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Assessing Supply Chain Performance and Exploring Improvement Strategies in a Finnish Technology Industry Case Company

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ABSTRACT :

The purpose of this thesis was to assess the supply chain performance of a Finnish technology industry case company and explore suitable improvement strategies based on this assessment. This was carried out through the identification of several advantages and challenges to the company's supply chain performance and finding ways to alleviate the identified challenges. Furthermore, the applicability of the identified improvement strategies to other relatively small-scale technology industry companies in general is also outlined.

This study is a qualitative case study, as the aim was to study the topic of supply chain performance holistically, in the unique environment of a case company. The primary data collection was done through six semi-structured interviews, conducted within the supply chain team of the case company. Each interviewee represented a distinct role in the team, so that a balanced view of supply chain performance could be gained. Data was analysed through deductive content analysis, in which supply chain performance attributes outlined in the SCOR model were used to relate collected data to specific aspects of supply chain performance.

Through the analysis of the interview data, it was found that the case company experiences various advantages that affect their supply chain performance, most often exhibiting strengths in performance in the aspect of reliability, and less so, agility, and to a very limited extent, costs. It was also found that the case company experiences various challenges that affect their supply chain performance, most often exhibiting weaknesses in performance in the aspects of assets and responsiveness, and less so agility, and to a very limited extent, profit, reliability, and costs.

Multiple possible improvement strategies are suggested for alleviating the identified challenges, including implementing collaborative forecasting, establishing diverse back-up suppliers, implementing SAP, implementing ERP training, implementing RPA, implementing lean production, implementing cross-functional practices, conducting precautionary sourcing work, conducting stringent supplier evaluation and -selection, implementing collaborative practices, and increasing order quantities. It is suggested that when implementing improvement strategies, the case company prioritise aspects of performance with consideration of both how often related challenges occurred in interview responses, and how significant their effects were rated as by the interviewees. The identified challenges draw parallels with several different challenges, trends, and characteristics generally associated with companies of similar size, and their supply chains, throughout the Finnish/European technology industry, which is why this study contributes to literature in said context when it comes to assessing and improving supply chain performance.

KEYWORDS: Supply chain performance, supply chain management, technology industry, supply chains

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TIIVISTELMÄ :

Tämän tutkielman tarkoitus oli arvioida suomalaisen teknologiateollisuuden tapausyrityksen toimitusketjujen suorituskykyä, sekä tutkia mahdollisia strategioita suorituskyvyn parantamiselle. Tämä toteutettiin tunnistamalla erilaisia etuja ja haasteita, jotka vaikuttavat yrityksen toimitusketjujen suorituskykyyn, sekä etsimällä tapoja, millä lievittää tunnistettuja haasteita. Myös tunnistettujen parannusstrategioiden sovellettavuutta muihin suhteellisen pienimuotoisiin teknologiateollisuusyrityksiin käsiteltiin yleisellä tasolla. Tämä tutkielma on laadullinen tapaustutkimus, jonka tavoitteena oli holistisesti tutkia toimitusketjujen suorituskykyä aiheena, tapausyrityksen uniikissa ympäristössä. Ensisijainen tiedonkeruu suoritettiin kuuden puolistrukturoidun haastattelun avulla, jotka suoritettiin tapausyrityksen toimitusketjutiimin jäsenten välillä. Jokainen haastateltava edusti omaa rooliaan tiimissä, jotta tasapuolinen kuva yrityksen toimitusketjujen suorituskyvystä saatiin esitettyä. Kerättyä tietoa analysoitiin käyttäen deduktiivista sisällönanalyysia, jossa eri SCOR malliin sisällytettyjä toimitusketjujen suorituskyvyn ominaisuuksia käytettiin yhdistämään kerättyä tietoa eri toimitusketjujen suorituskyvyn osa-alueisiin.

Analysoimalla haastatteluilla kerättyä tietoa, monia etuja löydettiin, jotka vaikuttavat yrityksen toimitusketjujen suorituskykyyn, osoittaen useimmiten vahvuuksia liittyen reliabiliteetin, pienemmissä määrin agiliteetin, sekä hyvin rajoitetuissa määrin kustannusten osa-alueisiin toimitusketjujen suorituskyvyssä. Todettiin myös, että yrityksellä on monia haasteita, jotka vaikuttavat yrityksen toimitusketjujen suorituskykyyn, osoittaen useimmiten heikkouksia liittyen varojen ja responsiivisuuden, pienemmissä määrin agiliteetin, sekä hyvin rajoitetuissa määrin voiton, reliabiliteetin ja kustannusten osa-alueisiin toimitusketjujen suorituskyvyssä. Useita parannusstrategioita ehdotettiin haasteiden lievittämiseen. Näihin kuului yhteistoiminnallisen ennustamisen implementointi, monipuolisten varatoimittajien hankkiminen, SAP implementointi, ERP koulutuksen implementointi, RPA implementointi, lean-tuotannon implementointi, poikkitoiminnallisten käytäntöjen implementointi, ennakoivan hankintatyön tekeminen, tiukan toimittajien arvioinnin ja valinnan tekeminen, yhteistoiminnallisten käytäntöjen implementointi, sekä tilausmäärien lisääminen. Suositellaan myös, että implementoidessaan parannusstrategioita tapausyritys priorisoisi toimitusketjujen suorituskyvyn osa-alueita harkiten sekä sitä, kuinka usein kyseisiin osa-alueisiin liittyviä haasteita tunnistettiin haastatteluvastauksissa, että sitä kuinka merkittäviä kyseisten haasteiden vaikutukset ovat vastaajien arvioiden mukaan. Eri tunnistetut haasteet heijastavat monia niitä haasteita, trendejä, ja ominaisuuksia, jotka yleisesti liittyvät myös muihin samansuuruisiin yrityksiin ja heidän toimitusketjuihinsa suomalaisessa/eurooppalaisessa teknologiateollisuudessa, jonka takia tämä tutkielma täydentää kirjallisuutta kyseisessä kontekstissa, toimitusketjujen suorituskyvyn arviointiin ja parantamiseen liittyen.

AVAINSANAT: Toimitusketjujen suorituskyky, toimitusketjujen hallinta, teknologiateollisuus, toimitusketjut

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1 Introduction

European technology industry companies, especially those of relatively small scale like SMEs have faced various challenges during the 2020s, including but not limited to the global COVID-19 pandemic, the Russo-Ukrainian war, as well as the consequent global energy crisis, surges in inflation and supply chain disruptions (European Commission, 2024a). The fallout of the aforementioned challenges is still being felt today, especially when it comes to those companies that operate in the technology industry. Recently, trends such as low demand, as well as rising costs emerge as common challenges in the European technology industry, the effects of which are also significant for Finland's technology export-heavy economy (Technology Industries of Finland, 2024a).

In Finland, the aforementioned trends and consequent challenges, in terms of profitability for instance, also have other substantial effects such as reductions in the sizes of workforces (Technology Industries of Finland, 2024a). This indicates that prevailing conditions are having substantial effects on company performance, as according to Bottazzi et al. (2008) profitability, for instance, is one crucial part of a company's overall performance. As a result of these challenges, among others, many Finnish technology industry companies may find themselves in a position, where growing one's business, and even maintaining one's business becomes magnitudes more difficult. This is why ongoing challenges must be addressed if companies want to take a proactive approach in improving their prospects of good performance amidst the prevailing conditions.

One way that companies could take concrete action in enhancing said performance would be to try and optimise their supply chains, as according to Hove-Sibanda & Pooe (2018), improving supply chain performance (SCP) can help boost the overall performance of businesses. In this paper, the focus is on exactly this; what kind of challenges to supply chain performance can exist in a Finnish technology industry company, and what actions can be implemented to ease said challenges, in order to overcome them.

1.1 Background

In this thesis, the discussed performance-related topics are examined through the lens of a case company. Since the turn of the decade, the chosen case company has struggled with some similar challenges that were outlined, as most likely have many other Finnish technology industry companies. The case company's business and supply chains are also highly global, which introduces its own implications. According to Aydin et al. (2014), global supply chains are inherently longer and more complex than domestic ones. This means that extra care should be taken to ensure adequate supply chain performance in the company, in order to prevent any amplified negative effects.

Some factors, that are important to consider, when it comes to why the case company could benefit from supply chain performance improvement, are the possible opportunities it could bring, even in the presence of significant pressures and constraints, in terms of improved company performance. The mentioned pressures and constraints include, for instance, growing competition, high costs, and limited resources, all of which can be part and parcel of being a relatively small scale company within the Finnish technology industry, as is discussed later on.

The reason as to why supply chain performance improvement has been chosen as the method through which possible improvement opportunities are examined in this thesis, is due to the quite holistic nature of how it can be applied to a company's operations. The definitions for supply chain performance vary to some extent, however, according to Hausman (2004), in the most basic terms, supply chain performance stands for the level of fulfilment in supply chain activities meeting customer requirements while optimising factors such as on-time delivery, availability, and responsiveness. This definition allows the study to not only focus on a particular process, but rather a chain of different processes. In the circumstance of the case company, this sort of holistic approach could prove effective in introducing possible strategies that could have the largest impact on overall performance.

This thesis aims to fill a research gap that exists as a consequence of the size and location of the case company, the characteristics of the specific industry, as well as the scope of the research. Many studies exist that cover the topics of supply chain performance, and even supply chain performance in companies of relatively small scale, such as SMEs. For instance, Sukwadi et al. (2013), as well as Eyaa et al. (2010) both explore SME supply chain performance. However, the settings for the research are the Indonesian garment industry and several Ugandan industries respectively.

Several authors also focus more on the effects of specific concepts on supply chain performance in companies of similar size. For instance, Sawangwong and Chaopaisarn (2023), Tripathy et al. (2016), and Oubrahim et al. (2023) all focus mostly on the effects of digital innovation and information technology on supply chain performance. There are also those who focus mostly on building or developing new tools for supply chain performance in companies of similar size, as is the case with Banomyong & Supatn (2011) for instance.

Even though the listed studies might have important and useful insight, differences in geography and industries, as well as overall focuses of the studies will naturally cause them to have their own varying outcomes and implications. As it has proven difficult to find example studies on the topic of supply chain performance assessment and improvement in the context of Finnish/European companies of smaller scale, this thesis could prove useful in filling this gap.

1.2 Objectives

In order to set concrete goals for the study, appropriately clear and targeted research questions have to be set. As the main goal is to assess supply chain performance from the perspective of the case company, and explore improvement strategies, which can provide gains in supply chain- and overall company performance down the line, the research questions are then as follows:

Q1. *What are the largest advantages and challenges associated with the company's supply chain performance, and how do they affect said performance?*

Q2. *How could found challenges be alleviated to improve supply chain performance?*

Q3. *What do found solutions indicate about supply chain performance improvement within the established context?*

These three questions sufficiently cover the aspects of the desired outcome of this thesis. Along with these questions, more detailed objectives should be outlined, which guide the research process throughout the span of the thesis, in order to ultimately answer the research questions to a sufficient degree. The objectives are as follows:

- ***Identify the advantages and challenges associated with the case company's supply chain performance***

This objective includes using the appropriate data collection and analysis methods, in order to identify the sort of advantages and challenges that exist related to supply chain performance within the case company.

- ***Assess supply chain performance***

This objective includes the further utilisation of the chosen data analysis method to relate the found advantages and challenges to different aspects of supply chain performance, on the basis of which supply chain performance can be assessed.

- ***Explore possible improvement strategies***

Possible improvement strategies are explored through seeking ways to alleviate found challenges, addressing their causes- and mitigating their effects, in order to ultimately improve supply chain performance.

1.3 Structure

The structure of the thesis consists of six distinct parts. These include introduction, literature review, methodology, findings, discussion, and conclusions. Starting with the first part, introduction, first some general information about the current state of small-scale technology industry companies were relayed, along with reasonings as to why better supply chain performance is a possible way of alleviating current challenges. Then, in the "background" section, information about the case company was provided, along with reasonings for the choice of supply chain performance as the general topic, as well as an explanation of the research gap. After this, in the "objectives" section, the selected research questions were presented, alongside appropriate objectives that guide the research to answer said questions. Then, the current section "structure" outlines what steps are followed throughout thesis writing process. The final section of the introduction "delimitations" defines the boundaries to which the study of the topic is fit into.

After the introduction, the next part is the literature review, where the theory of the thesis is built. The first section of the literature review is "small-scale technology industry companies", where the current circumstances, including challenges and trends of technology industry companies of smaller scale are discussed. The second section is "technology industry supply chains and SCM" which outlines the general characteristics and current conditions of technology industry supply chains, as well as supply chain management (SCM) as it relates to the technology industry. The third section is "supply chain performance", where the broader concept of supply chain performance, and its improvement, as well as related assessment frameworks are discussed. The fourth section is "conceptual framework", where the preceding theory is synthesised into a single framework for performance assessment and improvement.

After the literature review, the next part is methodology, which is the first part of the empirical section. In this part, the ways in which empirical research was conducted are discussed. The first section of this part is "research methods", which outlines the approach of the empirical research. Next in the "data collection" section, the method used

to collect primary data is explained. In the “data analysis” section, the method for data analysis is explained, as well as how said method functions within the context of the study. Lastly, in the “reliability and validity” section, the overall trustworthiness of the research is examined.

After methodology, the fourth part is findings. In this part, the outlined methodology is applied, and the conceptual framework is followed to reach the desired results according to the thesis objectives. This part consists of the sections “case company background”, “assessing SCP”, and “improving SCP”. After findings, the fifth part is discussion. In this part, the implications and limitations of the findings are discussed, including sections of “answering research questions”, “managerial implications”, and “limitations”. The sixth and final part is conclusions. In this part, the main findings are summarised and presented in a clear and concise manner, along with reflection on possible future research.

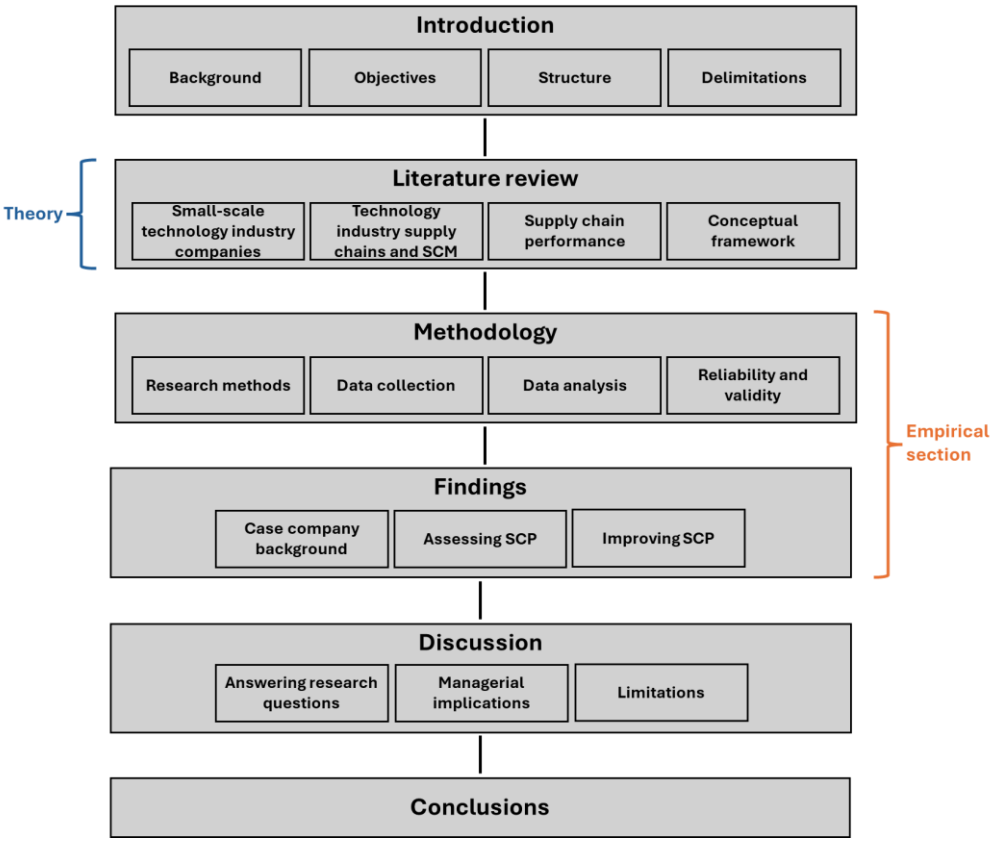

Figure 1 - Thesis structure *(author’s illustration)*

1.4 Delimitations

In order to properly set boundaries and a sufficient scope for the study, it is important to have clear delimitations. The delimitations for this thesis go as follows. The exploration of small-scale companies and supply chains in the first two sections of the theoretical part of the thesis places focus on the technology industry. The main focus is on the European/Finnish side of said things, however, global considerations are also included due to the global nature of supply chains and business today.

The empirical part of the thesis is focused on assessing supply chain performance exclusively from a case company's perspective, as mentioned earlier. What this means is that the focus is on the aspects of supply chain performance the case company can control with its own actions. This means, that for example, if there is an issue with another party in the supply chain, the focus is less so on what said party should or could do, and more so on what the case company could do, in order to try and influence the situation and associated outcomes. This approach also shows in that for example the primary data for the thesis is sourced internally, from within the case company.

2 Literature review

In order to gain a good basis for approaching the thesis topic empirically, a comprehensive literature review is of critical importance. When thinking about the different keywords and concepts of the thesis, a blueprint for building the theory becomes clearer. To get a basic understanding about the nature of technology industry companies of smaller scale, as it pertains to their overall business and the challenges they face, a section of the literature review is dedicated to exploring said topic.

Another section is dedicated to technology industry supply chains and supply chain management (SCM) in general, when it comes to unique characteristics, challenges, and more recent developments; and different SCM phases and practices, as well as their importance in the industry, respectively. The section after is dedicated to supply chain performance itself, as far as expanding on the concept and its improvement, as well as the different related assessment frameworks, so that the implementation of said concept can be easily understood later on in the empirical part of the thesis. The last section outlines the synthesis of a conceptual framework for performance assessment and improvement, based on the preceding theory, that is then applied in the empirical part of the thesis.

2.1 Small-scale technology industry companies

In this section, the current challenges and trends associated with technology industry companies are discussed, with a focus on smaller scale companies like SMEs. According to the European Commission (2024b) SMEs stand for small to medium-sized enterprises and represent the overwhelming majority of businesses in the European Union (EU). Also, it is outlined that businesses are defined as small if they employ less than 50 staff members and have a turnover or balance sheet total of 10 million euros or less. Medium sized businesses on the other hand are considered as such if they employ less than 250 people and have a turnover of 50 million euros or less, or a balance sheet total of 43 million euros or less. According to these criteria, the case company is comparable.

It is however important to note, that the case company is a subsidiary of a larger parent company, which means that it cannot actually be formally recognised as a standalone SME, as subsidiaries could sometimes find it easier to, for example, acquire emergency financial backing due to its ownership structure, than standalone SMEs. Despite this, for the purposes of this part of the thesis, the company is treated as being comparable to an SME. This is justified by the company's financial profile, employee headcount, budgetary restrictions, and substantial degree of autonomy. Another reason as to why SMEs are used as a reference point, is because the different challenges faced by the company are much more comparable to those of SMEs than companies of any larger scale.

For the purposes of clarifying the term "technology industry" in the context of this thesis, a designation provided by the Technology Industries of Finland (2024b) is used, which outlines that the technology industry consists of five different sub-industries, which are the electronics- and electrotechnical industry, mechanical engineering, metals industry, engineering and consulting, as well as information technology. The Technology Industries of Finland (2024b) also highlight the importance of technology industry companies for the Finnish economy, as for instance, the technology industry accounts for over half of all Finnish exports, employs nearly 340 000 people, and accounts for around 30% of all gross domestic product.

2.1.1 Challenges and trends

As touched upon earlier, technology industry companies have recently faced several serious challenges related to several global crisis. One of the latest of said crisis in the Russo-Ukrainian war, and the consequent effects are taking their toll on the function of companies, particularly in Europe. According to the OECD (2023) although the direct effects from the war to companies are minimal, indirect factors such as supply chain disruptions, surging inflation and consequently increased energy costs and commodity prices, and generally tightened fiscal conditions, along with exacerbating issues such as labour shortages are all weakening prospects of future growth and performance.

According to Bednarski et al. (2023) geopolitical disruptions are especially harmful for high-technology industry supply chains. Also, according to Foli et al. (2024) smaller scale companies are particularly vulnerable to external threats and are affected by supply chain disruptions to a high degree. For these reasons as well, said companies ought to start building more capable supply chains, in order to also be able to adjust more effectively to possible future situations that might cause further volatility.

Apart from the more recent challenges that companies are facing, there are additional challenges that are more inherent to companies of smaller scale. According to Gamage et al. (2020) as smaller companies like SMEs can inherently be lacking in things such as resources, technical skills, innovative capabilities, and international strategy capabilities when compared to larger companies, the fast globalisation over the recent decades, as well as the consequently high market competition can cause smaller companies difficulties in staying competitive.

Competition can be especially pronounced in the technology industry, as according to Ratajczak-Mrozek (2012) high-technology products are characterised by fast growing competition in international trade. This comes as no surprise, considering that according to Eurostat (2024a), trade in high-tech products has almost doubled in the past decade in the EU alone. From looking at the occurring challenges, it is clear that in order to combat both modern challenges, as well as the more inherent challenges that relate to companies of smaller scale, measures for mitigation should be taken. From the following discussion, it becomes evident that approaches for mitigating said challenges can be seen in action, when it comes to the modern trends in the industry.

Gamage et al. (2020) remark that focusing on developing ICT and digital capabilities is generally considered one of the most effective ways of addressing prevalent challenges due to potential improvements in effective resource utilisation, costs, and efficiency, which is why digitalisation is currently a very significant trend in smaller companies. However, digitalisation does come with its own challenges. According to Kádárová et al.

(2023) advancing digitalisation, when done so in a strategic manner, is bound to improve productivity, competitiveness, and overall performance in smaller companies like SMEs. It is also discussed, that being more efficient in asset and financial performance is also made possible by means of adopting new digital technologies. It is then clear to see why such emphasis is being placed on accelerating digitalisation under the current circumstances.

According to Kádárová et al. (2023) there are many different types of digital technologies that can have these positive effects on company performance, such as e-commerce platforms, new software, communication and sharing platforms, and mobile security applications, or more advanced technologies like artificial intelligence (AI), internet of things (IoT), big data, and blockchain technology. According to the OECD (2024) also things such as cloud computing and digital supply chain management solutions can help with innovation and adaptability in companies' approaches to business when it comes to dealing with changing market conditions. However, as can be extrapolated from the different discussed challenges, many companies might find quick adoption of new digital technologies quite difficult.

According to the OECD (2024) smaller companies like SMEs can often struggle with inadequate access to said digital technologies, as technologies that are both affordable and high quality can be far and few between. Also, issues related to continuous improvement of digital literacy and skills can be prevalent due to gaps in knowledge. According to Mikkola & Salonen (2022) the need for further technology adoption is seen in manufacturing companies in that the pressure of keeping up with larger supply chain partners with more advanced digital capabilities is mounting. It is also discussed that the main reasons as to why so called "industry 4.0" implementations are still not as prevalent in smaller companies include a substantial shortage in workers that are qualified to operate new technologies, limited resources, as well as uncertainty about the risks associated with new integrations and investment decisions.

It is important to note that decisions to invest in- and implement digital technologies in the near future will be important even if it can be difficult for the reasons stated above. This is because according to the OECD (2023) if there is significant lag in adoption of digital technologies within companies, future digital transformations can be that much more difficult to engage with. Prioritising the adoption of digital technologies can make existing barriers less difficult to deal with in future adoptions, as for example, according to Mikkola & Salonen (2022) limited resources can act as a barrier for digitalisation, but on the other hand, according to Gamage et al. (2020) advancing digitalisation can lead to more effective resource utilisation, thus freeing up more of said resources. The challenge is then mainly getting over the first hurdle of initial investment and commitment.

Another very popular trend that is currently saturating the technology industry, along with digitalisation, in the prioritisation of sustainability. The digital and sustainability transitions are in fact firmly entwined in what is called the “twin transition”. According to Rehman et al. (2023) the twin transition is based on the idea that digitalisation in companies can also help further sustainability efforts in response to new requirements from stakeholders.

According to Ortega-Gras et al. (2021) digitalisation can improve sustainability and circular economy (CE) practices through factors such as gains in process efficiency. It is also discussed how the EU is driving sustainability advancements with legislative action through the European Green Deal initiative and associated objectives. This is one more reason why companies should also be focusing on sustainability aspects of their business. However, as is with the digitalisation aspects of the twin transition, furthering development and compliance with the sustainability aspects can also have its own barriers.

According to the International Labour Organisation (2024) challenges including financial resources, market conditions, knowledge gaps, and lack of technological capabilities are restricting opportunities for smaller companies like SMEs, when it comes to develop-

ment in sustainable practices. Overall, very similar or even causal challenges when compared to those regarding digitalisation aspects. This highlights the interconnection of digitalisation and sustainability that the twin transition is all about.

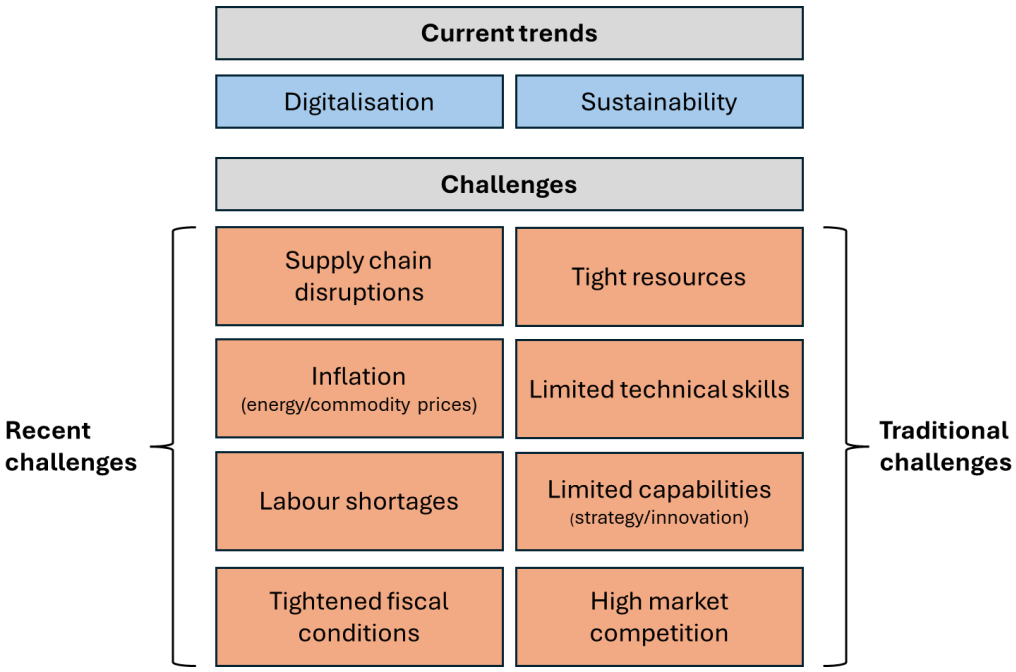

Figure 2 - Trends and challenges for small-scale companies *(section summary, author's illustration)*

2.2 Technology industry supply chains & SCM

Since the central theme of this master's thesis is supply chain performance, basic understanding of the concepts from which said theme is derived from plays an important role in building the theory of the thesis. This is why the characteristics and current circumstances of technology industry supply chains, as well as different associated supply chain management (SCM) practices are explored in this section of the literature review. The supply chains of each industry will always have their own challenges and characteristics depending on factors such as what kind of resources are required, and where potential suppliers and customers are located. This is why this section serves to provide important context for the remainder of the thesis.

In order to provide some simple definitions that will help further contextualise this section, supply chains and their management are defined as follows. According to Chopra (2019), supply chains consist of all the processes, functions, and parties involved in the fulfilment of customer requests for products. Supply chain management (SCM) on the other hand stands for all of the actions required to make a supply chain function efficiently, including phases of sourcing and procurement, demand planning and forecasting, supplier management, production, inventory management, logistics, as well as continuous monitoring of industry trends (ASCM, 2024).

2.2.1 Characteristics of technology industry supply chains

In order to gain a basic understanding of the characteristics of technology industry supply chains, it is useful to look at factors such as what kind of products do said supply chains carry, what sort of locations do they commonly start from and end in, what sort of parties are involved, as well as what kind of current conditions affect the function of said supply chains. In simple terms, the characteristics of said supply chains can be quite unique, and so understanding said structures will prove beneficial in understanding the setting the further topics in this thesis are discussed in.

As mentioned earlier, in the simplest terms, supply chains deal in the fulfilment of customer requests regarding different sorts of products. These products can include, depending on the nature of the company's business, raw materials, intermediate goods, or finished products. According to Fung & Korinek (2013), Miroudot et al. (2009), and Bełdycka-Bórawska (2023) said groups stand for: unprocessed or minimally processed goods, produced goods used as inputs in further production processes, and goods produced through production processes that are sold for customer use, respectively.

A good sense of what sort of goods and materials are the centre of technology industry supply chains can be gained from looking at the different types of sub-industries listed earlier on in the first section of the literature review. According to the Technology Industries of Finland (2024c), the electronics and electrotechnical sub-industry mainly focuses

on manufacturing different sorts of electronical devices such as automation equipment, medical electronics, sensor systems, network devices, as well as aviation and aerospace equipment for example.

Also, according to the Technology Industries of Finland (2024c) the mechanical engineering sub-industry focuses primarily on manufacturing machinery such as motors, ships, forestry- and agricultural machinery, cranes, as well as mineral processing machinery for example. The metals industry on the other hand focuses on manufacturing and processing of metal components that are used in manufacturing of products such as vehicles, major appliances, fuel cells, superconductors, and renewable energy systems for example.

It can then be extrapolated from the listed goods and materials in each sub-industry, that technology industry supply chains mainly deal in things such as metals, plastics, and minerals, and chemicals based raw materials and goods. The rest of the sub-industries mainly deal in immaterial goods, and do not really contain supply chains of very much significance. These sub-industries in specific include engineering and consulting, as well as information technology.

When looking at the structure of any given supply chain, it is useful to look at the supplier-manufacturer/distributor-customer axis. When looking from an EU perspective, according to Eurostat (2024a) during the past decade, high-tech imports to the EU from extra-EU countries have mainly originated from China and US by some margin. In fact, in 2022, Chinese imports made up a total of 36% of extra-EU imports, meanwhile the second largest portion is made up of US imports at 19%. The rest of the extra-EU countries hold only marginal percentages respectively when compared to China and the US, with the next most significant ones being countries like Switzerland, Taiwan, and the UK.

According to Eurostat (2024a) the largest manufacturers of high-tech within the EU include countries like Germany, France, and Italy. Also, when it comes to extra-EU exports

of high-tech products, the US is by far the most popular destination, making up around 26% of said exports. Other popular partners are China, the UK, and Switzerland. Additionally, according to Eurostat (2024b) the ratio of intra-EU and extra-EU imports of categories of goods that can include technology industry products or related materials for EU countries in 2023 was around 65% (intra) and 35% (extra), and the ratio of exports was around 61% (intra) and 39% (extra).

The EU has also outlined a list of critical raw materials, mostly including various types of metals and minerals, the availability of which is of crucial importance to industry and modern technology (European Commission, 2024c). According to the Technology Industries of Finland (2022), nearly half of all the volume of critical raw materials sourced by the EU originates from China. This is especially prominent when it comes to materials like rare earth elements (REEs), often used for applications such as lasers, magnets, fuel cells, electronics, medical devices, aviation equipment and many other important technologies. This is also the case with other, more common industrial metals such as magnesium, tungsten, and titanium.

Extrapolating from these facts, the structure of a given supply chain within a European technology industry company very commonly includes a supplier or customer relationship with either another European, a US or a Chinese entity, or some combination of these options. This is logical, as each of these options can provide their own unique benefits. According to Veld (2019) the European Single Market allows businesses to move around goods freely within the EU, without internal borders or associated obstacles like tariffs, thus reducing risk and improving efficiency in trade and supply chains. On the other hand, according to the European Commission (2024d) the EU and US have a deep and established bilateral trade and investment relationship, in which buying power and common interests are abundant.

According to Al-Haschimi et al. (2024) trade with China has mainly had a cost-effectiveness incentive as far as imports go, due to their cheap commodity prices. However, according to Vandermeeren (2024) China's has also lately gained significant buying power, and consequently has also grown as an export market. It is evident that the European countries have trade dependencies with each other, the US, and China when it comes to technology industry goods. According to Gehringer (2023) trade dependencies are not necessarily a bad thing, as for example, the associated cost savings can lead to gains in efficiency. However, due to the nature of Europe's dependencies with China, as well as the currently prevailing economic and geopolitical climates, some added risk is introduced, as according to Brinza et al. (2024) the EU-China relationship has been under pressure due economic and political disagreements, which could lead to trade restrictions affecting technology industry supply chains.

Overall, looking at the discussed characteristics of technology industry supply chains in a Finnish/European context, it is evident that there are implications regarding things such as high costs due to the nature of the of the products and raw materials associated with the industry, as well as often long and complex supply chains when looking at the different parties usually involved, spread across different geographical locations with differing policies and customs, with some products and materials being quite rare and specified for the more sophisticated uses within different sub-industries.

2.2.2 SCM practices

In order to understand supply chain management (SCM), in the context of the technology industry, in this section, the different phases of SCM are defined, examples of the various practices involved in each phase are outlined, and the importance of each phase as it relates to the technology industry is explained as extrapolated from the different characteristics mentioned previously. The example practices that are included can include the use of various different strategies, methods, and tools.

According to Grilli & Webb (2023) sourcing stands for the identification and selection of most suitable suppliers to meet a company's requirements, and procurement stands for the more grass-roots procedures and operations involved in obtaining commodities. When it comes to sourcing and procurement, several different practices exist that can be implemented. According to Giunipero et al. (2019) these practices can include use of strategies, such as single- or multiple sourcing, local-or global sourcing, sustainable sourcing, and new product development sourcing.

According to Giunipero et al. (2019) other practices can involve use of different tools such as e-procurement systems. Also, according to Hwang & Min (2015), another tool that can be useful in this regard are ERP systems. Generally, when it comes to choosing sourcing and procurement practices, especially various outlined strategies, it can be beneficial to focus on an appropriate mix and balance of them, as their differing focuses might leave gaps in competencies if applied in isolation. This is especially true when looking at the technology industry, as the availability, specifications, and uses for different technological components and products may make it difficult and counterproductive to focus on only a very narrow selection of strategies.

Demand planning and forecasting in simple terms stands for using different methods to estimate future sales and demand across the supply chain (Bonde & Hvolby, 2005). When it comes to demand planning and forecasting, several different practices also exist that can be implemented. According to Jaiwant & Kureethara (2024) these practices can include the use of methods such as analysis and utilisation of historical data and pattern recognition via regression analysis, time series analysis, and exponential smoothing, whereas more qualitative methods can include various means of consulting and collaboration with supply chain partners, experts, and customers. An example of the latter could include implementing something like collaborative planning, forecasting, and replenishment (CPFR), as discussed by Hill et al. (2018).

Other practices in this paradigm can include utilisation of various tools, such as enterprise resourcing planning (ERP) software, as well as more advanced artificial intelligence (AI) and machine learning (ML) applications, such neural networks. According to Fathima et al. (2024) combining and integrating these technologies with each other can lead to even better level of utilisation. Accurate demand planning and forecasting is important in supply chains, especially in technology industry companies, as materials and products can often be of quite high value, which can make suboptimal material flows challenging to deal with financially.

Supplier management, in the simplest terms, stands for ensuring a sufficiently low cost, high quality, and steady and secure flow of materials or goods from suppliers through practices such as diligent planning-, implementation-, development-, and monitoring of supplier relationships (Chuah et al., 2010). A big part of supplier management is supplier relationship management (SRM), which according to Lambert & Schwieterman (2012) stands for developing and maintaining supplier relationships in order to align goals and enhance collaboration for more successful outcomes. When it comes to supplier management, several different practices can also be implemented. According to Wittinger (2019) said practices can include the use of several methods such as proper supplier evaluation and selection, extensive cooperation, and IT platform utilisation.

According to Wittinger (2019) other derivative practices can include utilisation of tools such as total cost of ownership (TCO) analysis, supplier qualifications, task fulfilment monitoring, periodical contract reviews, on-site supplier audits and in-person meetings, big data analysis, ERP systems, procurement apps, e-auction/bidding systems, and cloud computing solutions. In technology industry companies, proper supplier management is important, as the commonly global and diverse sets of suppliers can make it more difficult to ensure sufficient visibility in terms of ensuring things such as quality, security, and overall compliance of the supplier.

Production, in the simplest terms, stands for transforming raw materials and intermediate goods into finished products (Kahraman & Çebi, 2018). Production processes and methods can vary widely, but in the context of manufacturing companies, according to Esmaeilian et al. (2016) these can be divided into joining, dividing, subtractive, transformative, and additive processes. It is also discussed, that aside from the processes themselves, some important process planning dimensions in production include things such as production/inventory/resource planning, scheduling, as well as quality control.

When it comes to production, several different practices also exist that can be implemented. According to Esmaeilian et al. (2016) modern production practices can include the use of methods such as lean and agile manufacturing systems, as well as utilisation of tools such as automation and robotics for instance. According to Chopra et al. (2022) another commonly used tool in production are ERP systems. Effective and efficient production practices can be of significant importance, especially to technology industry companies, as factors such as expensive materials, and complex products involving intricate designs, and the associated process complexity can become limiting factors without utilising them.

Inventory management, in simple terms, stands for the process of monitoring, controlling and planning inventory (Atnafu et al., 2018). Inventory management and production are highly related, and interdependent on each other. When it comes to inventory management, several different practices also exist that can be implemented. According to Nemtajela & Mbohwa (2016) practices can include the use of strategies such as just-in-time (JIT), and related to this, according to Zhao & Tu (2021) keeping adequate safety stock can also be an important strategy. Practices can also include the use of methods, such as economic order quantity (EOQ) and ABC analysis for instance (Nemtajela & Mbohwa, 2016)

According to Zhao & Tu (2021), practices can also include utilisation of tools, such as ERP systems. Also, according to Oghazi et al. (2018) another useful tool in this paradigm can

be radio-frequency identification (RFID). Adequately accurate inventory management is crucial for technology industry companies, as overstocking of expensive products can tie up a considerable amount of capital, and stock-outs can be difficult to deal with due to often long supply chains and associated lead-times.

In the context of supply chain management, logistics stands for management of material flows between different locations and associated transportation, warehousing, and material handling aspects, also including inbound, outbound, and reverse logistics (Makris et al., 2014; ASCM, 2024). Logistics is tightly intertwined with previously outlined procurement and inventory management aspects of the supply chain for instance, which is why it also deals with fulfilment of orders based on established guidelines, such as delivering the correct amount of goods while meeting delivery time targets, as well as accounting for terms of delivery, which according to the International Trade Administration (2024) deal with allocation of responsibilities relating to logistical activities such as customs, insurance, and documentation. According to de Oliveira et al. (2022) warehousing specific aspects of logistics include processes such as receiving, storage, picking, packaging, and finally shipping.

The associated practices can include the use of strategies, which according to Chakravarty (2014) can involve choices in transportation modes like road, rail, sea, and air transport, as well as outsourcing decisions, such as utilisation of third party logistics (3PL) for instance. Also, practices can involve use of tools, which according to Shamsuzzoha et al. (2015) can involve, for example, cloud-based tracking portals integrated with RFID-, barcode, and GPS systems used in connection with ERP systems. Proper logistical practices are important to technology industry companies, as supply chains in the industry can often be long and complex, making improper execution of said practices especially disruptive.

The importance of monitoring industry trends in supply chain management is at an all-time high due to the highly globalised and complex nature of modern supply chains. Not

only does this monitoring promote competitiveness of companies' supply chains, but it also promotes ethical and sustainable conduct, regulatory compliance, and security. In pursuit of achieving these goals, according to Shrivastava (2023) the trends of today exhibit themes of enhancing cyber security in the face of the rapid digitalisation of supply chains, taking precautions to navigate geopolitical and regulatory volatility, as well as ensuring the ethicality of working conditions and practices in upstream supply chains. These trends are very important for technology industry companies to follow, as digital technologies, global settings, and economies of scale can often play a large part in supply chains throughout the industry.

2.3 Supply chain performance

As defined at the beginning of this thesis, supply chain performance (SCP) stands for the level of fulfilment in supply chain activities meeting customer requirements while optimising factors such as on-time delivery, availability, and responsiveness (Hausman, 2004). However, the overall concept of supply chain performance is of a much broader scope. This scope is explored further in this part of the thesis. The ways in which supply chain performance improvement can be achieved are also explored in this part of the thesis. The assessment of supply chain performance is an important part of successfully identifying aspects that are to be remedied if beneficial improvements to said performance are to be made. This is why discussion on different assessment frameworks and methods is included as an important part of laying the groundwork for finding suitable improvement strategies for supply chain performance.

2.3.1 Defining SCP

Supply chain performance as a concept is quite a complex one, as it is broad and encompasses the entirety of a company's supply chain processes. Descriptions of the different aspects and dimensions of supply chain performance can also vary somewhat, although said variation can often be a matter of perception, as the basic ideas behind different descriptions are of a similar nature. To illustrate this, according to Fatorachian & Kazemi

(2021), Sillanpää (2015), and Arif-Uz-Zaman & Ahsan (2014) in the associated literature, the different measures/criteria, referred to from this point on as “aspects” of supply chain performance are described with varying terminology, with some of the most common ones including things like quality, cost, efficiency, flexibility, responsiveness, reliability, innovation, asset management, time, agility, profit, and sustainability. Overall, supply chain performance can then be considered as quite a complex and holistic concept, however, one that always describes the aspects that are involved in supply chains meeting customer requirements in the most optimal way possible.

According to Sillanpää (2015) in the literature, supply chain performance is usually examined in the context of different kinds of processes, which can have some variation, however, most typically include wider processes such as plan, source, make, deliver, and return. Also, according to Sillanpää (2015), the main purpose of measuring supply chain performance in a business context is to primarily provide top management, as well as other managerial levels, information about the efficiency of a company’s supply chains, which is necessary for the improvement of supply chain management practices. The aforementioned illustrates the interconnectedness of the concepts of supply chain performance and supply chain management, and could indicate that supply chain performance improvement can be done through deploying good supply chain management practices. According Sukati et al. (2012) it has been found that good supply chain management practices in fact do lead to improved supply chain performance.

Supply chain performance as a topic is one growing in prevalence and popularity. According to Reddy et al. (2019) research has shown considerable growth in the number of papers focused on the topic of supply chain performance. It is also said that said that this trend is expected to continue for the foreseeable future. Also, according to Reddy et al. (2019) recently competition between companies has widened in scope to competition between supply chains. This makes the importance of supply chain performance and supply chain management heightened, as they have become essential to keeping up

with competition, as well as gaining competitive advantage. This might give indication as to why the research on the matter has also gained similarly increased interest.

2.3.2 SCP improvement

Improvement of supply chain performance, as mentioned earlier, can be done through employing effective supply chain management practices. In doing this, also several overarching themes can be found which are essential enabling factors and drivers to supply chain performance improvement. In this section, the positive effects of various SCM practices on supply chain performance are discussed, accounting for each phase of SCM individually, apart from continuous monitoring of industry trends, as said phase does not generally include practices that are very established or specified.

Practices in the sourcing and procurement phase of supply chain management, in the context of supply chain performance improvement, are grouped within the larger "source" process. The associated practices discussed in the last chapter can improve supply chain performance in various different aspects. For instance, according to Giunipero et al. (2019) single sourcing can provide benefits such as higher quality and lowered costs via improved collaboration, meanwhile multiple sourcing can improve reliability via reduced disruption risk. Additionally local sourcing can prove beneficial in terms of flexibility, reliability, and cost efficiency via improved collaboration and reduced risk, whereas global sourcing provides lower costs via access to new markets. Also, sustainable sourcing and new product development sourcing can improve aspects of sustainability, as well as costs and innovation, respectively.

Furthermore, supply chain performance can be improved through e-procurement platforms, as according to Chang et al. (2013) they can enhance efficiency of sourcing activities, and product quality, via improved information sharing between supply chain partners, closer partner relationships and collaboration, and increased supply chain integration. Also, it was found that collaborative activities such as joint learning between partners further improves integration, thus amplifying its benefits. According to Hwang &

Min (2015), utilisation of ERP systems on the other hand, can be used to automate invoice and payment systems and track order history for instance, which in turn can improve responsiveness, as a consequence of streamlined processes.

Practices in the demand planning and forecasting phase of supply chain management, in the context of supply chain performance improvement, are grouped within the larger "plan" process. The practices discussed in the last chapter can also provide improvements to supply chain performance in several aspects. According to Hill et al. (2018), collaborative planning, forecasting, and replenishment (CPFR) carries the ability to respond to issues stemming from poor demand visibility throughout the supply chain, consequently reducing inventories and improving product availability. It is also discussed that these effects can decrease costs, as well as improve responsiveness, reliability, and asset management within the supply chain, via utilisation of extensive information sharing between supply chain partners and collaborative action in development and adjustment of forecasts.

Also, the more advanced digital technology practices in demand planning and forecasting can improve supply chain performance, as according to Feizabadi (2020) machine learning models paired with time series forecasting are proven to improve forecasting accuracy and mitigate the so called "bullwhip effect" of compounding demand distortion, and consequent inventory imbalances, improving aspects such as costs, asset management, and profits, via improved information processing capabilities. According to Oghazi et al. (2018) a similar effect can be achieved by utilising ERP systems, however, via means of effective information sharing regarding sales throughout the supply chain.

Practices in the supplier management phase of supply chain management, in the context of supply chain performance improvement, are grouped within the larger "source" process. The practices discussed in the last chapter can also provide improvements to supply chain performance in several aspects. According to Emon et al. (2024) an increased focus on supplier collaboration, -development, -evaluation and selection, as well as long-term

supplier relationships lead to improved cooperation, clearly defined and comprehensive selection and evaluation processes, as well as longer and more stable partnerships.

According to Emon et al. (2024) the aforementioned improvements mainly contribute to aspects of cost-effectiveness, efficiency, quality, innovation, and reliability within supply chains, via increased information sharing and collaboration. It is also discussed that practices involving utilisation of digital platforms and tools are important facilitators of these improvements due to their vast information sharing capabilities. As an example of this, according to Hwang & Min (2015) ERP systems enable early supplier involvement in new product development, via enhanced information sharing and collaboration.

Practices in the production phase of supply chain management, in the context of supply chain performance improvement, are grouped within the larger “make” process. The practices discussed in the last chapter can also provide improvements to supply chain performance in several aspects. According to Arif-Uz-Zaman & Ahsan (2014) lean production processes can lead to benefits such as decreased product defects, shorter production times, and increased output, which in turn lead to improvements in aspects of efficiency, quality, costs, and lead-time. Said benefits can be primarily considered to be the result of process streamlining as the enabling factor.

According to Chopra et al. (2022), as ERP systems can include modules such as material requirements planning (MRP), capacity needs planning (CNP), and manufacturing resource planning (MRP II), via their utilisation production planning can be improved to a significant degree. This in turn can lead to benefits such as reduced production costs, improved quality, and increased process efficiency, via improved process integration and cross-departmental information sharing. It is also discussed that technologies like robotic process automation (RPA) may also be implemented alongside ERP systems for added benefit, especially in increasing integration between ERP systems and legacy systems.

Practices in the inventory management phase of supply chain management, in the context of supply chain performance improvement, is hard to group exclusively with any one larger process, as it must be considered across most of them. The practices discussed in the last chapter can also provide improvements to supply chain performance in several aspects. According to Zhao & Tu (2021), keeping adequate safety stock can ensure product availability during unexpected demand. This can improve aspects such as agility and reliability via reduced risk and improved resilience. According to Nemtajela & Mbohwa (2016) utilising JIT, EOQ and ABC analysis on the other hand can lead to improved inventory control and customer service, leading to improvements in aspects of efficiency, costs, and flexibility, via improved prioritisation and streamlining of inventory.

Improved supply chain performance can also be gained via utilisation of ERP systems, as according to Shuai et al. (2007) they can provide fast access to accurate information and increased information visibility, leading to improved inventory control and customer service, consequently improving aspects of efficiency and reliability, via increased integration. According to Fatorachian & Kazemi (2021) RFID utilisation can also provide further benefits by speeding up warehouse processing, and consequently improving efficiency, via integration with the warehouse management capabilities of ERPs.

Practices in the logistics phase of supply chain management, in the context of supply chain performance improvement, are grouped within the larger “deliver” and “return” processes. The practices discussed in the last chapter can also provide improvements to supply chain performance in several aspects. According to Çankaya & Sezen (2019) different practices regarding packaging, such as reducing packaging material and using reusable packaging, can improve aspects of sustainability and costs, via what can be considered as more streamlined processes. According to Ke et al. (2015) choices in transportation modes are often adjusted to prioritise different things in the face of factors such as cost of capital, demand variation, and industry competition. It is outlined that an appropriate modal mix can lead to improvements in aspects of costs or responsiveness for instance, via improved prioritisation.

Another practice that can provide beneficial outcomes in terms of supply chain performance is utilising third party logistics (3PL), as according to Vasiliauskas & Jakubauskas (2007), by outsourcing functions such as warehousing and transportation, and consequently being able to utilise providers' advanced coordination abilities and sharing logistical risks with them, aspects of reliability and efficiency can be improved, via reduced risk and increased information sharing.

By utilising proper reverse logistics, supply chain performance may be improved further, as according to Pushpamali et al. (2021) by ensuring circular flows of materials within supply chains, improvements can be made in aspects such as sourcing costs and sustainability. Finally, according to Shamsuzzoha et al. (2015), utilising tools such as RFID-, barcode-, and GPS systems in integrated cloud-based tracking portals used in connection with ERP systems can improve visibility and decision-making in supply chains, consequently improving efficiency of deliveries, via better data integration and risk mitigation.

It is then illustrated here, that supply chain performance improvement is possible through all SCM phases, with the use of various SCM practices. Themes of enabling factors that are at the root of improvement opportunities can also be found throughout the discussed phases and associated practices. To reiterate said factors in the clearest way possible, the most common ones could be grouped thematically as follows: information sharing and collaboration, streamlining, prioritisation, integration, as well as risk mitigation.

According to Cao & Zhang (2010) supply chain collaboration stands for supply chain partners working together in order to plan and carry out supply chain operations. According to Chang et al. (2013) information sharing in supply chains stands for the proper flow of high quality information between supply chain partners. These two could involve aligning priorities and ensuring effective communication when working together with partners, as well as adopting and utilising digital information systems for example.

According to Raffington & Joseph (2024) streamlining in supply chains entails minimising non-essential activities, complexity, errors, and waste in processes. This could involve, for instance, implementing lean practices or automation. Prioritisation is rarely discussed as a standalone concept, but according to Faisal (2009) when it comes to supply chain risk management for instance, prioritisation involves comparing the importance of relevant variables in order to enhance decision making and consequent efforts in areas of most importance. This could involve different choices in sourcing decisions or transportation modes for instance.

According to Chang et al. (2013) supply chain integration stands for coordinating and integrating different processes and activities within supply chains. This might involve coordination and integration between departments or digital systems for instance. According to Chang et al. (2015) supply chain risk mitigation and associated strategies stand for actions related to minimising the chances of negative incidents taking place within supply chains. This might include ensuring a consistent and secure flow of materials in the supply chain through sourcing decisions or keeping safety stock for instance.

2.3.3 SCP assessment frameworks

In order to distinguish the appropriate routes for supply chain performance improvement, the aspects of supply chain performance that are being hindered must be identified. For this purpose, there exists several assessment frameworks. Said frameworks can be utilised to assess supply chain performance from data collected via qualitative means, such as interviews, and/or quantitative means, such as surveys or company data (Lehyani et al., 2021). Performance can then be improved on the basis of said assessment. Examples of said frameworks are discussed in this part of the thesis. According to Lehyani et al. (2021) and Reddy et al. (2019) the most prevalent frameworks for assessment include supply chain performance measurement systems (SCPMS) such as the SCOR model, balanced scorecard (BSC), and hierarchical based approaches.

Supply chain operations reference (SCOR) model is a model that provides companies and organisations tools that can be used to make rapid improvements to their supply chain processes (ASCM, 2022). SCOR is made up of several sections, of which the one titled "performance" is primarily concerned with the assessment of supply chain performance across several management processes (ASCM, 2022). Said section also includes a list of performance attributes, which provide descriptions about strategic characteristics of supply chain performance on dimensions of resilience, economic, and sustainability. According to Lehyani et al. (2021) the benefits of the SCOR model include fast assessment and effective identification of performance challenges. The model also can also provide additional tools, such as metrics related to each performance attribute (ASCM, 2022).

Balanced scorecard (BSC) is a management tool that focuses on assessing supply chain performance across four different perspectives, which include customers, financial, internal processes, and innovations, by monitoring associated strategic objectives through different indicators and metrics (Lehyani et al., 2021; Reddy et al., 2019). The goal is to get a balanced view of all four perspectives. The benefits of utilising BSC can include improvement of customer service, as well as better operational and strategic performance (Lehyani et al., 2021).

Hierarchical based approaches in turn are focused on assessing supply chain performance on all hierarchical levels of organisations, including strategic, tactical, and operational levels (Reddy et al., 2019). This approach is intended to provide different levels of management with the appropriate information regarding supply chain performance, by means of allocating useful and appropriate measures and metrics to managers on said levels (Reddy et al., 2019).

2.3.4 Conceptual framework

Concluding the literature review, a comprehensive picture of small-scale technology industry companies, technology industry supply chains and supply chain management, as well as supply chain performance has been gained. The understanding of the first part

gives important context to the conditions surrounding the remaining two parts, as a small-scale company- and technology industry context brings its own nuances to supply chain management and -performance. When it comes to the parts regarding supply chain management and performance, structural outlines for practical assessment and improvement of supply chain performance can be identified.

As discussed earlier, according to ASCM (2022) the SCOR model identifies and defines several supply chain performance attributes, used to assess supply chain performance, describing the strategic characteristics of supply chain performance and aligning supply chains' performance with business strategy. By utilising these attributes and associated definitions, the concrete function of supply chains can be related to different aspects of supply chain performance. These performance attributes unify the varying aspects of supply chain performance discussed earlier under eight broader ones.

Also, as discussed before, according Sukati et al. (2012) different supply chain management practices can be utilised to improve supply chain performance. As was outlined previously, these practices can include the use of various tools, methods, and strategies, across all phases of supply chain management, which according to Hwang & Min (2015), Esmaeilian et al. (2016), and to Giunipero et al. (2019) can include, for instance, things such as ERP systems, lean production systems, or multiple sourcing, respectively.

As was also found, supply chain performance benefits from application of said various supply chain management practices are often enabled by factors such as improved information sharing and collaboration, streamlining, prioritisation, integration, and risk mitigation. All of the aforementioned aspects, and their connected nature can then be synthesised into one conceptual framework for supply chain performance assessment and improvement to guide the empirical section of this thesis. This framework is illustrated below (figure 3).

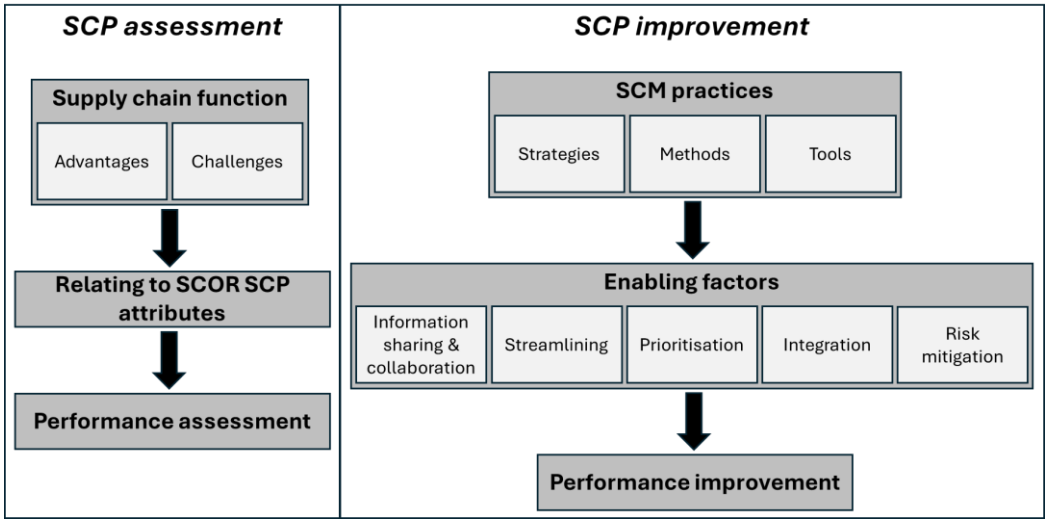

Figure 3 - Conceptual framework *(author's illustration)*

3 Methodology

In order to conduct empirical research on the topic chosen for this thesis, the appropriate methodology must be constructed. This part of the thesis aims to do just that, as the chosen approach, as well as means of data collection and analysis that are applicable in the next part of the thesis "findings", are outlined. This part also aims to provide the reasoning for why said methods are chosen, as far as the scope and environment of the research goes. Also, the reliability and validity of the research is assessed.

3.1 Approach

The approach chosen for this thesis is a qualitative case study. According to Denzin & Lincoln (2005) qualitative research is concerned with interpreting phenomena in their natural settings, based on people's perceptions, by addressing "why" and "how" questions. According to Yin & Campbell (2003) the case study sets out to understand a phenomenon in a specific real-life context. In this case, the phenomenon is the performance of the company's supply chains, and the context is the case company's unique environment. The qualitative method is chosen, as the purpose of this study is to examine why and how supply chain performance is being affected in the company based on internal perceptions, as well as how it can be improved based on the findings to these questions.

According to Denzin & Lincoln (2005) the data collection for qualitative research most often includes techniques such as conducting interviews, examining documents, and personal observation. When it comes to data analysis in qualitative research, according to Bengtsson (2016) qualitative content analysis is one of the most applicable data analysis methods, as it can be used on all written data, no matter the source. It is also discussed that content analysis is carried out by organising data, drawing meaning from said data, and finally inferring rational conclusions. According to Lincoln & Guba (1985) the concepts of reliability and validity in qualitative research can be examined through the parallel concept of trustworthiness, the presence of which is essential for demonstrating the overall worth of qualitative studies.

3.2 Data collection

The data collection for this thesis was conducted in the form of semi-structured interviews. According to Adams (2015) semi-structured interviews are interviews conducted with one interviewee at a time, often including a mixture of both open-ended and closed questions, as well as clarifying follow up questions. The interviews were conducted among the supply chain team of the selected case company. To ensure a complete picture of the company's supply chain activities, each of the interviewees specialise in different tasks relating to the company's supply chains.

A total of six interviews were conducted within approximately one month's time. The interview framework consists of ten questions, both open-ended and closed in nature. The questions were split into categories of general questions, supply chain performance assessment questions, and supply chain performance improvement questions. A second interview framework with an additional three general questions was used for the team lead only, in order to gain some additional, general background knowledge, that does not require the insight of all of the interviewees.

The interviews were conducted in Finnish, after which they were translated into English for the purposes of this thesis. Translation software was used first to assist the translation process, after which the text was diligently reviewed and adjusted by hand, to ensure the language matched the nuances of the original interview responses, with the help of various dictionaries. The interviewees were provided with the interview framework days prior to the interview sessions, so that they could familiarise themselves, and provide more in-depth answers. They were also provided with informative material related to the concept of supply chain performance, including the basic definition of said concept, as well as a list of the previously mentioned supply chain performance attributes.

The choice of the method for data collection in semi-structured interviews was made, as it presents the clearest and most efficient way of identifying advantages and challenges

to supply chain performance from the case company's perspective, whilst accounting for the different phases of supply chain management. The somewhat broad natured questions in the interview are intended to allow the interviewee to prioritise their answers according to what they see as most important, to gain a more accurate understanding of the distribution of advantages and challenges among the different aspects of supply chain performance.

The early timing of interviews is also justified by the nature of the interview questions, as well as the preconceived clarity about the objectives and aims of the thesis in the time leading up to the research process. The durations of the interviews ranged from 20 minutes to 51 minutes, the average being around 33 minutes. The variation in interview durations is due to some participants having more straightforward and clear answers than others, as well as generally varying amounts of challenges that they could identify from their unique perspectives. In some interviews, also more clarifying follow-up questions were needed, than in others, lengthening the duration of some interviews.

Interviewee	Date of interview	Duration
Logistics specialist *(LS)*	5.6.2024	36 minutes
Production planner *(PP)*	10.6.2024	20 minutes
Sourcing manager *(SM)*	12.6.2024	39 minutes
Production manager *(PM)*	17.6.2024	51 minutes
Supplier quality manager *(SQM)*	19.6.2024	27 minutes
Head of operations *(HoO)*	24.6.2024	24 minutes

Table 1 - Interview schedule *(author's illustration)*

3.3 Data analysis

Data analysis in this thesis was conducted in form of deductive content analysis. The general characteristics of content analysis already being explained earlier, this particular type of content analysis is determined as the most suitable type of analysis for the purposes of this thesis. According to Bengtsson (2016) deductive content analysis is carried out on the basis of a pre-determined structure that is used to code/categorise data. Said structure in this case is based on the previously discussed supply chain performance attributes found in the SCOR model, also illustrated below (figure 4), which in this case are used to determine the relationships between supply chain function, such as the various advantages and challenges found in the data, and the correspondingly affected aspects of supply chain performance, also resulting in the categorisation of the advantages and challenges along the outlined attributes.

	Performance Attributes	Definition
Resilience	**Reliability (RL)**	The ability to perform tasks as expected. Reliability focuses on the predictability of the outcome of a process. Typical metrics for the Reliability attribute include delivering a product on time, in the right quantity, and at the right quality level.
	Responsiveness (RS)	The speed at which tasks are performed and the speed at which a supply chain provides products to the customer. Examples include cycle-time metrics.
	Agility (AG)	The ability to respond to external influences and marketplace changes to gain or maintain a competitive advantage.
Economic	**Costs (CO)**	The cost of operating the supply chain processes. This includes labor costs, material costs, and management and transportation costs.
	Profit (PR)	The Profit attribute describes the financial benefit realized when the revenue generated from a business activity exceeds the expenses, costs, and taxes involved in sustaining the activity.
	Assets (AM)	The ability to efficiently utilize assets. Assets' strategies in a supply chain include inventory reduction and insourcing rather than outsourcing.
Sustainability	**Environmental (EV)**	The Environmental attribute describes the ability to operate the supply chain with minimal environmental impact, including materials, water, and energy.
	Social (SC)	The Social attribute describes the ability to operate the supply chain aligned with the organization's social values, including diversity and inclusion, wage, and training metrics.

Figure 4 - Supply chain performance attributes *(from the SCOR model) (ASCM, 2022)*

3.4 Reliability & validity

As discussed earlier, the concept of trustworthiness is considered the qualitative research parallel of reliability and validity. According to Lincoln & Guba (1985) trustworthiness can be examined in aspects of credibility, transferability, dependability, and confirmability. Following these aspects as outlined by Lincoln & Guba (1985), according to Ahmed (2024) one way of ensuring credibility in qualitative research is to use triangulation, which stands for using multiple data sources in order to corroborate and verify information within the study. This was achieved, as primary interview data was often compared with secondary data sourced from relevant academic literature, in order to verify connections made by the interviewees.

According to Ahmed (2024) another way of ensuring credibility in qualitative research is to spend time in the field, whilst building rapport with study participants to gain deeper understanding into their respective perspectives. This was achieved, as several cumulative months was spent in the field interacting with the study participants on-site at the company, gathering perspective and knowledge on the company's supply chain operations.

According to Ahmed (2024) one way of ensuring transferability in qualitative research is to provide detailed contextual information. This was achieved, as the size of the company, the broader industry the company operates in, the company's product category, the nature of the company's business and supply chains, the company's structure, as well as the differing roles and responsibilities of the interviewees are all explored in the thesis. It is also discussed that one way of ensuring dependability in qualitative research is to detail the research procedures applied in the study. This was also achieved, as the utilised approach, data collection-, and data analysis methods are described comprehensively previously in this section, following a clear structure.

Lastly, according to Ahmed (2024) one way of ensuring confirmability of qualitative research, is to allow participants to validate the accuracy of interpretations in the thesis

work. This was also achieved, as during the semi-structured interviews, follow-up questions were often asked about the viewpoints of the participants, so that the documentation of the correct designations of different challenges was ensured. Also, check-ups on the thesis contents were conducted with the team-lead during the writing process.

4 Findings

At this point in the thesis, the empirical findings of the thesis are presented. Here, the collected data is utilised, and analysis is conducted by employing the discussed data analysis method. The aim of this part is to follow the objectives of the research in order to uncover the information necessary to adequately answer the set research questions. The findings are separated into various parts, of which the first one includes general background information about the case company, as well as the interviewees, to provide more context. The second part includes assessment of supply chain performance, which follows the first part of the conceptual framework of the thesis, after which, possible improvement strategies are explored on the basis of this assessment, following the remaining part of the conceptual framework. The presentation of the findings follows the structure of the interview frameworks available in the appendices of the thesis.

4.1 Case company background

In order to properly contextualise the topic of supply chain performance in the environment of the case company, first some general background about the company, its business, its supply chains, as well as the interviewees involved in the interviews are discussed via the general questions included in the interview frameworks. The numbering of the questions follows the longer framework used only for the team lead, as it includes the previously discussed three additional general questions, used to gain more general background knowledge. After interview questions 1, 2, and 3, questions are for all interviewees.

Q1. *How would you describe the company and its business in general?*

As discussed at the beginning of the thesis, the company is a relatively small-scale Finnish technology industry company, and a subsidiary of a larger parent company. It was also discussed that the company's business in highly global, also in terms of its supply chains. In order to present more information about the nature of the actual business of

the company, the question above was presented. This is meant to give additional indication as to what sort of considerations can apply to the case company and its supply chains. The interviewee commented the following:

"In short, we sell metal materials as a consumer product." — "We do only indirect sales from here. The parent company then takes care of the distribution to the end [business] customers." *(HoO)*

As can be seen, the company's subsidiary status introduces some nuances to its supply chains. Indication about the nature of the supply chains is also given, as business in metal products is outlined, which could also come with its own implications regarding factors such as high material costs or longer supply chain lengths for instance, as discussed in the theory of the thesis.

Q2. *What are the company's supply chains like structurally, and has this structure changed in recent years?*

The purpose of the second question in the interview framework is to gain some more insight into what the supply chains of the company are like, and how said supply chains have evolved during recent years. The interviewee commented the following:

"We have increased the number of our raw material suppliers and incoming raw material batches significantly." — "For those materials that have the most sales and the most competition, we have tried to build more alternatives, mainly to improve competitiveness and to ensure availability." (HoO)

This answer highlights the company's growing business and increasing efforts as it relates to supplier diversification. The reasons for these efforts also become clear, as the competitiveness and availability of high-sales and high-competition products are highlighted as priorities in this context. It is implied that the company's supply chains have been operating on a smaller scale in the past, in that volumes have been smaller, and single sourcing has been more prevalent, indicating recent growth.

Q3. *Is supply chain performance currently being tracked in the company, and if so, how?*

The third question is intended to find out whether or not there are practices in place at the company for tracking the performance of their supply chains. The interviewee answered the question above as follows:

> *"If we are talking KPIs, we have target levels for our inventory, then we have a target for responding to customer orders from our distribution centres within a certain timeframe, then there is the on-time delivery monitoring of our raw material suppliers, and then also availability reporting on a weekly basis. We also monitor forecast accuracy and the development of stock levels. Since our industry is also quite cost-sensitive, material costs are also closely monitored on a delivery-by-delivery basis." (HoO)*

It is then clear that the company does apply some basic methods for performance monitoring, especially in inventory, cost, and reliability aspects. The outlined targets and measures could useful when tracking the development of any improvements that may result as an effect of successful supply chain performance improvement strategies. This answer also affirms the inherently high costs related to metal product based trade, which was mentioned earlier.

Q4. *What is your job description, and how long have you worked at the company?*

The interviewees were chosen so that every single role in the case company's supply chain team was accounted for, so as to gain the most complete understanding of the company's supply chains, with the help of the nuanced perspectives of the interviewees specialising in different functions and activities within said supply chains. The six interviewees answered the question above and confirmed their positions as being tasked with the company's logistics, production planning, production (and laboratory) management, supplier quality management, raw material sourcing, and managing as the head of operations, respectively.

Based on the given responses, it evident that a sufficient array of different roles and responsibilities are distributed among the interviewees, as it pertains to the company's supply chains. When it comes to the durations of the interviewees' respective employment at the company, the average was around 6 years. This could be of help in getting more comprehensive views and insight into the company's supply chain operations, as the interviewees have extensive experience within this environment.

Q5. *What is your role in the company's supply chains, and what are you main responsibilities?*

To get an even more specified look into what sort of responsibilities specific to the company's supply chains relate to the aforementioned roles of the interviewees, the question above was presented. From the interviewees' answers it was found that the company's logistical work mainly deals with things such as arranging outbound deliveries and ensuring their arrival, as well as dealing with tasks related to inbound deliveries such as customs related matters with extra-EU imports, for instance the newly relevant EU mandated carbon border adjustment mechanism (CBAM) reporting responsibilities. Production planning on the other hand includes responsibilities such as ensuring material availability and managing the company's inventory levels.

It was also found that the duties associated with production management are mainly concerned with the internal supply chain, that being overseeing production operations. These operations are mainly comprised of relatively simple material processing, as well as quality assurance of final products via laboratory functions. Supplier quality management related tasks on the other hand are mostly concerned with ensuring supplier quality and dealing with issues relating to production quality. Sourcing management responsibilities then deal mostly with raw material supplier management and collaboration, supporting product development, as well as production material needs planning and supplier forecasting.

Lastly, managing as the head of operations includes responsibilities related to ensuring the proper function of supply chains across their entire spans, as well as ensuring the development of product quality and availability, and finding ways to competitively introduce new products. With these descriptions, the wide repertoire of duties involved in the company's supply chains and their management are represented.

4.2 Assessing SCP

As the responses gained via the implementation of the first part of the interview framework are presented, the sufficient background knowledge needed to understand the remaining answers related to the assessment and improvement of supply chain performance at the company is in place. The assessment of supply chain performance is required first, so that improvement can be targeted to the appropriate areas of performance. The purpose of this section is the identification of different advantages and challenges and their respective practical effects, specific practical causes for different challenges, and associated SCM phases of origin. Then, the final categorisation of these factors is done through utilising the supply chain performance attributes outlined earlier, to relate them to different aspects of supply chain performance, through the respective practical effects of the advantages and challenges. After this, the overall assessment of supply chain performance is done based on this categorisation.

4.2.1 SCP advantages

Q6. *What things do the company's supply chains perform the best at in terms of internal functions and/or external functions/partners in your opinion?*

Starting with the positives, the interviewees were first questioned on what they saw as the best aspects of the company's supply chains, through which various advantages and associated practical effects could be identified. This acts as the first half of assessing overall supply chain performance. The responses had variation, but clear themes could be found. To provide added structure, the responses are sorted here by the SCM phases,

from which the advantages originate, also defined in the theory of the thesis. The first SCM phase is sourcing and procurement, regarding which a single related response was outlined as follows:

"Our price-competitiveness is good. It has required a lot of change in our practices and processes. A significant amount of work has been done to find good competitive suppliers." (SM)

Looking at the response, the advantage can be identified as good supplier acquisition capabilities, leading to the effect of good price-competitiveness. According to Ting & Cho (2008) finding and selecting the right suppliers can be especially important in terms of improving price-competitiveness for those companies that spend a lot on raw materials. As the effect of the advantage improves the supply chains' ability to respond to marketplace changes related to price to maintain competitive advantage, the primarily effected supply chain performance attribute would in this case be agility. According to the SCOR model (ASCM, 2022) the agility attribute stands for the ability of the supply chain to respond to external influences and marketplace changes to gain or maintain a competitive advantage. The second SCM phase garnering responses regarding advantages to supply chain performance was supplier management. Said responses included the following:

"The reliability or accuracy of our deliveries is also at a good level, as we spend quite a lot of time trying to understand the capability of suppliers and their delivery schedules. We have contracts and supplier commitments to timeframes in which they can deliver." (SM)

"Perhaps what works best is that there is reasonably good predictability in that when we decide to order goods from our approved material suppliers, shipments will arrive on time, and they will also be shipped out in roughly the target time." (HoO)

"In my view, our supply chain is of rather good quality." — "We rarely have any big challenges with the raw materials we source." (SM)

As can be seen from the responses, what is essentially the same identified advantage in both of the first two responses, supplier predictability, mainly has positive effects regarding on-time delivery. According to Najjar et al. (2024) improved supplier predictability, reached through practices like contractual agreements for example, can improve on-time delivery of suppliers. This would then also enable better on-time delivery to customers. In the third response, the identified advantage of good quality upstream supply chains has the effect of reduced issues and defects in sourced materials. According to Huo et al. (2014) integration of appropriate quality practices in upstream supply chains generally leads to reduced quality-related problems and product defects.

As the effects of each three advantages improves the ability of the supply chains to perform as expected, specifically regarding consistent delivery of shipments on time, as well as good level of product quality in this case, the supply chain performance attribute primarily affected is reliability. According to the SCOR model (ASCM, 2022) the reliability attribute stands for the ability of the supply chain to perform tasks as expected with predictable outcomes, for instance, in terms of delivering products on time, at correct quantities and good quality levels. The third SCM phase that was involved in the responses was production. A single response included the following:

> *"In terms of internal operations, I have knowledge about production and laboratory matters, and I've gotten feedback from employees on both sides that the teamwork is working pretty well. We are on the same page every week about incoming shipments and the prioritisation of them." — "So, if you think about the work between the lab and production, prioritisation is a critical factor, as situations may often evolve." (PM)*

This response communicates that coordination of the company's internal supply chain in terms of procedures relating to production is at a good level. The beneficial effect of this coordination can be identified as processes that are flexible and adaptable. According to Tiwari et al. (2015) good coordination in supply chain functions can lead to improved flexibility. As the effects of the advantage improve the ability of the internal supply chain to respond to external influences, the primarily effected performance attribute would then be agility. The fourth SCM phase represented in responses when it comes to

advantages to supply chain performance was logistics. One related response included the following:

"I would say that for all outbound shipments, our logistical partners work really well." — "The biggest problems regarding them [outbound shipments] in the past half a year, for example, has been the [dockworkers'] strike, which was after all a completely external factor, which affected us a lot. But then again, our partners managed to handle it really well." (LS)

The response indicates that the company enjoys a good and functional relationship with its partners in outbound logistics. The effects of this manifest in the form of flexibility in associated processes, which has proved helpful in dealing with external shocks and influences. According to Abidi et al. (2019) cooperative partner relationships with high levels of trust do indeed enhance flexibility in logistics networks. As the effects of this advantage also improve the supply chains' ability to respond to external influences, the primarily affected supply chain performance attribute would then be agility. Lastly in the advantages category, some more general advantages were identified, not necessarily pertaining to any one SCM phase. Associated responses were the following:

"I think our internal supply chain works well. Everyone has a role and they are done well, and there is clear communication every time material arrives, and when the certifications are checked, and then when the material batch is completed and released, it is all very clear." (PP)

"Our in-house operations, which is basically our supply-production-delivery, I think work well and are closely monitored. We have weekly monitoring, some people have it on a daily basis. There are clear responsibilities. We have indicators that we monitor, and in practice we know what we need to do the following week, and then we monitor whether we have done it." (SQM)

"Our external partners, such as laboratories and logistical partners, are quite predictable in their operations. Also, in terms of costs, as we use annual contracts. That is perhaps what is going quite well." (HoO)

The responses touch more broadly on supply chains, regarding the company's internal supply chain operations and collaboration with external partners in several phases. The

first response communicates again that coordination of the company's internal supply chain is at a good level. The beneficial effect of this coordination can be identified as processes that are clearly defined and consistent. According to Cloutier et al. (2019) having adequate coordination though clear internal standards and policies can indeed improve supply chain process consistency. The second response is very similar, as it outlines the monitoring practices and subsequent coordination of the internal supply chain operations, which also elicit positive effects in terms of clearly defined and consistent processes, mirroring the same process consistency benefits achieved through coordination with clear internal standards and policies, as outlined by Cloutier et al. (2019).

The third response details the highly predictable operation of external logistics and laboratory related partners, which leads to positive effects in terms of more stable costs in supply chain processes. According to Power et al. (2007) contracting external logistical service providers for instance can indeed enable better cost management in supply chains. As in the first and second advantages, the consequent effect improves the supply chains' ability perform as expected, primarily the performance attribute of reliability would be affected. As in the third advantage, the consequent effect improves the proper management of costs within the supply chains, primarily the performance attribute of costs would be affected. According to the SCOR model (ASCM, 2022) the costs attribute stands for the costs of operating supply chain processes in terms of labor-, materials-, management-, and transportation costs for instance.

4.2.2 SCP challenges

Q7. *What are the largest challenges to the company's supply chain performance in terms of internal functions and/or external functions/partners in your opinion?*

Q8. *What do you think are the causes for said challenges?*

Q9. *How do you think said challenges affect the company's supply chain performance?*

After going through advantages, the interviewees were then questioned on the different challenges they associate with the company's supply chains and their performance, as the second aspect of assessing overall supply chain performance. These responses also had variation, but clear themes were present. The responses are once again sorted by SCM phase of origin for added structure, and this time, also more specific lines of questioning are implemented regarding practical causes and effects of listed challenges, so that more comprehensive strategies for improvement will be easier to formulate later on. To note, a subset of the effects associated with some of the identified challenges are ones yet to be realised, but are significant possibilities in the future, and are thus also included. The first SCM phase with significant representation in the responses was sourcing and procurement, regarding which related responses included the following:

"There is of course growth, our objective is to grow. The challenge is how we can prepare for that growth and maintain the current level of quality, reliability and price competitiveness." — "If and when demands increase, there is that our supply chain must have sufficient capacity to offer us products, in that we must be able to further diversify it, in order to manage risks, that is we would need more capable, price-competitive suppliers." (SM)

"An issue we have at the moment is that we have two different ERP systems in use, one which we use in our company's warehouse, and then there is SAP which is used everywhere else throughout the corporate group." — "For example, in creating raw material orders, when you think about some orders which are created four times over … the workload is quite enormous." — "As an investment, SAP integration is so sizable, that in some way it is still felt that we can manage without it." (LS)

The first listed challenge suggests that as there is a possibility of fast growing business and consequent demand in the future, the company's supplier base could struggle to provide the adequate capacity to effectively adapt to said growth, leading to a possibility of the company having to, at some point, try to further diversify and expand the supplier base, likely with quite a bit of urgency, as an effect. According to Tang et al. (2014), to reduce risks associated with demand growth, supplier diversification is often needed. It is perceivable how also pre-emptively doing so could be difficult, when it comes to costs of acquisition and holding suppliers for instance. Then, as in this case, a potential urgency in supplier diversification would make the process more difficult to successfully manage,

and thus reduce the ability of the company's supply chains to effectively respond to marketplace changes regarding growing demands, in terms of supply chain performance, this would primarily indicate the agility attribute to be negatively affected.

The second challenge suggests that tight resources are causing the company to have to partially employ several digital systems, ERP systems in this case, that are incompatible, in digital procurement processes, leading to said processes becoming inefficient as an effect. According to Henninger & Mashatan (2021) when data is handled in several differing digital mediums, the resulting data fragmentation and lack of system interoperability can indeed cause supply chain processes to become inefficient and slow.

As these inefficient digital processes reduce the speed at which tasks are performed within the supply chains, in terms of supply chain performance, this would primarily indicate the responsiveness attribute to be negatively affected. According to the SCOR model (ASCM, 2022) the responsiveness attribute stands for the speed at which tasks are performed and at which the supply chain provides products to customers. The second SCM phase represented in the responses was supplier management, regarding which responses included the following:

"Also, the fact that we have really long supplier lead-times, and it's difficult to influence them because the [manufacturing] operations happen with the external suppliers, means that our response times are really long." – "The [supplier] flexibility is fairly weak" – "That [inflexibility] is the reason why the lead-times are long, and why they also fluctuate somewhat." – "Keeping high stock levels compensates for the volatility that comes from the uncertainty in demand forecasting and long lead- and response times." (HoO)

"CBAM is going to be one big issue that needs to be addressed somehow. We would basically need to get information from extra-EU suppliers on carbon emissions." – "There is also the fact that with extra-EU suppliers there are language and cultural differences, which brings significant challenges." – "Monetary sanctions may be possible at some point. For example, in the CBAM there will be sanctions if you don't get it sorted." (LS)

The first response suggests that a level of supplier inflexibility stemming from the suppliers' inherent ways of operating is causing long and uncertain supplier lead-times, and

consequently long response times for the case company, which in turn leads to the company having to keep high inventory levels in order to maintain an adequate supply to its customers. According to Heydari (2014) long lead-times can indeed often force companies to keep high inventory levels, in order to maintain service levels. Additionally, according to Bandaly et al. (2016) uncertainties in lead time, like lead-time variability can also be common causes of increasing inventory levels. As keeping high inventory levels interferes with asset strategies like inventory reduction, in terms of supply chain performance this would indicate that primarily the assets attribute is negatively affected. According to the SCOR model (ASCM, 2022) the assets attribute stands for the supply chain's ability to utilise assets efficiently, including strategies such as inventory reduction and insourcing.

The second challenge suggests that the utilisation of extra-EU suppliers and associated communicational issues in the company's supply chains are causing difficulties in CBAM reporting, leading to a possibility of future monetary sanctions. According to Pauwelyn (2024) failure to comply with CBAM reporting duties can indeed lead to monetary sanctions for the importing party. As potentially increased monetary sanctions lead to increased costs of operating supply chains within the company, it is then indicated that primarily the costs attribute of supply chain performance is negatively affected. The next SCM phase prevalent in the responses is demand planning and forecasting. The responses included the following:

"What causes problems is that the customer needs can be very sudden, and then this is complicated by the quality of the forecasts, in that the forecast is not necessarily quite accurate." – "The customer is more sudden, and then the supplier, due to the nature of their business, has to look further ahead." – "Then the simple solution is that the inventory that sells a lot is kept in stock." (SQM)

"Our sales department does not get good enough visibility of our customer needs, and that's why we have to stock a lot of inventory that ties up capital, so that we can make quick deliveries to customers." – "So, the problem there is probably really the forecasts provided by our sales." – "The challenges related to the length and visibility of supply chains perhaps come from the fact that needs have been smaller in the past." (SM)

"It is really challenging to get good forecasts" – "There are [sales] organisations in different parts of the world after all, so it must have its own challenges to collect accurate information about the future." – "Of course, there is then the fact that there may not be sufficient visibility into what customers are ordering or will be ordering in the near future." – "We then get these sudden [production] needs. We then try to accommodate them." (PM)

"Our demand forecasting is at a fairly poor level." – "A small percentage of our customers are production customers. Even for those who are, there is not necessarily much professional procurement activities, where availability would be ensured by sharing forecasts and making annual contracts with us." – "Keeping high inventory levels compensates for the volatility that comes from the uncertainty in demand forecasting and long lead- and response times." (HoO)

The responses suggest that there is strong consensus that within the demand planning and forecasting phase, the challenge of generally poor demand forecasting is negatively affecting the company's supply chain performance. The first, second, and fourth responses suggest that volatile and changing customer demand, as well as customers' limited procurement expertise are causing poor demand forecasting, leading to the company having to compensate by having high inventory levels. According to Truss et al. (2006) poor demand forecasting is indeed often compensated for by keeping high inventory levels. As discussed earlier, having to keep high inventory levels in terms of supply chain performance indicates that primarily the assets attribute is negatively affected.

The third response identifies the same challenge, however, with an alternate cause and effect. The identified cause is the dispersion of the sales organisations that are involved in the company's indirect sales and consequently demand forecasting. An alternate effect is also identified, as poor demand forecasting is said to cause unexpected production needs. According to Bag et al. (2021) poor demand visibility and forecasting can affect production scheduling for instance. It is also remarked in the response that unexpected production needs occurring means that the case company has to often adjust to accommodate everything. This would mean that the flexibility for responding to further external influences diminishes, as capacity is strained. Then, as unexpected production needs

reduce the ability of the company's supply chains to respond to further external influences, primarily the attribute of agility is negatively affected. The next SCM phase represented was production. The responses included the following:

"There perhaps has not been enough digitalisation, and the same things are logged manually into many places."– "We are now at the stage where it would be good if things were more digitalised, and even though our operations are still not of a very large scale, we are moving in that direction all the time." – "In internal communication, and production and laboratory-related work phases, in things like acknowledgements and checks, it [digitalisation] would save time and make things more efficient generally speaking." (PM)

"It is perhaps the case in every company, that only a certain amount of resources are allocated to operations. I mean the employees. After all we have quite a narrow leeway there." – "Of course, these internal challenges are brought about by resource constraints." – "So, if it happens that in production or the laboratory even a couple of people are ill at the same time, it always has an effect in the planned work being slowed down." (PM)

The first response suggests that the company's slow adaptation to their own operational growth is causing the implementation of older, pre-existing digital systems in production to become increasingly more complex to operate. This then leads to digital production and associated laboratory processes becoming more inefficient and time consuming. This instance of less efficient and slowed processes mirrors that of which was discussed earlier as it relates to data fragmentation and lack of system interoperability as outlined by Henninger & Mashatan (2021). As these inefficient digital processes reduce the speed at which tasks are performed within the internal supply chain, in terms of supply chain performance, primarily the attribute of responsiveness is negatively affected.

The second response suggests that generally tight resources within the company are causing the production and laboratory to be staffed quite tightly. This in turn is said to lead to processes being slowed down whenever someone is absent for instance. According to Ganster & Dwyer (1995) appropriately staffed or overstaffed workforces generally have higher levels of productivity than understaffed ones. As slower operation of production processes reduces the speed at which tasks are performed within the internal

supply chain, in terms of supply chain performance, primarily the attribute of responsiveness is negatively affected with this challenge as well. The last specific SCM phase represented in the responses was logistics. The one related response included the following:

"Then there are these extra-EU imports. They have to be worked on for a while before they start to run smoothly. Customs is one of the things that puts a lot of restrictions on this environment we're in, and in certain countries, they can't receive shipments properly." – "Maybe it is the ways of operating that are the problem, because again you are dealing with people from different countries." – "[Effect is] Delays. A good example is the issues with discharging transit procedures, which recently caused delays to our shipments." (LS)

This response suggests that incoming logistics are being affected by customs issues to some degree. More specifically, the utilisation of extra-EU imports requiring customs procedures in foreign countries with their own ways of operating are causing issues with said procedures. This is said to then ultimately cause delays to incoming- and consequently outgoing shipments, affecting on-time delivery. According to Zhou & Zhang (2024) customs issues, among other things, can be prevalent sources of delays in characteristically volatile global supply chains. As delays reduce the ability of the supply chains to perform as expected, specifically in delivering products on time in this instance, in terms of supply chain performance, this would primarily indicate that the reliability attribute is negatively affected. After logistics, the remaining responses did not relate to any specific SCM phase, rather relating to several in a more general sense. The responses included the following:

"Another challenge is the cost side of things, so what our customer is willing to pay, and then at what price we can get the raw material, and then finding that balance in some cases is a problem." – "So, one wants to buy cheap and the other wants to sell expensive, so you are between two parties who both want to optimise the cost structure."– "This is the problem, of course depending on the product and the market where it is sold, with which we sometimes have to wrestle. The margin there can be pretty thin." (SQM)

"[Challenge is] the fact that we have to maintain our price-competitiveness." – "As we have come from a customer base, that is able to pay for our products, and as this [field

of industry] has moved a bit from sort of prototyping to small series production, the price is starting to be more important for the customer." – "The market determines the price levels and we have costs resulting from our operations, so we have to keep our own cost structure as low as possible so that we are competitive in the market." (SM)

"I think the biggest challenge to the performance of our supply chains is the incompatibility of the systems we use, and the many different places to manage. We don't have a single system that can maintain all these functions, and it's not helped by the fact that we also have two ERPs" – "Of course, money is always a factor, so now that we are living in somewhat unstable times, I also understand that leaning systems and buying new software is not a foregone conclusion. Then, as the company is small, there are also a lack of operators." – "Well, to put it plainly, [effect of the challenge] is time is spent on double the work, triple checking and coping with uncertainty. In other words, it really slows things down." (PP)

"It is also the case that it is not entirely clear, at least not to me, who is responsible for what at the parent company. So, you have to for example add to e-mails all the possible parties that could be in some way involved in deliveries or orders and so on." – "Then on the root causes on the parent company's end, I think there has been a good understanding in the past of who is who, and who is responsible for what. Nowadays I think that there is a lot of staff turnover, and people are given new responsibilities." – "So that's the challenge, slows down the work and reduces efficiency significantly." (PP)

"Then perhaps it a problem, that as we have only a few people using SAP, it may not be perceived as something that requires much training." – "When it comes to training, we have been able to work with the existing training as well." – "So maybe it is not even perceived that it [training needs] is much of an issue." – "It [SAP] could certainly be used more efficiently if we knew more about the transactions and how you could use it for different things." (LS)

The first response suggests that differing priorities between suppliers and customers are causing difficulties in balancing raw material costs and sales pricing within the company's supply chains. This leads to the company having thin profit margins. According to Grover (2007), companies occupying a "distributor" role in a supply chain can inherently have to reconcile with the profit challenge of operating with low margins, costs, and assets, while maintaining steady service levels with both suppliers and customers. As thin profit margins will reduce revenues in relation to the expenses generated in the company's supply chain operations, in terms of supply chain performance, it is indicated that primarily the profit attribute is negatively affected. According to the SCOR model (ASCM,

2022) the profit attribute stands for the financial benefit gained when the revenue generated from business activities exceeds the associated expenditure in the supply chain.

The second response suggests that the growth of the industry and consequently changing customer requirements is causing the company to have to grapple with maintaining price-competitiveness in the market. This in turn leads to a need to perpetually minimise costs to maintain competitiveness. According to Linn et al. (2006) when trying to maintain price-competitiveness, cost considerations such as conducting supplier selection with a price focus can often be applied.

So, meanwhile a fine strategy in itself, relying on perpetual cost minimisation to maintain price-competitiveness might eventually cause certain ceilings to be hit, and if prioritised excessively, other drivers of price-competitiveness to be neglected. As relying on perpetual cost minimisation would then reduce the supply chains' ability to respond to further marketplace changes to maintain a competitive advantage, in terms of supply chain performance, this would primarily indicate the agility attribute to be negatively affected.

The third response suggests that tight resources within the company are causing them to have to utilise a range of incompatible digital systems and functions. This in turn leads to digital processes becoming inefficient and slow. This challenge is essentially identical to the second challenge discussed relating to the sourcing and procurement phase. In this instance, however, the challenge relates more broadly to several SCM phases. The same principles of data fragmentation and system interoperability and consequent process efficiency and speed implications discussed by Henninger & Mashatan (2021) apply here. As these inefficient digital processes reduce the speed at which tasks are performed in the supply chains, in terms of supply chain performance, this would indicate that primarily the responsiveness attribute is negatively affected.

The fourth response suggests that a dispersed and changing organisation is causing communicational issues with partners at the parent company who are involved in supply

chain functions. This in turn leads to supply chain processes becoming inefficient and slow. According to Negi (2021) clear communication between all parties within supply chains is critical for overall supply chain efficiency. This means that the lack of such in this case can indeed act as an impediment to efficiency. Then, as these inefficient processes reduce the speed at which tasks are performed in the supply chains, in terms of supply chain performance, this would indicate that primarily the responsiveness attribute is negatively affected.

The fifth and final response suggests that a lack of prioritisation of deeper ERP know-how is causing the company to employ a fairly low level of associated ERP training. This in turn leads to more inefficient utilisation of ERP systems. According to Svensson & Thoss (2021) a lack of ERP related training often does make it harder for organisations to utilise ERP systems to the fullest extent. As inefficient utilisation of ERP systems impairs the ability to efficiently utilise assets within the supply chains, in terms of supply chain performance, this would indicate that primarily the assets attribute is negatively affected.

4.2.3 Final SCP assessment

Now that the various identified advantages and challenges have been successfully related to different affected aspects of supply chain performance via analysis utilising the previously discussed supply chain performance attributes, the overall performance of the company's supply chains can be assessed. Illustrated below (table 2) are the different identified advantages, associated SCM phases of origin, and practical effects of said advantages, categorised through the affected supply chain performance attributes.

Advantages	SCM phase of origin	Effects	Performance attribute
Good supplier aquisition	Sourcing and procurement	Good price-competitiveness	Agility
Supplier predictability	Supplier management	On-time delivery	Reliability
Supplier predictability	Supplier management	On-time delivery	Reliability
Upstream supply chain quality	Supplier management	Reduced issues and defects	Reliability
Internal supply chain coordination	Production	Flexible processes	Agility
Outbound logistics partner relationships	Logistics	Flexible processes	Agility
Internal supply chain coordination	General	Consistent processes	Reliability
Internal supply chain monitoring	General	Consistent processes	Reliability
Logistics and laboratory partner predictability	General	Stable costs	Costs

Table 2 - SCP advantages *(author's illustration)*

Judging from the primary positively affected performance attributes, it can be inferred that the case company's supply chain performance most often exhibits strengths in the aspect of reliability. Also, strengths can be seen notably, although to a lesser extent, when it comes to the agility aspect, and to an even lesser, very limited extent, when it comes to the costs aspect. The advantages that the company possesses, that lead to good performance on said aspects are things such as good supplier acquisition capabilities, supplier predictability, good upstream supply chain quality, internal supply chain coordination and -monitoring, good outbound logistics partner relationships, as well as external logistics- and laboratory partner predictability. On the other hand, illustrated below (table 3) are the different identified challenges, associated SCM phases of origin, as well as practical causes and effects of said challenges, once again categorised through the affected supply chain performance attributes.

Challenges	SCM phase of origin	Causes	Effects	Performance attribute
Adapting to future growth	Sourcing and procurement	Potential growth of business	Potential urgency to diversify supplier base	**Agility**
Digital system incompatibility	Sourcing and procurement	Tight resources	Process inefficiency	**Responsiveness**
Long and uncertain supplier lead times	Supplier management	Supplier inflexibility	High inventory levels	**Assets**
CBAM reporting difficulty	Supplier management	Extra-EU suppliers	Possible sanctions	**Costs**
Poor demand forecasting	Demand planning and forecasting	Volatile customer demand	High inventory levels	**Assets**
Poor demand forecasting	Demand planning and forecasting	Changing customer demand	High inventory levels	**Assets**
Poor demand forecasting	Demand planning and forecasting	Dispersed sales organisations	Unexpected production needs	**Agility**
Poor demand forecasting	Demand planning and forecasting	Limited customer procurement expertise	High inventory levels	**Assets**
Digital system complexity	Production	Slow adaptation to growth	Process inefficiency	**Responsiveness**
Tightly staffed production	Production	Tight resources	Slower processes	**Responsiveness**
Customs issues	Logistics	Extra-EU imports	Increased delays	**Reliability**
Balancing costs and pricing	General	Differing supplier and customer priorities	Thin profit margins	**Profit**
Maintaining price-competitiveness	General	Growth of industry	Reliance on cost minimisation	**Agility**
Digital system incompatibility	General	Tight resources	Process inefficiency	**Responsiveness**
Poor intra-organisational communication	General	Dispersed organisation	Process inefficiency	**Responsiveness**
Limited ERP training	General	Lack of prioritisation	Inefficent utilisation	**Assets**

Table 3 - SCP challenges *(author's illustration)*

Judging from the primary negatively affected performance attributes, it can be inferred that the case company's supply chain performance most often exhibits weaknesses in aspects of assets and responsiveness within supply chains. Weaknesses can also be seen fairly notably, although to a lesser extent, when it comes to the aspect of agility. Weaknesses are also seen to an even lesser, very limited extent, when it comes to the costs, reliability, and profit aspects. Of the final total of sixteen challenge-related responses, half of them identify challenges related to either demand forecasting or digital systems, which highlights the importance of alleviating said types of challenges when it comes to improving overall supply chain performance.

Something of note is the fact that the agility attribute is represented to a fairly notable degree in connection to both advantages and challenges when it comes to supply chain performance. This would mean that the company's overall supply chain agility could be considered as somewhat of a fluctuating aspect of performance. This could also possibly mean that by coming up with ways to address the associated challenges, overall supply chain agility could have the potential to become a significant strength in performance.

Another observation is that none of the identified advantages or challenges really have a primary effect on supply chain performance in terms of two specific attributes, those being the environmental- and the social attributes, which together form the "sustainability" portion of the attributes. This could perhaps indicate that there is limited prioritisation of said aspects within the company's supply chain operations. This could have its own implications, as sustainability issues are becoming increasingly more important in terms of supply chains and their management, as was discussed in the theory of the thesis.

Q10. *How would you rate the significance of the effects of the listed challenges on the company's supply chain performance? (1-5, 1 = Insignificant, 5 = Very significant)*

As the aim of the rest of the empirical section is to focus on improving supply chain performance, it is also useful to look at how significant the interviewees see the different effects of the various challenges as being, when it comes to supply chain performance. This is why the question above was presented. The interviewees were asked to rate the significance of the effects related to the various challenges on a scale of 1-5, 1 = Insignificant, 2 = Somewhat significant, 3 = Moderately significant, 4 = Significant, 5 = Very significant. Illustrated below (figure 5) are the amounts of times that each performance attribute occurs in connection to the identified challenges, as well as the average significance ratings tied to the associated effects.

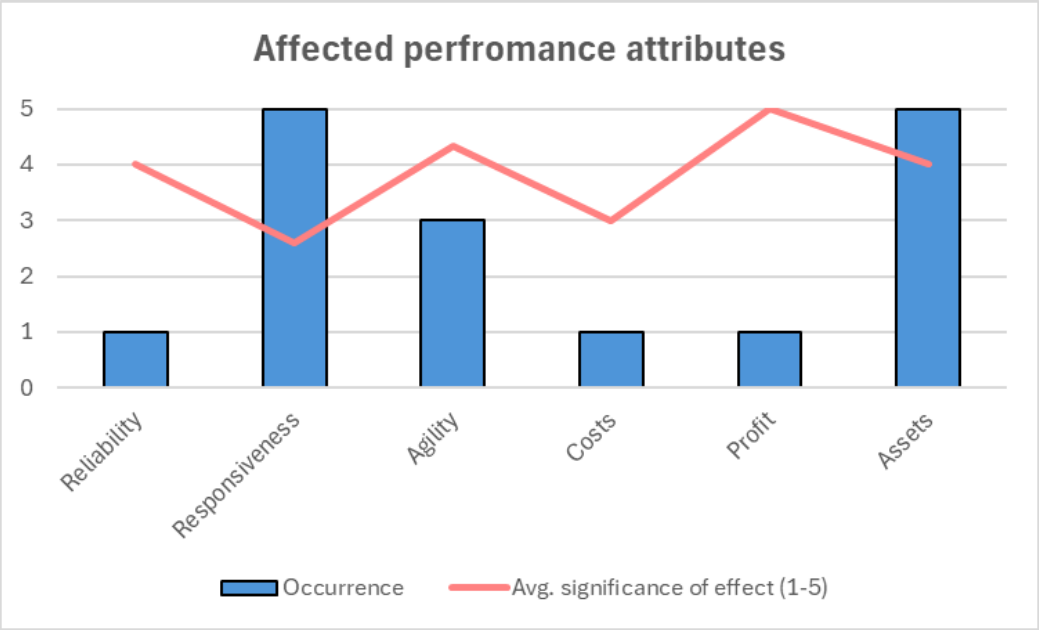

Figure 5 - Negatively affected performance attributes *(author's illustration)*

When looking at the figure, the prioritisation of alleviating challenges relating to particular aspects of performance when starting improvement efforts could be refined, as it seems that of the most often occurring challenges related to their respective aspects of performance, those relating to assets are seen as "significant" in their effects on average, along with occurring most often along with challenges related to responsiveness. This would place most priority on addressing challenges related to the aspect of assets. Challenges related to responsiveness could be seen as the next most important priority, as they occur as often as challenges related to assets but are rated closer to being "moderately significant" in their effects on average.

Then, next to be prioritised could be challenges related to agility, as they occur three times, with their effects also being rated as "moderately significant" on average. Then, of the less common challenges related to their respective aspects of performance, which only occurred once per, prioritisation from most to least priority could be set as the challenge related to profit first, as it is rated as "very significant" in its effects, the challenge related to reliability second, as it is rated as "significant" in its effects, and the challenge related to costs third, as it is rated as "moderately significant" in its effects.

Q11. *How would you rate the company's overall supply chain performance?*

(1-5, 1 = Very poor, 5 = Very good)

As seen from the interview question above, the interviewees were also asked to rate the level of the company's supply chain performance in a more general sense. This rating was also on a scale of 1-5, 1 = Very poor, 2 = Poor, 3 = Moderate, 4 = Good, 5 = Very good. The resulting average rating was **3,66**. This means that the company's supply chain performance is largely seen as moderate to good. This could mean that the company places a lot of priority and value on the positive aspects of their supply chain performance, such as the reliability of their supply chains. An aspect like reliability is very important, perhaps even the most important, at least from the customer's perspective. However, judging from the different identified challenges, improvements can be made to several areas of supply chain performance, in order to make things more efficient from the company's perspective as well.

An additional observation that can be made on the basis of the interviewees' responses, is that the only SCM phase, from which supply chain performance challenges were not identified to originate, is inventory management. This can also be seen in the illustration below (figure 6) where the amounts of times that identified challenges originated from issues in each SCM phase are illustrated. This might seem surprising, as the company's high inventory levels is a prevalent effect of several of the challenges discussed.

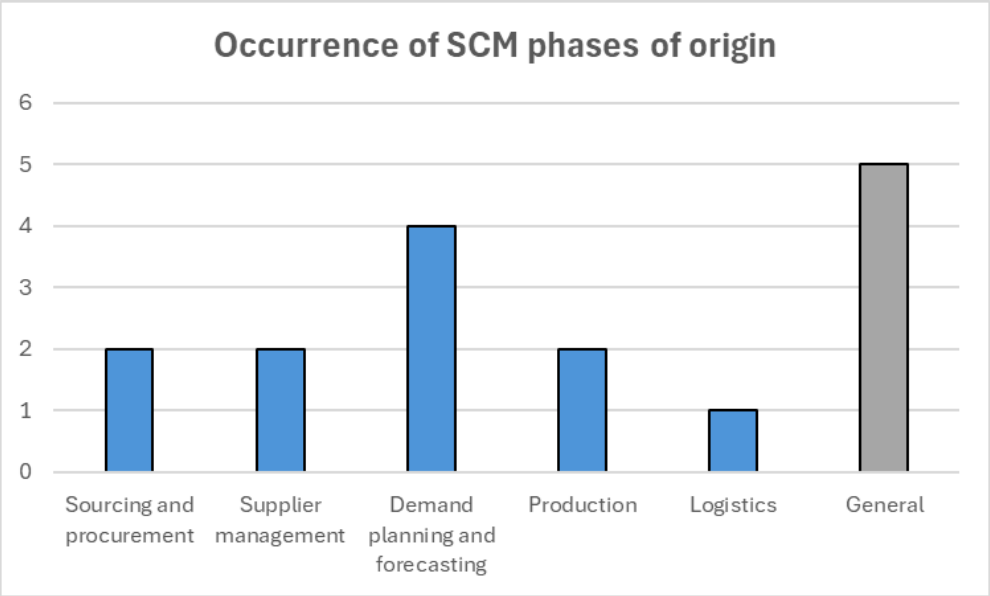

Figure 6 - Occurrence of SCM phases of origin *(author's illustration)*

However, based on the interview responses, it appears to be the case that none of the challenges are really specific to inventory management, and keeping high stock levels seems to be more of a deliberate measure to maintain the supply chains' service levels as far as maintaining adequate material availability to customers, despite the restrictions caused by demand forecasting issues for instance. In other words, none of the challenges themselves are really inventory management specific in origin, as they originate from issues in different phases, only having consequential outcomes in terms of inventory-related issues.

4.3 Improving SCP

As the different challenges, practical causes and effects of said challenges, and performance implications have now been identified via analysis of the associated interview responses, it is time to move on to exploring strategies for improving supply chain performance. With the help of the theory of the thesis, this section focuses on trying to find ways to alleviate found challenges via utilisation of strategies that deploy appropriate supply chain management practices, that can improve supply chain performance. The challenges are this time grouped and addressed thematically according to similarities in

challenge characteristics. As different improvement strategies are explored, responses to the final two questions of the interview framework listed below are also considered.

Q12. *What do you think the company should do in order to alleviate discussed challenges?*

Q13. *Are there some factors that are preventing the company from implementing said actions?*

4.3.1 Demand forecasting

A frequently occurring challenge type was challenges specific to demand forecasting, specifically poor demand forecasting withing the supply chain. This type occurred a total of four times, relating to the SCM phase of demand planning and forecasting. As discussed previously, the identified causes of these challenges are volatile- and changing customer demand, dispersed sales organisations, and limited procurement expertise of customers. Identified effects included having to keep high inventory levels and unexpected production needs occurring. The affected attributes of supply chain performance in this case were primarily assets, and secondarily agility.

Improvements suggested by the interviewees included better engagement and communication with the customers on the importance of demand forecasts, better utilisation of ERP software in the supply chain to improve demand visibility, better management support to improve forecasting and increase investment into new tools, and lowering inventory levels to incentivise salespeople to perform more accurate forecasting. The only significant barrier to implementing improvements was identified as resource constraints for improving forecasting and investing into new tools. Overall, judging from the causes to these challenges, it seems that there is a significant disconnect between the different parties of the supply chain, those being the case company, the corporate group's sales organisations, and the customers, when it comes to demand forecasting related communication and responsibilities. This is why particularly the case company's

downstream supply chains could then feasibly benefit from improved information sharing and collaboration.

One major information sharing and collaboration related improvement strategy, that was also discussed in the theory of the thesis, is collaborative planning, forecasting, and replenishment (CPFR). However, according to McCarthy & Golicic (2002) a full CPFR implementation can often be too large of a commitment for companies due to its labour- and resource intensive nature. It is, however, also discussed that adopting only certain aspects of CPFR, specifically collaborative forecasting, can still provide companies similarly significant supply chain performance benefits through better forecasting, whilst having much lower resource requirements, which is relevant when considering the size of- and resources within the company. According to McCarthy & Golicic (2002) collaborative forecasting can be defined as the exchange of timely information between supply chain partners to collaboratively develop a shared demand projection.

According to McCarthy & Golicic (2002) improved information sharing and collaboration the integral features of collaborative forecasting, through which it enhances demand visibility throughout the supply chain, consequently also improving demand forecasting in its accuracy. This would reduce the need for the company to use high inventory levels as a buffer for poor demand forecasting, as well as reduce unexpected production needs and the need to accommodate them, as the company would have improved knowledge of future demands.

According to McCarthy & Golicic (2002), as demand visibility is improved through collaborative forecasting, a company's ability to anticipate demand changes can indeed improve markedly, and the need for companies to stockpile inventory can reduce significantly. Because these benefits improve the ability of the company's supply chains to respond to further external influences, and enable inventory reduction, respectively, as

defined through the SCOR model (ASCM, 2022), collaborative forecasting can indeed improve supply chain performance along the attributes of agility and assets through these avenues.

According to McCarthy & Golicic (2002) collaborative forecasting can include both intra- and inter-firm forecasting practices. What this means is that different departments within organisations, such as sales and sourcing departments for instance, can collaborate in forecasting in addition to also doing so with external stakeholders, like customers. This could bridge the gaps in between the different parties involved, as forecasting could be done collaboratively by the case company, the corporate group's sales organisations, and the customers, simultaneously in collaboration. Suppliers could also be involved in the process, however, concluding from the interviews, it seems that there are no significant issues in the case company's actual information sharing itself with suppliers. So, for the sake of reducing complexity, the supplier could be excluded from the process, if the case company is diligent in providing accurate demand information, gained through the collaborative forecasting process, to suppliers in a timely manner.

According to McCarthy & Golicic (2002) the concrete steps to implementing collaborative forecasting include auditing the company's own internal forecasting processes, garnering management support, training employees to engage with and educate supply chain partners on benefits of collaborative forecasting, identifying and initially targeting only key partners with collaborative forecasting practices, scheduling regular forecasting specific meetings between partners, ensuring direct lines of information sharing between partners, and finally producing one joint forecast between partners to maximise the benefits from this collaboration.

If the case company feels the need to have a route for incentivisation, perhaps to further encourage partners to take up collaborative forecasting initially, when the benefits of the practice have not yet had the chance to be realised, they could perhaps introduce price-based incentives into demand forecasting. According to Mishra et al. (2009) contracts

can be introduced that offer price discounts to customers in exchange for the sharing of accurate demand information, which in turn would prompt increased information sharing between partners. This could in turn further facilitate the collaborative forecasting process.

The interviewees' improvement suggestions can also be relevant to collaborative forecasting, as for instance, during the step of auditing the company's internal forecasting processes, possible needs relating to new forecasting methods and tools can be assessed. As mentioned earlier, as the company also wants to utilise ERP systems to a better degree to create visibility in the supply chain, needs for associated training, that could also prove helpful when conveying the desired use of ERPs to partners in the collaborative forecasting process, can be established.

Also, in the case of a future full SAP implementation, as was discussed, some new tools could be adopted, as for example, according to Grobler-Debska et al. (2021) SAP includes a forecasting specific module that can be used to utilise several different forecasting methods. Also, if wanting for more advanced forecasting tools down the line, it was also discussed in the theory of the thesis, that artificial intelligence tools like machine learning models have also been shown to improve forecast accuracy significantly when paired with forecasting techniques like time series forecasting, as was found by Feizabadi (2020).

Also, with collaborative forecasting, better engagement and communication about the importance of forecasting to customers will be easier, as the process enhances opportunities for collaboration between supply chain partners, and also due to employees being specifically trained for this purpose, as discussed earlier. The improvement suggestion regarding increased management support can also relate to collaborative forecasting. This is because according to McCarthy & Golicic (2002) by focusing collaborative forecasting efforts on only a few important supply chain partners at first, management can be incentivised to provide further support due to quick and significant benefits realised from the process. This limited focus at the beginning would then also limit the need for

extensive initial resources, and the increased support could also improve possibilities for further resource allocation for additional improvement of demand forecasting and investment into new tools, addressing the identified barrier.

The suggestion regarding incentivising salespeople to perform their forecasting duties with more accuracy, by lowering inventory levels as the first measure, could also be effective, in that salespeople would likely want to keep product availability at a sufficient level for their customers. However, as remarked in the interviews, this approach might carry a risk of product availability suffering if forecasting is not improved. This is why the method of incentivising customers as outlined earlier might be a preferrable approach as far as incentivisation methods go.

In conclusion, the causes of the identified challenges can be addressed with this strategy, as organisational dispersion and customers' limited procurement expertise can both be addressed as partners can communicate and help each other more effectively. The cause of fluctuating customer demand, and especially volatile demand at the customer end can also be addressed as customer demand is made more predictable through better demand visibility. The effects of the challenges can also be mitigated, as unexpected production needs and high inventory levels are mitigated through the improved ability to anticipate demand changes, as well as the reduced need to stockpile inventory, induced by collaborative forecasting.

4.3.2 Digital systems

Another frequently occurring challenge type was challenges specific to digital systems, specifically digital system complexity and incompatibility, as well as a limited ERP training. This type occurred a total of four times as well, relating to the SCM phases of sourcing and procurement, production, and also more generally along several other phases. As discussed previously, the identified causes of these challenges are tight resources, slow adaptation to growth, as well as lack of sufficient prioritisation of ERP know-how. Iden-

tified effects included process inefficiency, and inefficient utilisation of ERPs. The affected attributes of supply chain performance in this case were primarily responsiveness, and secondarily assets.

Improvements suggested by the interviewees included minimisation of repeated digital tasks, full SAP implementation, and added ERP-specific training. The barriers for implementing improvements were identified as resource constraints for investing into new technologies and aversion to change within the company when it comes to changing digital systems. Extrapolating from the interview process, the company's digital systems seem to be somewhat disjointed and perhaps structured and operated somewhat inefficiently, generally conveying that the supply chains could feasibly benefit from improved streamlining, integration, and prioritisation as it relates to digital technology.

One obvious streamlining, as well as integration specific improvement strategy that was also often discussed in the theory of the thesis is full ERP system implementation, which in this case would be SAP. According to Al-Mashari (2002) ERP systems can help in delivering both improved integration and streamlining of processes, as it provides businesses a single comprehensive digital platform, through which dispersed digital systems and processes can be centralised and standardised. Thus, also reduced digital system incompatibility and complexity can be facilitated by ERP systems. This could in turn enable more efficient, and consequently faster operation of associated processes.

According to Shuai et al. (2007) ERP systems can indeed improve process efficiency in supply chains, also in time aspects. As this benefit would improve the speed at which tasks are performed in the supply chains, as defined through the SCOR model (ASCM, 2022), a full ERP implementation can indeed improve supply chain performance along the attribute of responsiveness. However, as is apparent from the interviews, as the case company uses two different ERP systems only partially, these specific benefits can currently be largely negated, as elements of complexity and incompatibility are added.

At the same time, the barrier of resource constraints standing in the way of a full implementation of SAP is seen as a very significant one in the company. On the other hand, as discussed in the literature review, according to the OECD (2023), if there is significant lag in adoption of new digital technologies within companies, future digital transformations can become much more difficult to engage with. Also, according to Svensson & Thoss (2021) even though ERP implementation is a very significant investment, especially for a smaller company, ultimately, said implementation is intended to help said companies in gaining competitive advantage. It is important to see it as more than just an expense, keeping the long-term benefits and efficiencies in mind.

Taking into account the benefits to supply chain performance, as well as the considerations mentioned above, along with the fact that most of the corporate group, of which the case company is a part of, is already using SAP in full capacity, also in addition to the fact that SAP is also already partially in use at the case company already, it is apparent that full SAP implementation should start to be seen as a priority as soon as it is possible from a resource standpoint. However, the case company should not be idle in the meantime, as actions can be taken now to enhance the prospects of a successful implementation in the near future, as well as improve the current utilisation of the existing systems at the company.

A simple prioritisation oriented improvement strategy that could also be applied is to provide added ERP training to the relevant employees. Applying additional ERP training can be used to improve the prioritisation of appropriate resources within supply chains, as according to Badewi et al. (2018) employment of ERP training and skill development is very important in the development of organisational capabilities within companies, which are crucial for improving the utilisation of ERP systems as assets. Because this benefit improves the company's ability to efficiently utilise assets within the supply chains, as defined through the SCOR model (ASCM, 2022), ERP training can indeed improve supply chain performance along the attribute of assets.

This also relates to the prospect of possible full SAP implementation in the future, as according to Svensson & Thoss (2021) training is an essential prerequisite for a successful ERP implementation, as inadequately trained and educated users can develop negative attitudes towards the technology, leading to unsuccessful implementation. According to Beheshti et al. (2014) aside from sufficient training, other critical success factors for SAP implementation are things such as clear goals and objectives, interdepartmental communication, user involvement in evaluation and implementation, top management support, and involved project management.

Another streamlining and integration oriented improvement strategy that could also be applied, apart from SAP implementation, is the implementation of robotic process automation (RPA). According to Syed et al. (2020) RPA is a technology that employs so-called software robots that mimic the behaviour of human users, in order to automate rule-based, repetitive, and time-consuming processes that require actions across multiple applications. As discussed in the theory of the thesis, according to Chopra et al. (2022) RPA can be implemented to increase integration between ERP systems and legacy systems.

According to Kim (2023) RPA is also capable of improving process integration in general, and according to Martinez (2023) RPA can also streamline processes and associated workflows effectively, through automating digital processes. This, according to Syed et al. (2020) leads to reduced workloads and manual tasks for employees. As the need for employees to manually navigate multiple incompatible and complex systems and processes is reduced, this could also enable more efficient, and consequently faster operation of associated processes.

According to Syed et al. (2020), RPA can indeed improve process efficiency, also in time aspects, which is a benefit it shares with ERP, due to which RPA implementation can also, as defined in the SCOR model (ASCM, 2022), improve supply chain performance along the attribute of responsiveness. The types of processes that the application of RPA is

most suited for, as described earlier, is why this technology could be very applicable, as case company interviewees recognised repetitive and time-consuming processes as prevalent issues, for instance, in the inefficient order creation process caused by their double ERP conundrum. According to Syed et al. (2020) RPA is also much easier to implement, configure, and maintain, when compared to other more standard forms of automation, as RPA interacts with front-end user interfaces, whereas standard automation interacts with back-end systems that are much more complex.

According to Santos et al. (2020) RPA is also much faster and more affordable to implement than ERP systems for instance. It is also discussed that the steps for successful implementation of RPA are the identification of the business problem and associated objectives, identification of repetitive processes and associated challenges, establishing criteria for suitable processes for automation, ascertaining which processes fit these criteria, choosing the processes to automate, designing and implementing the RPA software robots, and finally testing and evaluating the results based on set objectives.

According to Santos et al. (2020) critical success factors for RPA implementation largely mirror those of the ERP implementation success factors discussed earlier, in terms of top management support, communication, and clear goals and objectives, in addition to things such as good change management, as well as garnering a clear understanding of RPA and its advantages and limitations for instance. Lastly, it is important to note, that RPA does not fix the underlying issues of incompatibility and complexity of digital systems and associated processes, but rather just automates processes as they currently are, to make dealing with these aspects more manageable through more efficient, automated operation.

This is why the company should also consider more fundamental ways of reducing complexity and incompatibility in their digital systems, in order to address issues that could be considered so called “low-hanging fruit” to facilitate better operation of digital systems and processes, in order to both improve existing ways of operating, as well as make

future improvements easier to implement effectively. This could, for instance, include placing more priority on the governance of the company's data which according to Zhu et al. (2023) could include removing unnecessary and redundant data, improving the consistency of data, and completing missing data, as means of improving overall data quality.

The interviewees' improvement suggestions can also relate to the discussed strategies. For instance, implementation of SAP, as well as implementation of RPA both provide benefits specifically through minimising digital tasks, as different systems and digital locations that contain data are reduced, and repetitive and time-consuming tasks are automated, respectively. The strategies of implementing SAP and added ERP training are also directly in line with the remaining suggestions. The barrier of resource constraints for investing into new technologies can be addressed by initially focusing of less resource intensive options like RPA. The barrier of aversion to change within the company could also be addressed to a degree with the aspects of added training, user involvement, and generally increasing awareness of the discussed strategies and associated benefits within the company.

In conclusion, the causes of the identified challenges can be addressed with these strategies, as slow adaptation to growth is addressed by adopting new digital technology applications more suitable to the company's current operations, lack of prioritisation when it comes to ERP know-how is addressed with providing added ERP specific training to staff members, and again, tight resources is addressed with initially focusing on less resource intensive solutions like RPA. The effects of the challenges can also be mitigated, as the process efficiency gains from implementing SAP and RPA mitigate the current process inefficiency, and applying more ERP training can help the company to fully utilise their ERP systems, which in turn mitigates the currently inefficient utilisation.

4.3.3 Raw material imports

The next challenge type was challenges specific to raw material imports, specifically relating to CBAM reporting difficulty and customs issues. This type of challenge occurred a total of two times, relating to the SCM phases of supplier management and logistics. As discussed previously, the identified causes of these challenges are the utilisation of extra-EU suppliers and -imports, which include associated implications regarding communicational barriers, and foreign ways of operating, respectively. Identified effects included possible sanctions and increased shipment delays. The affected attributes of supply chain performance in this case were costs and reliability.

Improvements suggested by the interviewees included establishing solid communicational foundations with suppliers for conducting CBAM reporting. No significant barriers for improvement were identified for these challenges. Extrapolating from the interview process, difficult communication and foreign ways of operating being a cause for issues in upstream supply chains generally conveys that said supply chains and associated importing procedures could feasibly benefit from improved information sharing and collaboration, as well as integration.

One information sharing and collaboration related improvement strategy that could be applied is to conduct more stringent supplier evaluation and consequent selection, which were also discussed previously in the theory of the thesis. More stringent supplier evaluation and -selection can improve information sharing and collaboration between supply chain partners, as according to Shore & Venkatachalam (2003) supplier evaluation can be made to include criteria regarding suppliers' information sharing and collaboration capabilities. Evaluation and eventual selection of suppliers based on these criteria can then act as a way of ensuring related capabilities of suppliers, which in this case could feasibly include things such as the ability to share accurate information or provide assistance and insight, as it relates to CBAM reporting and customs procedures, or even more generally, the ability to communicate in a common language.

This would help to facilitate more successful conduct in described areas of material imports, leading to avoided monetary sanctions and reduced shipment delays, and consequently reduced costs and more consistent on-time delivery. According to Shore & Venkatachalam (2003) this approach in supplier evaluation- and selection has to do with collaboration specifically defined by aspects such as support and helpfulness in reducing costs and adequately servicing customers in supply chains. As these benefits can then help the company to reduce the cost of operating supply chain processes, as well as improve the ability of the supply chains to perform as expected, as defined through the SCOR model (ASCM, 2022), more stringent supplier evaluation and -selection can indeed improve supply chain performance along the attributes of costs and reliability.

Supplier selection, as it relates to both suppliers of raw materials and suppliers of logistical services like forwarding companies in this case, could then be done partly based on this sort of evaluation criteria in the case company. However, there is a caveat related to the latter, in that there would have to be an agreement with raw material suppliers to allow the case company to have a larger say in selecting suppliers of logistical services, like forwarding companies, as it pertains to incoming logistics, so that collaboration with competent partners, who can better help in facilitation of customs procedures can be ensured.

Another information sharing and collaboration, as well as integration related improvement strategy, that could be applied to alleviate these challenges more presently, is to implement more collaborative practices within the supply chains. According to Koçoğlu et al. (2011) integration, as well as information sharing and collaboration can be improved in supply chains with various practices, which in this case could be designated as various collaborative practices. It is also discussed that this can deepen the relationships between different parties within supply chains in various aspects such as communication, familiarity, and coordination. This would also be beneficial in jointly working on CBAM reporting and customs related issues in a more effective manner, in order to improve

conduct is said areas, to once again, avoid associated sanctions and delays, and consequently reduce costs and improve on-time delivery.

According to Koçoğlu et al. (2011) the benefits of these practices can often include things such as reduced supply chain costs and improved order fulfilment rates for instance. As these benefits can help the company to reduce the cost of operating supply chain processes, as well as improve the ability of the supply chains to perform as expected, as defined through the SCOR model (ASCM, 2022), implementing more collaborative practices within the supply chain can indeed improve supply chain performance along the attributes of costs and reliability.

According to Koçoğlu et al. (2011) these practices can include things such as such as fostering long-term and transparent relationships with supply chain partners, arranging more regular internal and external team meetings in which timely issues are discussed thoroughly, utilising IT infrastructure that allows for efficient diffusion of information, as well as jointly working across internal departments and sharing responsibilities and resources. In addition to collaborating directly with external partners, the mentioned internal aspects could also play a significant role. This is because as discussed in the interview responses, these challenges are quite new and have a lot of uncertainty associated with them, and thus collaborative team efforts may prove beneficial in dealing with said uncertainty internally, as resources and responsibilities can be shared more effectively.

The interviewee's improvement suggestion can also relate to the discussed strategies, as establishing solid communicational foundations with suppliers can be facilitated to a large degree via the utilisation of the discussed supplier evaluation and selection criteria in reducing language barriers for instance, as well as in particular with the collaborative practices related to fostering long-term and transparent relationships, and conducting in-depth meetings with supply chain partners on a more regular basis.

In conclusion, the causes of the identified challenges can be addressed with these strategies, as utilisation of extra-EU suppliers and imports, as well as the associated implications regarding communicational barriers and foreign ways of operating, can both be addressed as the outlined criteria in evaluation and selection of suppliers, and increased collaborative practices improve communication, shared insight, and assistance between supply chain partners. The effects of the challenges can also be mitigated, as with improved conduct in CBAM reporting and customs procedures achieved through ensured capabilities of- and deeper relationships with supply chain partners, effects of sanctions and delays can be mitigated.

4.3.4 Maintaining competitiveness

Another challenge type was challenges specific to maintaining competitiveness, specifically adapting to future growth, as well as maintaining price-competitiveness. This type occurred a total of two times, relating to the SCM phases of sourcing and procurement, and also more generally along several other phases. As discussed previously, the identified causes of these challenges are the potential growth of both the company's business, as well as the growth of the wider industry, including implications regarding growing customer demand and changing customer requirements, respectively. Identified effects included a possible future urgency in diversifying the supplier base, as well as a reliance on cost minimisation. The affected attribute of supply chain performance in this case was agility in both challenges.

Improvements suggested by the interviewees included actively sourcing for alternative suppliers for diversification purposes. The barrier to implementing improvements was identified to be resource constraints. Extrapolating from the interview process, potential gaps in ensuring future capacity in supply, and reliance on a limited scope in efforts to maintain competitiveness generally convey that the supply chains could feasibly benefit from improved risk mitigation, as well as prioritisation when it comes to sourcing and competitiveness.

One prioritisation related improvement strategy that could be applied is to once again, implement collaborative forecasting, the practicalities of which were already discussed earlier. Collaborative forecasting can be used to improve prioritisation of added product value within the supply chain, as according to McCarthy & Golicic (2002), and Cook & Garver (2002) collaborative forecasting can improve product availability significantly within supply chains, leading to improved customer satisfaction. According to Yeung & Ennew (2000) this can induce improved customer loyalty and reduced price-sensitivity of said customers. This in turn can lead to better price-competitiveness, as the company is able to retain customers at higher price-points.

This means that there would be alternative means to relying on perpetual cost minimisation to maintain price-competitiveness. Then, as this benefit can also improve the ability of the company's supply chains to respond to marketplace changes to maintain a competitive advantage, as defined through the SCOR model (ASCM, 2022), collaborative forecasting can indeed improve supply chain performance along the attribute of agility through this avenue as well.

One risk mitigation related improvement strategy that could be applied is to conduct precautionary sourcing work. Precautionary sourcing work can be used to mitigate risks more effectively in the supply chain, as it can create a base for conducting more extensive sourcing processes to gain additional suppliers more quickly in the future, which according to Tachizawa & Giménez (2007) and Wagner et al. (2018) exemplifies sourcing flexibility, which can mitigate risks associated with uncertain demand.

As this leads to the company being more prepared to quickly conduct extensive sourcing processes, they can be better adapted to possible fast growth in the future, and as a result, the supplier diversification process can be better managed with reduced urgency. Then, as this benefit can help the company to better respond to marketplace changes to

maintain competitive advantage, as defined through the SCOR model (ASCM, 2022), precautionary sourcing work can indeed improve supply chain performance along the attribute of agility.

According to Zeng (2003) the sourcing process incudes phases of investigation and tendering, evaluation, supplier selection and development, implementation, as well as performance measurement and continuous improvement. The case company could focus only on pre-emptively applying the first phases in order to create a base for future diversification. This limited scope could be beneficial, as according to Chiu (2014) acquiring a large number of suppliers can come with negative effects such as increased negotiation costs. This is why conducting more extensive sourcing processes in larger diversification of the supplier base only as a precaution, before having any clarity about potential growth and associated demand, could be difficult to facilitate, and counterproductive, especially in the presence of resource constraints.

To conduct this work in practice, the case company could start with phases of investigation and tendering, as well as evaluation, which according to Zeng (2003) could entail analysis of market and customer requirements and competitors to determine the market positioning and objectives of the company, establishing work plans, collecting data about stakeholder needs, establishing appropriate supplier selection criteria, identifying suppliers based on said criteria, as well as estimating the potential beneficial outcomes. Then, perhaps a database of potential suppliers and associated plans and specifications could be established based on the outcomes of these steps. The interviewee's improvement suggestion can also relate to the discussed strategies. This is because doing precautionary sourcing work contributes heavily to sourcing for additional suppliers. The barrier of resource constraints can be addressed, as the work related to sourcing for new suppliers can be limited to less resource-intensive precautionary work for the time being.

In conclusion, the causes of the identified challenges can be addressed with these strategies, as through precautionary sourcing work, the company is better prepared for possibly fast growing business and associated demand. Also, by providing added product value through collaborative forecasting, the company can better compete in a growing industry with shifting demand as it relates to price. The effects of the challenges can also be mitigated, as the effect of the potential urgency in diversifying the supplier base is mitigated, as precautionary sourcing work enables the company to conduct a more managed, faster diversification process. Also, the effect of the reliance on minimising costs can be mitigated by improving price-competitiveness via alternative means in increasing customer loyalty and decreasing customers' price sensitivity, through collaborative forecasting.

4.3.5 Company positioning

The next challenge type was challenges specific to the company's positioning, specifically relating to balancing raw material costs and sales pricing within the supply chain. This type of challenge occurred only one time, relating generally to several SCM phases. As discussed previously, the identified cause of this challenge is differing customer- and supplier priorities. The identified effect is thin profit margins. The affected attribute of supply chain performance in this case was profit. No suggested improvements or barriers were identified by the interviewees relating to this challenge. Difficulties in buying raw materials at sufficiently low prices, as well as difficulties in selling products at sufficiently high prices, would indicate the supply chains could feasibly benefit from improved streamlining, as well as prioritisation in procurement and sales operations.

One prioritisation related improvement strategy, that could be applied is the same one that was discussed before in relation to maintaining price-competitiveness, which was to utilise collaborative forecasting in order to improve prioritisation of added product value within the supply chain via improved product availability, and consequent customer satisfaction. As outlined earlier, this can lead to improved customer loyalty and reduced price-sensitivity of said customers. This can also be beneficial in finding a better

balance between raw material costs and sales pricing, as the company is able to retain customers at higher price-points, whilst raw material costs would be largely unaffected.

This would then lead to better profit margins, and consequently better profits. Collaborative forecasting can indeed improve profits through customer loyalty and reduced price-sensitivity, as according to Yeung & Ennew (2000) these factors can lead higher revenues, and improved profits. As this benefit can enable the company's revenues to be higher in relation to its expenses within supply chains, as defined through the SCOR model (ASCM, 2022), collaborative forecasting can indeed improve supply chain performance along the attribute of profit.

One streamlining related improvement strategy, that could be applied is to further increase order quantities. Increasing order quantities can help in streamlining procurement costs in the supply chain, as according to Aljazzar et al. (2017) price discounts are often offered by suppliers for orders in larger quantities. This lowers the unit price of purchased raw materials. This consequently helps in finding a better balance between raw material costs and sales pricing, as materials can be bought at a lower cost, whilst maintaining sales prices. This would lead to better profit margins, and consequently better profits. Increasing order quantities can indeed improve profits via lowered unit prices, as according to Arnold et al. (2009) raw material procurement prices in supply chains have a significant effect on generated profit.

As this benefit can also enable the company's revenues to be higher in relation to its expenses within supply chains, as defined through the SCOR model (ASCM, 2022), increasing order quantities can indeed improve supply chain performance along the attribute of profit. It is however important to note, that whilst on its own, this strategy could have negative implications in terms of inventory levels for instance, which are already an issue within the company's supply chains, when paired with the extensively discussed strategy of implementing collaborative forecasting, this issue can be alleviated.

This is because with added clarity about demand, bulk quantities could be ordered in a more time-accurate manner, allowing the company to expedite the faster movement of said quantities, which could be seen as moving closer to adopting just-in-time practices in this paradigm. However, as it has become clear in recent years, an adequate level safety stock should still be held, as according to Paul & Rahman (2018) safety stock plays a very important part in dealing with more sudden supply disruptions and delays. The resources freed up by accurate demand forecasting could also make buying in larger quantities easier monetarily, as less capital is tied up in inventory. More miscellaneous, irregular, and infrequent needs could then be addressed by utilising suppliers with more of a lead-time priority.

In conclusion, the cause of the identified challenge can be addressed with these strategies, as the different priorities between suppliers and customers can be brought closer by offering the parties value in different ways, those being better product availability and larger orders, to prompt them to make compromises on their respective positions and priorities as it pertains to price. The effect of the challenge can also be mitigated, as the effect of thin profit margins can be mitigated by being able to retain customers at higher price points due to increased customer loyalty and reduced price-sensitivity, and by reducing raw material costs via discounts associated with increased order quantities.

4.3.6 Lead-times

The next challenge type was challenges specific to lead-times, specifically relating to long and uncertain supplier lead-times. This type of challenge occurred only one time, relating to the SCM phase of supplier management. As discussed previously, the identified cause of this challenge is inflexibility in suppliers' operations. The identified effect is having to keep high inventory levels. The affected attribute of supply chain performance in this case was assets. Improvements suggested by the interviewees included the diversification of suppliers. No significant barriers for improvement were identified for this challenge. Extrapolating from the interview process, long and uncertain supplier lead-times caused by the inflexible operations at the supplier-end would indicate that the

supply chains could feasibly benefit from improved information sharing and collaboration, as well as risk mitigation when it comes to interacting with and choosing suppliers.

One information sharing and collaboration related improvement strategy that could be applied is to once again, implement collaborative forecasting. As discussed earlier, extensively improved information sharing and collaboration are the integral features of collaborative forecasting, through which according to Liu & Deitz (2011) supplier lead-times can be significantly reduced, as supply chain planning improves on the supplier end. This can in turn reduce the need to buffer long supplier lead-times with high inventory levels. Collaborative forecasting can indeed be used to reduce inventory levels also specifically through reduced lead-time, as according to Bertolini et al. (2007) reduction of supply chain lead-time, including supplier lead-time, can enable inventory reduction. As this benefit can help in inventory reduction within supply chains, as defined through the SCOR model (ASCM, 2022), collaborative forecasting can indeed improve supply chain performance along the attribute of assets through this avenue as well.

One risk mitigation related improvement strategy that could be applied is to establish diverse back-up suppliers for all high-priority materials. Establishing back-up suppliers can be used to mitigate risks more effectively in the supply chain, as according to Kouvelis & Li (2008) maintaining flexible back-up supply options can be effective in mitigating risks related to lead-time. It is discussed, that using back-up suppliers adds redundancy in the supply chain, when these suppliers can be used as an emergency response to uncertainty in the lead-time of a primary supplier, reducing overall lead-time uncertainty. This can in turn reduce the need to buffer uncertain lead-times with high inventory levels.

Utilisation of backup suppliers can indeed be used to reduce inventory levels through reduced lead-time uncertainty, as according to Chung et al. (2018) reducing delivery uncertainties like uncertain lead-time in supply chains can enable the reduction of inventory levels. Then, as this benefit can help in inventory reduction within supply chains, as

defined through the SCOR model (ASCM, 2022), establishing back-up suppliers can indeed improve supply chain performance along the attribute of assets. Although the company has already had an increasing focus on this in recent years, as discussed earlier, some important considerations should be accounted for.

For instance, according to Hong et al. (2018) focusing too much on specific non-diverse supplier attributes like low cost in supplier selection and order allocation can lead to bad supply chain outcomes, and that lead-time uncertainty of each individual supplier should be considered in these decisions. For the case company this could mean, for instance, trying to maintain sufficient representation of intra-EU supplier options in the overall portfolio, so that in addition to, for instance, cost-considerations, geographical locations and associated risks and uncertainties, pertaining to lengths and complexities of logistical routes are also considered.

The interviewee's improvement suggestion can also relate to the discussed strategies, as establishing diverse back-up suppliers is an example of supplier diversification. In conclusion, the cause of the identified challenge can be addressed with these strategies, as collaborative forecasting and utilisation of diverse back-up suppliers can improve planning and increase redundancy in the supply chains, respectively, to compensate for inflexibility on the supplier end. The effect of the challenge can also be mitigated, as the effect of high inventory levels is mitigated due to shorter and more certain lead-times, achieved through utilising collaborative forecasting and back-up suppliers, reducing the need to build buffers in inventory.

4.3.7 Human resources

The next challenge type was challenges specific to the company's human resources, specifically relating to tight production staffing. This type of challenge occurred only once, relating to the SCM phase of production. As discussed previously, the identified cause of this challenge is tight resources. The identified effect is slowing of processes. The af-

fected supply chain performance attribute in this case was responsiveness. Improvements suggested by the interviewees included minimising unnecessary tasks. No specific barriers to implementing this improvement were identified. Extrapolating from the interviews, as the limited workforce in production can have difficulties in handling workloads, this would indicate that the company's internal supply chains could feasibly benefit from improved streamlining when it comes to production processes.

One major streamlining specific improvement strategy that could be applied is to systematically implement lean production, which was also discussed in the theory of the thesis. In addition to reducing the complexity of digital processes as discussed earlier, which are also associated with production, performance can also be improved by considering production processes in general. According to Agus & Hajinoor (2012) lean production can improve and streamline production processes, as it can eliminate waste and non-value-adding activities from said processes.

By eliminating activities, the workload associated with production can be decreased, thus making the existing number of staff more sufficient for the operation of the associated processes. This could in turn make these processes faster to operate. According to Agus & Hajinoor (2012) when implementing lean production, things like setup-, cycle- and lead-times can be reduced in processes, which will consequently improve the speed of said processes. Then, as this benefit can improve the speed at which tasks are performed in the supply chains, as defined through the SCOR model (ASCM, 2022), lean production can indeed improve supply chain performance along the attribute of responsiveness.

According to Sahoo & Yadav (2018) common lean production practices include things such as total quality management (TQM), just-in-time (JIT), human resource management (HRM), total productive maintenance (TPM), Kaizen, Kanban, and value stream mapping for instance, all of which promote a philosophy of continuous improvement in

a company's production operations. According to Netland (2015) from a managerial perspective, successful implementation of lean production requires several structured steps.

According to Netland (2015) these steps include ensuring active commitment to- and leadership of the implementation, arranging sufficient education and training on lean practices, creating a long-term plan and following progress on a regular basis, allocating sufficient resources to the implementation and rewarding successes, as well as applying and utilising lean practices. These largely mirror the critical success factors of lean implementation, of which the most important ones were outlined as active leadership, personal participation, employee education, manager education, communication, target setting and monitoring, employee participation, dedicating resources, as well as use of lean tools and methods. Even though lean implementation does require its own resources, it is a cost-effective choice in the long term.

The interviewee's improvement suggestion can also relate to the discussed strategy, as the suggestion regarding minimising unnecessary tasks is strongly connected to one of the main principles of lean, which is the removal of non-value-adding activities. The cause of the identified challenge can be addressed with this strategy, as by eliminating activities, workloads can be reduced, making processes easier to operate with the existing number of staff, eliminating the need for resources required to employ new staff. The effects of the challenge can also be mitigated, as the effect of slower processes can be mitigated due to production times being sped up by implementing lean production.

4.3.8 Organisational structure

The final challenge type was challenges specific to the company's organisational structure, specifically relating to intra-organisational communication. This type of challenge occurred only once, relating generally along several SCM phases. As discussed previously, the identified cause of this challenge is organisational dispersion. The identified effect is process inefficiency. The affected supply chain performance attribute in this case was responsiveness. Improvements suggested by the interviewees included familiarisation

with the parent company's ways of operating and organisational structure. No specific barriers to implementing this improvement were identified. Extrapolating from the interviews, as a lack of communication within the wider organisation that is the corporate group can make processes more difficult to conduct, this would indicate that the company's supply chains could feasibly benefit from improved information sharing and collaboration, as well integration within the wider organisation.

One information sharing and collaboration, as well as integration related improvement strategy that could be applied is to implement more cross-functional practices. According to Swink & Schoenherr (2015) several practices, which in this case could be designated as cross-functional practices, can enable better integration, as well as information sharing and collaboration between different departments within organisations. It is also discussed that this can lead to formation of cross-functional interdependencies and improvement of overall intra-firm alignment, which can in turn improve communication within organisations.

This could lead to more efficient, and consequently faster operation of supply chain processes, as poor communication is no longer a hinderance. According to Swink & Schoenherr (2015), overall process efficiency can be significantly improved as a result of these practices. Then, as this benefit can improve the speed at which tasks are performed in the supply chain, as defined through the SCOR model (ASCM, 2022), cross-functional practices can indeed improve supply chain performance along the attribute of responsiveness.

According to Swink & Schoenherr (2015) via utilising cross-functional practices, employees working in different departments can understand how different processes work, as well as what kind of resources exists, and where said resources are located between different departments within an organisation. It is also discussed what sort of cross-functional practices exist, those including establishing cross-functional teams and meetings,

sharing resources, integrating information systems and creating more data-visibility, engaging in joint planning activities, as well as standardising and synchronising joint processes for instance. An example of this could be collaborative forecasting, linking back to the associated cross-functional practices described earlier.

The interviewee's improvement suggestion can also relate to the discussed strategy, as the suggestion regarding familiarisation with the parent company's ways of operating and organisational structure is strongly connected with the described practices' abilities to raise awareness of the resources and processes that are associated with different departments within organisations. The cause of the identified challenge can be addressed with this strategy, as cross-functional practices make organisations more cohesive by establishing cross-functional interdependencies and improving intra-firm alignment. The effect of the challenge can also be mitigated, as the effect of process inefficiency can be mitigated due to overall process efficiency being improved by the practices.

4.3.9 Bonus: Sustainability

As was discussed in the theory of the thesis, alongside digitalisation, sustainability is a very significant trend that is occurring in the world of business today. In the interview process, no sustainability related challenges, or advantages for that matter, were identified relating to sustainability aspects of supply chain performance. This could indicate something like a lack of prioritisation of said aspects within the company for instance, as discussed earlier.

It can be seen how prioritisation of sustainability could start to be a relevant within the company's supply chains, as is illustrated by the new EU legislated CBAM reporting duties, which, as discussed earlier, have to report on carbon emissions related information when it comes to imported goods. This is in line with the increasing future need to comply with sustainability legislation, which was discussed in the theory of the thesis. Even-

tual outcomes of this reporting at the company could possibly uncover either a new advantage or challenge related to supply chain performance from a sustainability point of view.

It is not unforeseeable either that the case-company's customers could also start to establish more sustainability related requirements, as the sustainability trend grows. So, it could be advisable for the case-company to start looking more at possibilities for added sustainability of their supply chains and associated products, in order to successfully fulfil customer requirements in the future. This might, for instance, be achieved via re-assessment of supplier evaluation and selection criteria, which was also suggested to improve importing procedures earlier on in the thesis.

4.3.10 Summary of improvement strategies

With all the improvement strategies now presented, the ones applicable for improving performance along each negatively affected performance attribute are as follows. For assets, strategies can include implementing collaborative forecasting, implementing ERP training, and establishing diverse back-up suppliers. For responsiveness, implementing SAP, implementing RPA, implementing lean production, and implementing cross-functional practices. For agility, conducting precautionary sourcing work, and implementing collaborative forecasting. For profit, increasing order quantities, and implementing collaborative forecasting. For reliability, conducting stringent supplier evaluation and -selection, and implementing collaborative practices. Then finally for costs, also conducting stringent supplier evaluation and -selection, and implementing collaborative practices. This summary can also be seen represented below (figure 7).

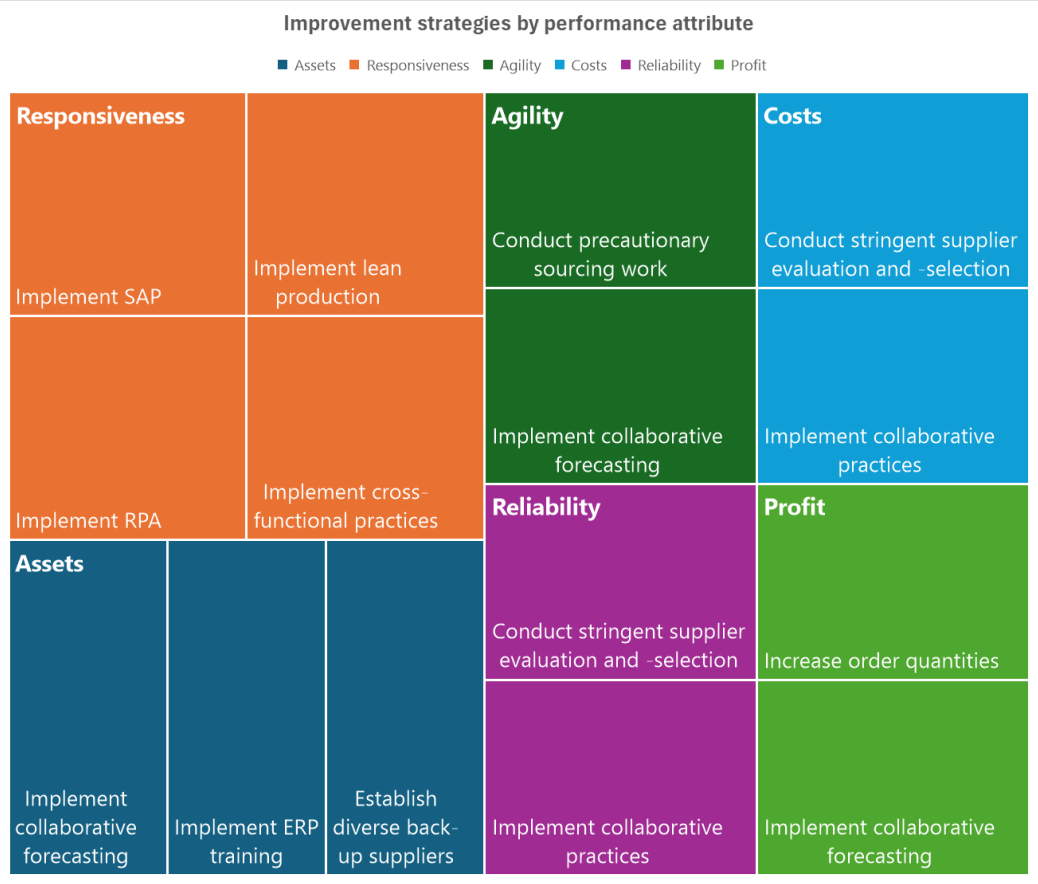

Figure 7 - SCP improvement strategies *(author's illustration)*

5 Discussion

Now that the findings of the research have been presented, it is time to move on to general discussion about said findings, including answering the research questions laid out at the beginning of the thesis. In addition to answering research questions, this part discusses managerial implications that emerge from the findings. After this, as the final part of the discussion, possible limitations regarding the thesis and the research process are also contemplated.

5.1 Answering research questions

Q1. *What are the largest advantages and challenges associated with the company's supply chain performance, and how do they affect said performance?*

As a result of the analysis of the conducted interviews, all together nine advantage-related responses, and sixteen challenge-related responses were given by the interviewees, which included advantages and challenges originating from several different SCM phases. Advantages identified from these responses included good supplier acquisition capabilities, supplier predictability, upstream supply chain quality, internal supply chain coordination, outbound logistics partner relationships, internal supply chain monitoring, as well as logistics and laboratory partner predictability. Supplier predictability and internal supply chain coordination were both included twice.

Challenges identified from these responses included adapting to future growth, digital system incompatibility, long and uncertain supplier lead-times, CBAM reporting difficulty, poor demand forecasting, digital system complexity, tightly staffed production, customs issues, balancing costs and pricing, maintaining price-competitiveness, poor intra-organisational communication, and a limited ERP training. Poor demand forecasting was identified a total of four times, and digital system incompatibility twice.

The identified challenges could be thematically grouped into 8 different challenge type groups, which include demand forecasting, digital systems, raw material imports, maintaining competitiveness, company positioning, lead-times, human resources, and organisational structure. The largest groups, in terms of how often challenges occurred in responses, were those of demand forecasting and digital systems. This is also why the largest portions of the supply chain performance improvement section of the findings were dedicated to said challenge groups.

Through their respective practical effects, the identified advantages were found to most often positively affect supply chain performance in the aspect of reliability, also notably, though to lesser extent, the aspect of agility, and even less so, to a very limited extent, the aspect of costs. The identified challenges on the other hand were found to most often negatively affect supply chain performance in the aspects of assets and responsiveness, also notably, though to lesser extent, the aspect of agility, and even less so, to a very limited extent, the aspects of profit, reliability, and costs. It was also found through asking interviewees to rate their perceived significance for the effects of the challenges, that when starting to improve supply chain performance, prioritisation of alleviating different types of challenges could be set as challenges related to the aspect of assets first, responsiveness second, and agility third, profit fourth, reliability fifth, and costs sixth.

Q2. *How could found challenges be alleviated to improve supply chain performance?*

Several supply chain improvement strategies were identified, which can alleviate all of the identified challenges to improve overall supply chain performance. In total, eleven different strategies were identified, which included implementing collaborative forecasting, establishing diverse back-up suppliers, implementing SAP, implementing ERP training, implementing RPA, implementing lean production, implementing cross-functional practices, conducting precautionary sourcing work, conducting stringent supplier evaluation and -selection, implementing collaborative practices, and increasing order quanti-

ties. Additionally, it was suggested on a general level that the company should start prioritising sustainability aspects of performance, as no advantages or challenges relating to said aspects were identified in interviews, possibly indicating a lack of prioritisation.

Challenges associated with the performance attribute of assets can be alleviated with strategies of implementing collaborative forecasting, implementing ERP training, and establishing diverse back-up suppliers. Challenges associated with the performance attribute of responsiveness can be alleviated with strategies of implementing SAP, implementing RPA, implementing lean production, and implementing cross-functional practices. Challenges associated with the performance attribute of agility can be alleviated with strategies of conducting precautionary sourcing work and implementing collaborative forecasting.

Challenges associated with the performance attribute of profit could be alleviated with strategies of increasing order quantities and implementing collaborative forecasting. Challenges associated with the performance attribute of reliability can be alleviated with strategies of conducting stringent supplier evaluation and -selection and implementing collaborative practices. Challenges associated with the performance attribute of costs can also be alleviated with strategies of conducting stringent supplier evaluation and -selection and implementing collaborative practices.

Q3. *What do found solutions indicate about supply chain performance improvement within the established context?*

During the research process, it became clear that the case company can experience similar challenges to those that other relatively small-scale Finnish/European technology industry companies can encounter in the modern day, as outlined in the theory of the thesis, chief among them tightened fiscal conditions, tight resources, limited capabilities and technical skills, and high market competition for instance, as illustrated by the digital technology and competitiveness related supply chain challenges, as well as the often

occurring causes for challenges and barriers for improvement related to tight resources for instance. In the same context it can be seen how the company has had a limited focus on associated modern trends, such as digitalisation and sustainability in terms of their supply chains, which are important to ensuring future competitiveness, as outlined in the theory of the thesis.

Also, the general characteristics of technology industry supply chains, as outlined in the theory of the thesis, are on full display when looking at the different challenges to supply chain performance within the company, as inherent factors such expensive materials and highly global supply chains have their own implications as far as the identified challenges related to lead-times, customs issues, CBAM reporting, costs and pricing, and price-competitiveness go for instance.

Then, as indications of these fairly common challenges, trends, and characteristics generally related to relatively small-scale European/Finnish technology industry companies and their supply chains, are present in the identified challenges to supply chain performance, it would be fair to suggest, that the proposed supply chain performance improvement strategies could be applicable also in many companies sharing these common features, as they are likely to be facing at least some of the same challenges as the case company, when it comes to supply chain performance. In conclusion, this study then contributes to the literature on supply chain performance assessment and improvement in European/Finnish small-scale technology industry companies.

5.2 Managerial implications

When it comes to what the findings of this thesis indicate from a managerial point of view, what could be most important is to ascertain which improvement strategies to allocate resources to and focus on, and in which order. Overall, the strategy of implementing collaborative forecasting seems to be the most widely applicable improvement strategy, improving challenges in four different challenge type groups, along three different

performance attributes, those being assets, agility, and profit. Earlier it was also discussed, that when starting to look at making improvements to supply chain performance in general, alleviating the challenges related to each aspect of performance could follow a highest to lowest importance prioritisation of challenges related to assets first, then responsiveness, agility, profit, reliability, and finally costs.

This would mean that improvement strategies like implementing collaborative forecasting could take first precedence in addressing the performance aspect of assets first, then looking at things like implementing RPA for instance to address responsiveness, and continuing to move down the priority hierarchy, trying to address areas of performance in which challenges are most commonly occurring and significant first. Of course, many aspects of performance could also be improved at a time, as some strategies are applicable to improving many, and the company might also be able to implement several strategies at a time. However, strategies must also be implemented with care, so that the company does not overstretch its resources too much.

5.3 Limitations

When it comes to the limitations of this study, they mainly relate to the size of the company and its operations, and consequently the sample size in data collection. As the company's supply chain team is not very large, when the aim is to ensure that every role in the team is represented equally, there is a limited sample size that can be used. However, this is alleviated to a degree by the fact that the interviewees are largely very experienced in their respective roles, giving their responses an increased sense of reliability.

Another limitation is that as the study is focused on exploring the chosen topic in the nuanced environment of the case company, and as is in the nature of the case study as an approach to conducting research, it might not be the most widely generalisable one. However, this too is alleviated to a degree, as the various challenges that the company

faces in terms of supply chain performance draw many parallels to the different conditions affecting other companies of similar size within the Finnish/European technology industry, as was discussed previously.

6 Conclusions

The case company faces several advantages and challenges related to their supply chain performance, spread across different aspects of supply chain performance. Advantages that were identified included good supplier acquisition capabilities, supplier predictability, upstream supply chain quality, internal supply chain coordination, outbound logistics partner relationships, internal supply chain monitoring, as well as logistics and laboratory partner predictability. Challenges that were identified included adapting to future growth, digital system incompatibility, long and uncertain supplier lead times, CBAM reporting difficulty, poor demand forecasting, digital system complexity, tightly staffed production, customs issues, balancing costs and pricing, maintaining price-competitiveness, poor intra-organisational communication, and a lack of ERP training.

As a result of the outlined advantages, supply chain performance is most often positively affected in the aspect of reliability, as well as less often, agility, and to a very limited extent, costs. As a result of the outlined challenges, supply chain performance is most often negatively affected in the aspects of assets and responsiveness, as well as less often, agility, and to a very limited extent, profit, reliability, and costs. It is also suggested that when implementing improvement strategies, the case company prioritise aspects of performance with consideration of both how often related challenges occurred in interview responses, and how significant their effects were rated as by the interviewees. This order of priority would be assets first, then responsiveness, agility, profit, reliability, and costs, in descending order.

Improvement strategies to alleviate these challenges, and consequently improve supply chain performance, were explored, and as an outcome it is suggested that the case company considers the strategies of implementing collaborative forecasting, establishing diverse back-up suppliers, implementing SAP, implementing ERP training, implementing RPA, implementing lean production, implementing cross-functional practices, conducting precautionary sourcing work, conducting stringent supplier evaluation and -selection, implementing collaborative practices, and increasing order quantities.

The different identified challenges to supply chain performance also draw parallels with several different common challenges, trends, and characteristics, associated with relatively small-scale companies and their supply chains throughout the Finnish/European technology industry. This is why the identified improvement strategies could also be applicable in other such companies. When it comes to possible future research, the topic of supply chain performance could be handled also in more quantitative research, perhaps as a way of monitoring future changes and improvements gained via the application of improvement strategies akin to those outlined in this thesis. This could feasibly include utilising the company's simpler pre-existing supply chain metrics, or perhaps the further utilisation of the SCOR model, which provides more complex metrics to measure supply chain performance quantitatively, as discussed in the theory of the thesis.

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Appendices

Appendix 1. Interview framework (general)

General questions

Q1. *What is your job description, and how long have you worked at the company?*

Q2. *What is your role in the company's supply chain, and what are you main responsibilities?*

Performance assessment questions

Q3. *What things do the company's supply chains perform the best at in terms of internal functions and/or external functions/partners in your opinion?*

Q4. *What are the largest challenges to the company's supply chain performance in terms of internal functions and/or external functions/partners in your opinion?*

Q5. What do you think are the causes for said challenges?

Q6. *How do you think said challenges affect the company's supply chain performance?*

Q7. *How would you rate the significance of the effects of the listed challenges on the company's supply chain performance? (1-5, 1 = Insignificant, 5 = Very significant)*

Q8. *How would you rate the company's overall supply chain performance? (1-5, 1 = Very poor, 5 = Very good)*

Performance improvement questions

Q9. *What do you think the company should do in order to alleviate discussed challenges?*

Q10. *Are there some factors that are preventing the company from implementing said actions?*

Appendix 2. Interview framework (team lead)

General questions

Q1. *How would you describe the company and its business in general?*

Q2. *What are the company's supply chains like structurally, and has this structure changed in recent years?*

Q3. *Is supply chain performance currently being tracked in the company, and if so, how?*

Q4. *What is your job description, and how long have you worked at the company?*

Q5. *What is your role in the company's supply chains, and what are you main responsibilities?*

Performance assessment questions

Q6. *What things do the company's supply chains perform the best at in terms of internal functions and/or external functions/partners in your opinion?*

Q7. *What are the largest challenges to the company's supply chain performance in terms of internal functions and/or external functions/partners in your opinion?*

Q8. What do you think are the causes for said challenges?

Q9. *How do you think said challenges affect the company's supply chain performance?*

Q10. *How would you rate the significance of the effects of the listed challenges on the company's supply chain performance? (1-5, 1 = Insignificant, 5 = Very significant)*

Q11. *How would you rate the company's overall supply chain performance? (1-5, 1 = Very poor, 5 = Very good)*

Performance improvement questions

Q12. *What do you think the company should do in order to alleviate discussed challenges?*

Q13. *Are there some factors that are preventing the company from implementing said actions?*