YRKESHÖGSKOLAN
NOVIA

Supply Chain Risk Analysis: Cruise Ship Warranty Logistics Process

Julia Keskitalo

Master's Degree Thesis

Thesis for a Novia University of Applied Sciences - Master of Engineering

Degree Programme in Maritime Management

Turku, 2023

MASTER'S DEGREE THESIS

Author: Julia Keskitalo
Degree Programme and place of study: Maritime Management, Turku
Specialization:
Supervisor(s): Thomas Finne

Title: Supply Chain Risk Analysis: Cruise Ship Warranty Logistics Process

---

Date: 31.5.2023 Number of pages: 58 Appendices: 2

Abstract

The purpose of the thesis was to get a better understanding and holistic view about Supply Chain Risks in Cruise Ship Warranty Logistics Process when sending or returning spare parts or other warranty material and to provide a mitigation plan for the identified risks. The goal was to create Process Descriptions for the Cruise Ship Warranty Logistics Process, including communication between different parties. This thesis was completed for a Finnish shipyard which is one of the world's largest and most advanced manufacturers of large cruise ships and passenger ferries.

A qualitative research method was chosen, and the data was collected by conducting interviews and one focus group for the key parties involved in the warranty logistics process. The aim of the interviews and focus group was to clarify the supply chain and to identify risks involved in the process to provide a risk mitigation plan as well as improvement ideas regarding the process. The theoretical part of the thesis focused on supply chain management and risk management. Previous literature and research as well as the researcher's own experience were exploited when planning the improvement and risk mitigation plan for the case company.

According to the results of the research, process descriptions were created, identified risks were analyzed by using risk assessment matrix, and realistic recommendations for future improvement were provided.

Language: English
Key Words: Supply Chain Management, Risk Management, Warranty, Logistics, Cruise Industry, Shipbuilding Industry

Table of Contents

Abbreviations

AM	Additive Manufacturing
ERP	Enterprise Resource Planning
GC	Guarantee Claim
ISN	Intertwined Supply Network
LCM	Landing Cargo Manifest
MSDS	Material Safety Data Sheet
RFID	Radio Frequency Identification
SCM	Supply Chain Management
SDS	Safety Data Sheet

1 Introduction

The topic chosen for the thesis is Supply Chain Risk Analysis: Cruise Ship Warranty Logistics Process. This topic focuses on the warranty process of delivered vessels and more specifically on the risk management of logistics of the whole process. Cruise ship warranty logistics refers to spare part and material deliveries to delivered ships with an ongoing warranty period. The warranty agreement is between the ship owner and the shipyard, which are the main responsible parties in the process. However, there are many other parties involved in the implementation of the process. The ship's warranty process is a complex entity, which differs significantly from a basic consumer goods warranty process making it a challenging and interesting area of research.

This topic covers the investigation and analysis of the shipyard's current warranty logistics practices, and related risk management solutions. In addition, the current challenges within the process will be clarified. The aim of the thesis was to provide improvement suggestions regarding the working methods or activities of the process. Clear process descriptions including communication between different parties will be one of the end results of the thesis. The purpose was to determine what kind of risks there were in the supply chain of warranty logistics process and how those could be mitigated at different stages of the process.

Considering the events of the past years this topic is current as the Covid-19 pandemic, the war in Ukraine and climate change have affected global environment, economy, and supply chains. Businesses must be resilient and able to adapt to the changing environment to survive. New trends, such as technological and climate related trends also have an impact on changing supply chains and risks.

Economic systems are increasingly prone to complexity and uncertainty. Therefore, making well-informed decisions requires risk analysis, control, and mitigation. The increased frequency and the severe consequences of past supply chain disruptions have resulted in an increasing interest in risks. This development has led to the adoption of risk concepts, terminologies, and methods from related fields (Heckmann, Comes & Nickel, 2015).

While working in a Finnish shipyard's warranty department, the researcher has come across challenges and noticed potential development areas related to the logistics of

warranty process. The handling of warranty process of a cruise ship requires cooperation of various people from different organizations, and it can be challenging sometimes when there are cultural differences and different ways of working. Warranty is a mandatory and lengthy process in shipbuilding and cruise industry. By improving the process, long-term effects in terms of cost effectiveness as well as overall efficiency could be created, which would benefit the daily work of many people.

2 Purpose and problem statement

The main research problem is that there are many parties involved in the warranty logistics process but no transparency between them. Although everyone knows their part and how to handle it, the bigger picture is unclear for many people. Therefore, the goal is to collect information from each party in the chain to combine different parts and get a better understanding about the whole supply chain. Another identified research problem was that there is no clear or separate risk management process in use now. The goal is to first define the supply chain of cruise ship warranty process and then explore and identify the most common supply chain and delivery risks to analyze and mitigate them. By creating clear process descriptions, understanding of other parties' responsibilities and the cooperation between the parties could be improved.

The warranty process overall is a complex and lengthy process. Generally, the process takes longer than agreed in the ship contract. With more efficient ways of working, the project can potentially be completed faster and more cost-effectively. A more transparent process may also improve cooperation between different parties to advance the issue. The issue is current, as the coronavirus has affected the cruise and shipbuilding industry dramatically. Now and in the coming years, cost minimization and risk management will have a significant importance in the industry.

Streamlining the warranty process benefits both the ship owner and the shipyard as well as all other suppliers and subcontractors who are involved. A more efficient way of working could have an effect not only on the ship operation but also on end-customer satisfaction. Identifying and managing supply chain risks in the warranty logistics process can have a decreasing effect on the costs, making operation more economically viable. According to the shipyard's warranty department, getting a spare part on board is typically 50 percent

of the effort of closing a guarantee claim which makes the topic important and will benefit many different stakeholders involved in the process. Figure 1 demonstrates the many parties involved in the Cruise Ship Warranty Logistics Process.

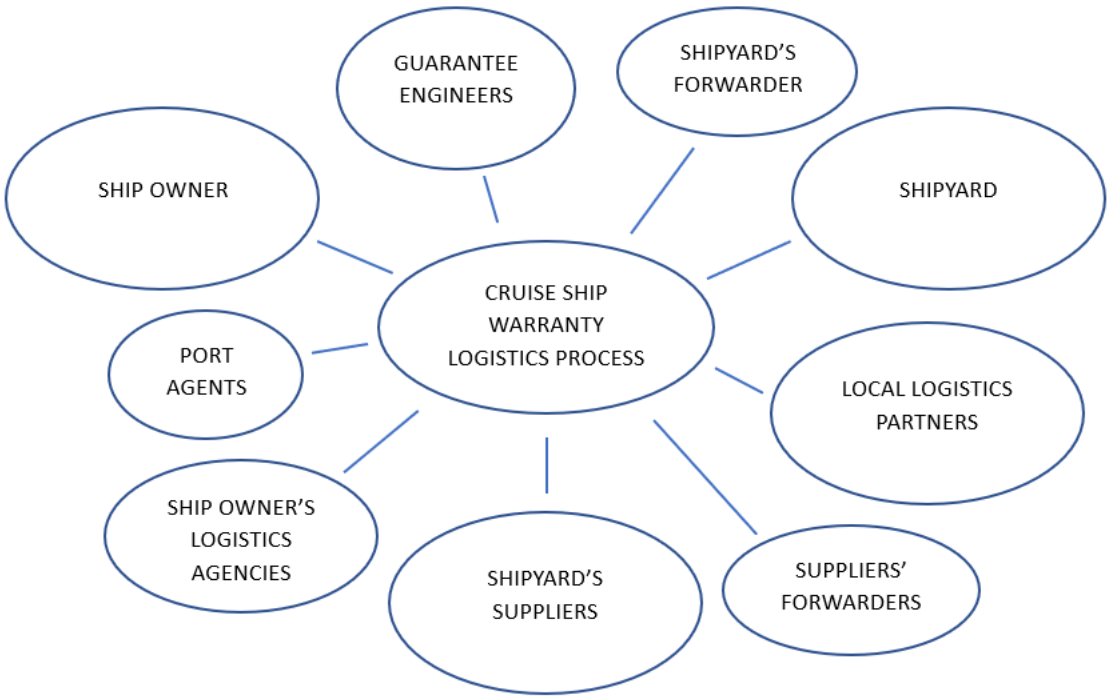

Figure 1. Parties involved in the Cruise Ship Warranty Logistics Process (Keskitalo, 2023).

2.1 Short description of the current situation

Once a cruise ship is delivered, the ownership of the vessel is transferred from the shipyard to the ship owner and the warranty period begins. The warranty period is typically one or two years. During the warranty period, the ship owner is allowed to create guarantee claims in the common task management software, Jira, as soon as the issue is noticed. Jira software enables all warranty related communication between three different parties: shipyard, ship owner and shipyard's suppliers to happen. It is the shipyard's responsibility to handle the guarantee claims opened during the warranty period. All guarantee claims are directly assigned to the shipyard, but most of the guarantee claims the shipyard will further assign to the correct shipyard's subcontractors who have warranty obligation to the shipyard. According to the shipyard's warranty department, approximately 30 percent of the claims are assigned to the shipyard and 70 percent of claims are assigned to the shipyard's subcontractors. This roughly corresponds to the amount of construction responsibility.

Some of the claims can be settled without spare part or material delivery, but this thesis will focus only on cases where a spare part or material delivery is needed to close the guarantee claim. The shipyard's guarantee managers together with on board personnel will communicate and if a spare part is needed a new one will be requested from the shipyard's subcontractor or if the claim is directly for the shipyard, a spare part will be ordered or collected from the shipyard's warehouse. The shipyard's logistics department then sends bigger shipments to the ships, consisting of material and spare parts for shipyard's own claims as well as on behalf of some subcontractors. Most subcontractors handle their warranty deliveries themselves directly to the ship.

2.2 Warranty process

General warranty terms, such as duration and scope, are defined in the shipbuilding contract and specifications between the shipyard and the ship owner. The main responsibility for warranty management lies with the warranty department in cooperation with the project manager of the ship. The shipyard's warranty department is responsible for the practical handling and coordination of warranty issues.

Design and production are obliged to actively support warranty handling when requested by the warranty department. System Responsibles (in planning) and Area Managers (in production) are responsible for taking measures that will help to complete warranty claims and lessons learned for the future. It is the department heads' responsibility to ensure that the necessary actions are taken.

The warranty department must notify System Responsibles or Area Managers about new guarantee claims and request the necessary actions to handle the claim. The warranty department must monitor and report on the overall progress. The warranty department is responsible for handling guarantee claims until they are closed. Design and production are obliged to actively support the warranty department.

When handling guarantee claims that are the responsibility of the shipyard's subcontractors, the primary contact person at the shipyard is agreed between the Warranty Manager and the System Responsible or Area Manager for each subcontractor. The shipyard's contact person is responsible for ensuring that the subcontractor company's contact person is aware of all guarantee claims concerning the company and that the

company takes immediate action to handle their guarantee claims. The Warranty Manager and the System Responsible or Area Manager are responsible for ensuring that the subcontractor company's guarantee claims are closed within a reasonable time. The Warranty Manager gives permission to the finance department to terminate the subcontractor company's warranty bond or, based on open guarantee claims, requests an extension of the warranty bond.

Now, there is no specific risk management process for the warranty logistics process. Risks and obligations are defined in the shipbuilding contract between the ship owner and shipyard as well as in the delivery contracts between the shipyard and its suppliers. One risk management tool in use is the warranty bond which is between the shipyard and its suppliers. It is a bond which will be released once the supplier has fulfilled its warranty obligations and all their guarantee claims have been settled. Furthermore, the risks of warranty shipments are managed by the delivery terms and for more valuable shipments separate transport insurance is taken.

The current logistics instructions for the shipyard’s suppliers when sending spare parts, material, or tools on board are the following:

1. Check shipping instructions from the shipyard’s warranty department.
2. Mark the material (all items) with GC-number and label. Label must include information such as recipient on board (shipyard guarantee engineer), guarantee claim number, supplier name, spare part name, spare part ID and transportation date. The packing list must be placed both on and inside the package.
3. Do not pack materials for different claims inside each other.
4. Suppliers use their own forwarder or courier. Always put a comment in Jira, specifying what has been shipped, tracking code and ETA.
5. Do not send hazardous material without proper packing and documentation.
6. A proforma invoice and list of content (in English) must be included when shipping tools that will be returned.

Now, the logistics instructions for the shipyard's suppliers when requesting material returned from the ship are the following:

1. Put the return request in Jira within 7 days of receiving the claim. Otherwise, material may be scrapped.

2. Add forwarder or courier account and delivery address in Jira as a comment.

2.3 Research questions and the research objectives

Research questions

1) What is the Supply Chain of Cruise Ship Warranty Logistics Process when sending spare parts or warranty material on board or returning material or spare parts from the ship?

2) What kind of risks are there in the Cruise Ship Warranty Logistics Process and how can they be mitigated?

Research objectives

1) To create Process Descriptions (flow chart) for Cruise Ship Warranty Logistics Process (delivery and return), including communication between different parties.

2) To get a better understanding and holistic view about Supply Chain Risks in Cruise Ship Warranty Logistics Process when sending or returning spare parts or warranty material and to provide a mitigation plan for the identified risks.

2.4 Limitations

The research is limited to already delivered cruise ships which have open guarantee claims. Material deliveries for ships under construction will not be dealt with in this thesis. The risks are described and analyzed from the case company's perspective. The research focuses only on the case company's processes and risks and therefore the results of this thesis cannot be generalized for all shipyards. For ethical reasons, research is conducted by protecting the participants' anonymity. Confidential information is not presented in this thesis.

3 Supply Chain Management

A supply chain is a network in which several organizations work together to manage and develop material or service flows as well as related money and information flows. Each organization has its own role in the supply chain. The structure of a supply chain varies depending on the products, customers, and industry of the company. The company and its suppliers are connected to distribution organizations and customers by the supply chain. As a result, the supply chain is an entity that emphasizes cost effectiveness, customer orientation, and added value creation (Logistiikan maailma, 2023).

A supply chain consists of a company, its suppliers, and customers in its most basic form, which Mentzer has also referred to as a direct supply chain. The company, the supplier, and the customer are thus the three primary members of the supply chain. The supply chain's further participants are collectively referred to as secondary members, which includes the supplier's suppliers and the customer's customers. The supply chain also includes other secondary members, such as financial service providers and third-party logistics providers (Mentzer et al, 2001).

A supply chain network consists of the member companies and the links between these companies. Primary members carry out value-adding activities. Secondary members provide resources, for example, knowledge for primary members. Examples of secondary members are companies that supply production equipment or provide administrative assistance (Mentzer et al, 2001).

According to previous research, in every supply chain, there are producers, distributors or wholesalers, retailers and customers or consumers. If compared to Mentzer’s research, this definition would correspond with the extended supply chain, which includes supplier’s suppliers as raw material or material suppliers to manufacturers or producers and customer’s customer as the end user or customer of the retailer. In this research, the company, supplier, and customer are referred as the primary members of the supply chain (Mentzer et al, 2001).

Supply Chain Management (SCM) is the term used to describe the detailed planning, instruction, and administration of a company network's material, information, and financial flows with the aim of enhancing customer value. The creation and continuous development

of the chain's structure plays a significant role in supply chain management. Supply Chain Management thinking emphasizes cooperation among chain partners, customer value creation as well as time, reliability, and transparency (Logistiikan Maailma, n.d.).

Although the terms logistics and supply chain management are frequently used as synonyms, there are different perspectives within the terms. Logistics refers to the management of material movements within a company or industry, while supply chain management aims for the optimal operation of an entire collaboration network (Logistiikan Maailma, n.d.).

Supply chain management has traditionally been associated with factories, assembly lines, warehouses, vehicles for delivery, and time sheets. Whereas modern supply chain management is a highly complex, multidimensional problem set with nearly infinite optimization variables. Just-in-time delivery, precise inventory visibility, and distribution-tracking capabilities may be available in an Internet-enabled supply chain. Supply chains can now be used as strategic weapons to help prevent disasters, cut costs, and make money thanks to advances in technology. Researchers face a wide range of challenges, ranging from internal business processes to external business connections with suppliers, transporters, channels, and end users (Kordic, 2008).

Historically, the management of flows was mainly focused on internal company processes with the aim of optimizing material, information, and financial flows. This early stage in the development of flow management was characterized by the concept of logistics. Procurement, production, and distribution were not considered separately in logistics management, but they were managed as part of a broader view of flows within the company (Estampe, 2014).

In 1986, logistics management was defined as “The process of planning, implementing, and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished good, and related information flow from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements” by the Council of Logistics Management, which is nowadays the Council of Supply Chain Management Professionals (Estampe, 2014).

By definition, according to Estempe (2014), supply chain management requires companies to do the following:

- make the integration of behaviors available to suppliers and customers;

- exchange information with other members of the chain;

- create a competitive advantage while sharing risks and rewards;

- collaborate with their partners within close relationships;

- share goals with their partners and serve customers; and

- integrate processes, from procurement to distribution, including manufacturing.

3.1 Supply Chain Risk Management and Resilience

Supply chain risk can be defined as the possibility of damage occurring because of security risks posed by suppliers, their supply chains, and the goods or services they provide. The threats, exposures, and vulnerabilities to the supply chain as well as those to the goods and services that pass through the supply chain are examples of supply chain risks (The National Institute of Standards and Technology, n.d.).

Overall, the term resilience can be defined as the capability to survive or recover fast from difficulties or challenges (Oxford Learners Dictionaries, n.d.). Business resilience refers to an organization's capability to respond and adapt quickly to disruptions or substantial, unexpected changes that could compromise its operations, people, assets, brand, or reputation (Cisco, n.d.).

The conflict between Russia and Ukraine, wider geopolitical consequences and COVID-19 restrictions in China have worsened the already troubled global supply chain situation. This has affected supply especially in certain sectors, including metals, food, chemicals, and commodities. The current restrictions on Russia and possible future restrictions will continue to have an impact on fuel costs and worsen the supply chain crisis. Despite the limited direct exposure of the freight market to Russia and Ukraine, there are a rising number of risk variables that global logistics must manage, such as airspace restrictions, uncertainty of consumer demand, and ongoing bottlenecks caused by China's COVID-19

response. Supply chain issues were evident during the COVID-19 lockdown, including demand changes, labor shortages and operational factors (J.P. Morgan, 2022).

Although earlier in 2022 there were signs of an easing of the supply chain disruption, changing global factors and geopolitics are creating new risks. Risk factors for further supply chain disruption include a possible recovery of congestion at the US ports; the spread of the conflict between Russia and Ukraine to the ports of Northern Europe; restrictions on air cargo traffic and rail freight disruptions (J.P. Morgan, 2022).

Some industries are likely to be more involved in future supply chain issues than others. Russia's dominant role in the global supply of energy, industrial metals and soft commodities has already advanced commodity price inflation to its highest level since around 1960. The EU and the UK have also banned Russian ships from docking in ports, which causes a significant risk to European supply chains and commodity prices. The solution for the ongoing supply chain issues seems to be either an increase in capacity or a decrease in demand (J.P. Morgan, 2022).

Based on the synthesis between concept of supply chain risk management and the views of actors, four critical aspects of the management concept were identified: (1) assessment of supply chain risk sources; (2) defining the concept of supply chain risk and adverse consequences; (3) identification of supply chain strategy risk factors; and (4) mitigating supply chain risks (Jüttner, Peck & Christopher, 2003).

Positive research tries to describe, explain, predict, and understand supply chain risk management activities that are currently practiced and therefore actually exist. Suitable methods are qualitative methods, such as in-depth interviews and case studies, but also quantitative surveys. In contrast, normative research attempts to prescribe what organizations and individuals should do with respect to supply chain risk management. More positive research is needed to fully understand the complexities of supply chain risk management before practical management guidelines and frameworks can be developed. More empirical research on supply chain risk management is needed (Jüttner, Peck & Christopher, 2003).

Current awareness of supply chain risk management has increased in recent years due to several disruptions affecting the international business environment. While these cases

have emphasized the importance of resilient supply networks for individual organizations and entire industries, they pressure us to propose quick fixed solutions. Individuals and organizations may have a strong temptation to return to normal life after major crises, but it is believed it is an academic responsibility to place supply chain risk management as an important, if so far neglected, area of applied research (Jüttner, Peck & Christopher, 2003).

As Darwin's saying goes, only the adaptive survive, and therefore more appropriate adaptive supply chain planning and management are needed. Understanding the rules and readiness assessment can help. Eventually, managers must master the three rights of supply chain design: the right players in the right roles with the right relationships. Of course, these three rights are constantly changing so that today's players, roles, and relationships may not fit tomorrow's game. Scanning and changing management skills have never been more important. Research is needed to help managers navigate chaos. The unwritten rules can be unraveled by narrowing down the emerging supply chain game changers and delimiting their dynamics, for example, the forces that promote and hinder the building of a winning team (Fawcett & Waller, 2014).

Khajavi, Partanen & Holmström examined the readiness of additive manufacturing technology (AM) in its current state and the future development of the technology will affect the changes in spare parts supply chains (Khajavi, Partanen & Holmström, 2014). Additive manufacturing describes the technologies that build 3D objects by adding layer-upon-layer of material (Jones, 2023). The supply of spare parts for the F-18 Super Hornet environmental management system was explored, one of the earliest and most publicized deployments of AM technology to manufacture operational products. The results suggest that the purchase price and personnel intensity of AM machines are major obstacles to the decentralized adoption of this technology in spare parts supply chains. The slow production speed compared to the delivery of spare parts from the central warehouse is still a problem to be solved (Khajavi, Partanen & Holmström, 2014).

The analysis of the modeling results led the researchers to consider what are the critical requirements for the future AM machine to overcome the current shortcomings of this technology in a distributed deployment in spare parts supply chains. By utilizing the exact same model and only changing the specification of the AM machines it was possible to identify distributed production scenarios where the total cost is lower than centralized

production. This suggests that the higher automation, lower purchase price and shorter production time of AM machines are factors that producers of these machines should strive to develop to enable a radical change in the operation of the spare parts supply chain (Khajavi, Partanen & Holmström, 2014).

In addition to the potential financial benefits, moving to distributed manufacturing also provides the organization with a production capacity buffer that can be utilized because more and more spare parts are manufactured with AM. The capacity buffer also increases flexibility during unexpected demand surges or enables the sale of capacity to other suppliers. Additionally, a decentralized logistics function can reduce the need for third-party logistics providers and forwarders, as the need to transport parts around the world is not as significant (Khajavi, Partanen & Holmström, 2014).

The following potential benefits of using AM machines for distributed production of spare parts can be summarized as follows: lower overall operating costs, shorter downtimes, better potential for customer satisfaction, lower capacity utilization, higher flexibility, higher resistance to supply chain disruptions, reduced need for inventory management and logistics information systems, and opportunities for sustainable improvements as the AM machines become smaller and more energy efficient (Khajavi, Partanen & Holmström, 2014).

Supply chains evolve towards Intertwined Supply Networks (ISNs) characterized by structural dynamics. Unlike linearly oriented supply chains with a static structure, companies in ISNs can exhibit multiple behaviors in buyer-supplier relationships in interconnected or even competing supply chains simultaneously. These new dynamic, co-evolving structures require a rethinking of some traditional analysis concepts (Ivanov & Dolgui, 2020).

ISN is a series of interconnected supply chains, which together secure the supply of goods and services to society and the market. Unlike the resilience of individual supply chains, the viability of ISNs has not received much consideration in the literature so far. The recent example of the COVID-19 shows that in extraordinary events, the resilience of the supply chain to disturbances must be considered on the scale of survival or viability to avoid supply chain and market collapses and to ensure the availability of goods and services (Ivanov & Dolgui, 2020).

Ivanov & Dolgui (2020) discussed the integrity of two new perspectives, ISN and viability. The input of their study is the conceptualization of a novel decision-making environment that considers ISNs and viability in a unified way that ensures survival at a large scale. Using the similarity of ISNs and ecological systems, they illustrated the formation of viability through dynamic game-theoretic modeling of the ecosystem as shown in Figure 2 (Ivanov & Dolgui, 2020).

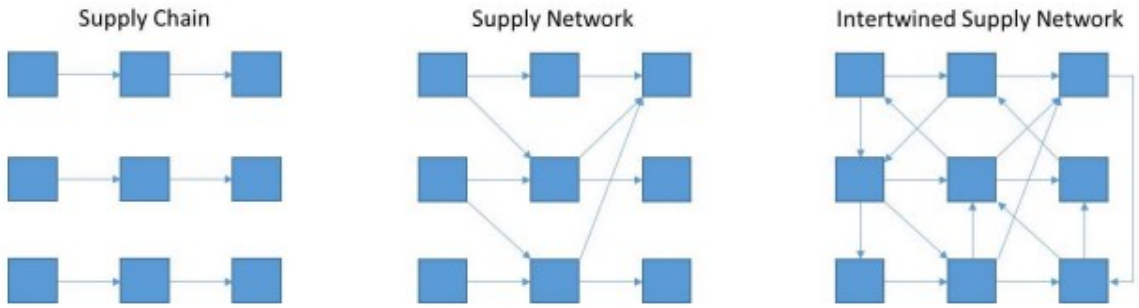

Figure 2. Linear supply chains, supply networks and intertwined supply networks (Ivanov & Dolgui, 2020).

In concrete applications, the concept of viability and trophic chain modeling should be detailed and extended to the context of decision-making situations. In addition, the ISNs themselves need to be thoroughly investigated in terms of the methodology and practice of their formation and control. Finally, the role of ISN survival must be considered in securing the supply of goods and services in the event of exceptional events such as epidemics and global pandemics, for example, COVID-19. These fields can be considered as promising lines of future research (Ivanov & Dolgui, 2020).

One promising area of research in the study of ISN networks and their viability is the utilization of digital, data-driven technologies to reveal their potential to support decision-making in long-term, serious disruption situations, such as outbreaks of epidemics. Digital supply chain twins, computerized supply chain models that represent the state of the network at a given moment in real time can be further explored in this direction. The importance of flexible and adaptable production and distribution systems (for example, omnichannel, additive and digital manufacturing) and reactive, real-time demand and supply mapping is increasing (Ivanov & Dolgui, 2020).

3.2 Supply Chain Measurement

Beamon (1999) presented a model for measuring the performance of supply chains. These metric categories are resource, output, and flexibility-based metrics. All three perspectives influence each other, and when setting goals around each point of view, one should think about their effect on each other (Beamon, 1999).

Regarding the supply chain, performance measurement has become increasingly important; especially in the manner the benefits of integration with suppliers improve performance. Furthermore, close contact with suppliers and customers is increasingly mentioned as a differentiating factor in the performance of supply chains. In fact, information sharing, communication, and trust as being the essential factors to improve the performance of companies and integrated supply chains (Beamon, 1999).

The goal of resource measures is a high level of efficiency, which is critical to profitability. The main goal of any business is to make profit, which makes resource measurement very important to any organization. Resource-based metrics include inventory levels, personnel requirements, equipment utilization rate, energy use and costs. For example, manufacturing costs, including labor, maintenance, and re-work costs affect not only the organization itself but its customers as well. Manufacturing costs affect the prices for end-customers and therefore to profitability. Costs associated with held finished goods inventories affect the organization as well as it is expensive to have too large inventories. Distribution costs can affect all members of the supply chain and therefore it will influence the strategic decisions regarding suppliers and delivery areas (Beamon, 1999).

The goal of the output measure is a high level of customer service. It is important, as without acceptable output, customers will turn to the other supply chain. Output-based metrics include customer orientation, quality, and number of finished products. Output measures are highly connected between the organization and customers. Output measures include customer responsiveness, quality and quantity of the final product produced. Some output performance measures are more difficult to measure numerically, such as customer satisfaction or product quality. However, for example measuring fill rate, on-time deliveries, shipping errors, backorder levels or customer complaints can provide important information (Beamon, 1999).

The goal of flexibility measure is the ability to respond to a changing environment. In an uncertain environment, supply chains must be able to respond to change. Flexibility metrics take a stand on the supply chain's ability to react, for example to demand changes. This measure is connected to most members of the supply chain, as any change will usually have some sort of effect on all members. Reductions in the number of backorders or in the number of lost sales or reductions in the number of late orders can affect all supply chain members. Increased customer satisfaction might have a positive effect on the number of customers but can also increase the number of material orders from suppliers. The ability to respond to seasonality can give a competitive advantage to the organization and increase customer satisfaction (Beamon, 1999).

Supply chain performance measures can be divided into strategic, tactical, and operational decision-making levels. For strategic level, metrics include metrics that support the senior management's decision-making process. On tactical level, the metrics deal with the allocation of resources set at a strategic level and examine the success required to achieve those goals. Operational level metrics focus on measuring and reviewing the performance of "everyday" operations achieving the goals set at the tactical level (Gunasekaran & Kobu, 2007).

Moreover, the performance measurement system may also be classified as financial and non-financial. While financial performance measures are important for strategic decisions, day-to-day control of manufacturing and distribution operations are better handled with nonfinancial measures (Gunasekaran & Kobu, 2007).

The most challenging task for the managers is how to determine the key performance indicators based on the organization’s strategic goals and then how to measure and implement them. For example, if a company targets a low volume and high variety market, then the organization should use metrics for measuring flexibility. There are different types of flexibility measures and some of them are based on volume, product, and delivery (Gunasekaran & Kobu, 2007).

Typical problems in a performance measurement system include organization’s strategy and measurement system not being connected, a biased focus on financial metrics, and too many isolated and incompatible measures. Traditional performance measurement systems tend to be narrow and inward looking and fail to include qualitative factors, and they are

poor predictors of future performance. Overlap between the metrics in performance measurement system should be minimal to avoid double counting and unnecessary measurement costs (Gunasekaran & Kobu, 2007).

In addition to the complex structure of the supply chain, measuring its performance also involves several other problems. To effectively measure supply chain performance and to avoid typical mistakes, organizations should be aware of the typical problems related to measurement. The most common problem is that those contained in the supply chain organizations imagine they are measuring supply chain performance when in fact the metrics measure the efficiency of an individual organization's internal logistics. One example of such a measure is the stock turnover rate, which only considers a single company's efficiency of warehouses but does not explain anything about the performance of the entire supply chain (Gunasekaran & Kobu, 2007).

Another very typical pitfall in measuring supply chain performance is related to the process of selecting metrics. In the process of selecting metrics, it is not understood to focus on choosing metrics relevant to the operation, but to choose many different metrics. Analyzing the results of several metrics takes time and resources, leaving less time for more important tasks and decisions. Probably, many selected meters are also functional irrelevant metrics, which are "nice to know". The chosen metrics should be based on the company's goals and the results of the metrics should support the company's decision-making. The necessity of the meters in use should be periodically evaluated and updated as situations change (Gunasekaran & Kobu, 2007).

Another mistake made in the process of choosing measures is that many similar types of meters are chosen. This manifests itself in the selection and use of metrics that in practice describe the same thing from a slightly different point of view, for example inventory turnover rate and capital tied up in inventory. The number obtained as the stock's turnover rate tells how many times stocks rotate annually. The higher the number, the less is committed to the warehouse capital. If both above-mentioned measures are used in the situation, it leads again to inefficient use of resources. Reducing the second measure frees up resources and clarifies decision-making (Gunasekaran & Kobu, 2007).

Generally, the larger and more complex the system, the more challenging it becomes to measure effectively. While there is an ever-increasing number of supply chain models

presented in the literature, there is very little available in supply chain performance measure selection. As such, many of the existing models use inappropriate or ineffective performance measures that are non-inclusive (Gunasekaran & Kobu, 2007).

Beamon (1996) identified and evaluated various individual supply chain performance measures. It was concluded that significant weaknesses were present in each of the performance measures evaluated, based on such criteria as inclusiveness, universality, measurability, and consistency. Repeatedly, the most consistent weakness for these performance measures was inclusiveness. For a measure to be inclusive, it must measure all relevant aspects of the supply chain. For instance, if a company decides to use cost as the measure of supply chain performance. Although the supply chain may be operating at minimum cost, it may at the same time indicate poor customer response time performance or lack flexibility to meet random variation in demand (Beamon, 1999).

Individual performance measures used in supply chain analysis have been shown to be non-inclusive. Consequently, important supply chain characteristics and their associated interactions have been ignored. Measuring the use of resources, especially cost, has also been identified as an important part of the supply chain. Many strategic goals of organizations recognize not only the importance of minimizing resources, but also the overall importance of the output of the system. Additionally, ignoring the effects of uncertainty on the supply chain results in a system that is unable to adapt to future changes (Beamon, 1999).

3.3 Supply Chain Trends

Logistics and supply chain management are currently facing disruptive economic, technological and climate change developments which require new strategies. The Internet of Things, digital manufacturing, and blockchain are a few examples of new technologies that are rapidly emerging and could give a competitive edge to businesses that use them wisely, while companies who resist change risk falling behind. Sustainability factors like low-carbon transportation, closed-loop supply chains, or socially responsible supply chain structures will become crucial to operate effectively in the future, and are perhaps the most significant for humanity. All these aspects will affect logistics and supply chains as well as

various operational areas such as air cargo, maritime logistics or procurement (Merkert & Hoberg, 2023).

According to leading scholars and industry experts, logistics and supply chain management will advance in the next decade and new academic qualities and skills will be required to succeed and adapt in the changing environment that will be characterized by volatile and more and more disrupted business eco-systems (Merkert & Hoberg, 2023).

Overall, in many supply chains, there are extremely effective and carefully planned flows that exploit value for all parties. However, in addition to opportunities, there are current difficulties such as supply chain disruption and rising costs as well as new challenges that must be resolved in the upcoming wave of optimization (Merkert & Hoberg, 2023).

3.3.1 Technological Breakthroughs

With the huge increases in computing power, the availability of low-cost sensor technology, and the improvements in Internet communication, there are various technological breakthroughs that affect our everyday lives: new tools like voice-enabled smart assistants like Amazon Alexa, Netflix recommendations for new streaming shows, and driver support systems in cars like Tesla's autopilot are becoming second nature to us. Even though many of these technologies are intended for the end user, many of them also have advantages for logistics and supply chain management. Truck routes can be optimized in real time based on traffic conditions, the most recent pick-up and delivery request and data on orders and invoices are exchanged contactless between supply chain partners, avoiding new lengthy and error-prone data entry, and new warehouse technologies are being implemented that essentially shift the traditional man-to-goods design principles. Authentication and verification will be added to those processes by using block chain technology. However, this is only the tip of the iceberg, and what can be done now is more important than what we might see in the not-too-distant future (Merkert & Hoberg, 2023).

Many new technologies for the supply chain are currently being tested and piloted, and these will allow for a whole new level of optimization. For instance, technology clusters such as advanced robotics in warehousing or autonomous transportation will affect more fundamentally supply chains in the next decade. Many supply chain processes are expected to see a significant improvement in efficiency, resilience, adaptability, and customer

orientation because of these new technologies. Some of these technologies need certainly more time for validation and testing, for example, autonomous transport and delivery technologies or collaboration and crowd platforms while other technologies are already relatively far in the development process and have potential for widespread adoption soon, for example, advanced robotics in warehousing and IoT or smart sensor technology (Merkert & Hoberg, 2023).

Although technology is not the answer to all issues, a combination of many technologies can result in significant increases in productivity and innovative disruptions, such as the concept of a physical Internet or the promise of lights-out warehouses. While technology appears to be beneficial to future supply chains, it is important to note that Internet security and the possible loss of human capabilities and experience could pose risks during the transition to a more intelligent and autonomous logistics and supply chain process (Merkert & Hoberg, 2023).

3.3.2 Climate and Resource Security

The public's awareness of the effects of climate change and resource scarcity has significantly increased over the past few years. Throughout the twentieth century, industrialization and emissions, particularly carbon dioxide, which causes a greenhouse effect, contributed to climate change. The release of greenhouse gases significantly accelerated in the twenty-first century. Consequently, under the 2015 Paris Agreement, nations worldwide agreed to limit global warming to 1.5 C. By 2030, carbon emissions must be significantly reduced, and by 2050, emissions must be near zero. Manufacturing and shipping all kinds of products clearly fall under the scope of supply chain management, despite the fact that logistics and transportation are only directly responsible for approximately twenty percent of global CO2 emissions. Superior supply chain management practices have been recognized as a means of lowering CO2 emissions by businesses and governments (Merkert & Hoberg, 2023).

The boundaries of the planet are a limiting the economic growth on a global scale as the humankind is consuming resources at an alarming rate for many commodities and raw materials, exhausting the planet. In addition to the race between China and other nations to secure future rights for the majority of the essential commodities that they require for their growth, it becomes much more difficult for companies to acquire the necessary raw

materials at reasonable prices and at steady rates. Rare earth metals have been the most pressing example of such supply constraints in recent years; however, in light of the rising demand for electric vehicles, other metals like lithium and cobalt are now also on the radar of governments and investors. As a result, it is likely that ensuring access to raw materials will become a significant challenge in the future (Merkert & Hoberg, 2023).

Companies have to deal with increasing energy costs, local environmental requirements, and probably the limited availability of important resources. In addition, transportation and manufacturing networks must be assessed much more frequently. Companies have to find new alliances and partners who can in cooperation help them to reduce emissions of greenhouse gases. This is especially important because scope 3 emissions, which include all indirect emissions that occur in a company's value chain, are increasingly becoming the standard for measuring emissions (Merkert & Hoberg, 2023).

New technologies that can reduce a company's carbon footprint need to be analyzed and tested. These technologies could change the game or fail completely despite huge investments. When it comes to environmental responsibility on the one hand and agility and responsiveness on the other, trade-offs must ultimately be reviewed and defined. As a result, the question of whether Apple should continue to ship "empty iPad boxes halfway across the world and back" to have happy customes, will become significantly more complicated. With a stronger emphasis on greenhouse gas emissions and new ethical guidelines, this might be possible under the current economic climate (Merkert & Hoberg, 2023).

3.3.3 Changing Customer Requirements

The overarching goal of logistics and supply chain management practices has always been customer centricity, or delivering products in line with customer expectations: delivering the correct product at the correct time to the correct location at the correct cost. Nowadays, most customers expect countless options or instant customization, which makes design, sourcing, and manufacturing more complicated. In addition, the customers are now used to receiving the ordered product on the following day, if not the same day. This challenge increases the complexity and effort in warehousing and transportation for many retailers and logistics service providers. Customers are used to a world where individual needs are met with one-click ordering, quick delivery, and instant gratification as

a result of this so-called Amazon effect. This also applies to the B2B customers, who are used to these exceptionally fast customer services from their private lives as the new normal. This may in the future result in over-expectations all over the world, and businesses competing fiercely are frequently unable to charge for the value added of these expensive expectations. B2B customers must be segmented in order to avoid becoming overwhelmed by the numerous distinct operational requirements and demands that are resulting from the increasing the complexity of supply chain operations and their models. Markets can change quickly, as evidenced by lockdowns related to COVID-19. Customers are now significantly more engaged with e-commerce platforms. In times like these, companies with quick supply chain adjustments gain market share while others suffer (Merkert & Hoberg, 2023).

3.3.4 Changing Ecosystems

Logistics and supply chain management ecosystems have become more competitive and evolved into advanced industries because of technological advancements, operational environment modifications, and shifting consumer preferences. Companies in the supply chain and logistics sectors benefit from the unconventional solutions of young, innovative individuals. The market leaders are being challenged by new entrants and business models, many of which have grown to become global companies with significant market or bargaining power (Merkert & Hoberg, 2023).

In addition, there has been a shift from globalization to onshoring and sure shoring, as well as a trend toward omni-channel distribution, a boom in e-commerce, horizontal and vertical collaborations, such as joint ventures, and increasing market concentration, which has continued during the COVID-19 pandemic. Platforms that create value through value co-creation, co-opetition, and dynamic configuration, for instance, have also been shaped by political environments that include competitive regulation and tax regimes. Disruptive technology transition and an increased focus on environmental sustainability have also transformed logistics ecosystems (Merkert & Hoberg, 2023).

The last mile continues to undergo significant change as delivery drones and automated, electric vehicles replace traditional transportation assets, even though those ecosystems are increasingly centered around automated warehouses and distribution centers. Naturally, these modifications extend to more traditional components of the supply chain,

such as procurement and risk management in a circular economy (Merkert & Hoberg, 2023).

Some of those changes have accelerated because of the COVID-19 pandemic, which has made it clear that global supply chains need to be flexible and resilient as well as empathetic at the individual level. Since the beginning of the pandemic, many supply chains have been severely impacted, but not everything about that is problematic. For instance, the COVID-19 pandemic and subsequent disruptions to the global supply chain have transformed air cargo logistics into profitable and commercially viable businesses, even though air cargo has traditionally been loss making (Merkert & Hoberg, 2023).

4 Risk Management

Risk is the effect of uncertainty on objectives. The outcome differs from what was anticipated. With respect to the anticipated effect, the effect could be either positive or negative. Risk refers to the exposure of someone or something valuable to harm, danger, or loss (Oxford Learners Dictionaries, n.d.). In the context of business, a risk is anything that poses a threat to an organization's capability to achieve its planned levels of profitability. Over the long term, risks may be a threat to an organization's sustainability (Kenton, 2022).

Risk management is a process which purpose is to minimize the risks of a specific object or activity and their impact. In risk management different risk analysis techniques are applied to improve decision making in project investments, schedule, quality, or other operating processes point of view (Visure Solutions, Inc., n.d.).

Every company and organization within a company possesses different risks which may originate from various sources. The risks may include all kinds of risks from the mistakes of strategic management to information security threats or natural disasters. The risks variate and change intermittently, which is why it is important for the organizations to carry out regular risk assessment and execute a plan to mitigate possible disruptions (Visure Solutions, Inc., n.d.).

Risk management is usually based on a process, the parts of which are identification, analysis, measures, and monitoring. The company can do it internally or in cooperation with an external expert, for example an insurance company. Risk analysis is always relevant

in connection with changes and at irregular intervals. Figure 3 presents a simple model that is suitable for examining other operational risks in addition to delivery risks (Logistiikan Maailma, n.d.).

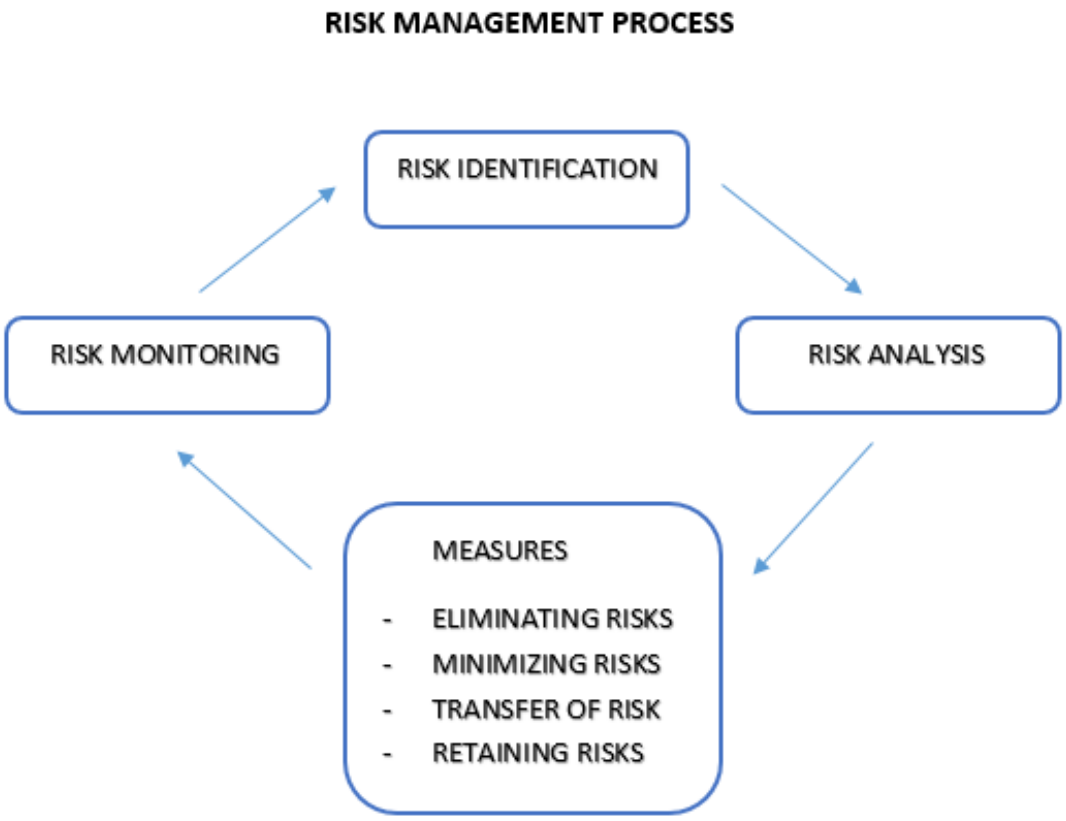

Figure 3. Risk management process (Keskitalo, 2023. Adapted from Logistiikan Maailma, n.d.).

Risk identification: First, the risks are identified. The risk can be apparent or hidden. The potential temporal and geographical distance of the risks and their consequences must be taken into consideration during both risk identification and analysis (Logistiikan Maailma, n.d.).

Risk analysis: After the identification of risks, the significance of the risks is assessed. The magnitude of each individual risk is determined by multiplying its probability and impact. The significance and impact of risks and their financial effects are measured with a magnitude class, which can be a three- or five-step scale. The outcome is a list of identified risks in order of their magnitude. Each company can classify risks according to its own resources (Logistiikan Maailma, n.d.).

Measures: Once the risks have been identified and their probability, significance and impact have been assessed, it is necessary to decide on further measures, for instance, how the risks will be managed. When considering the measures, the importance of risk analysis, the urgency of various factors and the available capacity must be considered (Logistiikan Maailma, n.d.).

The primary aim is always to eliminate the cause of the risk. If the identified risk cannot be entirely avoided, its impact is minimized by damage prevention work. The risk can also be transferred. It can be transferred to another contracting party, but this does not eliminate the risk. One option of risk transfer is insurance. The insurance company bears the consequences of any risk that may materialize in return for payment. Small risks can be kept by the company at its own risk. Even in that case, the party who was injured can seek compensation directly from the party who caused the damage. It should be noted that damages are not covered by the carrier's liability insurance unless the carrier is responsible for them, and even then, only within the scope of the applicable law or contract (Logistiikan Maailma, n.d.).

In the case of continuous and steady flows of goods, one way to manage minor risks arising from the handling of goods is a recourse agreement. In this case, the client and the company handling the goods agree that the costs of the detected damages that fall below the agreed limit will be shared in some proportion, for instance 50/50 or 60/40 (Logistiikan Maailma, n.d.).

Risk monitoring: A crucial part of risk management is monitoring and reporting. They serve as the foundation for the next risk management phase. Monitoring and statistics that are up to date are crucial because the company must also prepare for unknown risks. Damages are a cost that can be easily hidden in the absence of current statistics. However, the risk must be considered as a separate cost in both cost accounting and budgeting. Therefore, cooperation with financial management is important. Every risk, whether it is realized or not, is an expense in terms of costs. The company oversees deciding whether the costs are paid for preventing damage or when risks occur (Logistiikan Maailma, n.d.).

According to Waters (2011) there are two main factors to evaluate risks, the likelihood, and the impact. The likelihood (probability) explains how likely a risk will occur whereas the impact (consequence) is an estimation of the damage that could be caused by an event.

Additionally, risk analysis can be divided into two methods, qualitative and quantitative (Berg, 2010). Qualitative risk analysis is the method of scoring a risk based on a person's estimation about the risk's probability and its consequences and it aims to come up with a short list of risks which need to be prioritized (SafetyCulture, 2023). A qualitative approach is more suitable when the likelihood of the events is very difficult to estimate or when the risks are subjects of more expensive quantitative research. Most common tools used in qualitative risk analysis include hazard matrices, risk graphs and risk matrices. Qualitative risk analysis should contain a description of the risk, evaluation of impact and likelihood of the risk and measures for mitigating the risk (Berg, 2010).

4.1 Risk categories

The risks can be categorized into various categories. One option is to categorize supply chain risks into five main categories: Supply, Demand, Process, Control or Environmental risks. Supply risks include any disruptions in the supply chain. Demand risk is related to volatility of the demand. Process risk describes the resilience of processes and possibility to have additional capacity if needed. Control risk includes disturbances and distortions in the internal control system which could cause disorder in the supply chain. Environmental risks cover any external force that can disrupt the supply chain. Many different sources identify the same elements and causes of potential risks (Christopher, 2011).

A risk includes all events or circumstances threatening a normal business or organizational operation. These events or circumstances can originate internally or externally. It is very challenging for an organization to mitigate all the risks. Risk categorization is a complex process that involves grouping risks of one type separate from another to provide a simple method of determining where the most significant risks lie (Hager, 2022).

Furthermore, risk management should be holistic enough to predict the likelihood of risk occurrence and prepare a mitigation plan to prevent the risk from occurring or avoid the impacts that it might pose to an organization or business. Therefore, understanding the various types of risks and their possible impacts (risk categorization) is critical to the complex risk management process since it enables organizations to remain risk-tolerant and soften themselves from potential loss (Hager, 2022).

Risk categorization aims to make it easy to identify risks since they have already been grouped together, to help to create appropriate risk-specific mitigation strategies, to define the areas prone to risks based on the types of risks in each category and to plan out the parts of the business that are most likely to be affected by a risk (Hager, 2022).

Another theory is to categorize risks in three main risk categories: internal risks, external risks, and strategic risks. Breaking down various risks into risk management categories makes it easier to carry out plans to mitigate them. To score various risk categories, different businesses employ different methods. The impact of the risk, risk assessment data, the impact matrix, and root cause analysis serve as the foundation for these methods. An organization might run into several different kinds of risks. These risks can be financial, legal, reputational, security, human, or operational risks. In risk management, the three most common risk categories are internal, external, and strategic risks (Hager, 2022).

Internal risks are the internal threats and factors which originate from within an organization and can appropriately be handled by the organization. Physical, technological, and human resource risks are examples of internal risks. The organization aims to eliminate and minimize these risks by utilizing internal control measures to ensure the operations run efficiently. There are several ways to eliminate internal risks. For instance, by controlling the environment, by monitoring, by communication or by risk assessment (Hager, 2022).

Controlling the environment can be accomplished by making changes to the organizational workplace to reduce risks. It includes, for instance, installing firewalls to protect IT infrastructures and safety equipment to prevent accidental risks. Monitoring includes closely monitoring operations to identify potential threats. This makes it possible to anticipate solutions to such issues before they have a negative impact on operations (Hager, 2022).

Communication is an important factor in avoiding any issues. Different departments, managers, and employees all benefit from well-established communication and information sharing which can avoid last-minute problem solving in hurry. Risk assessment is a control mechanism that identifies and allocates a financial value to each potential risk, allowing a company or organization to prioritize risk mitigation (Hager, 2022).

In contrast to internal risks, external risks cannot be controlled by the organization because they originate from the outside of the organization. External risks include political, legislative, and natural risks (Hager, 2022).

Risks that have a negative impact on a nation's economic stability and consequently on business and organizational operations are referred to as economic risks. These risks include for instance deflation, inflation, and increased government taxes. Economic risks can be controlled by having emergency funds or by decreasing operational expenses to ensure survival in the occurrence of economic risk (Hager, 2022).

The term natural risk refers to unexpected natural disasters like hurricanes that may influence the organization’s normal operation. Natural risks can be managed by excluding business from natural disaster-prone areas or by insurance against natural disasters (Hager, 2022).

Political risks are threats that an organization or business might face because of political change or instability. Risks related to politics can be managed by following the government regulations and trade requirements to avoid closure or sanctions (Hager, 2022).

Strategic risks are threats arising from the decisions made by an organization's board of directors regarding an organization’s goals. Because they affect a company's output or value, strategic risks are frequently pursued. If not handled properly, they can prevent an organization from achieving its desired output or specific goals, eventually leading to its collapse (Hager, 2022).

Understanding strategic risks is critical in business for various reasons. Organizations can achieve their objectives by giving leaders the authority to make favorable and informed decisions. Having a solid understanding of strategic risks provides leaders with crucial information they need to avoid difficulties and achieve their full potential. By understanding strategic risks, the management of an organization can prioritize and mitigate issues that can possibly have a significant impact on the organization (Hager, 2022).

4.2 Risk Mitigation

A strategy for preparing for and mitigating the effects of potential threats is known as risk mitigation. Risk mitigation, in contrast to risk reduction, focuses on minimizing the negative effects of threats and disasters on business continuity. Cyberattacks, natural disasters, and other causes of physical or virtual harm are all potential threats to a company. One component of risk management is risk mitigation. The implementation of risk mitigation varies by organization (TechTarget, n.d.).

There are several types of strategies for risk mitigation. Depending on the company's risk background, one of these strategies may be preferable to another. All these strategies are a part of the risk management concept as a whole and are frequently used together (TechTarget, n.d.).

Risk avoidance is used as a strategy when the consequences are believed to be too high to justify the cost of addressing the issue. An organization can, for instance, decide not to engage in certain business practices or activities to limit its exposure to potential risks. Risk avoidance is a common business strategy. One example of risk avoidance is limiting investments. It can also be more serious, for instance not building offices in areas in possible war zones (TechTarget, n.d.).

Another risk mitigation strategy, risk acceptance, means that a risk is accepted for a certain period to focus mitigation efforts on other risks. Risk transfer distributes risks among various parties in accordance with their capacity to mitigate or prevent the risk. A defective product made with some material from a third party is one example of risk transfer. Due to this, the product manufacturer may transfer responsibility for a portion of the risk. Risk monitoring is the action of observing projects and the related risks for changes in the impact of the associated risks (TechTarget, n.d.).

4.3 Risk Analysis

Risk analysis can be defined as the process of understanding the nature and severity of risk. Risk analysis is the basis for determining the significance of risk and making decisions regarding risk management. An assessment of the magnitude of the risk is included in risk analysis (Visure Solutions, Inc., n.d.)

Risk analysis is the practice of evaluating and managing uncertainties to reduce their potential negative impact. Although risk analysis can be utilized in a variety of contexts, it is mostly employed in investment and business decision-making. The main advantage of risk analysis is that it helps organizations make more informed decisions by considering the possible effects of uncertainties. Risk analysis can be divided into two main categories: qualitative and quantitative. In quantitative risk analysis, the likelihood and possible impact of risks are determined using mathematical and statistical techniques. Whereas, in qualitative risk analysis, expert knowledge is used to evaluate the likelihood and impact of risks (Visure Solutions, Inc., n.d.).

The risk analysis aims to thoroughly examine the identified risks in terms of their probabilities, consequences, sources, impacts, and management strategies. Because the event that caused the risk can have multiple causes and consequences, going through the risks enhances understanding of its nature and characteristics. The risk analysis itself can be carried out using either quantitative or qualitative methods or a combination of the two. It must consider at least the probability of the risk occurring and the consequence, as well as the magnitude of the consequences and the degree to which the control measures are working (SFS-ISO 31000, 2018).

The risk analysis can be influenced by non-fact-based factors like prejudices, opinions, and assumptions together with the assumptions and limitations made. When determining the significance of risks, these factors should be taken into consideration and reported along with information up the organizational chain. However, in the end, the outcome of the risk analysis is only a starting point for decision-makers to determine whether the identified risks need to be addressed and which the most suitable methods for managing the risks are (SFS-ISO 31000, 2018).

The risk analysis matrix presents a list of risks in ascending order of importance, with the most significant risks appearing first. Its primary objective is to assist decision-makers in categorizing risks and developing a risk management strategy with appropriate resources and approaches to threat management. The relative level of risk probability is determined using qualitative risk rather than statistical risk (Visure Solutions, Inc., n.d.).

The five fundamental steps that are followed by all risk assessments are the same, though the steps may be described in different terminology or slightly altered to better suit the requirements of different organizations (Visure Solutions, Inc., n.d.).

Step 1: Risk identification. The objective of the initial risk assessment is to identify all potential threats to the organization and its objectives. This step can be completed using a variety of methods for identifying risks.

Step 2: Risk analysis. When the risks are identified, they need to be analyzed and decide their likelihood and impact. By the end of this phase, the company should have a much better understanding of the risks it faces and how they might affect the objectives of the project.

Step 3: Risk classification. The next step is to categorize the discovered risks based on the magnitude of their potential effects. While some risks may have little impact, others may have such a significant negative impact that they should not be accepted.

Step 4: Planning the risk response. The objective is to develop a strategy that minimizes their likelihood and impact by starting with the highest risks.

Step 5: Review of the risk assessment. To stay relevant and useful, the risk assessment needs to be reviewed and updated on a regular basis because organizations are continuously changing (Visure Solutions, Inc., n.d.).

5 Methods and procedures

5.1 Research method

The research method chosen for the thesis is qualitative research method. Considering the research objectives and questions, qualitative research method was the most suitable as the aim of the research is to get better understanding about supply chain of cruise ship warranty logistics process and risks involved as well as to find out new insights about the topic and possible improvement suggestions.

Qualitative research involves collecting and analyzing non-numerical data to understand concepts, opinions, or experiences. It is used to collect in-depth insights regarding a

challenge or to create new ideas. Qualitative research differs from quantitative research, which involves collecting and analyzing numerical data for statistical analysis. In qualitative research the sample size is typically relatively small compared to quantitative research in which the sample size is usually large for the research results to be generalized. Therefore, the results of qualitative research cannot be generalized for large populations (Stanford Libraries, n.d.).

Exploratory research design was chosen as the aim of the thesis is to explore and analyze the supply chain of cruise ship warranty logistics process as well as to find out what kind of risks there are in the process and how those can be mitigated. There is not much previous research about this specific topic.

The objective of exploratory research is to explore the research questions and not necessarily to offer certain solutions to occurring problems. Exploratory research is typically conducted to determine the nature of the problem and to gain a better understanding of the problem. Exploratory studies are often conducted using interpretive research methods and they answer questions such as how, what, and why. Exploratory research can be used as a basis for more conclusive research. Typical data collection methods of exploratory research include interviews, focus groups, observation, and surveys. (Business Research Methodology, n.d.).

Each research approach involves using one or more data collection methods. The most common qualitative data collection methods for primary data include observations, interviews, focus groups and surveys. Secondary data is collected from existing data in the form of text, images, audio, or video recordings (Bhandari, 2023). In this thesis, secondary data was collected mostly from books, e-books, journal articles and website sources.

There are several methods for analyzing qualitative data, but they all follow the same five steps:

1. Organize and prepare data.
2. Examine and review data.
3. Create a system for data coding.
4. Assign codes to the data.

5. Identify recurring themes.

The details of each step depend on the focus of the analysis (Bhandari, 2023).

Qualitative research aims to maintain the voice and perspective of the participants and to understand them. Qualitative research has many benefits including flexibility. In qualitative research method, the data is collected in natural or real-world settings, and it is an appropriate method to collect important insights. Qualitative research is suitable for generation of new ideas as new problems or opportunities can be uncovered and detailed descriptions of people's experiences, feelings and perceptions can be used in designing, testing, or improving systems or products (Bhandari, 2023).

There are some disadvantages with qualitative research methods and therefore researchers must consider practical and theoretical limitations in analyzing and interpreting their data. Some disadvantages of qualitative research include unreliability, subjectivity, limited generalizability, and labor-intensiveness (Bhandari, 2023).

Unreliability - Because of uncontrollable variables that affect the results, qualitative research is frequently unreliable when conducted in a real-world situation.

Subjectivity - Due to the researcher's key role in analyzing and interpreting data, qualitative research cannot be repeated. When analyzing data, the researcher selects what is relevant and what is not, therefore different people may interpret the same data very differently.

Limited generalizability - To collect comprehensive data regarding certain contexts, small samples are frequently used. It is challenging to get generalizable findings despite thorough research techniques since the data may be biased and unrepresentative of the larger population.

Labor-intensive - Large amounts of text can be managed and recorded using software, but data analysis is frequently checked or done manually.

Since all observations, interpretations, and analyses are conducted via the qualitative researcher's own personal lens, they frequently view themselves as "instruments" in the research process. For this reason, it is important to reflect on the chosen approach and to thoroughly explain the choices made in collecting and analyzing the data (Bhandari, 2023).

5.2 Data collection

The data was collected by conducting a focus group and theme interviews for the most relevant parties involved in the cruise ship warranty logistics process. A focus group was conducted for the shipyard's Warranty Managers who all work with similar tasks and who encounter similar challenges. Theme interviews were conducted with internal and external logistics partners who are involved with the warranty logistics process and have many years of experience in the process. The aim of the theme interviews was to gain better understanding of the current situation, supply chain and the risks faced in different stages of the warranty logistics process. Previous literature and research, current process descriptions and other internal data as well as this author's own experience about the topic were exploited in the research.

The interview and focus group questions included mostly the same questions but some questions were modified according to the professional knowledge of the participants. The data for creating the process descriptions was collected mainly from the interviewees whereas the focus group was used to collect data about the overall process situation: what works well and what challenges there are. Risks were identified according to data collected from all participants.

The focus group and interviews were done face to face, except two interviews which were conducted via Microsoft Teams. The sample of the research included a total of nine people. The sample size of the focus group consisted of five people and interviews were conducted for four people. The sample consisted of internal personnel working in the shipyard's warranty and logistics departments and external logistics partners. Data was collected between late 2022 and April 2023. Notes were taken during the interviews and the focus group and summarized later. Participants are treated anonymously.

5.3 Analysis

Data collected in the focus group and interviews was first organized and summarized. When all data was in a clear written form, the data was reviewed and examined for patterns or repeated ideas that emerged. To categorize the data and identify risks a data categorization system was developed. The data was categorized according to the interview

and focus group questions to find out similarities. Each participant's answers were examined and tagged with a category. This was how recurring themes were identified. After the data was organized, the answers regarding the process were analyzed and then the process descriptions were created accordingly. Identified risks were listed to enable risk analysis. The chosen method for risk analysis was Risk Assessment Matrix.

6 Results and interpretation of the results

The current supply chain was determined and analyzed. The current situation was explained, and process flow charts were created to make the process more understandable. In the interviews and focus group, a better understanding of the process was gained. It was determined what worked well and what did not work well. All the interviewees mentioned similar points. Of course, there were some different points mentioned as the interviewees are working in different stages of the supply chain. Some stages of the supply chain work better than others.

First, risks were identified by conducting interviews and one focus group. Secondly, the risks were prioritized, and the most common risks were analyzed by using a risk assessment matrix which also includes a description of how to respond to the risk, in other words mitigate it.

6.1 Focus group results

The focus group was conducted for five people working in the shipyard's warranty department to gain a better understanding of the current situation and how it could be improved.

What is working in the Warranty Logistics Process when sending or returning spare parts or material on board?

Overall, shipments prepared and sent by the shipyard are working well. The warranty shipments sent by suppliers, including spare parts or material, are also reasonably well delivered to the ship. Overall, very few deliveries go missing.

There are challenges finding out the exact type of material or part and details such as thickness. The process should be simpler. It might be clear to the person responsible for

the specific system, but not to the warranty department who handles guarantee claims of the whole cruise ship consisting of millions of different parts. There are both internal and external challenges in the beginning of the supply chain. It is challenging to receive detailed information about what needs to be ordered as well as to get someone to place the order. There are similar challenges with communication with the suppliers when the warranty department needs information from the supplier about where a specific part was originally purchased or even to find out who is the correct supplier.

When asked what works well with warranty shipments to Europe, many participants mentioned that it was fast. For example, when the shipyard's dispatch center sends a message to the shipyard's forwarding partner, it does not take more than an hour before the shipping documents arrive and the shipment is on the move. Sometimes it can take only three days and the shipment is on board. The shipyard's dispatch center keeps the warranty department up to date with what is happening by open communication. Communication is fast and easy, which enables the warranty department to react if there are any issues. The ship owner stores the warranty goods well on board. Each package is stored under the guarantee claim number and can be found easily on board.

With the shipments to the USA, it was a common opinion that the shipyard's and its forwarding partner's part works well. Suppliers often want to send warranty goods to the shipyard rather than delivering directly to ship. Deliveries to the ship owner's warehouse work well, but because of the huge size of the warehouse and challenging customs process in the USA, it is faster and more reliable to make warranty deliveries through the shipyard's local logistics partner in the USA. Overall, the goods arrive on board the ship just fine. In general, there are very few cases where the item would not have arrived or would have been lost compared to the total claim amount.

What is not working in the Warranty Logistics Process when sending or returning spare parts or material on board?

When asked from the focus group participants, what was not working in the warranty logistics process when sending or returning spare parts or material, the main consensus was that the journey of the goods was not known, and the tracking of shipments did not work even though it should work nowadays with the technology available. Some suppliers report well about their warranty shipments but more comments like "goods are now on

the way" would be needed. The supplier's shipments do not work as well as they could. The information does not flow between the shipyard and its suppliers. More communication would be beneficial about who sends what and when. Sometimes guarantee claims are left hanging open when it is only found later that a part has arrived on board a long time ago, but the receipt acknowledgment from the ship was missing. Many times, there is uncertainty whether a shipment has arrived when the receipt acknowledgment is not consistent. The beginning of the supply chain does not work when there is not enough information. The shipyard's Warranty Managers must put a lot of effort into finding out what kind of spare part or material is needed and from where it was originally ordered.

Approximately 90 percent of the shipments go well to countries in Europe and arrive smoothly. The ship owner's port agent regulates what time is suitable to load the shipment to the ship. When there are no staff, it might cause problems. Also, the receipt of delivery arrival is not often received by the shipyard. The warranty department would like to receive confirmation from the receiving port agent once the shipment has arrived on board.

There is no transparency between the ship's on board spare part stock and the shipyard. After the official warranty period, it is sometimes unclear who is the responsible person on board receiving the warranty deliveries if the shipyard's guarantee engineer has already disembarked.

The responsibilities regarding returning material are unclear between the ship owner and the shipyard. It is not clear who should create the return documents and handle the packaging. Often the suppliers do not react if they wish to have parts or material to be returned and there is not proper information. The suppliers should react within seven days in case they need something returned and provide their courier number and delivery address. Although there are significant differences between suppliers, some work well and some do not.

Another issue with the material returned is the collection of the material, which is the ship owner's responsibility. There is variation but sometimes it can take up to three months before the material is ready to be offloaded and returned. It is not clear who will handle the packaging and the landing cargo manifest (LCM) of material to be returned. This should be the ship owner's responsibility, but the contract can be understood in many ways. No

material comes out of the ship without an LCM which the port agent receives. The ship owner is obliged to take care of the physical offloading of the material. It was also unclear for the focus group participants, where the returnable material can be left, quayside or pier, at which point does the ownership of the goods change from the ship owner to the shipyard or shipyard's supplier who has requested the material return. A very small amount of material ends up returning to the shipyard. The shipyard does not receive information of when the goods have been returned to the supplier's delivery address.

It is challenging when some of the shipyard's logistics partners are not willing to invoice the shipyard's suppliers directly and the shipyard must reinvoice the costs from its suppliers later. It is challenging to identify and allocate costs correctly to tens of suppliers.

Challenges are similar with the shipments to the USA. The shipyard's warranty department does not always receive information from the suppliers if something has been sent when it has not been registered in Jira nor been informed to the shipyard's warranty department in other way either. There are a lot of challenges with the ship owner's central warehouse. The delays caused by the warehouse are significant. The suppliers' forwarding agents, such as DHL or UPS deliveries are always running, but it is uncertain what happens if they cannot deliver, and the goods must wait or will be returned.

There have been situations in previous years when someone went to find some missing goods from the ship owner's warehouse and the goods were not found there. In one example case, goods were sent by DHL, and according to the tracking number, the shipment was received at the ship owner's warehouse, but it took three weeks before the warehouse personnel responded. In another example case a shipyard's supplier had sent paint (dangerous substances) to ship in the USA. The paints were waiting at the airport, but the ship owner did not react, so eventually the paints were sent back to Finland and the costs were significant. This example case was a waste of time and money. The shipyard is unable to influence the operation of the ship owner's warehouse, so it has organized its own system for the shipyard's warranty deliveries through a local logistics partner. It is worth paying to have a working and reliable system for warranty deliveries.

The discussion about responsibility for material return is difficult; everything falls on the shipyard even though it should be the ship owner's responsibility. Some ship's guarantee

engineers create the LCMs as it should be. The material returns handled by the shipyard's forwarding partner work well in both the USA and Europe.

It is already a challenge itself to transport the material to the ship when the ship is sailing in different places. Also sometimes, when the ship is sailing for a longer period to new areas, it is challenging to form and adapt new procedures for warranty deliveries as different countries have different formalities regarding customs and other issues. The port agent affects the warranty delivery process as well.

One of the biggest challenges is the material return process. It is unclear what the process is after a broken part is removed. There are lot of intermediaries, and it is unclear what happens after material has been offloaded, for example, who the responsible party is at each stage. Also, port services and the USA regulations could be clearer. Only parts or material the supplier has requested should be returned, but sometimes the material that could have been scrapped is offloaded and returned.

What do you think is the root cause of the problems?

When the focus group participants were asked what they thought was the root cause of the problems, they all agreed the main root cause is the contract. The contract gives a lot of room for maneuver, both for the ship contract and for the contracts between the suppliers and the shipyard. The warranty part of the contract is unclear with plenty of room for interpretation. The same contract base with the same conditions should be used for all suppliers, of course, with some case-specific changes. But in supplier contracts, there are differences between suppliers; the same contract basis has not been used which makes it challenging to negotiate with the suppliers. Responsibilities and obligations regarding the warranty should be more clearly expressed in the contract.

In addition, a root cause for the challenges in the process is that there are multiple people involved in the process. Communication between all parties is challenging. Cruise ship warranty logistics is a complicated process, but it was questioned whether it must be that complicated.

How are the risks managed now in the warranty logistics process?

When the participants were asked how the risks were managed now in the warranty logistics process, the answer was that there is no clear process to manage risks and some parts; for instance, the ship owner's warehouse, cannot be influenced by the shipyard. Warranty logistics partners' responsibilities are defined in the contracts. Risks are managed by contracts, delivery terms and for more valuable shipments a separate transport insurance is taken. Regarding the risk of losing a shipment, the shipyard's shipments are mitigated by packaging the warranty shipments in black film and by marking and labeling them well, by using special tape with text "WARRANTY" on it.

What improvement suggestions do you have regarding the process?

When the focus group participants were asked what improvement suggestions they have regarding the warranty logistics process, many of their suggestions were related to shipment tracking. For instance, RFID tags in the shipments, better tracking in Jira and better use of tracking codes were mentioned.

Also, photos of the shipment would be beneficial as that would help to locate missing packages on board when the ship personnel know what to search for. There was a common opinion that the areas of responsibility should be more clearly defined in the contracts. Better communication and transparent information flow with the logistics partners and other parties could be improved. The whole process should be made as straightforward as possible.

It was mentioned that clear process descriptions or flow charts illustrating the warranty logistics process would help to understand the process and make it clearer to think about possible alternative solutions or better options when all parties and steps are clearly visible. The process could be improved by allocating the costs to the right place in the first place. It was also suggested that further risk analysis is needed once the current situation and process, including all details, are known. Benchmarking with other companies would be beneficial.

How are the responsibilities of different parties agreed according to the contracts between the ship owner, shipyard, and shipyard's suppliers regarding sending or returning spare parts?

The responsibilities between the ship owner and the shipyard are recorded in the contract in a way that can be interpreted in many ways. For instance, the ship owner is responsible for material returns but it is unclear for which part or until what point they are responsible. The shipyard's suppliers are responsible for delivering spare parts and material needed to close their guarantee claims as well as all costs related.

6.2 Interview results

Process descriptions were defined according to the information received from the logistics partners who are one of the most important members of the supply chain. The process varies slightly between the ships and the countries where the deliveries are made but there are a lot of similarities. Separate process descriptions for deliveries on board and material returns were created according to the answers to interview questions "What is the Supply Chain of the Cruise Ship Warranty Logistics Process when sending spare parts on board or when returning material or spare parts from the ship? Describe the process step by step. What documents are needed in each step?" The interviewees were also asked "What kind of risks are there in Cruise Ship Warranty Logistics Process and how can the risks be mitigated?" These answers are analyzed in the risk analysis part of the thesis.

What is working in the Warranty Logistics Process when sending or returning spare parts or material on board and what is not?

According to the shipyard's logistics partner in the USA, now that they have finally established a clear and reliable passage for the ships everything is working well regarding the deliveries made on board. As for different ships, there are different processes and ways of working; the logistics process should be discussed and agreed between the ship owner and shipyard well in advance before delivery of the ship. It would benefit all parties if the supply chain was well established in advance. Logistics costs-related accounting is still a grey zone and costs are difficult to allocate on correct parties (Shipyard's Logistics Partner in USA, 2023).

From the shipyard's dispatch center's perspective, the communication and flow of information with the warranty department works well. With some people you do not get an answer for weeks, other than the warranty department, which delays the work and preparation of shipments. One example is that someone announces that some part is very urgent and after that, you do not hear from them for weeks and the shipment is waiting for that urgent part. The material usually arrives at the dispatch center with all the necessary information, but sometimes you must ask for the GC-number or it is not marked in the shipping documents. If you must wait for the missing information, there is a risk it may be forgotten (Shipyard's Dispatch Center, 2023).

From the shipyard's forwarding partner's point of view, everything works well regarding warranty shipments leaving from the shipyard to cruise ships in both Europe and the USA. Regarding the material returns, it seems the guarantee engineer on board packs and prepares documents in hurry, which sometimes leads to missing information (Shipyard's Forwarding Partner, 2023).

Everything with delivering shipments on board works very well and goes smoothly according to shipyard's logistics partner in Europe. There are more challenges when offloading and returning material. Mostly the challenges are customs related when the goods must be cleared, for example in cases when the material is going outside the EU, but some companies are willing to pay taxes and duties and handle necessary formalities (Shipyard's Logistics Partner in Europe, 2023).

What improvement suggestions do you have regarding the process?

When the interviewees were asked how the process could be improved, some of the same points were mentioned as in the focus group, but different perspectives from each party were offered as well. The shipyard's logistics partner in the USA mentioned the supplier's courier account usage must be improved regarding the material returns. One solution could be clearer instructions and a stricter policy for providing delivery addresses and a courier account number within the announced seven days. If this cannot be done, then the material should be scrapped. Also, packing on incoming shipments could be improved. The number of separate packages should be minimized to minimize costs as the costs and documents are charged per package (Shipyard's Logistics Partner in USA, 2023).

From the shipyard's dispatch center's perspective there could be improvement with the shipping documents from the suppliers' side. Often the suppliers' shipments lack proforma invoices, even though the ship is always considered outside the EU and the proforma invoice is needed. Material deficiencies and other related information could be updated better (Shipyard's Dispatch Center, 2023).

It was suggested by the shipyard's forwarding partner that in some cases local procurement would be a better option instead of sending the material from Finland. For instance, there are cases when hazardous materials have been sent without the safety data sheet (SDS) or material safety data sheet (MSDS) causing problems in the later stages of the supply chain (Shipyard's Forwarding Partner, 2023).

The shipyard's logistics partner in Europe mentioned it could be helpful if the shipyard would send a pre-alert to suppliers about upcoming offloading, notify them that the goods are in bonded status and ask whether they want to proceed with T1 transit or proceed by paying taxes and duties. This could make the process faster and decrease the response time if the suppliers had time to prepare before they are in hurry (Shipyard's Logistics Partner in Europe, 2023). T1 document and T1 transit, for example, the external transit of the European Union, is used when undeclared goods are imported into the EU from outside the EU or undeclared goods are transferred within the EU (between Member States or within one Member State) or to countries under common transit (Suomen Tulli, n.d.).

6.3 Process descriptions

The process descriptions were created according to the data collected in the interviews with the main logistics partners involved in the process. The main logistics partners have several years' experience of the topic and therefore can be considered as reliable sources. The process for both warranty deliveries on board and material returns are described and illustrated below in Figures 4 and 5 to make it more understandable.

6.3.1 Warranty deliveries on board

The process for warranty deliveries on board cruise ships is mostly the same for all deliveries; there are only different partners in different countries. The process starts when the ship owner creates a guarantee claim in the common warranty handling system, Jira,

which enables all warranty related communication and co-operation between all three key parties: the shipyard, the ship owner, and the suppliers. The guarantee claims are assigned to the shipyard or to a shipyard's supplier according to contractual responsibilities.

In case there is a need for a spare part or material to settle shipyard's guarantee claims, the first step is that the Warranty Managers together with the System Responsible find out the details of the part or material needed. In case it is not in the shipyard's stock, it must be ordered. The procurement department will then place an order and the order will be delivered to the shipyard's warehouse where it will be collected from and sent to the shipyard's dispatch center.

The shipyard's dispatch center will collect all packages to be sent, prepare a shipment for each ship separately and create proforma invoice. Information needed to create proforma invoice includes package amount, weight, value, material description and GC-number. It is important that all packages include correct information, especially the correct ship and GC-number must be mentioned.

After packaging and creation of proforma invoice, the dispatch center will send pre-advice about the shipment to the warranty department and the shipyard's forwarding company. The forwarding company will then book the transport, create a waybill, and do the export clearance. The forwarding company will organize pick up from the shipyard and then the shipment will be transported to a local logistics partner either in the USA or in Europe. Pre-advice regarding the upcoming shipment will be sent to the ship owner as well as to the local logistics partner by the shipyard and the forwarding company.

Once the shipment arrives at the local logistics partner, they will agree the delivery date on board with the ship owner's port agent who then contacts the ship owner's logistics agency who handles the customs clearance if needed. The ship owner's logistics agency arranges the customs clearance and lifting or loading equipment for the shipyard's local logistics partner who will then make the final delivery on board. Once the shipment has been received on board, the guarantee engineer on board will inform the shipyard that the shipment was received.

In cases of supplier's guarantee claim, the supplier will ask for delivery instructions from the shipyard and shipyard will inform supplier about the correct delivery address received

from the ship owner as well as other necessary instructions regarding making the shipment. Supplier will then prepare the shipment and send it to the ship owner's warehouse or port agent. The ship owner's logistics personnel will then handle the delivery of the shipment on board. Once the shipment has been received on board, the responsible guarantee engineer on board will add a comment in Jira, under the correct GC-number, that the material was received. Figure 4 shows the process for warranty deliveries on board.

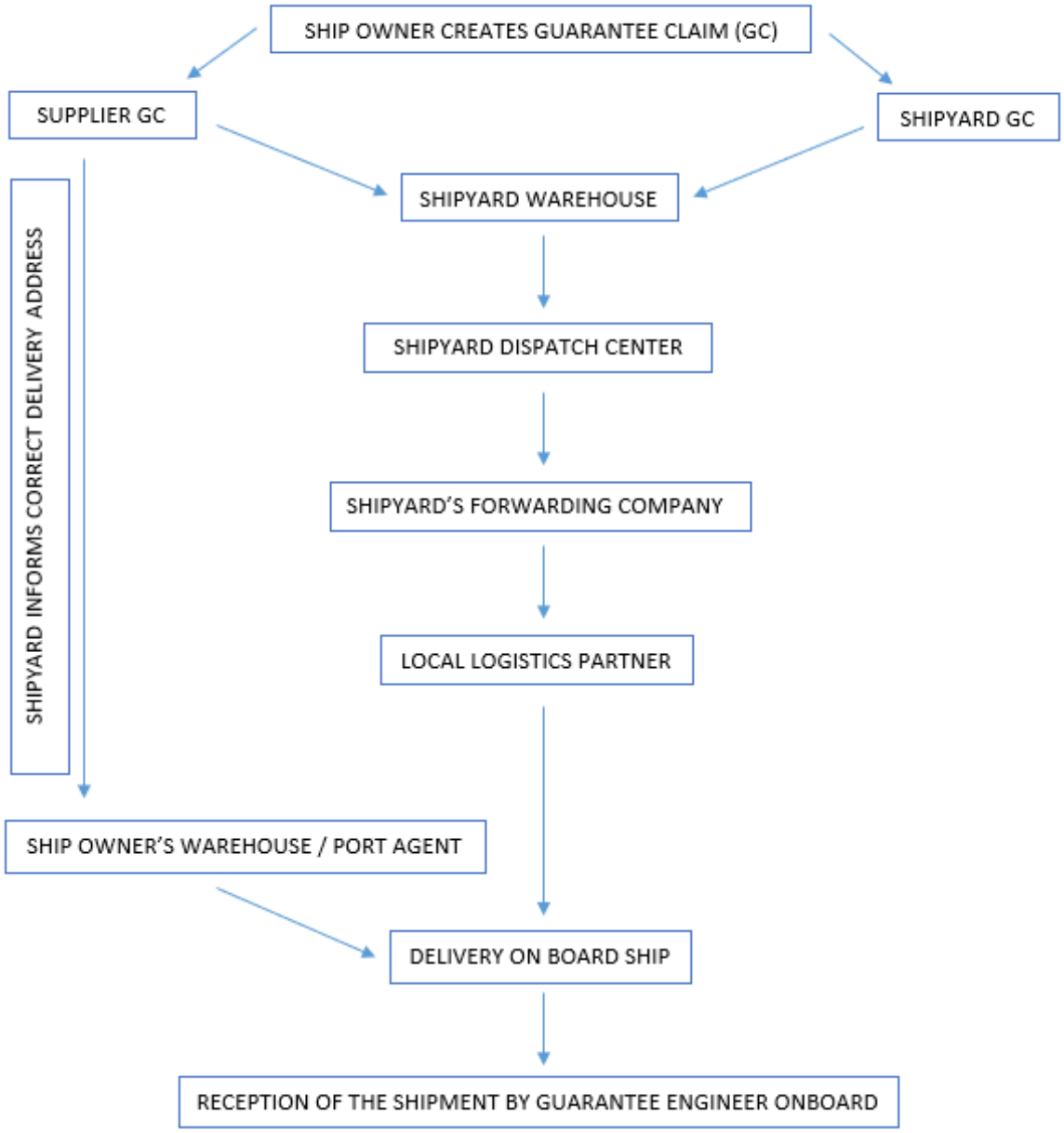

Figure 4. Process flow chart of warranty deliveries on board (Keskitalo, 2023).

In some cases, the suppliers will send the warranty material or spare parts to shipyard's warehouse, where the material is then collected and delivered to shipyard's dispatch center. The dispatch center will then prepare a package including material and spare parts

for both suppliers' and shipyard's guarantee claims. In both cases, direct deliveries to ship or shipyard's warehouse, the supplier must provide a packing list and commercial invoice or proforma invoice.

6.3.2 Material returns from the ship

Warranty material is only returned to the supplier or shipyard if requested within the agreed time. If material or parts are not requested back, they will be scrapped. The returning material or parts are usually excess material left from fixing a guarantee claim or a broken part that has been removed. For instance, with the electrical parts, the suppliers often request the part back so that they can investigate what caused the issue. Most of the returning material is requested by the suppliers and only a small part by the shipyard.

The process of the offloading and material return process starts when the supplier or the shipyard requests material or part to be returned. The requester must provide a delivery address, contact person for delivery, courier account number as well as information for the LCM document which includes the number of packages, weight and value of the goods and a sufficient description of the goods for a correct customs code. The Guarantee Engineer on board then collects the material and prepares the LCM and packaging of the goods according to information provided by the requester. Once the LCMs are ready, the Guarantee Engineer on board will send offloading pre-advice including the LCMs by email to shipyard warranty personnel, local logistics partner and shipyard's forwarder.

The ship owner's logistics agency issues T1 to shipyard's local logistics partner and does the physical offloading from the ship. The local logistics partner arranges pick-up from ship and organizes transport to their warehouse. The entire consignment shipped is recorded in the local logistics partner's customs warehouse's accounting. After that, the local logistics partner clears the T1, meaning the shipment is removed from the records of the local logistics partner's customs warehouse and waybills are prepared. The local logistics partner communicates with the recipients and asks the supplier if they want to receive goods in bonded status (T1) or not and proceed with import formalities and pay taxes and duties.

The recipient of the shipment agrees on the transportation with their courier who then clears the T1 if goods are sent in bonded status. The T1 is closed in the customs accounting of the receiving terminal. The receiving courier or forwarder then picks up the package

from the local logistics partner's warehouse and makes an import declaration, then the shipment is removed from the customs warehouse's records. Only after that the package can be delivered to the final destination, for instance, to the shipyard or supplier's delivery address. Figure 5 shows the stages of offloading and material return process.

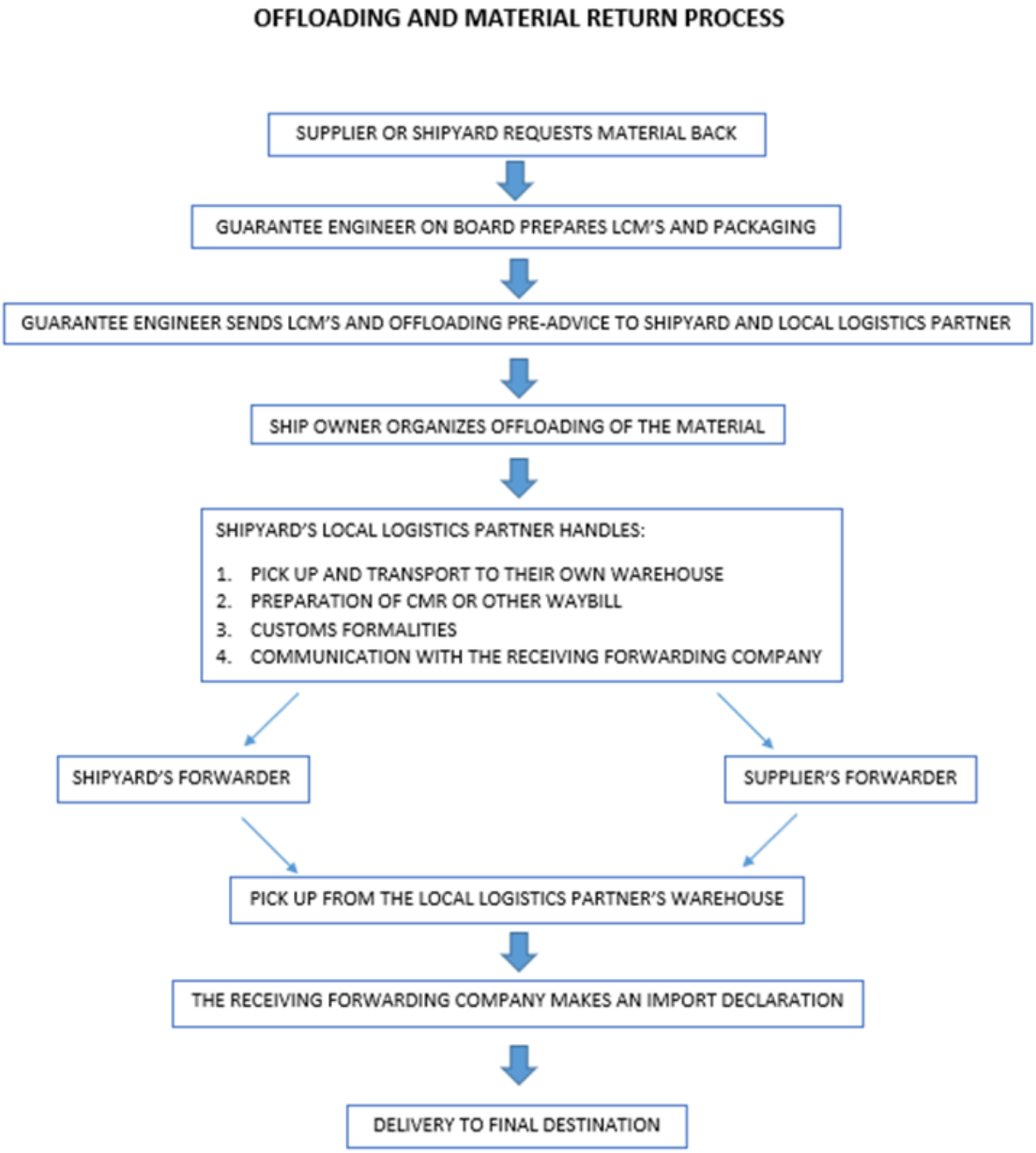

Figure 5. Process Flow Chart of Warranty Material Return Process (Keskitalo, 2023).

6.4 Risk analysis

The interviewees and focus group participants were asked about what kind of risks there are in the Cruise Ship Warranty Logistics Process and how can the risks be mitigated. The

chosen risk analysis method is Risk Assessment Matrix which is shown in Figure 6 below. The most common risks identified by the interviewees were listed and evaluated according to the risk likelihood and impact of risk happening according to the Risk Assessment Scale illustrated in Figure 7. By multiplying the likelihood score with the impact score, a risk rating for each risk was formed.

RISK ASSESSMENT MATRIX

	VERY UNLIKELY (1)	UNLIKELY (2)	POSSIBLE (3)	PROBABLE (4)	VERY LIKELY (5)
CATASTROPHIC (5)	5	10	15	20	25
SIGNIFICANT (4)	4	8	12	16	20
MODERATE (3)	3	6	9	12	15
LOW (2)	2	4	6	8	10
NEGLIGIBLE (1)	1	2	3	4	5

Figure 6. Risk Assessment Matrix (Keskitalo, 2023).

1-3 NEGLIGIBLE	NO MEASURES NEEDED
4-6 LOW	NO MEASURES NEEDED
8-12 MODERATE	MITIGATIVE MEASURES CAN BE CONSIDERED
15-16 SIGNIFICANT	MITIGATIVE MEASURES TO BE CONSIDERED
20-25 CATASTROPHIC	URGENT MITIGATIVE MEASURES NEEDED

Figure 7. Risk Assessment Scale (Keskitalo, 2023).

No catastrophic risks were identified in the analysis and only one significant risk. The most significant risk identified was that there are many parties involved in a long supply chain, which was also found to be the biggest challenge in the whole process according to the interviewees. Almost half of the identified risks were moderate, and the rest of the risks were low or negligible which do not need mitigative measures. Some mitigation measures were recommended for the low-level risks as well.

The most highly evaluated moderate risks were poor or intermittent communication, contract, unclear responsibilities, and bad packaging, labeling, or marking. Negligible risks

included risks such as material disappearance, late material, and changes in cruise schedules. These are minor risks which the case company cannot affect much.

When the focus group participants were asked about what risks are involved when sending or returning spare parts or material on board and how can the risks be mitigated, the participants identified many risks. The most common risks included disappearance of shipment, either during the transport or after delivery on board; bad packaging, bad package labeling, shipping a wrong part, wrong documentation which does not match the goods sent, information or communication breakdown, change of personnel and problems caused by delay, for example, a shipment lost at the ship owner's warehouse.

Additional costs were mentioned as a risk. The risk of additional costs can be either direct, such as sending the wrong kind of spare part or material on board or indirect, for instance, sending technicians on board before the goods needed for the repair have arrived on board, which leads to additional costs such as travel costs. Some of the shipyard's suppliers have decided not to send technicians on board before they have received confirmation the material has arrived on board. When there is no transparency through the whole supply chain, there is a risk the shipyard ends up paying too much, for instance, costs that would belong to the suppliers or to the ship owner, are directed first to shipyard as an intermediary of the process.

One risk is that the shipment goes missing. There have been cases when information has been received that the material is on board but then later it cannot be found. To mitigate this kind of risk RFID tags could be a solution. The cost-benefit relationship together with the risk likelihood would need to be considered.

One of the biggest risks is that the supply chain is very long, which means that the information does not travel to the end of the chain. This could be mitigated by more intense follow-up, clearer and more transparent information and by having a reliable, designated contact person for each party in the supply chain. The shipyard provides detailed delivery instructions including labeling instructions to the supplier; the supplier then orders the part or material from their own subcontractor, but the information about the delivery instructions does not travel that far which causes problems at later stages of the chain.

As all the parties under contract with the shipyard have access to the common warranty handling system, Jira, there could be a separate logistics dashboard including all delivery instructions, packaging and labeling instructions collected in one place. Also, would be beneficial if the suppliers would upload a picture of their shipment and tracking code on shipment in Jira under the specific guarantee claim ticket.

One of the biggest risks is the contract, in which the warranty responsibilities and obligations of each party are defined. The contracts could be more precise with less scope for interpretation. This would mitigate the risk of unclear responsibilities. A clearer contract or referencing shipyard's warranty work instructions in the contract as well as a description of the warranty operating process, which is unclear now and varies between the ship owners, would help mitigate the risk.

The warranty logistics is quite a big area of work to be handled within the warranty department itself. The shipyard's logistics department could have a bigger role in the process. There could even be a separate Warranty Logistics organization within the shipyard.

When asked what kind of risks there are in cruise ship warranty logistics process and how the risks can be mitigated, the shipyard's logistics partner in the USA mentioned the following risks: risk of losing the material, no verification material is delivered to ship, takes time to deliver to ship if the shipment is sent to ship owner's warehouse, risk of having material wrongly forwarded or even returned to sender, no transparent information sharing with the shipyard, material saved or hidden for other purposes on board or in warehouse and risk of having material stolen. Another identified risk was the possibility of mixing warranty deliveries with ship owners' other deliveries when using the same network. Also, there is a risk of mixing suppliers especially in the material return process, which makes it difficult to allocate costs correctly (Shipyard's Logistics Partner in USA, 2023). Figure 8 shows the assessment of the risks identified in the Cruise Ship Warranty Logistics Process.

RISK ASSESSMENT FORM

RISK	LIKELIHOOD	IMPACT	RISK RATING	RESPONSE (ACTION)
Many parties involved, long supply chain	5	3	15	Process defined clearly to all parties involved. Minimization of supply chain members. More transparency between parties involved.
Poor or intermittent communication	4	3	12	Clarification of communication channels, more intense follow-up, clearer and more transparent information, designated contact person for each party. Logistics dashboard in Jira.
Contract	3	4	12	Responsibilities and obligations regarding the warranty expressed more clearly in contracts.
Unclear responsibilities	3	4	12	Responsibilities regarding warranty defined more clearly in contracts.
Bad packaging, labeling or marking	3	4	12	Clear instructions provided to suppliers. Better monitoring on the suppliers' shipments.
Incorrect information in documents or documents missing	3	3	9	Clearer instructions regarding needed documents and information.
Additional costs	3	3	9	Better planning and tracking of warranty logistics costs by using technology. Costs assigned directly to the correct party.
No transparency between different parties	3	3	9	More transparent communication between different parties.
Customs regulations	3	3	9	Risk must be accepted. Increased knowledge regarding customs regulations.
Allocation of suppliers' logistics costs	3	3	9	Use of technology for better tracking of the warranty logistics costs.
Material is damaged and arrives defective	2	3	6	Proper packaging. Transport insurance.
Change of personnel	3	2	6	Sufficient orientation regarding the warranty process and tools used provided to new personnel.
No verification of shipment arrival on board	3	2	6	Improved use of tracking technology. RFID tags. Better communication with the recipient of the shipment.
Material stolen or hidden	2	3	6	RFID tags in the shipments, better tracking in Jira, better use of tracking codes and photo of the package uploaded to Jira.
Mixing warranty shipments with ship owner's shipments	2	3	6	Special unified packaging for all warranty deliveries.
Material disappearence	2	1	2	RFID tags in the shipments, better tracking in Jira, better use of tracking codes and photo of the package uploaded to Jira.
The material is late	1	2	2	More proactive action in case critical material is sent.
Cruise schedule changes	1	1	1	No measures needed, risk must be accepted.

Figure 8. Risk Assessment Form (Keskitalo, 2023).

According to shipyard's dispatch center personnel, there are many risks in the process, and anything can happen during the transport. For instance, a recent risk related to a strike was mentioned. A shipment can be loaded in the transport vehicle when a strike begins. This causes delays in the shipments as well as additional expenses. For instance, a forwarder can ask for a strike allowance of approximately 300-400 euros per shipment. From the dispatch center's perspective, who handles the packaging and creation of shipping documents, one must avoid and minimize risks and correct the situation when it occurs. Urgent goods are always prioritized for shipment. One way to mitigate risks such as loss or damage of goods is "bombproof" packaging. Black film and warranty tapes are used for the shipyard's own shipments packaging which makes it easier to identify them. Transport insurance is taken separately only for more valuable shipments (Shipyard's Dispatch Center, 2023).

Incomplete information, loss or breakage of goods and specially designed packages were the most common risks identified by the shipyard's forwarding partner. Loss or breakage of goods can be mitigated by adequate packaging as well as by sufficient marking on the package during the entire chain. Specially designed packages, such as long pipes which would not be accepted for air cargo, will be stopped, and sent back for repackaging in case such deliveries arrive at the forwarder's premises in inappropriate packaging (Shipyard's Forwarding Partner, 2023).

From the perspective of shipyard's logistics partner operating in Europe, the biggest risks are related to the customs procedure when returning material. The main risk is that the supplier does not reply when they are asked if they want to proceed with T1 or proceed with paying duties and taxes. This is mainly because of a lack of understanding why the goods need to be sent as T1 bonded goods. Local custom rules are challenging and sometimes the supplier does not know which item is to be returned. This might be because it can take up to three months for the ship owner to collect and offload the returning material. The fact that many people are involved in the process and might not understand the entire process was identified as a risk (Shipyard's Logistics Partner in Europe, 2023).

7 Critical examination and discussion

In conclusion the research questions were answered in the thesis and objectives were achieved. Since the topic is quite wide, there are many suggestions for further research. The process descriptions and flow charts will be helpful for all the parties involved in the process. Now that the current situation has been described, it will be easier to evaluate other different possibilities of handling the process. The conducted risk analysis will be supportive when mitigating risks. It is suggested that the case company reviews the risk analysis continuously.

The research covered the exploration of the current situation and risk analysis for most common risks now. The research was conducted from the case company's point of view taking into consideration only the key members of the supply chain. Further research on the topic could be done by collecting data also from the shipyard's suppliers and their suppliers as well as from the ship owner's personnel.

Based on the results of this research, quantitative research could be conducted. In the quantitative research a survey could be conducted on a larger sample size which could include shipyard personnel from other departments than warranty department, shipyard's suppliers, ship owner personnel and logistics partners. Different parties might have different perspectives on the topic. It would be interesting to see the statics about their opinions.

A survey could be used to collect data on possible issues and development ideas from different parties involved in the process. Since most of the warranty shipments are sent by the suppliers themselves, a separate survey regarding the risks and their analysis could be conducted for the shipyard's suppliers to find out how they understand the process and what kind of risks they identify. Further and wider risk analysis could be needed once the current situation and process including all details are known. It will be recommended for the case company to implement a risk management process specifically for warranty logistics.

Based on the results and theory presented in this thesis it is suggested the case company performs an in-depth supply chain analysis. Supply chain measures presented in this thesis

may be utilized to gain a deeper understanding of the underlaying reasons causing challenges in the process.

Regarding further research on the topic, benchmarking would be beneficial with other shipyards. Also, benchmarking shipyard's suppliers could be done to find out what kind of risk management process and supply chain they have.

Due to the results presented in this thesis, I believe that technology could be used for further research to find out how many of the identified risks occur and how often. For instance, with correct tools, data could be collected on how many deliveries are delayed, gone missing, arrive defective or a wrong part is sent. The use of AM machines for distributed production of spare parts could be considered by the case company. The additional costs related to warranty logistics per supplier could be researched and tracked with correct technology. Additionally, automation technology could be utilized to follow up on deliveries and returns and their costs, but it would require resources and investment of money. To collect this kind of data, it would also require transparency with the suppliers and their shipments.

Possible improvement suggestions regarding the process include clear instructions for all parties involved; the shipyard's logistics department could be more involved in the process or there could even be its own organization for warranty logistics. As one of the biggest risks identified was the contract, it is suggested that the responsibilities would be defined more clearly in contracts, which would decrease the chance of misinterpretation.

The biggest challenges of writing this thesis were limitation of the research topic and time management. It was also challenging to organize the data collected in the interviews and focus group and put the data into a coherent format.

I would like to thank the case company and all logistics partners for their cooperation and participation in the research process and for their expertise on the topic.

8 Reference list

Beamon, B. M. (1999). Measuring supply chain performance. University of Cincinnati, Ohio, USA. International Journal of Operations & Production Management, Vol. 19 No. 3, 1999, pp. 275-292, # MCB University Press, 0144-3577.

Berg, H-P. (2010). Risk management: Procedures, Methods and Experiences. Bundesamt für Strahlenschutz, Salzgitter, Germany.

Bhandari, P. (2023). What Is Qualitative Research? Methods & Examples. Scribbr. Retrieved 2023, February 12 from https://www.scribbr.com/methodology/qualitative-research/

Business Research Methodology. (n.d.) Exploratory Research. Retrieved 2023, February 12 from https://research-methodology.net/research-methodology/research-design/exploratory-research/

Christopher, M. (2011). Logistics & supply chain management. Prentice Hall, 2011.

Cisco. (n.d.) What is Business Resilience? Retrieved 2023 February 13 from https://www.cisco.com/c/en/us/solutions/hybrid-work/what-is-business-resilience.html

Estampe, D. (2014). Supply chain performance and evaluation models. Supply Chain Management Modeling (pp. 1-35). ISTE. DOI:10.1002/9781119005421

Fawcett, S. E., & Waller, M. A. (2014). Supply Chain Game Changers—Mega, Nano, and Virtual Trends—And Forces That Impede Supply Chain Design (i.e., Building a Winning Team) Jpurnal of Business Logistics Volume 35, Issue 3, September 2014, (pp. 157-164) https://doi.org/10.1111/jbl.12058

Gunasekaran, A., & Kobu, B. (2007). Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995–2004) for research and applications. International Journal of Production Research, 45:12, 2819-2840, DOI: 10.1080/00207540600806513

Hager, J. (2022). Risk Categories and Examples. Internal, External and Strategic Risks. Retrieved from https://study.com/learn/lesson/risk-categories-examples.html

Heckmann, I., Comes, T., & Nickel, S. (2015). A critical review on supply chain risk – Definition, measure and modeling, Omega, 2015, Pages 119-132. https://www.sciencedirect.com/science/article/abs/pii/S030504831400125X

Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak, International Journal of Production Research, 58:10, 2904-2915, DOI: 10.1080/00207543.2020.1750727

Jones, J. B. (n.d.) AM Basics - An Introduction to Additive Manufacturing (Also known as 3D printing). Retrieved 2023, May 6 from https://additivemanufacturing.com/basics/

J. P. Morgan. (2022). What's Behind The Global Supply Chain Crisis? Retrieved from https://www.jpmorgan.com/insights/research/global-supply-chain-issues

Jüttner, U., Peck, H., & Christopher, M. (2003). Supply chain risk management: outlining an agenda for future research, International Journal of Logistics: Research and Applications, 6:4, 197-210, DOI: 10.1080/1367556031000162701 6

Kenton, V. (2022). What Is Business Risk? Definition, Factors, and Examples. Retrieved from https://www.investopedia.com/terms/b/businessrisk.asp

Khajavi, S. H., Partanen, J., & Holmström, J. (2014). Additive manufacturing in the spare parts supply chain. Aalto University/School of Science, Department of Industrial Engineering and Management.

Kordic, V. (2008). Supply Chain. IntechOpen. DOI 10.5772/57

Logistiikan Maailma. (n.d.) Riskienhallinta. Retrieved 2023, February 10 from https://www.logistiikanmaailma.fi/sopimukset/riskienhallinta/

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., et al. (2001). Defining supply chain management. Journal of Business Logistics. Vol. 22, No. 2, 2001, pp. 1-25.

Merkert, R., & Hoberg, K. (2023). Global Logistics and Supply Chain Strategies for the 2020s: Vital Skills for the Next Generation. Springer Nature. DOI: 10.1007/978-3-030-95764-3.

Oxford Learners Dictionaries. (n.d.) Resilience. Retrieved 2023, February 13 from https://www.oxfordlearnersdictionaries.com/definition/english/resilience

SafetyCulture. (2023) Qualitative and Quantitative Risk Analysis. Retrieved 2023, February 13 from https://safetyculture.com/topics/qualitative-and-quantitative-risk-analysis/

SFS-ISO 31000. (2018). Riskienhallinta. Ohjeet. 2. Painos. Suomen Standardoimisliitto SFS.

Stanford Libraries. (n.d.) Qualitative Research. Retrieved 2023, March 20 from https://guides.library.stanford.edu/qualitative_research

Suomen Tulli. (n.d.) Mitä on passitus? Retrieved 2023, March 27 from https://tulli.fi/en/businesses/transport-and-warehousing/transit

TechTarget. (n.d.) Risk Mitigation. Retrieved 2023, February 13 from https://www.techtarget.com/searchdisasterrecovery/definition/risk-mitigation

The National Institute of Standards and Technology. (n.d.) Supply chain risk. Retrieved 2023, February 18 from https://csrc.nist.gov/glossary/term/supply_chain_risk#:~:text=Supply%20chain%20risks%20include%20exposures,NIST%20SP%20800%2D53%20Rev.

Visure Solutions, Inc. (n.d.) Risk Analysis. Retrieved 2023, March 15 from https://visuresolutions.com/fi/blog/risk-analysis/

Waters, D. (2011). Supply chain Risk management. Vulnerability and Resilience in Logistics. 2nd Edition. KoganPage.

9 Appendices

APPENDIX 1

INTERVIEW QUESTIONS

1. What is the Supply Chain of the Cruise Ship Warranty Logistics Process when sending spare parts on board or when returning material or spare parts from the ship? Describe the process step by step. What documents are needed in each step?

2. What kind of risks are there in the Cruise Ship Warranty Logistics Process and how can the risks be mitigated?

3. What is working in the Cruise Ship Warranty Logistics Process when sending or returning spare parts or material on board and what is not?

4. What improvement suggestions do you have regarding the process?

APPENDIX 2

FOCUS GROUP QUESTIONS

1. What is working in the Warranty Logistics Process when sending or returning spare parts or material on board?

a) Shipments to Europe

b) Shipments to the USA

2. What is not working in the Warranty Logistics Process when sending or returning spare parts or material on board?

a) Shipments to Europe

b) Shipments to the USA

3. What do you think is the root cause of the problems?

4. What risks are involved when sending or returning spare parts or material on board and how can the risks be mitigated?

5. How are the risks managed now in the warranty logistics process?

6. What improvement suggestions do you have regarding the process?

7. How are the responsibilities of different parties agreed according to the contracts between the ship owner, shipyard, and shipyard's suppliers regarding sending or returning spare parts?