all times tied up in the unfinished items that are in the manufacturing process. Before the items are sold, the capital is not in the company's use. Only after they are sold, the capital is freed to use in other purposes. The aim of warehousing planning is to find the lowest amount of inventory that is enough to ensure operations can be run smoothly. This is no easy task as the optimal inventory value may be different for each individual item. In worst cases, excess inventory can become obsolete, which will need to be scrapped. This in turn creates costs in addition to the already wasted capital. (Karhunen, Pouri & Santala 2004, 25, 305.)

Warehouse, or the kept inventory, doesn't directly add value to the final customer. Price of the items can't be justified to customers with the warehousing costs. The challenge for companies is to identify how and where their items should be stored in order for them to be available when needed, while at the same time avoiding keeping too much inventory that ties up capital. The structure and value of the stored item needs to be closely examined when doing these decisions. In some cases it may be most cost effective to store components and only assemble and deliver ready items to customers based on their orders. (Inkiläinen 2009, 31-32.)

In warehousing the most expensive cost is space. The building and its maintenance take capital and in all warehouses there needs to be empty space for the handling of the items. Costs vary from company to company and they are very different in various industries. For example food industry has very particular and high standards for warehousing, when a component warehousing structure can be simpler. Often the overhead costs are two thirds of the total warehousing costs. On average 55-60 % of variable costs are caused by outbound material flows, deliveries to customers. Around 30% of variable costs is caused by inbound material flows. The cost of operating a warehouse often averages between 1-5 per cent of the total sales, depending on the type of company and the value of the goods stored. Valuable items stacked on a pallet will take the same amount of space and handling as not so valuable items on a pallet, but the value of the goods is completely different. (Karhunen, Pouri & Santala 2004, 59.; Richards 2011, 212.)

Order picking is the most costly activity in the warehouse. It's labour intensive and usually difficult to plan or automate. Customers can directly see the picking errors when they occur and they may lead to significant costs if corrective action is taken. Often quick picking leads to more errors whereas slower accurate work is deemed expensive. Today the growing trend is for smaller delivery batches and more frequent deliveries, which is a challenge especially for the picking process in the warehouses. According to studies movement between pick locations can count up to 60 per cent of the picker's time. Although there are different methods to picking, the best practises always depend on the items, needed quantities and other qualities. (Richards 2011, 59, 73.)

Supply chain trends affecting warehouses now and in the future are for example the growth of e-commerce, sustainability views and reduction in a number of warehouses and instead having bigger purpose-built distribution centers. E-commerce requires warehouses for storing in bulk and then shipping out individual items to consumers. This type of business is very seasonal and it requires flexibility of the warehousing function. On time deliveries as well as delivery accuracy are also an increasingly important factor when dealing with consumers directly. Another thing that differentiates e-commerce warehousing from traditional warehousing, is the number of returns. According to some studies, the return rate may be as high as 40 per cent of outbound volumes. This calls for highly effective processes for handling the returns. (Richards 2011, 18-19.)

The company's needs and structure of their supply chains are the major factors to consider when planning the location of the warehouse. What is most important for their particular needs? Where are the major customers located? Often the accessibility of the warehouse is the key. The closeness to airports, ports or major highways can be more important than simply the cost of the warehouse. And the cost consideration should not only be limited to the building, but should also include the network needs and the availability of services on the area. (Luton 2000.) Choosing the right location for the warehouse can boost the entire supply chains efficiency.

3 Risk management

3.1 What are risks and how can they be recognized?

The single most important part of a risk management process is recognizing the risks. Only by recognizing risks, a company can start to think of a ways to prevent them or mitigate their effect if they occur. (Vesterinen 2011, 114.)

There is risk in everything. Even the most mundane actions, such as walking or driving a car to work contains risk. The key to recognizing risks is going through and analysing the different actions, models and processes in detail. By doing this, it is possible to break down the factors that make up that particular process, and locate what could be potential sources of risk.

Risk depends on the context. Risk can be defined as a subjective expectation of loss. The greater the probability of loss, the greater the risk. Taking a risk may also provide an opportunity, meaning risk can't be solely categorized as negative. Can risks actually be objectively measured or are they always subjective and based on the individual's perception? This question has no definitive answer. (Khan & Zsidisin 2010, 2.)

Three factors affect how risks are experienced. First of them is uncertainty. One key factor of a risk is, that there's certain amount of uncertainty of the consequences after an event. If the consequences can be accurately predicted, the event is not a risk. Second factor is expectations. How the risk is expected to occur or how the possible realization of the risk is expected to show will affect the way risk is experienced. Third factor is the extent and the relevance of the risk. (Juvonen, Koskensyrjä, Kuhanen, Ojala, Pentti, Porvari, Talala 2014, 8; Huuhka 2016, 189.)

In business, risks and risk management are traditionally seen as negative. However some risks have two sides. They can either be negative or they can be seen as possibilities to adapt or even grow the business. The same tools and methods can be used in recognizing both negative and positive risks and opportunities. Opportunities are usually found in the strategic level. On operative level the opportunities are often related to improving the profitability of the company through savings in the operations or improving efficiency. (Ilmonen, Kallio, Koskinen & Rajamäki 2016, 16-17.)

Risk management procedures should be incorporated into all management actions in a company. The aim is to achieve the strategic goals by eliminating or managing the risks or by turning them into opportunities. This means the company successfully manages uncertainty. Risk management can point out areas the company needs to improve in and by doing that map out new possible strategic choices for the company. Risk management also has a role in fulfilling the requirements that are set by the society or officials. This means for example industry regulations or safety regulations. (Ilmonen et al. 2016, 18, 36.)

Global risks in the operating environment affect the company and its competition the same way. Therefore, these risks should be considered from the point of view of the whole industry. For example in the logistics field if the price of oil goes up this means higher fuel prices which leads to higher operating costs for the entire field. This is a risk in itself, but the true risk for an individual company would be if it was unable to transfer this price increase to its customers like its competitors. This could be caused by the status of the company or the lack of negotiation skills in the agreement phase. (Ilmonen et al. 2016, 83.)

Generally risk management process is often seen as having three components. Firstly risk identification determines all risk factors that could occur on a project or to an organization. Secondly risk analysis creates understanding of the likelihood and the extent of the most significant risks. Third step is risk evaluation. This step consists of deciding the management responses for each risk or their combination. Risk managing responsible party should also be identified at this stage. (Khan & Zsidisin 2010, 3.)

One thing to note is that risk management functions are support functions in a company. They should not take the focus of the actual work or take up too many resources. The methods should be kept simple, so the risk management terms or practises do not become overwhelming or distract people from their main responsibilities. Even though risk management is beneficial for the company and can at best lead to improved competitiveness, it still only has an instrumental value. Usually it is not what the company actually lives on. (Ilmonen et al. 2016, 43.)

In 2013 in Finland a survey on supply network risks in business was conducted as a part of a two-year large research-project. In this survey it was found that Finnish companies have a lack of skills using special risk management methods and tools. Most important risk management element according to the study was subjective judgement and the decision-maker's experience of the supply market. Companies rely on their own experiences and supplier references. (Lintukangas et al. 2014, 12.)

3.2 Assessing risks

Assessing the risks objectively is extremely difficult. People assess the risks based on their personal background, experiences and beliefs. Different worldviews lead to different assessments on risks. The same is true in business and even with risks assessment professionals. The key is to try to assess each risk based on how likely it is to happen and how severe the results to the company would be if the risk realized. (Juvonen et al. 2014, 13-14.)

Assessing each risk takes time and resources, but the value of doing the work properly and at least yearly comes from the daily operations that run smoothly, when risks have been anticipated and managed, or even removed. The tools and resources used to manage risks should be chosen based on the risk and its ranking. Risks that are seen most harmful for the company, should be managed as well as possible. Smaller risks may be recognized, but their severity to the company seen so low, that the chosen action is to not do anything. (Vesterinen 2011, 116.

Risk management's value is made practical when companies focus on their core competences, combine all functions in one geographical location or target only one segment of customers. From the risk management point of view, it should be considered would the company still be viable if something for example changed the priorities of their only customer segment? (Inkiläinen 2009, 45.)

The main point in corporate risk management is to ensure that the company can continue its operations without interruptions which may in turn give it advantage over its competition. Effective risk management requires the identification of risks in the surrounding society or in the company itself. Risk management should be conscious, continuous and organized action in recognizing and assessing the risks. As the society or the company changes and evolves, the risks may change as well. Something that was considered a minor risk before may have turned out to be a critical risk to the operations. The key elements in managing risks are: knowing what is being done, clear roles and responsibilities, efficient processes and ways of working and finally risk taking is always a conscious decision. (Vesterinen 2011, 111.)

In an organization the risk assessment process is often started with the analysis of the operating environment. Four main areas are mapped: business environment, organization, risk management process and willingness to take risks. (Juvonen et al. 2014, 17-18.)

Business environment analyses focuses for example on social, political, economic surroundings and megatrends that are affecting the industry. Organization analysis focuses more on the individual company and its organizational structure and hierarchy. The idea is to note what levels of organization should be included in risk management planning and operations. The same principle goes for risk management process analysis of the company. This should be focused on the different actions in the organization, such as development projects and how they affect and risks that the company faces. Finally the willingness to take risk should be thought through. This is very much dependant on the company and its managers and owners. How much risk are they willing to take in the way they run the business. (Juvonen et al. 2014, 17-18.)

Assessing the risks means that all recognized risks are reviewed and their probability and level of severity ranked. There are a number of tools available, but a simple spreadsheet is a good starting point. An example of such spreadsheet is illustrated below in figure 1. The benefit of using simple tools is, that little time is needed to learn to use the tool and the focus can almost immediately be turned to actually assessing the risks that were recognized by the company.

RISK			
	Low	Harmful	Severe
Not likely	Insignificant	Minor	Moderate
Possible	Minor	Moderate	Significant
Probable	Moderate	Significant	Unbearable

Figure 1. Risk assessment spreadsheet (Vesterinen 2011, 115.)

Generally small risks are realized often, but their effect on the companies is small. Also small risks are usually relatively easy to predict. Bigger risks are more rare

and more difficult to predict. Their effects may also be serious to the company. The most important role of risk management would be to eliminate or at the very least mitigate the most harmful risks. After these risks are under control, the focus can be turned to improving the profitability of the company by measures that make smaller risks less likely to happen. (Juvonen et al. 2014, 21-22.)

On an operative level risks can be divided into: supplier risks (creating and sustaining a supplier network), producing products or services, offering or distributing products or services. Operational risks can be reconized by going through the functions and reports on near misses or deviations in operations. Another method for assessing operational risks is analysis on the company. A SWOT-analysis is a useful tool in this. (Juvonen et al. 2014, 41, 48-49.)

Small risks may escalate and turn into significant risks when they are combined with other risks. Therefore it's important to evaluate the risks in correlation with other risks as well as evaluating them individually. (Khan & Zsidisin 2010, 228.) This also highlights the importance of assessing risks continuously. Same risk can be seen as severe at one point but through development or changes in the organization or the surrounding society, the risk severity can change over time.

In Finland for example a particularly risky area in the logistics chain are the ports on the Gulf of Finland. Sea transport comprises over 80 per cent of the country's cargo flows. Three of the biggest ports in Finland are located at the shores of the Gulf of Finland. If a port would be unable to receive cargo, it would cause delays and even disruptions in the supply chains in the whole country. Environmental risks as well as security risks can be seen as the most significant at the Gulf of Finland. (Vilko 2012, 19-20.) These risks affect an entire country, but companies might not have considered how this type of risk could harm their operations.

In a project, most common risks are schedule delays and exceeding the budget. However often the most critical risks in projects are human resources and experience. Risk assessment of a project is important to be done at the project planning phase. This analysis should clarify if the project is even possible in the given timeframe and with the resources available. It is also important to update the risk analysis throughout the project. (Ilmonen et al. 2016, 80.)

3.3 Mitigating risks

Identifying and assessing a risk may often prove to be a mitigation measure in itself. Added transparency means some risks may be handled, mitigated or even removed, in the daily operations with little action. Adding transparency especially in the supply chain also allows for the organizations to strategically think through its goals and risk taking willingness or ability. (Khan & Zsidisin 2010, 43.)

Optimally managed risks in a business mean that operations can be pursued without any unnecessary delays or disruptions. Company remains its image and creditability as a partner, customer satisfaction is high and owners are gaining revenue. Risk management is therefore in a sense also management of quality and costs. Risks to be managed include: personnel, property, knowledge and intellectual property as well as company image. (Vesterinen 2011, 112.) In the modern world cracks in a company's image are more expensive to handle than ever before, due to information being available to everyone at the same time.

The method to mitigating or even removing the risks should be based on the assessed severity and likelihood of the risk. Some risks can be avoided, redirected, divided or mitigated. There's also the choice of not doing anything and therefore keeping the risk to oneself. Most severe risks are worth insuring. The insurance is a form of redirecting the cost of the risk to an insurance company. By nature, business risks cannot be insured, so different methods of handling the risks need to be taken to mitigate them. (Juvonen et al. 2014, 23.)

Mitigating the risk in organisations might mean educating the personnel, putting health and safety measures in place or creating different contingency plans. This kind of methods are used when the risk can't be totally eliminated. Risk mitigation has a so called risk-cost optimum. This means that after a certain point the cost of mitigating the risk is no longer economical. Avoiding the risk altogether would be the preferable method of risk management when the risk to the company is substantial. However this is not always possible due to costs or the nature of the risk. (Juvonen et al. 2014. 25.)

Dividing the risks means creating separate risk points. This could mean fire compartmentation of the spaces or dividing the critical manufacturing to several factories or suppliers. This kind of measures could in worst cases prevent total destruction the space or shutdown of production. These are extreme examples, divining the risk is also applicable in smaller risk situations. Again the costs of these methods are to be considered against the severity of the risks. (Juvonen et al. 2014, 26.)

In a warehouse setting, removing the risk might mean creating a completely automated warehouse, in which people are not doing the hazardous work. This prevents serious accidents and improves the productivity of the warehouse. However, the risk-cost-optimum for this kind of solution would need to be considered carefully. (Juvonen et al. 2014. 26.)

As mentioned, risk-mitigating methods for each risk should be considered based on the risk likelihood and the severity of the risk. These factors vary from company to company making it difficult to provide comprehensive description.

3.4 Supply chain risk management

Supply chain risk management is a relatively new concept. It has however become more and more important in the recent years. The growing complexity of supply chains means that the need for managing the risks is also greater than ever. (Khan & Zsidisin 2010, 4.) Supply chain risk management combines components of supply chain management and risk management.

Problems in the supply chain can cause huge issues and losses for companies. Risks can come from within the company or they may be related to the external business environment. Risks originating from companies are called operational risks and business environmental risks are called rupture risks. Supply chains are becoming increasingly complex, which means that there is more possibilities for errors or breakdowns. Risk assessing and management is therefore now more important than ever. The aim of managing risks in a supply chain is to minimize the occurrence of interruptions, handle the interruptions as quickly and efficiently as possible and ultimately return the supply chain to its normal state. (De Oliveira 2017.)

The consequences of supply chain breakdowns are not just financial but also property and equipment damages, operation interruptions, product quality reductions, delivery delays, loss of goodwill among customers and suppliers and perhaps most significantly damaged reputation with the wider public. Global issues such as terrorism, disease outbreaks and natural disasters can disrupt even the most stable supply chains. These are extreme scenarios which affect a large amount of people and companies at the same time. Smaller more isolated events such as a traffic accident or IT-system failure also have the power to disrupt normal operations effectively. (Khan & Zsidisin 2010, 9.)

Supply chain vulnerability can be defined as an exposure to serious disturbance, arising from risks within the supply chain as well as external risks. Supply chain vulnerability is an indicator for how sensitive the supply chain is to disturbances both internal and external to the supply chain. The vulnerability depends on the structural agility and resilience of the supply chain. Risk management can have a big role in strengthening the supply chain resilience. (Christopher 2011, 190-191.; Vilko 2012, 27.)

Supply chains have become increasingly vulnerable due to various reasons. Globalization and outsourcing have a big role and compared to the former local manufacturing and supply, the lead times may be longer which forces companies to have more safety stocks in order to survive in case of delays. This in turn translates into higher warehousing and inventory carrying costs. On the other hand the purchase or manufacturing prices are often lower than in the traditional system. (Christopher 2011, 190-191.)

Continuing disintegration and specialization of operations is also a factor in the supply chain vulnerability. The disturbances can come from a variety of different sources both internal and external to the supply chain. The visibility to the entire supply chain is limited when companies have control over only a small portion of the total chain. Due to the many links in the supply chains, such as manufacturers, suppliers and carriers, the overall risk management in the chain is complex, but benefits all parties when successful. (Vilko 2012, 16.; De Oliveira 2017.)

Generally companies often associate certain supply chain problems or risks to individual suppliers instead of focusing on the entire environment surrounding the relationship with the supplier. This means that the risk is placed at the supplier level rather than on supply chain management level. An example of this kind of problem are transportation networks. Problems in the transportation networks can rarely be controlled by individual companies or even a few companies. The sources of risks could be increasing transport costs due to oil price changes, shifts in the amount or direction of shipping demand, low shipping capacity or failing transportation infrastructure. (Khan & Zsidisin 2010, 46-47.)

In a supply chain risks can be classified as quantitative or qualitative. Quantitative risks can be under- or overstock, obsolete components or lack of materials or components in a supply chain. Qualitative risks are lack of precision or reliability of components and materials in the supply chain. (De Oliveira 2017.)

The sources of risks can be further divided in several different ways. One way is to divide them into supply risks, operating risks, demand risks, information security risks, macroeconomic risks, political risks, competitive risks and resource risks. (De Oliveira 2017.) Another way of classifying sources of risks in an international supply chain is to divide them into costs risks, quality risks, security risks and lead time risks. (Khan & Zsidisin 2010, 14.)

Quality risks in supply chains usually lead to increase in costs when repairs are needed or the replacement products are in need of an express delivery. Supplier lead time reliability is a source of risk that is often not controllable by the parties. Lead times in global supply chains may vary for many reasons. Often they are out of control of both the supplier and the buyer. Port congestion, customs issues, capacity issues or even geopolitical issues can slow down deliveries significantly. As a whole quality and reliability risks can have a significant impact on manufacturing and possibly lifetime service costs in case a company is providing a warranty to its customers. These kind of costs have a direct impact on the total supply chain costs. (Khan & Zsidisin 2010, 17.)

A costs risk could be neglecting to include all sourcing costs when doing the sourcing decision for an organization. The costs are usually formed of the cost of

the product and the freight cost. However, this is not enough. The organization should also consider the costs of inventory risks such as in-transit inventory, stock-outs, obsolescence, long lead times due to long transit times or port congestion and the possible cost of intellectual property loss. (Khan & Zsidisin 2010, 14.)

Security risks consist of factors such as information systems security, infrastructure security and attacks on freight through terrorism, vandalism, crime or sabotage. Infrastructure security risks are mixed between public and private utility services which can increase the chances of attacks or violations. In addition to damage or loss of the products, global logistic chains may also encounter human trafficking or smuggling of weapons or illegal substances inside containers or vehicles. (Khan & Zsidisin 2010, 17.)

Globally the safety risks in supply chains have increased in the past years. As more and more cargo is moved by various methods, criminal activity has increased as well. Pirating complicates sea freight routing, but cargo theft is a global phenomenon. Europe is no exception. In Finland the logistics chains have still been rather safe, but that might not be a permanent status. Attacks on trucks have been common already in Southern Sweden. Entire loads can be lost before they reach their destination. In worst cases violent attacks have injured or even killed the driver. Statistically around a quarter of thefts happen during road transport and three quarters in warehouses, terminals and ports (Vesterinen 2011, 41-42).

Along with globalization, the changes in warehousing have also increased the security risks of the supply chains. Companies keep low inventories, so each delivery is essential and time-critical. Risks in a logistics chain often occur when the delivery is not moving due to various reasons. The delivery is stopped at terminals, ports, warehouse or on the road when the driver needs a break. In the logistics chain information travels faster than the cargo which can also be a source of risk. (Vesterinen 2011, 37.)

A suggested supply chain risk management process is pictured below in figure 2. The process starts with understanding and improving the chain and moves on to

adding visibility to the entire network and building co-operation between the parties.

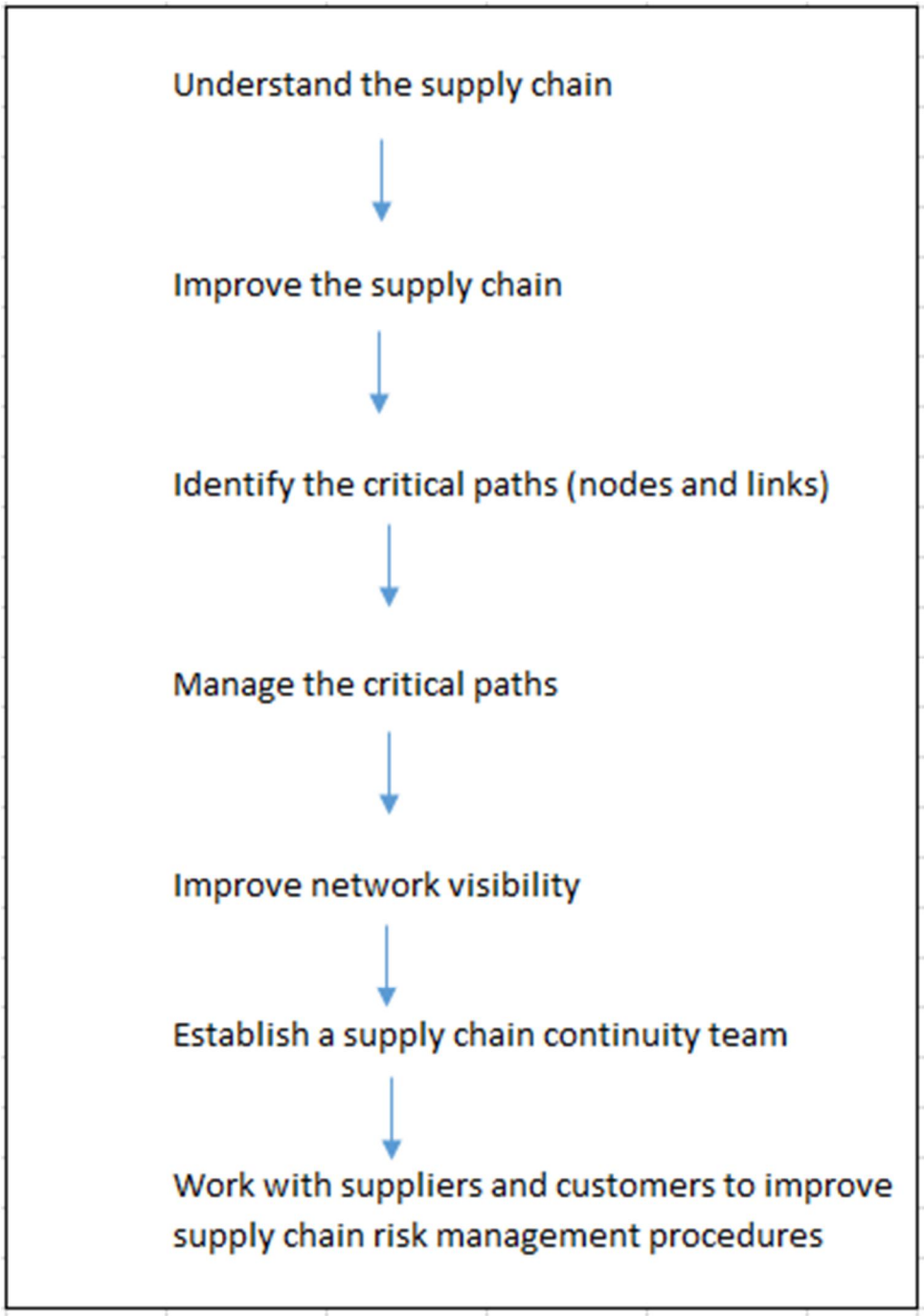

Figure 2. The supply chain risk management process (Christopher 2011, 198.)

Factors that may complicate risk management in global supply chains are for example regional narrow-mindedness, only focusing on costs when making global sourcing decisions, lack of training and the lack of visibility throughout the

supply chain which is not helped by the lack of information sharing. Ways to combat these barriers could be for example global organizational focus, global cost focus through performance measurement, internal and external integration and long-term contract with suppliers. In supply chains the risks can also be partially managed by ensuring multiple sources for products or services, building safety stocks and being aware of the country risks as well as supplier reputation or financial status when choosing suppliers. (Khan & Zsidisin 2010, 28.; Lintukangas et al. 2014, 32.)

3.5 Practical risk management examples in warehouse relocation

Most important part of a warehouse relocation is planning. Detailed planning process forces companies to think through the project and the risks involved. This minimizes the number of problems and “surprises” during the actual move. Customers often over-order, when they hear of an impending shutdown, which creates a significant workload just when a company least needs it. Of course this could be seen beneficial as well, since it reduces the inventory to be moved. Handling of emergency orders should be included in the planning, so customer needs can be satisfied even with the relocation project. (Petersen & Aase 2016)

In a warehouse relocation planning and risk analysing one aspect to consider is the loss of knowledge. If the warehouse operator changes and some or in worst cases all of the personnel is changed, there's a huge risk of losing valuable knowledge in the process. The learning curve of the new people and the organization will be steep and there's a risk of the new warehouse running into problems when starting the operations. Even if the processes are well documented, the new staff will need to learn and it will take some time. Tacit knowledge is not easily transferred. (MacLean 2011.)

In organizations and especially in projects, risks often emerge from unclear responsibilities. In projects all the decisions about project organization, their roles and responsibilities should be stated as early as possible, in the planning phase. The responsibilities should also be communicated clearly, so any communication and coordination risks between the project phases could be avoided. In projects risks should be measured throughout the project and evaluated on a high level to

make sure the combination of risks is acceptable or if it can be mitigated. Another common source of project risks are ambiguous agreements. If there are conflicting conditions on the agreements, the effective management of the project is much more difficult. (Khan & Zsidisin 2010, 223-224.)

Finnish retailer Stockmann combined five warehouses into one distribution center during the summer of 2016. Risk assessment was seen as one key element in the success of the move. The move was planned thoroughly and executed one warehouse at a time over the course of four months. The timing of the move was planned to be at a low season, so the warehouses wouldn't be working at maximum capacity while trying to move all at the same time. Number one risk the project team had recognized was congestion at the goods receipt of the new warehouse. This risk realized during the move, but major delays could be avoided since the risk was anticipated and action plan created beforehand. (Hipari & Laine 2017.)

A useful risk managing tool to be in warehouse relocations is planning for delays and tracking progress. In Stockmann's case the work was deliberately planned to be done in one shift, 8 hours. This meant that if delays occurred a second shift could be taken into use to help speed the process along. If the schedule had originally been done for two shifts, finding the extra time to handle delays could have been more difficult, since it would have meant working at night. Tracking the progress of the move is important, so any delays can be detected early and corrective measures put to action. Stockmann had solved the tracking by planning the move by item categories and even by items in some cases. (Hipari & Laine 2017.)

It has been stated that the shorter the shutdown, the longer the time to achieve smooth operations after the move. Relocating a warehouse is not cheap. The major costs include transportation of goods between the current and the new warehouse and the labour cost and possibly the cost of carrying additional inventory in both warehouses in case of an extended move. (Petersen & Aase 2016.) This means that the companies should consider all aspects of the move. Not just the possible downtime, but also the start-up phase at the new warehouse.

For the moving plan a true understanding of the flow of the operation is needed. What processed are tied together and what can be separated and for how long? Is there excess capacity at some point of the operations? How much inventory is stored and is there a need to create a buffer of some items? It can be said that planning is crucial, but reacting to issues and creating procedures to avoid or mitigate risks is even more important. Expecting the unexpected in a sense. (MacLean 2011.)

4 Transport need and cost planning

4.1 Packaging the items for transport

Transport need and cost planning are one tool to help mitigate the risk of the warehouse relocation. Reviewing the company's situation will help in executing the move. In the logistics field, there are several different types of warehouses, loading and transport equipment as well as transport modes. All goods need to be able to move through the logistic chain safely and efficiently. This means that the supplier or the packaging company needs to find a way to pack their items in a way that allows them to be loaded and transported to their customers. Domestic and international deliveries may also require different kind of packaging or markings.

In order for different warehouses and transport types to work efficiently, international standardized packaging sizes have been created. The basic standard size of a package is 600 mm in length and 400 mm in width. The standard doesn't define the height of the package. The standard packaging size is modified to create smaller packages by dividing the longest measurement in half (400 mm x 300 mm, 300 mm x 200 mm and so on). Bigger packages are created by doubling the shortest measurement of the standard size (800 x 600 mm, 1200 x 800 mm). (Karhunen, Pouri & Santala 2004, 307.)

Not all packages are made with the standard measurements. The properties of the items define how they can be packaged. However the standard packages have been planned so, that when packages are loaded on a pallet, the packages

don’t go over the edges of the pallet and therefore they are less likely to get damaged in the handling. Transport vehicles and their load spaces have also been designed with the standard package and pallet measurements, so that the transport space could be utilized as efficiently as possible. (Karhunen, Pouri & Santala 2004, 308.)

The main purpose of packing from a warehouses point of view is to ensure safe delivery and address items to certain customers, basically meaning correct labeling of the package. This will make sure the package is delivered to the correct place and the receicing warehouse can easily check if the package is meant for them or not. (Karhunen, Pouri & Santala 2004, 381.)

All kinds of products can be loaded on to a pallet for transport or storage purposes when different types of corner supports and support plates or cages are used. These allow for small items to be packed safely and sturdy supports also allow for the pallets to be stacked on top of each other. (Karhunen, Pouri & Santala 2004, 312.)

There are different types and sizes of pallets available. Pallets are most often wooden, but plastic pallets have also become more common. In Finland the standard FIN-pallet is 100 cm x 120 cm. This pallet size is also common in the United Kingdom. In Europe the most used pallet size is 80 x 120 cm. This kind of pallets are called EUR-pallets. Both of these pallet sizes are standardized, which helps in the planning of logistics companies. Pallets can also be re-used and recycled in various ways. There are companies that specialize in pallet pooling services. This means they administrate the pallets, deliver them to customers and collect them again from the destination for re-use.

Palletizing products have the benefit of being more protected from the handling during unloading and loading. Pallets are also quick to handle and the needed space at the unloading and loading area may be reduced compared to other types of packaging. On the other hand pallets may not be stackable, which leads to major reduction in the space utilization in the transport vehicles. This is likely to increase the transport costs, because the charge is based on the size the pallet takes up from the vehicle. (Richards 2011, 46-47.) This means that in the worst

case a company is paying for a space from the floor to the ceiling of the vehicle, even if the actual space used is much less.

4.2 The cost of warehouse processes

Labor costs are often around 48-60 per cent of the total warehouse costs. It is also the most difficult cost to control. In-handling is usually approximately 20 per cent of the total direct labour cost in a retail warehouse. To ensure quick and efficient inbound handling of the products in the warehouse, many practical details should be discussed within the organization as well as with the suppliers before placing the order. These details should include: size and type of cartons, type of transit packaging, palletized or non-palletized delivery of product, size (length, width and height) and type of pallets, specific labelling such as product description, barcode and quantities, carton quantities (inner and outer carton quantities), mode of transport, delivery quantity and frequency of delivery. (Richards 2011, 46, 50.)

Even in an outsourced warehouse, one of the key processes is checking the inbound items. There are several methods to this, but usually the load is visually checked whilst in the vehicle and again during the unloading. Received quantities are counted and matched to the delivery documentation. Any damages or discrepancies need to be reported immediately and documented on the waybill or other freight document, so there's chance to claim the costs from the supplier or carrier if needed. After the unloading and checking, the items are put away and shelved in their correct place.

The time it takes to unload a vehicle depends completely on the nature and volume of the items being received. A trailer filled with palletized items may be unloaded in 10-15 minutes when a similar trailer filled with miscellaneous packages will probably take three times as long. The same is true with the further handling and shelving of the items. (Richards 2011, 50.) This is something to note when packing goods for the relocation. The items should be packed properly and marked as clearly as possible, so the receiving warehouse will not need to spend time in sorting the items upon arrival.

The labour costs can be calculated by checking the times it takes to pick and bring the items to the despatch area and if additional packing such as shrink wrapping is needed at this stage. Similarly the estimated time at the new warehouse for unloading and putting the items away should be estimated. By multiplying these times with the total number of inventory moved will give an estimate on the total time these actions will take. This can be further calculated to determine how many people are needed at each end and then turning these numbers into financial figures using an average salary per hour as a multiplier. (Petersen & Aase 2016)

4.3 Effectiveness of transport

The effectiveness of the transport can be measured with how much of the total available space has been used. It can be measured by weight, in which case 100 % space utilization would mean maximum carrying capacity of the vehicle is used. This is calculated by subtracting the weight of the load from the total weight of the loaded vehicle. When transporting items that are lighter, the optimal space utilization is calculated of the space used in the vehicle. This is also easier to visualize than the weight of the items. (Karhunen, Pouri & Santala 2004, 404-405.)

The inventory amount and the timeframe allotted the move is used to calculate the number of truckloads per day required for the move. Truckloads can be further translated into man and equipment days. The estimated travel time from the current warehouse to the new warehouse including the unloading should be checked as well as the time needed for the loading at the current warehouse. To be checked is also if there's a possibility to load and unload more than one truck at a time. This will help in determining the needed trucks and their costs. (Petersen & Aase 2016)

In an example case by Petersen and Aase (2016) they calculated costs and needed resources with moves lasting one, two or three weeks. In the two and three week scenarios the inventory per move is based on the average quantity of products ordered per week divided by the total amount of product ordered during a week. Inventory was all on pallets so the number of pallets to be moved was

then used to estimate the transportation and labour cost. Truck capacity used in this example was 26 pallets per truck. The amount of truckloads needed to complete the move was calculated by dividing the total number of pallets with the truck capacity. (Petersen & Aase 2016)

5 Research strategy

The research method in this thesis is case study. Case study usually involves several different research methods. Therefore, it can be called a research strategy. This definition allows different data and methods to be used in one case study. In a case study, the case is usually a series of events or a phenomenon. Often only one case is researched. One of the key questions when doing a case study is: what can be learned from this case? (Laine, Bamberg & Jokinen 2007, 9-10.)

The objective of this study was to find out how case company Outotec's principal spare parts warehouse could be moved with minimal disruption for business. In order to reach the objective, an analysis of the current inbound and outbound material flows as well as the risks involved in the relocation needed to be done. The research strategy and the analysis are discussed in this chapter. The next chapter will discuss the findings of the study that were used when creating the project plan and risk analysis of the relocation.

5.1 Timing the relocation

The warehouse is constantly working. Each day a new batch of inbound and outbound goods needs to be handled, there's no downtime in the business. Depending on the volumes of that day the warehouse may be able to pack the outbound deliveries and label and put away the inbound goods early and already start on the next day's batch. Other days some work needs to be postponed to next day because it can't be finished in time. The daily variation means there's never really a perfect time for a move that will disrupt all the normal processes. The purpose of the analysis was to check the inbound and outbound material flows and try to determine the best possible timing for the move. At the time of writing this thesis, the warehouse is planned to be moved by February 2018.

The analysis was done by reviewing the data of all inbound and outbound deliveries. The data was gathered on an excel sheet by case company reporting specialist through a reporting tool. The data was gathered from January 2015 until May 2017. The source for the data was the company's enterprise resource planning system (ERP). The ERP system is used for example for handling all purchase and sales orders, so all the needed data was easily available.

5.2 Warehouse downtime during the move

One of the most critical decisions when planning a warehouse move is, whether to close the warehouse for a period of time or have two warehouses open simultaneously and doing the move gradually. Both options have their benefits and drawbacks and the ideal solution for one situation may not work in another situation. The company needs to consider their business as a whole and try to understand what the options are in their case.

It is said that the quicker the warehouse is moved, the longer the ramp up period is, before the warehouse is functioning normally again. The ramp up period can be expected to be a few months in any case, but if the move is poorly executed, it will slow the process down significantly.

For this analysis, the information was gathered from a number of sources. Warehouse costs were analysed through warehouse invoices from 2015 to August 2017. The invoices show detailed statements for rent, personnel and other expenses. It was possible to calculate average costs of the current warehouse from this data. The same average cost was used when estimating the costs at the new warehouse.

At the time of writing this thesis, the location of the new warehouse was not yet known. Therefore, full trailer costs for a few different locations in Finland were calculated, to simulate the possible costs. A calculator provided by a domestic transport company that the case company has a contract with, was used to check the pricing. The distance of the move is a crucial element and will affect the way the goods are packaged and loaded into the trailers. Short distance would mean goods could be loaded onto pallets and only secured lightly to the trailer, when a

longer distance would mean the goods should be packaged properly to minimize the needed trailers and also the keep the goods safe on the transit.

Estimating the actual amount of goods to be moved proved difficult. It was done by discussing with the warehouse and case company personnel and checking ERP system data. An estimate of the amount from the current warehouse operator was also received. Their estimate was based on the total available space at the warehouse. None of these sources provide full details of the amount to be moved, but they were used in the calculations and a few different scenarios were created based on the data.

5.3 Ratio of internal and external deliveries

It was already known at the start of this thesis, that most of the outbound deliveries that are handled at case company's Vantaa principal spare parts warehouse are being delivered to other case company units. The internal deliveries can be made directly for customer orders or to replenish the local stocks. Deliveries can also be made directly to end customers. The purpose of looking into the different types of deliveries was, to find out the usual ratio between case company's internal deliveries and external customer deliveries. The external deliveries can have strict delivery or payment terms and should therefore be payed extra attention to when planning the move.

The initial plan to check the outbound deliveries was to look at the delivery data and divide the data by names of companies. That would have given an idea on how many external customer deliveries were being done per month. However, the operating model in the case company made this impossible. Spare parts are being handled mostly through an intercompany operating model. In the intercompany operating model sales orders are put into the ERP system only once, even if they are being delivered through the principal warehouses to internal units. This means the sales orders are done at the market areas and then shipped to customers or market areas from the principal warehouses.

An intercompany invoice is created at the time of delivery through the same sales order the market area uses to invoice the end customer. The benefit of this model

is, that it eliminates the need for internal purchase orders in most cases and increases visibility throughout the entire supply chain. For this study this operating model meant that it wasn't possible to calculate the number of external deliveries by simply looking at the company names on delivery data. The names in the vast majority of deliveries were external companies.

In order to find out the ratio between internal deliveries and external end customer deliveries, the focus was then turned to invoices. The usual procedure in the case company's spare parts business is to invoice parts once they are delivered to customers. This means invoices are created only after the goods have been packed at the warehouse and it is known what is inside each package. In case there are several items on a sales order, but only one of them is being dispatched, only the one item is being invoiced. Down payments or other types of payment arrangements are also used, but the most common procedure is invoicing upon delivery. This means that the ratio between internal and external deliveries could be revealed by calculating the issued invoices.

For the analysis the first step was to find out the total number of invoices created. The data was searched through the ERP system starting from January 2015 until August 2017. This data was then filtered by invoice creator. Because the names of the invoice creators are stored in the ERP system and it is known who are creating invoices for the spare parts deliveries, this allowed for only the spare parts invoices to be checked. The total number of spare parts invoices was then crosschecked with the outbound delivery data to verify the overall quantities of outbound deliveries. Finally, the internal and external customers were filtered from the invoice data by using the customer codes. Internal customers have different coding than external customers. These codes could be accurately filtered from the invoice data.

5.4 Inbound material flows

The analysis of the inbound material flows, the purchasing process, was done mainly through the personal observations and experience of the writer. Discussions with the purchasing team manager and warehouse personnel were also had about the effect of the warehouse move to the inbound material flows and

suppliers. Also, the process charts of the case company were reviewed while doing the analysis.

Spare parts purchasing team is located in Finland, but parts are supplied from all over the world. Around 80 per cent of the company's manufacturing is sourced from outside suppliers. Many suppliers are long term partners of the case company and the variety of parts sourced ranges from very small items such as screws or bearings to large components or pieces of equipment.

5.5 Utilizing the Central European warehouse

The case company has another spare parts principal warehouse in Central Europe in addition to the warehouse at Vantaa. This warehouse is smaller than the one at Vantaa, but is used in exactly the same way to provide the items to customers globally. The main bulk of outbound deliveries from this warehouse are being shipped to Europe, but overseas deliveries are also handled at this warehouse.

From simply the warehouse point of view, there's no obstacles in using this warehouse as a backup during the move. This analysis is based on the observations of the writer, analysis of the purchasing process and experience in working with the deliveries of the case company.

6 Findings of the study

6.1 Timing the relocation

Analysis of the inbound material flows revealed, that the number of inbound purchase order lines has increased considerably from 2015 until 2017. The data from 2015 and 2016 can be used as a reference but for the purpose of this study the added volumes need to be considered. The variation in inbound volumes from month to month is most often a few hundred purchase order lines. Over this entire analysis period the difference between the lowest volume and the highest volume a month was over 1000 purchase order lines.

The analysis also showed that the inbound flows in January have generally been lower than the rest of the year. This can be partly explained with the year-end holiday period and supplier closing times during the holiday period. Also public holidays may take a few working days in January depending on their timing. An important factor is also the company's financial year. In December it is common in business to try and boost the sales by pushing the orders that are available, out of the warehouse. This means that inbound volumes may grow towards the end of the year and then be lower in January.

The number of outbound delivery lines has also increased from 2015 to 2017. The growth is partly due to the change in operational model, but partly it has also been a planned change in the case company to direct more and more volumes through this warehouse. The number of outbound deliveries has grown even more in comparison to the inbound purchase orders, which can be explained with the high number of outbound deliveries with only one or two lines.

There’s no real seasonal changing in the volumes. However, the same as in inbound volumes, analysis showed that the outbound volumes have been lowest in January the past years. The same kind of factors affect the outbound volumes as the inbound volumes. Holiday season, supplier closings and boosting the sales at the end of the year all contribute to January volumes being lower than in other months. The variation from month to month can be hundreds of outbound delivery lines.

The analysis of inbound and outbound volumes confirm that January 2018 would be the best time for moving the warehouse. All available outbound volumes could be pushed out of the warehouse at the end of the year as usual. This will help in reducing the inventory to be moved. One more factor considered in the analysis is that case company has a freeze period of internal deliveries at the end of the year due to concern accounting needs. This freeze period would allow warehouse to start packing inventory and preparing for the move.

The suggestion based on this analysis is that the move would take place during week 2 in January 2018. The first week of the year would be spent preparing and shipping out as much sales orders as possible as the internal deliveries can be

sent out during that week. The majority of outbound deliveries are internal, between case company units, so getting everything possible shipped out will help in the move. The obvious risk in the timing is the holiday season, but that risk can also be mitigated by not timing the move to week 1. Another way of mitigating the risk is to negotiate and communicate the move as early as possible to all parties, so all needed equipment and personnel are available.

6.2 Warehouse downtime during the move

As mentioned before, estimating the actual amount of goods to be moved and the possibly needed downtime proved difficult. Discussions with the warehouse and case company personnel confirmed that space usage at the warehouse is not monitored currently on an accurate level. There is no real system support for it. The warehouse is doing manual checking when handling the goods in their normal work, but there is no system in place to show how much of the available space is in use.

The ERP system shows the storage locations, so it is possible to check which locations are used and which are empty. However, currently the system doesn't recognize the size of the items, which makes it impossible to tell which storage locations are actually full. The system may show that a location is full when in reality the part that is on the shelf is a small part that would allow for something else to be stored on the same location. The same issue can also occur the other way around. Some parts are so large, they actually take more space than one storage shelf. The system shows the next location as empty, when the space can be used already.

The current warehouse operator estimated the needed trailers for the move based on the total available space at the warehouse and the assumption that goods would only be loaded on pallets and not stacked during transport. Their estimate was well over 100 trailers. The current warehouse has two loading docks, so maximum two trailers could be loaded at the same time. The space on the loading area is not very large, so loading two trailers full at the same time might mean collecting the outbound items also on the warehouse area. The new warehouse location and facilities were not known at the time of writing this thesis,

so it is not certain the new location would have a possibility to unload two full trailers at once.

Based on the estimated number of trailers, some calculations were done on how many trailers a day would be needed. The estimations were calculated with the moving time from two weeks to five days. A shorter time doesn't seem possible, when considering that the warehouse should be running normally after the move. An inventory count will currently close the warehouse down for a few days, so moving in the same time doesn't seem realistic. It might be possible to get the goods moved to the new location, but the receiving area would most likely be blocked for some time afterwards.

The time needed to collect the goods and load a single trailer will greatly vary depending on the packaging of the items. Case company moved a warehouse some years ago and the data from that move was utilized when doing the calculations in this thesis. At that time two full trailers were loaded a day. The goods were packed and the trailers were loaded to their maximum capacity. According to the case company the original plan was to load three trailers, but the resources at the dispatching side forced them to cut the number to two trailers a day. Trailers were loaded one in the morning and one in the afternoon, which meant that the receiving warehouse also handled two trailers a day as the trailer that was loaded the previous afternoon was unloaded the next morning.

One more thing to consider when thinking if the warehouse should be completely closed for a period or if two warehouses could work at the same time, is the ERP system requirements. If two warehouses are used simultaneously, the new one needs to be opened in the ERP system. Purchase orders and sales orders need to be configured to be sent through the new warehouse. Otherwise it's not possible to track orders or items through the system. This configuration will take some time, so even if the warehouse would not be closed, some downtime might be needed on the case company side to make sure everything is changed in the ERP system.

In case the current warehouse is closed for the moving period and the goods are then dispatched from the new warehouse, the changes needed in the ERP system might not be as great. If it's possible to use the same warehouse coding and just change the address details on the master data, a smaller update on open purchase and sales orders might be enough. In this case new shelf locations would still be needed in the system, because otherwise the goods would be dispatched and then received in the same locations from the system's perspective and tracking the physical location of the items would be difficult.

Based on the findings of the analysis, the proposal of this study is to close the warehouse down completely for the moving. There will in any case be overlapping rent and personnel costs in the two warehouse locations, but by having a closing time in inbound and outbound deliveries, the warehouses can focus on the move which should reduce the time it takes for the warehouse to start working normally in the new location. Trying to manage two working warehouses at once while at the same time updating the ERP system seems to be a worse option for the case company.

Due to the fact that the new warehouse location was not yet confirmed at the time of this thesis, the actual needed downtime and moving costs are only very rough estimates. A few scenarios based on the calculations were presented to the case company.

6.3 Ratio of internal and external deliveries

The analysis of the number of internal and external deliveries confirmed that most deliveries are made to internal units. Roughly 80 % (79 %) of all deliveries were made between case company internal units. Only 20 % (21 %) are sent directly to external customers.

This analysis doesn't provide full details of the ratio, because there are some exceptions that aren't visible through the invoice data. Some deliveries that are categorized as internal are in fact delivered directly to customers and not to other warehouses owned by the case company. However, because the purpose of this analysis was only to find out the approximate ratio for planning purposes, the analysis can be seen as accurate enough.

Based on the personal experience of the writer in working with outbound deliveries, the domestic market area and Central Europe are the ones with most time critical or urgent deliveries. The customers are expecting to receive their items quickly and in breakdown cases sometimes even on the same day. Even though all market areas are to be well and continuously informed of the warehouse move, these two market areas need even more attention.

6.4 Inbound material flows

Case company has thoroughly charted the various processes of its business. Spare parts purchasing process is no exception. Parts are purchased based on the material master data that is updated in the company's materials management and ERP system. The material master data contains details on for example item lead time, material, description and sales data such as commodity code of the item. Purchasing details are also maintained in material master data which allows the team members to manage their responsibilities in a simple manner. Acquiring all the needed data is sometimes not simple, but the basic process steps to follow have been established which helps in the daily work.

Once a sales order or a need for an item has been placed in the ERP system, the system will create a purchase requisition for the item, according to the material master data. Lead time information is especially important at this stage, because the system will automatically consider the lead time and create purchase requisition according to that. Another crucial information at this stage is the purchasing quantity. Some items have minimum purchase order quantities set by the suppliers or other types of restrictions on the purchasing. Case company might also have defined a purchase order quantity that is most beneficial for the company, for example purchasing large batches at a time in order to lower the unit costs of the items. Both of these factors are automatically considered by the system according to the item details maintained in the material master data.

A purchase requisition is created automatically but the purchasing team is then responsible for checking them and turning them into purchase orders to suppliers. Purchase orders are mainly sent by emailing them to suppliers or by using electronic data interchange (EDI). Lead times of purchase orders vary greatly. Some

orders are available in days, others take months to supply parts and then manufacture the purchased item.

Used incoterms, terms of delivery, also vary. Most commonly purchase orders are made with terms where case company pays the freight. Even in these cases, suppliers usually arrange the freight for the ready items. Freight can also be booked by case company in certain cases. Suppliers are required to use the transport partners named by the case company. Complete deliveries of purchase orders are preferred, but partial deliveries are accepted in case supplier is not able to deliver all the purchased parts on time or if some parts are in urgent need.

The case company's principal spare parts warehouse at Vantaa receives thousands of purchase orders yearly. The operating model of suppliers booking the inbound freights themselves makes it difficult to predict the exact timing of arrival to warehouse. The open purchase orders can be tracked from the ERP system, but there may be orders that are being delivered early or late or that are in transit for weeks.

The daily inbound volumes at the warehouse vary from day to day. The use of case company's freight forwarders limits the number of inbound loads to the warehouse. Usually inbound freight is received during the morning through a few different transport companies. The warehouse personnel handles the inbound items through the ERP system, labels them and puts them to their correct shelf location. Depending on the number and size of items received this may take anywhere from 5-10 minutes to several hours per purchase order. Unclear inbound freight, items with wrong or missing labelling and so on, can in worst cases take a few days to sort out if the supplier needs to be contacted to clarify the delivery content.

The inbound material flow will present a big challenge for the execution of the warehouse move. As previously stated it's not possible to predict all inbound deliveries to the warehouse. The main focus should be put on communicating the change to the suppliers as early as possible and then again closer to the actual move. A continuous dialog is needed between the purchasing team and the suppliers.

Equally as important is to communicate the change to the transport companies and possibly request them to store the inbound freight at their terminals during the move. At the case company warehouse the inbound freight will need to be left unhandled for a time, to allow for the moved stock to be handled in the system. The inbound freight that is delivered at the warehouse will be physically there, but at a preserved location, that won't mix up the inventory.

6.5 Utilizing the Central European warehouse

If more inbound and outbound volumes were to be sent through the Central Europe warehouse, the decision would need to be made well in advance, at the time of handling the customer purchase orders in the ERP system. Once the order is handled in the system, the system starts to check the available materials and create purchase requisitions for needed materials according to the master data. After the materials for the sales order have been purchased, the suppliers deliver them to the chosen warehouse based on the purchase orders.

If the decision of the used warehouse is not done at order handling phase it will create manual extra work later in the process due to the structure of the ERP system. Also, because the customer orders are handled all over the world, the number of people handling them is so large that communicating the logic would be challenging. The fact that this is meant to be a temporary change could be lost and result in more work after the move when correcting the orders.

Materials are normally purchased in reasonable batches defined in the material master data and often they are needed for several customer orders, not just for a single order. The bulk of outbound deliveries are done through Vantaa warehouse, which means most of the inbound materials are also coming to Vantaa. If more outbound orders were to be handled through the Central Europe warehouse, this would mean splitting the inbound orders to two warehouses and could be confusing to suppliers. Inbound freight costs are also a factor to consider. While the actual freight costs vary depending on the supplier location, the splitting of the orders would definitely add the freight costs, because the goods would need to be delivered to two locations instead of one.

One thing considered, was the use of the Central European warehouse as a backup for urgent outbound orders during the moving of Vantaa warehouse. This could be easily done in case the material is already available at the warehouse. This is a valid option and can be utilized if needed. The problem is, there's no way of predicting urgent orders which are usually the result of a breakdown on customer site. This means there's no way of making sure all urgently needed items are available at the warehouse.

If an item is only stored at Vantaa warehouse and it becomes urgent during the move, there's practically no benefit in trying to handle the order through the other warehouse. The time needed to move the item to Central Europe, a day at the very least, is time that could be used serving the customer. A strategy for handling the extremely urgent orders during the warehouse move needs to be put together as a part of the risk mitigation plan.

7 Risk analysis of the warehouse relocation

Case company has a risk assessment tool that is used in different types of projects. In the tool the risks have been categorized into ten groups, such as customer, contractual, financial, technological and implementation. These groups then contain more detailed list of issues to consider and assess. For example in the finance category payment terms should be checked, are they clearly stated and are all parties aware of their obligations during the project. (Operational risk assessment tool 2017.) The tool wasn't used in this thesis, because it contains many parts that aren't applicable in this project. However, the tool served as a checklist and help in recognizing the different types of risks in this study.

The risk analysis of this study was done purely of the warehouse relocation point of view. Since the warehouse operator, the new location or the availability of the new warehouse was not yet confirmed at the time of writing this thesis, those risks could not really be considered. The tender process was handled in the case company separately. Very obvious risks any relocation are the contractual risks as well as the new facility, its characteristics, limitations, equipment and schedule. These issues will need to be checked separately once the contract is being drafted and the new location is confirmed. The risk assessment sheet can be

found in appendix 1 at the end of this thesis. The identified risks are discussed in this chapter in detail.

Risk of congestion in the goods receipt of the new warehouse is something that will very likely realize. It is probable that the goods receipt area will at some point of the move get blocked for one reason or another. Likely causes of congestion are technical issues, for example printers jamming or simply slow handling of the inbound cargo. This risk can be mitigated by planning the move schedule so, that the receiving warehouse will have enough time and resources to handle each incoming trailer and having a plan in place for adding staff to receiving and shelving if needed.

Missing, wrongly labelled and damaged goods are also a risk that will most likely realize during the move. In the case company's previous warehouse relocation the number of issues was high even when the staff doing the move was highly experienced. This risk can be mitigated by tracking each package and trailer closely and by having checks in place in both the dispatching and the receiving warehouses. The order of moving the items should also be agreed before starting, so the tracking is as simple as possible. In case of damages, there needs to be clear agreements on what terms the items are compensated for. A very important factor are also the contracts between the parties. The responsibilities of each party need to be clear before the moving is started. Who is responsible for the items at the dispatching warehouse, during the transport and once received to the new warehouse.

The risk of technical issues during the move is also something to consider. It could be the entire network is down or the case company's ERP system won't work. Even a single printer or computer failure could slow the processing at the warehouses. The mitigation of this risk is to test all functions beforehand and communicating the move to IT-departments of both case company and warehouse operator. Also, to prepare for the worst case scenario, a plan of manually recording the warehouse events should be put together. This could even be something like printing ready templates to both warehouses, so everyone would record the events the same way. That might help later on when transferring the events into the ERP system.

Availability of trailers, packing materials and resources at the dispatching warehouse are risks that should be easily avoided or reduced with good preplanning. Once the new warehouse location and moving schedule are set, the negotiations should start immediately to ensure all the needed resources will be available for the move.

Delays in schedule are almost certain to occur at one point or another during the project. It is very likely that something unexpected will happen that will cause some delay. The way to mitigate the delay risk is, to have a detailed plan in place and track the progress closely throughout the project. In case of delays there needs to be an action plan in place. That could mean adding staff temporarily or working in two shifts. Prolonging the entire move should be considered the last possibility, since that will directly affect the case company's customers. The move might still affect the customer service in some cases, but open and continuous communication both in the case company and to customers, suppliers and other stakeholders is the way to mitigate this risk. Also a plan for very urgent orders handling during the move should be out together.

QEHS, quality, environment, health & safety risks need attention, but are mostly in the hands of the warehouse operators. They are in charge of operations at the warehouses, so case company will have limited possibilities to affect this. What can be done is ensuring there are appropriate measures in place.

When moving the warehouse there's a chance that the knowledge on the products or packing requirements is lost during the process. This risk is mitigated by making sure there are adequate trainings for new employees. Case company already has in place written packing instructions, ERP instructions and process descriptions. These will help the new warehouse in their work, but in the beginning it is good to prepare to have also case company personnel at the warehouse to help.

New warehouse will need to be opened in the case company's ERP system in order for the operations to continue smoothly after the move. Changes in the system can be considered a risk. To mitigate this risk a freeze period should be set in the system in order for the master data to be updated. The time needed is

defined by the scope of the changes. It is likely that all open purchase and sales orders need to be updated which will take some time. Logical solution for the freeze period would be the time planned for the move. That could also ease the tracking of changes in the inventory during the move.

One more thing to consider in the ERP system is the tracking of the non-turning stock. Case company has in place a global inventory de-valuation and scrapping policy. Purpose of the policy is to give instructions on how non-turning inventory should be managed in all locations. An item is considered non-turning when there has been no usage for one year. After five years the non-turning item can be fully de-valued in accounting and the company's ERP-system. Non-turning items are relocated to other locations in case there is need. If an item has become obsolete or is otherwise unsellable they can be scrapped physically and in the ERP-system. (Outotec inventory de-valuation and scrapping policy for services 2016.)

It is important that the move is handled in such a way that it doesn't affect the non-turning stock tracking. This means that the goods can't be moved through stock transfer orders or sales orders that would register in the system as sales of the item. All unsellable items should also be scrapped physically as well as in the ERP system prior to the relocation.

8 Project plan for the warehouse relocation

The same as with the risk assessment, the project plan was done purely from the warehouse relocation point of view. The starting point of the plan is a signed contract with the warehouse operator. At this point the location of the new warehouse is known and availability of the new warehouse confirmed. The plan attempts to cover the next steps to a successful relocation from the case company perspective. Some steps, like recruiting the new warehouse staff have been left out, since they will be the responsibility of the warehouse operator. The contract between case company and warehouse operator will be an important tool for the actual relocation planning. The project plan can be found in appendix 2 at the end of this thesis.

After the contract with the warehouse operator has been signed and the details are clear, the planning phase of the relocation can fully begin. In reality some planning has been done already during the tender process. The first step is deciding on the relocation schedule. This thesis has provided some analysis and material for the case company to assess and the analysis can also be redone once more details are available. It is important to include also IT and other support functions to the planning from an early phase, so they can focus and plan their resources accordingly. The more different functions are involved in the planning may help in the execution if possible issues have been identified already in planning.

The communication on the upcoming relocation should be started as soon as possible after the finalization of the contract. Internal communication is important, so market areas can prepare and inform their customers. Additional orders can be sent through the existing warehouse and create buffer inventory on the market areas where needed. Even with early communication there are likely to be some issues, since the lead times on certain items are so long. The added workload to the warehouse just before the move is a risk, but the inventory to be moved is also reduced with every dispatched order.

Direct deliveries from suppliers to market areas can also be utilized at this stage more than in normal circumstances. Normally the majority of items are sent through the warehouses, but close to the relocation more orders could be handled as direct deliveries if reasonable. These are of course to be checked case by case, since this is not the preferred option with all customers or countries.

The relocation should also be communicated to case company partners, customers, suppliers, carriers and officials at an early stage. Some authorizations, such as customs authorizations will need to be updated or re-applied due to the relocation. Contracts with carriers may need to be updated and the new address inputted to various booking systems. The processes may take time, so it should be started as early as possible.

The planning phase of the relocation will consist of communicating the change internally and externally, planning the needed resources internally and with the

warehouses and carriers. It is likely that the warehouse operator of the new warehouse will be an active partner is the relocation planning as well, because it is also in their interest to get the inventory moved over as smoothly as possible and start the normal operations.

Before the actual move, it is crucial that the plans are reviewed and all systems and processes tested. Testing should be done both at the new warehouse and in the case company ERP system test environment. At the warehouse the most important things to be checked are that all needed connections are working and the warehouse has access and user rights to the case company ERP system. Individual user accounts should be established from the start at least for permanent staff members to help in tracking the inventory records if there are some discrepancies. The number and functionality of printers at the warehouse should also be checked at this point, because a label is printed on each inventory item and a malfunction of the printers will slow operations considerably.

Training the new staff members at the old warehouse before the move will help in transferring the knowledge that has been built in the processes. Written packing instructions, ERP instructions and process descriptions are available in the case company, but experience is the most effective way to learn. Depending on who the new warehouse operator is, there may be issues in arranging the training at the old warehouse because the companies are working in the same field. This is something to note in the contract negotiations if possible.

From case company perspective the optimal solution might be to have new staff training at the old warehouse and helping prepare for the move already a week or two beforehand. Although that will probably be a very busy season at the warehouse, the extra hands might be useful in packing the inventory. A risk in this is the availability of resources, such as forklifts or tools. It’s no use having extra staff available if they don’t have the needed tools available. Also the overlapping costs of the two warehouses are an issue to consider.

Close to the move a test delivery should be done. As well as serving as a final check of the IT-systems, this will allow the project team and both warehouses to get a feel on how much inventory can be sent in one trailer and how long the

picking, packing, unloading and shelving are expected to take. Possible errors in planning would hopefully also be revealed during the test delivery. The test delivery goods should be carefully considered. They can't be something that would still be needed for customers before the move or something so large it will block an area in the receiving warehouse. One possible solution is to move stock that is either non-turning or has a high inventory level but can be fitted into the normal racks of the warehouse.

All in all the order in which to move the inventory needs to be planned. Currently the case company has noticed an issue that the ERP system doesn't support the putting away process in the best possible way. When doing goods receipt the system doesn't show where the same items currently in stock are. This combined with the issue that the system doesn't recognize the size of the items sometimes results in small items being on multiple storage locations, when they could fit into one location.

One possible option for the relocation would be to pick items by item codes and not by location. This means moving all stock of a particular item at once. Possible inventory discrepancies would be noticed at the dispatching warehouse and the items could be smartly put away at the receiving warehouse. It doesn't solve the issue with the ERP system, but might help with the future operations in case the shelf location of the item would be checked prior to putting the received item away. An exception to this might be items that have been purchased for a specific sales order and are stored in sales order stock in the ERP system. These items have also been physically stored in a separate part of the warehouse, so it might make sense to move these together and not with other items.

The case company ERP system freeze would logically time to the moving of the warehouse. No outbound deliveries or inbound goods receipts would be done during that time, so changing the master data and open orders in the system would be possible. During the move the importance of tracking the progress and communicating any possible delays or issues is key. If delays are caught early there's a chance to react to them without the entire schedule falling apart. Dividing the tasks at the warehouses, so everyone knows what they are doing is also important. Especially if extra staff is used for the move, the warehouse managers

and case company personnel need to be clear on what is happening and when, so they best support the team. Clear plans for discrepancies or damages handling should be put to place beforehand so during the move the focus could be kept on moving the items.

After the relocation, it is likely that the new warehouse will need some extra support in order to get the daily operations running. It would be good if extra staff would still be available in case needed. Also the case company should prepare for having people supporting the warehouse for some time afterwards. The needed support also depends on the success of the relocation. If there are still lots of discrepancies or goods to be received, the time to get the warehouse to work at normal speed will be longer than if the issues have been cleared during the move.

Finally a closing of the project should be done once the warehouse has gotten the operations running. A lessons learned session should be held in order to collect feedback and reflect on the positive and negative thoughts of the project. Feedback should be collected from all parties in order to get the full benefit and learning to the organization.

9 Conclusions

Warehousing and inventory can be one of the biggest costs in organizations. On the other hand a well-functioning and effective supply chain and warehouse can be an asset to a company and set it apart from its competition. Decisions that affect the warehouse are usually not done lightly, since they can have such a profound effect on the whole organization’s performance.

The objective of this thesis was to create a plan for relocation of Outotec's principal spare parts warehouse. In order to create the plan, an analysis of the current inbound and outbound material flows needed to be done. The risks involved in the relocation also needed to be analysed. This thesis concentrated on the practical relocation planning process. The tender process of selecting a warehouse operator to partner with and the location of the warehouse were limited out of this thesis, since they were being handled in the case company separately. At the

time of writing this thesis the decisions had not yet been done. The warehouse layout was also limited out of the thesis, because the warehouse will be run by a warehouse operator, not the case company. The layout and daily operations will be on their responsibility.

The theoretical framework of this thesis started by defining what supply chains are and how they are managed. The role of a warehouse in the supply chain was then discussed as well as the growing trend of outsourcing the warehousing to logistics service providers. The second part of the theory section focused on risk management. Relocating a warehouse can be a needed step for companies to grow their business, but it is always a considerable risk because it disrupts the operative work even when carefully planned and executed. Supply chain risk management as a rather new concept was discussed before exploring some practical risk management examples specifically in warehouse relocations. The third and final part of the theory section discussed transport need and cost calculating.

The analyses were conducted by gathering data through case company ERP system, reviewing actual warehousing costs, interviewing case company and warehouse personnel and observing the warehouse daily operations. Freight calculator provided by case company's domestic carrier was used to simulate freight costs between different locations. Calculating the actual amount of inventory to be moved proved difficult. The case company's ERP system has partly limited data on the items, which doesn't allow for accurate calculations to be performed. The current warehouse also doesn't provide any tracking information on space usage to help in the planning.

Due to these restrictions and the fact that the new warehouse location was not yet known at the time of writing this thesis, the transport need calculations and cost estimations presented to the case company can be seen directive at best. Otherwise the analyses were quite successful in providing the current information on the number of inbound and outbound material flows to the warehouse. The findings of the study provided some insights as to how the case company's material flows fluctuate monthly and how the costs of the move can be estimated.

Based on the analyses, the risk assessment and a project plan were put together. As previously mentioned, both concentrated on the operational side and for example contractual risks are not really considered, although they are a major factor in any project. The risks recognised are very practical. One of the biggest risks for relocation schedule is congestion at the receiving warehouse. If goods can't be received and put away as they arrive, the risk is not only for delays, but also increasing the amount of discrepancies or mishandled items, since the items on goods receivable area are coming from suppliers with their markings. That makes them easier to mix up than properly labelled items in the warehouse.

The project plan was done on a rather general level, since the decisions on the relocation were not done yet. The aim was to create a plan that would be easy to modify at the time of the relocation by adding in more details on for example responsible people, resources or deadlines for each step. The starting point of the plan was a signed contract with the new warehouse operator. In reality many of the activities on the plan will probably be done simultaneously to the finalization of the contract and as mentioned the new warehouse operator is likely to have a big role in the relocation planning as well.

From the study point of view, the optimal situation would have been that the warehouse relocation in the case company would have been done over the course of the study. That would have allowed for the whole process to be planned, executed and then reviewed afterwards. In the current situation, the study serves as a guideline on how the process might go and an analysis of the risks that might realize over the course of the relocation.

The initial idea of the thesis was to provide more detailed information and calculations for the case company about the amount of goods to be moved and the needed resources. Over the course of writing the thesis, the focus was however turned more and more into the whole relocation process and recognizing the operational risks in it. The reasoning for this is partly the undefined situation in the case company, but also the later uses of this study. The study in its current form may serve the case company in later similar projects as well as other companies that may be considering a relocation. The numbers and amounts may change,

but the core processes usually stay somewhat similar if the warehouse is not completely automated.

Figures

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RISK	RISK LEVEL	IMPACT	MITIGATION AND CONTINGENCY
Congestion in the goods receipt of the new warehouse	Medium	Medium	Reduction - test delivery to check everything is working and check the time to shelf a full trailer. Enough computers and printers and possibility to increase staff if needed.
Missing, wrongly labelled, damaged goods	Medium	Medium	Reduction - clearly defined responsibilities, who is in charge of the goods at each stage. Packing lists for each package / trailer to be checked at dispatch and goods receipt. Plan in place for handling unclarities. In case of damaged goods clearly defined compensations agreed. Moving plan to be set, what is to moved in what order.
Technical issues	Medium	High	Reduction - test beforehand and test delivery to check everything functions as planned. Action plan in place in case network is down, ERP system or printers don't work etc. Communication to helpdesk beforehand so they know to prepare for the move in case they need extra resources.
Availability of trailers	Low	High	Avoidance - written contract with a carrier well in advance to make sure trailers are available in needed quantity. Detailed plan to be set up once clear on the new location. Close tracking of progress during the move, quick corrective actions if needed.
Availability of packing materials and resources (personnel, equipment) at the dispatching warehouse	Low	Medium	Reduction - packing materials to be purchased by the current warehouse operator in advance. Agreement to increase staff if needed during the move. Preparing for the move beforehand by prepacking items.
Delays in schedule	Medium	Medium	Reduction - agreed schedule and action plan in case of delays. For example second shift / added staff. Close tracking of progress and quick corrective actions in case of delays.
QEHS - quality, environment, health & safety risks	Low	Medium	Reduction - detailed planning, proper waste management by warehouse operators, training of (temporary) personnel in work safety issues, working in pairs when possible / needed.
Loss of knowledge on products, packing skills due to the move	Medium	Medium	Reduction - recruitment and trainings for new personnel in advance. Training / help also after the move at the start of operations. Written processes, packing instructions, ERP instructions etc. available.
Customer service affected due to the move	Medium	Medium	Reduction - internal and external communication (suppliers, carriers, customs, other stakeholders) in advance and also during the move. Action plan for unexpected urgent orders during the move.
ERP changes not properly carried out	Medium	Medium	Avoidance - freeze period in operation when master data changes are done. Each open purchase and sales order to be checked during the freeze period to avoid issues later on.
Non-turning stock tracking affected	Low	Low	Avoidance - scrapping any obsolete items before the move, handling the move in ERP system without affecting the tracking, meaning not through sales orders / stock transfer orders.
Inbound materials after the move at the old warehouse	Low	Low	Reduction - communication to suppliers, carriers and other stakeholders. Information / staff at the old warehouse to direct the goods to correct address.

Appendix 2

Warehouse relocation