Environmental friendly supply chains

How the purchasing department and its forwarder can contribute to more environmental friendly supply chains

Main field: Sustainable supply chain management
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Abstract

The purpose of this research study was to explore how the purchasing department and a forwarding company together can promote more environmental friendly supply chains. To achieve this, the three following research questions had to be answered; RQ1: How could better purchasing planning contribute to more environmental friendly supply chains? RQ2: How can the relationship between the purchasing department and its forwarding company contribute to more environmental friendly supply chains?, RQ3: How can changes in transportation modes contribute to more environmental friendly supply chains?

To be able to answer these questions, a single case study was conducted at two companies which already has an established business relationship. To ensure a rich data collection a mixed method was used, where interviews provided qualitative primary data, and quantitative data collection was conducted at both companies. The data was extracted and reduced, to ensure only the relevant information was considered in the research. All data was summarized in accordance with descriptive statistics to make it more comprehensive in the report. The interviews were performed as semi-structured interviews, which where voice recorded and then transcribed to ensure a fair analysis. A summarized version of the transcript is presented in the report.

The research indicated that the choice of transportation mode is crucial to ensure more environmental friendly supply chains. When considering what transportation mode to use, it is not enough to merely consider the theoretical carbon dioxide emissions associated with the mode. One also have to take the length of the route and weight of the cargo into account when evaluating which transportation mode is the most environmental friendly option for each shipment.

The findings also showed the importance of purchasing planning, to make sure that available containers are fully utilized and reduce the number of transportations by merging different shipments together. Purchasing planning will also make it possible to reduce the number of air shipments, which emits large amount of carbon dioxide and is mainly used as a transportation mode when there is a high level of urgency.

In addition, the research made it clear that sustainable business relationships also can contribute to more environmental friendly supply chains. By creating long lasting relationships with one or a few forwarders, it is possible to facilitate the achievement of the sustainability objectives. To be able to create sustainable business relationships, the individual organizations has to achieve a high level of integration between their own functions.

Keywords

“Environmental friendly transportation”, “Carbon dioxide emissions”, “purchasing planning”, “dynamic purchasing approach”, “purchasing framework”, “sustainable business relationships”, “organizational integration”, “transparency”

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1 Introduction

The modern market, pressures companies to become more sustainable and take global warming in consideration when doing business. The efforts of one organization is however not enough. True sustainability requires the involvement of all parties within the entire supply chain and need to cover all activities which are carried out, including the transportation element. Unfortunately transportation is often neglected in sustainability work, despite its large carbon dioxide emissions, which is known to contribute to global warming. In addition, transportation activities are generally outsourced to forwarders, which adds to the complexity, since an additional party need to make sustainable decisions. It is for this reason a case study is used to explore how the purchasing department and a forwarding company can contribute to more sustainable supply chains from an environmental perspective. Interviews and collection of secondary data is carried out to explore how purchasing and logistics can contribute to more environmental friendly supply chains, through their purchasing planning, transportation choices and business relationships. The investigation is carried out as a thesis for the bachelor program in sustainable supply chain management at Jönköping University in the spring of 2020, and applies the knowledge obtained during the academic time period.

1.1 Background

During the past few decades the market has changed considerably. In the past, most merchandise and consumables were purchased and produced locally and little planning was required, compared to today. This changed with globalization, and today's market has expanded to a global scale and requires shipping across continents. Hence, it has become a more complicated task, which requires extensive planning and a lot of resources. These resources might not be available within the company, due to the trend of focusing on one’s core competencies, which has been established as an attempt to increase one’s competitive advantage through efficiency and cost reduction (Grant, 2019). Even though a task is not considered to be a core competence, it still has to be attended to and therefore outsourcing has become a common practice (Abbasi & Nilsson 2016).

Outsourcing provides companies with the opportunity to utilize specialized competence, which would not be available if they had chosen to perform the tasks within the own organization. This is especially true for transportation activities, which rarely is handled internally. Therefor there has been a need to develop business relationships between an organization's purchasing and logistics departments and external forwarding companies, to ensure that purchased goods are transported efficiently and cheap. It is however not enough to merely develop business relationships. For outsourcing to become truly successful there is a need to develop sustainable relationships between the involved parties. It is important that the parties work towards aligned goals and simultaneously create value. However, the outsourcing process are facing new challenges as the consumers are becoming increasingly

invested in sustainability and global warming, which often is considered to be conflicting with companies objective to keep costs down. It is therefore important for both purchasers and forwarders to make business choices that will keep the carbon dioxide emissions down and decrease their contribution to global warming.

1.2 Purpose and research questions

The purpose of this report is to explore how the purchasing department and the forwarding company they use, together can promote more environmental friendly supply chains. It is important to investigate both these actors, as they have strong influence on the sustainability level of a supply chain. In addition, it is known that no company can be considered sustainable solely based on their own activities, it is a team effort. The whole supply chain needs to develop more sustainable and environmental friendly practices. One important aspect of the supply chain that has a great environmental impact is transportation, that often is being neglected, despite its large carbon dioxide emissions and customers putting more pressure on companies regarding sustainability. Companies focus on cheap and fast transportation, rather than sustainability and the environmental impact, to be able to meet deadlines and more prioritized demands. These trends have generated the research questions of this report;

RQ 1: How could better purchasing planning contribute to more environmental friendly supply chains?

RQ 2: How can the relationship between the purchasing department and its forwarding company contribute to more environmental friendly supply chains?

RQ 3: How could changes in transportation modes contribute to more environmental friendly supply chains?

1.3 Delimitations

There were a few delimitations that had to be incorporated into the research scope, to ensure it was kept within a reasonable size. First of all, the investigation only covers two companies, one company which has a purchasing department, and one of the forwarding companies they use. This might not be enough to generate a holistic generalization of the phenomenon. Secondly, the only quantitative data collected is secondary data from the companies business systems. The focus will only be on the relationship between the purchasing department and one forwarder. No other relationships between different parties in the supply chain will be investigated, despite them might having influence on the supply chains environmental impact.

In addition, the focus area will only be on transportations handled by the specific forwarder in the study, and between the other company's different company locations. There is also a high risk for traffic delays, where trucks are standing idle and generating large amount of carbon dioxide emissions, this can however not be taken into consideration in this research, since it would be impossible to determine the extent of the traffic jams and delays. Hence all quantitative data is based on smoothly flowing transportations.

1.4 Outline

The report will continue with a theoretical background to ensure that the reader has all required terminology, but also previously established knowledge available within the subject. Following is the methodology, clarifying the approach, methods and techniques used, as well as an account for all actions and decisions taken during the research process. The findings and an analysis of them are then presented, followed by a discussion of the methods, findings and possible limitations which occurred during the research process. Finally there is a conclusion section and an appendix containing raw data.

2 Theoretical background

2.1 Role of a purchaser

The role of the purchaser has advanced from a more clerical role within the company, to a more strategic role. One contributing factor to the development is the increased importance of reduced cost, while improving quality. Another factor stimulating the changes in the purchasing role, is the new management philosophy which emphasize closer relationships with suppliers and just-in time (JIT) delivery. To be able to meet the demands and arrange for deliveries in accordance with JIT, many companies purchasing function are becoming a collaborative arrangement. In addition, the purchasers has been assigned with the responsibility to develop more sustainable supply chains through their activities (Ellram & Pearson, 1993).

The purchasing department has great influence on cost, quality and sustainability due to the nature of their activities. Some of these activities includes determining which suppliers to use, but also what material to purchase. At the same time, the purchasing department need to balance the cost objectives, while meeting quality requirements and societal pressures concerning environmental and social issues. The list of appropriate suppliers becomes limited when the requirements for non-toxic materials, minimum waste and recyclable materials are accumulating. As a result, the purchasing function has become a challenging task, which requires large quantities of resources, time and planning (Teixera, Assumpcao, Correa, Savi & Prates, 2018).

2.2 Role of the forwarder

A forwarders main responsibility is to offer transportation and logistics solutions that are efficient, flexible and cost justified. The specifics of the forwarder's activities might change depending on the need of the individual clients, but the modern shipper´s expectation is mainly about efficient and timely door-to door solutions. These activities is often complicated to solve, and requires the forwarder to possess a number of specialized competences and a well-developed network. The role of the forwarder changed with the introduction of the container, which plays an important role in modern transportation, as it allows for larger shipping batches (Chain, 2014).

Today, it is considered imperative and evident to outsource logistics activities to third-party logistics (3PL) companies, such as a forwarder. This will facilitate the establishing of value creating supply chains, that are built on trust. Despite this being imperative, there is an issue when considering sustainability from a logistics perspective, to instead focus sustainability efforts on production and material extraction (Abbasi & Nilsson, 2016). One reason for this is

the lack of pressure 3PL companies experience from their clients. They are however experiencing pressure concerning low costs (Persson, 2013).

It is not uncommon that 3PL companies does have plans and objectives regarding sustainability, and some offer online calculations of emissions related to their clients transportations. They do however not include it in their mission or visions, hence it is not a priority and part of their core business. The main efforts made by 3PL companies, to achieve more sustainable supply chains, are to choose the transportation modes with more care. They aim is to be more energy efficient during transports by using combination shipments and thereby reduce the number of containers that are shipped, despite not being fully utilized (Abbasi & Nilsson, 2016).

In addition, climate compensation is a valuable supplement for the transportation industry, to make up for the environmental damage they convey (Persson, 2013). At least until truly sustainable transportation solutions can be developed and fully implemented.

2.3 Sustainability

2.3.1 Definition of Sustainability

In order for a company to become sustainable it needs to achieve financial success, while considering their environmental impact (Granados & Gámez, 2010). Sustainability within organizations is about having a sustainable supply chain which acknowledge all aspects of the triple bottom line. Sustainable supply chains are achieved when a firm is able to integrate environmental and social aspects into their internal and external activities, without compromising the economic performance of the companies (Ron, 1998). The triple bottom line is commonly used as a framework that assess the three interconnected dimensions economics, social issues and the environment, with the purpose to assist companies in achieving their sustainability objectives (Slaper & Hall 2011).

As outsourcing has accelerated the last decades, both purchasing and supply management has become important actors in the development of sustainable business behavior (Reuter, Foerst, Hartmann & Blome, 2010). In fact, the decisions that are being made by the purchasing department has become crucial, since they are the link between the own organization and the external businesses up-stream the supply chain and with the 3PL (Abdur & Piak, 2020).

Most Western companies nowadays, have expanded their supplier base to a global scale, and spend volumes are moving towards emerging countries (Reuter, Foerst, Hartmann & Blome, 2010). The environmental and social mindset in other parts of the world can differ widely, and this presents challenges for the Western companies, when there are increasing pressures of sustainability from their stakeholders. This forces companies to ensure that all their

suppliers are able to meet these sustainability demands, or they will compromise their competitiveness. In order to minimize the reputational risks associated with sourcing globally, most Western companies are establishing corporate codes of conduct, which their suppliers are required to meet. This will facilitate organization transparency in terms of social engagement and how they work towards reducing the environmental impact induced by their activities, which displays their sustainability efforts to the stakeholders (Baden, Harwood & Woodward, 2009).

2.3.2 Sustainability and transportation

Globalization has expanded the container-transporting market, as well as established a need for forwarders to manage these transportations. As a result, forwarders have developed a great influence on products sustainability status. The transportation industry has become so large, that in 2016 it stood for 22 percent of the total carbon dioxide emissions world wide, and it continues to increase (Berg & Langen, 2017). In fact, of those 22 percent, 74 percent are represented by road transport while only nine percent is represented by sea transport.

Even though logistics activities bring multiple socio-economic effects that are positiv, such as work opportunities, it also generate negative effects on both the society and the environment. Therefor, there is a need for joint efforts to create more sustainable supply chains, where the positive aspects are highlighted and the negative are reduced, or even eliminated (Abbasi & Nilsson, 2016). The focus in transportation is often costs, and therefore it only captures the impact assigned with a monetary value. There is a clear need to assess other kind of impacts from transportation activities, such as environmental ones (Bardfod, 2018).

More environmental friendly supply chains has become popular as a concept, to ensure that the supply chain emits less carbon dioxide and other pollutions, while still generating a profit and enables growth of the individual companies. There are various efforts available to improve production and develop alternative raw materials. The aim is to be able to create more sustainable products which emits less pollutions, as a response to the markets increasing demand on sustainability (Teixera et al, 2018). However, transportation, which generates great amount of pollutions, is neglected, to ensure low prices, as it is not consider to be a value adding activity (Berg & Langen, 2017). One reason for this could be the fact that it is hard to achieve fast, cheap and environmental friendly logistics. Therefor, the environmental aspects is down prioritized, since businesses are about profit and fast deliveries. This however, needs to change (Abassi & Nilsson, 2016)

Other activities to ensure more sustainable logistics are to utilize the available resources and containers at maximum, while keeping it within the weight limit (Abbasi & Nilsson, 2016). This is why its goods to use 3PL, as they can combine multiple clients cargo trough combination shipments. This ensures that the resources are utilized more effectively than the clients most likely could have achieved separately (Abassi & Nilsson, 2016).

There has been an increasing tendency among transportation companies to become more environmental friendly, while shippers have not prioritized this. Instead their focus has been on cost, since the customers most of the time is not willing to pay, to ensure lower environmental impact (Berg & Langen, 2016). Transportation management is critical for logistics and supply chain success. Even thought this is well known in the industry, many shippers solely use logic and knowledge from operations as old as from the 1980. Using information that is out of date and no longer is applicable, can contribute to poor performance and thereby cause higher environmental impact, compared to when using more modern and efficient tactics (Stank & Goldsby, 2000).

Forwarding and shipping companies first approach towards sustainability is lowering carbon dioxide emissions. To achieve this, the mode of transport and planning of the routes has to be determined carefully. Intermodal transportation will often generate lower carbon dioxide emissions, than when strictly using truck mode transportation. However, this is not true if the distance is short. Even though sea transport in theory generate the lowest carbon emissions per tonne per km of the traditional transportation modes, it is transported such long distances that it no longer can be considered environmental friendly, especially since the route seldom is straight (Berg & Langen, 2016).

Many forwarders and shippers are starting to develop sustainability targets, often concerning lowering of the carbon dioxide emissions, as they believe it will become more important as time progress. Despite this, their clients rarely demand sustainable solution from their forwarders and instead ask for cheap solutions (Berg & Langen, 2017). In addition, the customers rarely demand to see the environmental impact of their transportation, since the basic requirements of transportation nowadays are to meet low cost or elevated service requirements (Berg & Langen, 2017) (Stank & Goldsby, 2000).

There is an urgency that efforts are made to promote innovative solutions within sustainable logistics, but at a low cost, for companies to be on board and contribute to more environmental friendly supply chains (Björklund & Forslund, 2018). Example of these could be development of vehicles that run on alternative energy sources and aim for zero emissions. It is however, essential to consider the costs associated with development and implementation of new innovations, as this often limits the progress. Innovations within logistics can not be achieved by a single company. Actors from the whole supply chain need to be involved for it to be successful. This will require the development of sustainable, long-term relationships between suppliers, forwarders and transportation companies etc. To ensure that the innovations and efforts move towards more sustainable alternatives, key performance indicators (KPI's) concerning sustainability should be implemented, to track the progress (Björklund & Forslund, 2018).

Until this is possible, effort could be made to educate driving personnel in eco-driving, but also inform clients about the difference sustainability efforts can make. If the clients starts to demand more sustainable logistics instead of merely fast and cheap transportation, then 3PL companies will prioritize sustainability, to maintain their market share (Abbasi & Nilsson, 2016).

2.3.3 Environmental compensation

Environmental compensation is becoming increasingly common in today's society due to growing pressure from stakeholders, in terms of meeting environmental goals such as biodiversity targets and carbon footprints. The booming interest in sustainability has emerged from the severe problems of air pollutants, that is affecting both the environment and human health (Yang, Chang & Yan, 2014).

The main function of environmental compensation is to compensate for the damaged on nature made by company activities. Today it is used to sustain the biodiversity and ecosystem in various countries across the globe. This is an passive approach to become more sustainable, as it often is implemented after the damage already has been made. There are different environmental compensation efforts available, ranging from being as vague as “an acceptable level of loss” to a concrete action plan of improvement. Many companies and service providers are offering their customers to pay a fee for environmental compensation, when in fact obligatory compensation would be much more effective (Persson, 2013)

2.4 Supply chain relationships

To achieve a sustainable supply chain, the business relationships should be sustainable as well. The benefits that could be realized through a sustainable business relationship are several, and among them are competitive advantages, such as a strong market position. A sustainable business relationship can also promote a cooperative relationship, that benefits all parties involved. The resistance within each process is minimized and the interdependencies between the parties are developed and strengthen (Schiefer, Fritz, Reynolds, Fischer & Hartmann, 2009).

Sustainability within a business relationship is characterized by the same traits as sustainability within other areas. It is mainly about the ability to maintain a product, service or process, without interfering with the possibility of future generations having the same possibilities. The actions required to create sustainable business relationships are several. The first two are to create flexible organizational behavior and collaborative thinking. This will promote relationships that are stable and prone to overcome challenges. Another important action is to establish equal power distribution between all business partners, which will positively impact the sustainability of the business relationship, since no company will be overthrown by another. A fourth action is to implement clear and effective communication,

which can ensure that common and individual interests and objectives are declared. Without clear and effective communication, decision making and everyday operations are at risk for errors, which could result in unsustainable behavior (Schiefer et al. 2009).

Within sustainable supply chains and sustainable business relationships, it is crucial with transparency and trust. This will facilitate the empowerment of the weaker parties, while holding the stronger ones accountable for their actions (Mol, 2013). There is however important to identify the appropriate level of transparency, since to little transparency will make the collaboration difficult, while to much leaves the parties exposed.

Trust is an important factor within sustainable business relationships. The main reason for this is that supply chain partners depend upon one another, to create value from their common resources, especially when outsourcing certain activities. A supply chain is a complex, advanced and adaptable system and its success depend to a large extent upon the level of interaction between the supply chain parties and their interdependence. In order to have a good interaction and collaboration between the parties, they need to trust each other enough to willingly share information and future plans etc., that is, they have to be transparent (Capaldo & Giannoccaro, 2015).

In the past, purchasing and logistics were separated. In today's business world, successful companies have achieved integration between the functions to ensure smoother supply chains (Ashenbaum & Maltz, 2016). A supply chain will be able to become integrated if it is transparent and there is trust between the functions. This is crucial for superior supply chain performance, where sustainability is included (Fabbe-Costes & Nollet, 2015). It will also provide a more holistic understanding of the business's financial situation, as the logistics and purchasing costs are influenced by each other's activities. Integration facilitates information exchange, collaboration and organizational alignment, to ensure that all functions strive towards similar objectives (Ashenbaum & Maltz, 2016). In fact, when studying supply chains that generate low or non-existing value, there is evidence of the involved functions working towards different goals and objectives, that even could be contradictory. Common or similar objectives, which ensure functions working towards the same direction is essential for value-creating supply chains and this can be achieved through integration (Pagell, 2004).

As previously stated, for a supply chain to become integrated, the individual parties need to achieve integration within their own company as well (Fabbe-Costes & Nollet, 2015). In fact, it is crucial to achieving integration within and between companies, to ensure success (Pagell, 2004). This could also refer to the need to integrate different locations within the same company, even when they are in different countries. This is to ensure a strong and integrated internal base for the organization being able to develop sustainable business relationships, with other organizations (Fabbe-Costes & Nollet, 2015).

One of the most important flows in supply chain management is information flow, which enables integration and smoothly flowing supply chains (Pagell, 2004). If relevant information is not shared, decisions and actions could be made which does not generate the best practice and might not be in alignment with the objectives. That is, without sharing the relevant information, the collaboration is doomed to fail (Ashenbaum & Maltz, 2016). This is especially true when combined with the trend of outsourcing logistics activities to 3PL, which requires information sharing to ensure flexible and adaptable supply chains. It will also generate more efficient supply chains with a high level of strategic planning throughout the whole supply chain (Abassi & Nilsson, 2016). It is therefore important to nourish the relationship and not focus on blame when errors occur, but instead focus on problem-solving (Pagell, 2004). This is not only true between departments of the same organization, this is also relevant when activities are outsourced to another company (Ashenbaum & Matlz, 2016).

2.5 Purchasing planning

Purchasing strategy is of key importance for all businesses in order to be able to efficiently respond to customer needs. A purchasing strategy can assist in maintaining an appropriate service level toward the customers, and save money by improving cash flow. A purchasing process that is guided by a comprehensive purchasing strategy, will improve the delivery of goods and the overall value to customers (Myung & Drake, 2008).

Purchasing planning can be carried out as a static or dynamic purchasing approach. The dynamic approach is chosen when the procurement decisions are not made until the last second, and it prioritize the daily demand and market prices etc, rather than forecasted demands. The static planning approach takes a detailed time-based plan into consideration before making any decisions, and therefore it requires forecasts. This approach has less flexibility than the dynamic one, and its main objective is to minimize the total procurement efforts (Kerstholt & Pieters, 1994).

Some organizations choose to apply a generalized conceptual framework to their purchasing function, to facilitate the implementation of strategic purchasing strategies. This framework consist of a few different stages, which can vary between different organizations. An example of these steps are; analyze inputs, initiate activities, and abolish or avoid inertia (Rajagopal & Bernard, 1993).

To be able to analyze the inputs, it is crucial to collect all data available about the purchase. The initiation of activities is about identifying the stages required to do the purchasing process, while the abolishment of inertia happens when an organization implements strategic purchasing practices through their communication plans. As the purchasing activities becomes more complicated, it would be beneficial to apply a conceptual framework. This is even more important when a firm changes its competitive strategy to match the current

environmental conditions. The framework works as an excellent guide for implementing changes in the purchasing strategy (Rajagopal & Bernard, 1993).

Another purchasing framework available to guide the implementation of sustainability effort in purchasing are ISO 14001, that focus solely on evaluating suppliers in terms of sustainability. This framework can be used to integrate the sustainability concept into the purchasing strategy (Meehan & Bryde, 2011). Sustainability is a wide concept that include for example the utilization of the transportation modes used in the supply chain. Important to consider, is the need for planning in order to utilize the transportation modes at maximum. Hence, an integration of transportation planning into the transport service buyer's overall planning approach is required. This includes the purchasing planning (Hedvall, Dubois & Lind, 2017).

2.6 Transportation

The forwarding industry has multiple transportation modes to choose from when transporting cargo. The most common ones are sea, rail, air and truck mode which all servers their purpose, as they can transport goods at different volumes, speed and flexibility. More often than not, the forwarders combine multiple transportation modes for each freight, to provide door-to-door delivery. This is called intermodal transportation (Bowersox, Closs, Cooper & Bowersox, 2013).

Water is the most commonly used transportation mode, but also the oldest one and the cheapest. It allows for large quantities of goods to be transported at low variable costs, but at a slow pace and with a limited range and flexibility. In addition, it has lower fixed costs than rail, while generating smaller carbon emissions at only 10 gram of carbon dioxide per kg goods transported 20 000 km, which makes it the most environmentally friendly alternative of the big four transportation modes (Bowersox, Closs, Cooper & Bowersox, 2013) (TKL, 2020). The main disadvantage of the sea mode is the slow speed it operates at, which requires planning long time in advance, as the transportation takes about 45 days door-to-door from China to Sweden (TKL, 2020).

Rail allows for transportation of heavy goods at large distances, while keeping the variable costs and need for personnel low. The fixed costs on the other hand, are relatively high due to the expensive equipment and infrastructure required. Until today (or at least since the WWII) the train has mainly been used for transporting bulk goods and heavy equipments (Bowersox, Closs, Cooper & Bowersox, 2013). However, with the extensive development of the railroad system in China, rail are becoming an attractive transportation alternative for normal goods that are being exported from China to Europe. It is faster than the sea mode, as it takes about 24 days door-to-door from China to Sweden, but does not generate as much emissions as the air mode does, only 15 gram of carbon dioxide per kg goods transported 11 000 km.

Therefore it represents a good alternative to air, when time pressure will not allow for sea transports long lead-time (TKL, 2020).

Air is the fastest available transportation modes for normal goods, as it can transport cargo door-to-door from China to Sweden in 6 days (Bowersox, Closs, Cooper and Bowersox, 2013) (TKL, 2020). Even though air transportation has relatively low fixed costs, it has limited space and weight capacity and has very high variable costs. In fact it is the most expensive transportation mode available, which result in it not being utilized for all freight transport (Bowersox, Closs, Cooper & Bowersox, 2013). In addition, air is the most damaging to the environment, as it generates 4150 gram carbon dioxide per 8 200 km transported. These high level of carbon emissions, in combination with the high price associated with air freight, limits air freight to a last resort transportation option (TKL, 2020).

Truck, is the most flexible transportation mode and is often combined with the other transportation modes to ensure door-to-door deliveries. It has small fixed costs, but the variable costs can become high if the mode is used for large distances and multiple carriers are purchased by the forwarder. Each purchased truck requires licenses, gas, personnel and other fees associated with road transportation. Therefore the truck mode is mainly used to transport smaller quantities, for shorter distances (Bowersox, Closs, Cooper & Bowersox, 2013).

2.6.1 Alternative transportation

Electric vehicles are becoming more common in transportation, and will have large role in the future of road transportation. The electric vehicles are growing in numbers but are still relatively few in comparison with the traditional vehicles which are run by fossil fuels. The reason for the limited prosperity of the electric driven vehicles is due to their limited battery range and the high purchasing cost. There are undergoing development to produce better and cheaper electric vehicles all around the world (PIARC, 2018).

There are many potential benefits of using electric vehicles, among them are reduction of emission which contribute to a better environment both for the nature and the inhabitants of cities. Since the vehicles are quieter than traditional transportation vehicles they will contribute to quieter cities and are also possible to operate during hours when there are sound restrictions (Volvo trucks, n.d).

3 Methodology

The purpose of this research is to investigate how a company's purchasing department and an external forwarding company could contribute to more environmental friendly supply chains, through a single-case study.

3.1 Research design

This investigation is carried out as a case study, where the two collaborative companies TKL logistics and ROL group are in focus. TKL logistics are a forwarding company which has ROL as one of their biggest clients and assists them with the transportation between their different locations in China, USA, Lithuania and Sweden. As a result these companies has developed a dependent relationship between each other, that has potential for more environmentally friendly transportation habits. The reason these companies was chosen, originates from the authors already having established relationships with the companies, hence proving high level of access to data and information.

3.1.1 The choice of research design

A case study is the optimum option for this investigation, as it provides insight into real-life scenarios, by studying one aspect of a problem in-depth and uses multiple sources to collect data (Williamsson, 2002) (Bell & Waters, 2014). A case study requires a methodological plan of action, should be grounded in the literature review and be defined in the form of relevant research questions, which should be answered by carrying out the investigation (Yin, 2018). Traditionally, the main focus of data collection is qualitative, such as interviews, which will be carried out in this investigation. However, this study will be also acquire quantitative data, collected from the two companies business systems (Williamsson, 2002). It is important to carry out the study in a planned and methodical manner, where data is systematically collected and the relationship of the relevant variables are studied, to ensure in-depth knowledge (Bell & Waters, 2014).

The main issue with a case study, is its singular design, which limits the possibility to cross-check the result and create generalizations to a population, which can be applied to other situations. It can however be relatable, which can provide others with guidance of how to act in their natural settings, even though it is not the same as the one the case was carried out in. In fact, due to this, "relatability" can be more important than generalization, when evaluating the importance of a case study (Bell & Waters, 2014).

The reason for single-case studies being limited to create statistical generalization, has to do with the low number of studied units. Instead it is possible to create theoretical

generalization, where the research can provide a starting point for further research and extend and generalize theories, rather than a sample (Mills .J.A, Eurepos. G, Wiebe. Elden (2010).

3.1.2 ROL AB

ROL group is a business group that consist of the different companies, ROL Fredbergs, ROL Ergo, ROL USA, ROL Lithuania, ROL China and ROL Production, which operates in three different business areas. ROL Fredbergs are delivering turnkey projects that include general contracting, concept design and production of shopfitting and interiors, to meet the needs of clients within the retail, restaurant, cafe and public spaces.

ROL Ergo offers different solutions for office ergonomics and their main focus is adjustable tables. They are partnered with the market's leading office furniture manufacturers to be able to provide these products to their clients. The solutions are designed to facilitate and add value to the customers product portfolio. ROL Rio is a part of ROL Ergo, but have their own business area, which are offering the customers different smart solutions for office environments and have the purpose of empowering the employees to work healthier and more effective. ROL Rio also enables organizations to make decisions through real-world, real time data analysis. All companies within the ROL group have customers around the world hence ROLs shipping activities are crucial for the business success. Most shipping activities and the logistics processes at ROL are outsourced. ROL are currently using all the four traditional transportation modes available for transportation of their cargo, air, sea, road and train.

ROL AB is a privately-owned business founded in 1985, in Sweden. There are four different locations for ROL´s plants, which are in Jiaxing located in China, Siauliai in Lithuania, Jönköping in Sweden and Holland,Michigan which is situated in the USA. The headquarter is in Jönköping Sweden and they have retailers all around the world.
ROL are continuously working with both quality and environment, and is certified with ISO 9001: 2015 and ISO 14001: 2015. In the United States,their factory is ISO 9001: 2015 certified and have made plans for environmental certification in 2020. There are also certifications plans in the component factory in China, to be certified in ISO 14001 and ISO 9001 by 2021. The largest factory, that is situated in Lithuania, is undergoing improvements to existing quality and environmental management systems and is expected to be certified by the end of 2019/early 2020. More information about the company can be find on their webpage: https://www.rolergo.com/

3.1.3 TKL Logistics

TKL Logistics was founded 1994 in Sweden and have evolved from a forwarding and broker company, to a company focusing solely on logistics and forwarding services. TKL is a family owned company that provides transportation solutions by sea, road, train, air and courier. TKL offer their customers customized transportation solutions, where the optimal route for any shipment are identified, regardless if it is a small package or an entire container.

The company does not own their own carriers, instead they purchase the best transportation solutions from multiple shipping companies, haulage companies, air shipment companies and couriers. They do not perform the customs activities either, this is also outsourced. The aim is to not be limited by their own transportation potential and cost restrictions, but to purchase the best solutions at the market at any point in time, regardless if the objective is to provide fast or cheap solutions for the customer.

The company have offices in both Asia and Sweden with many collaborations and partnerships across the globe, to facilitate the transportation process. The company was one of the first forwarders to introduce train as a transportation option from China to Sweden. They work actively to promote the transportation mode as a more environmental friendly and cheaper option to air, when it is not possible to wait for the transit time associated with sea transport. They also offer environment reports to their clients if it is demanded, to increase the knowledge concerning transportations environmental impact. Despite this, they are not ISO 14000 certified, but they are working to meet the increasing demand of sustainability on the market by providing options and information to their clients. More information about the company can be find on their webpage: http://www.TKL.se.

3.2 Method

The research was carried out using a mixed method, chosen to strengthen the validity and the confidence of the research data. The idea of a mixed method is to combine at least two sources of data, theoretical approaches or methodical approaches to be able to identify unique findings and provide a clearer understanding of the problem or challenging the existing theories (Thurmond, 2001).

The benefits of quantitative data is the high external validity and the possibility to structure information and identify main issues, as well as having a well defined start and ending to the investigation (Weiss. J Personal communication March 09, 2020). However, the aim is to analyze the data and draw conclusions regarding the current situation through descriptive statistics, and declare potential improvement opportunities by combining the quantitatively derived information with the qualitative data. In addition, the analysis will combine the data from both companies, which previously have not been done.

There are many benefits of using qualitative data since it both offers flexibility and explorative possibilities in the research (Öqvist, n.d). The data investigation can be more or less extensive and the data is often collected from a few individuals, but concerns a large amount of variables (Kulturgeografiska institutionen 2016). Qualitative data is appropriate to use in the early phase in knowledge development, since it can be used to create hypothesis and theories about the subject of interest. It can also provide a deeper understanding, which make it appropriate to use as a complement to quantitative data (Öqvist, n.d).

The different data collecting instruments are contributing with data and findings that will assist in answering the three research questions, in accordance with below table.

Table 1: A matrix representing the research methods used and the research questions their findings are contributing to answer.

Research questions	**Collection of secondary data**	**Interviews**
RQ1: How could better purchasing planning contribute to more environmental friendly supply chains?	used to answer the questions	used to answer the questions
RQ:2 How can the relationship between the purchasing department and its forwarding company contribute to more environmental friendly supply chains?	not used to answer the questions	used to answer the questions
RQ:3 How could changes in transportation modes contribute to more environmental friendly supply chains?	used to answer the questions	not used to answer the questions

3.3 Data collection

3.3.1 Quantitative data collection

Data collection of secondary data concerning the transportations carried out the past three years, was conducted at both companies covered in the case study. The first cause of action was to investigate ROL's business system, to be able to determine the number of transports carried out between the different company locations in the last three years. In addition the monthly delivery precision was investigated, and all data was organized and summarized in an excel document.

The investigation was continued with the collection of transportation data from TKL logistics. All transports handled by TKL logistics for ROL in the last three years, was downloaded to an excel document. Then all the transportation between ROL's internal suppliers was sorted out, as this was the area of interest in accordance with the delimitations set in the beginning of the research process. The goal was then to determine the number of transports TKL handled for ROL each month during the last three years, and compare it to the total number of transports previously collected from the ROL database.

Once it was determined how large portion of the internal ROL transportations that was handled by TKL logistics, it was time to calculate the carbon dioxide emission for a number of chocien transports that potentially could emit smaller amounts of carbon dioxide, if transported by another mode.

To be able to achieve this, an online computer program called "NTM cacl 4.0" was utilized. This program is used by the same company who provide TKL with the yearly environmental reports they offer their clients. This program allows for calculations of emissions, especially carbon dioxide emissions, based on the transportation length, weight of the cargo and the chosen transportation mode. However, in the case of sea transports, the distance reported in the system was "as the crow flies", and therefore the distance of the sea route had to be determined and replaced for each sea route calculation. This was achieved by using the website; sea-distances.org, where the distance of the sea route was expressed in nautical miles and then converted to kilometers by multiplying with the converting factor 1,852. In addition, the train mode was based on public transportation, hence it was not possible to generate the railway distance from China to Europe. The train distance where therefore calculated trough google maps, by entering the start location Shanghai train station and then the destinations Terespol, Poland and Hamburg, Germany, depending on where the cargo was forwarded next.

It was not possible to calculate the whole transportation route in one go. Instead each intermodal transportation route had to be calculated separately in NTM calc 4.0 and then

added together in accordance to the route information presented in table 2. The table presents the different locations where a transportation mode was exchanged for another one, in each route, in accordance with intermodal transportation. The distance of each sub-route as well as the distance for the total transportation route is presented as well.

Table 2: Showing all the routes that has been analyzed to determine whether or not it is possible to identify a better transportation alternatives between the different internal suppliers within the ROL group.

Transportation route	**Distance 1**	**Distance 2**	**Distance 3**	**Distance 4**	**Totalt distance**
China to USA by SEA mode	Jiaxing to shanghai harbour by truck **137 km**	Shanghai harbour to Oakland harbour by sea **10 014 km**	Oakland harbour to Chicago train station by train **3809 km**	Chicago train station to Holland (USA) by truck **242,4 km**	**14 203 km**
China to USA by AIR	Jiaxing to shanghai airport by truck **126 km**	Shanghai airport to Chicago airport by air **11 539 km**	Chicago airport to Holland, by truck **280 km**		**11 945 km**
China to Lithuania by SEA for FCL	Jiaxing to shanghai harbour by truck **137 km**	Shanghai harbour to Klaipedia harbour by container ship **21 100 km**	Klaipedia harbour to Siauliai by truck **178 km**		**21 415 km**
China to Lithuania by SEA for LCL (via Sweden)	Jiaxing to shanghai harbour by truck **137 km**	Shanghai harbour to Gothenburg harbour **20315 km**	Gothenburg harbour via Kärra Terminalen to Karlshamn by truck **317 km**	Karlshamn via Klaipeida to Vilinius by ferry and truck **568 km**	**21 336,5 km**
China to Lithuania by AIR	Jiaxing to shanghai airport by truck **126 km**	Shanghai airport to Vilinus airport by plane **7793 km**	Vilinius airport to Siauliai by truck **221 km**		**8 140 km**
China to Lithuania by RAIL	Jiaxing to shanghai train station by train **104 km**	Shanghai train station to Terespol train station by train **7808 km**	Terespol train station to Siauliai by truck **565 km**		**8 477 km**
China to Sweden by	Jiaxing to Shanghai train	Shanghai train station to	Hamburg train station to		

RAIL	station by truck **104 km**	Hamburg train station by train **8513 km**	Jönköping by truck **800 km**		**9 417 km**
China to Sweden by AIR	Jiaxing to shanghai airport by truck **126 km**	Shanghai airport to Göteborgs airport by plane **8347 km**	Göteborgs airport to Jönköping by truck **121 km**		**8 594 km**
China to Sweden by SEA	Jiaxing to Shanghai harbour by truck **126 km**	Shanghai harbour to Göteborgs hamn by sea **20 315 km**	Göteborgs harbour to Jönköping by truck **148 km**		**20 588 km**
Lithuania to USA by SEA	Siauliai to Klaipeda harbour by truck **174 km**	Klaipeda harbour to Montreal by container ship **7008 km**	Montreal harbour to Chicago train station by train **1947 km**	Chicago train station to Holland, by truck **242 km**	**9 317 km**
Lithuania to USA by AIR	Siauliai to Vilnius airport by truck **219 km**	Vilnius airport to Chicago airport by plane **7720 km**	Chicago airport to Holland, by truck **280 km**		**8 219,5 km**
USA to Lithuania by SEA	Holland to Chicago train station by truck **242 km**	Chicago train station to Montreal by train **1947 km**	Montreal harbour to Klaipeda harbour by container ship **7 008 Km**	Klaipeda harbour to Siauliai by truck **174 km**	**9 317 km**
USA to Lithuania by AIR	Holland to chicago airport by truck **274 km**	Chicago airport to Vilnius airport by plane **7720 km**	Vilnius airport to Siauliai by truck **219 km**		**8 213 km**
Sverige till USA by Sea	Jönköping to Göteborg harbour by truck **148 km**	Göteborg harbour to Halifax harbour by sea **5 413 km**	Halifax harbour to Chicago train station by train **3 046 km**	Chicago train station to Holland, by truck **242 km**	**8 850 km**

When transporting by truck, the vehicle type “Rigid truck 14-20 t” was used, meaning that the truck only transported one container at a time, since this type best correlated with the reality. Sea transportation was calculated with the vehicle type “container ship” as this is the type of ship handling container transports. There was only one exception for the vehicle type when transporting by sea, this was for the route between Karlshamn and Klaipedia, since this short transportation was made by a ferry transporting cars and trucks, rather than a container ship. Therefor a general cargo ship was used, as this was the only available shipment type for this route. Train emissions was calculated by electing “electric cargo train” as vehicle type, as these are commonly used for cargo transport. Air shipments was calculated using the vehicle type “fright aircraft”, as this was the most appropriate one.

There was a large number of transportations performed between ROL’s internal suppliers, hence it was not feasible to calculate the carbon dioxide emission for each transport. Four shipments, representative for each transportation mode and route was selected. The selection was based on the weight of the cargo and the interpretation of the transportation mode not being the best one, to ensure that all weight classes was covered. In the cases where there was not four examples available, the maximum possible examples was used.

A sea transportation was considered not being the best one when an entire container was reserved for ROL cargo, but was not filled. No air shipments was considered a goods choice, while shipments transported by rail or in combination shipments by sea was considered accurate. However, this resulted in not all routes being included. The sea route China to Sweden was not considered in the analysis, as it only had shipments which was considered appropriate, as it only consisted of sea shipments that was transported in combination with other TKL customers. It was however considered when estimating alternative transportation modes to air. Also important to acknowledge is that the weight of the container had to be included in the calculations of the routes where a container was used, as its weight of 2300 kg generates a large amount of carbon dioxide by itself.

Once the carbon dioxide emissions was calculated for existing routes, it was time to calculate the potential emissions generated through alternative routes. All chosen air transportations was re-calculated as being transported by sea. However those from China to Lithuania and Sweden was also re-calculated as being transported by rail. Then the carbon dioxide emissions was compared between the original transportation and alternative routes, to determine how much the carbon dioxide emissions can be reduced when choosing another transportation mode. An analysis was also carried out to determine whether train or sea is the best substitute for air shipments from China to Sweden and Lithuania.

For 20 foot containers not being fully filled, the remaining amount of goods required to fill the container (a total of 21 000 kg is allowed) was calculated separately. Then the carbon dioxide emissions from these two shipments was calculated and compared with how much

carbon dioxide would be emitted if these 21 000 kg goods was transported in one container. The cubic feet limitation of 33,2 cbm was not taken into considerations, as it would not be possible to estimate the cubic feet of the potential goods, that could be placed in the not fully filled container. For example; if a container contains 10 800 kg goods, it means that the emissions from another transportation of 10 200 kg is determined as well. Then the emissions of these two shipments are summarized and compared to the emissions generated by one container filled with 21 000 kg.

In addition, there are variations in the sea transportation route between a container filled with only ROL's goods and a container filled with ROL goods and other TKL customers goods, when shipping to Lithuania. The containers only containing ROL goods are transported directly to Klaipedia, while the other kind is transported to Gothenburg and then transported by truck to Lithuania, see table 2. The result from the collective carbon dioxide emission calculations were summarized as averages, by using descriptive statistics as an analysis tool.

No 40-foot containers was considered in the investigation, as there was only a few number of containers in this size shipped between the ROL locations in the last three years. It would therefore not be possible to generate enough data to represent the reality.

3.3.2 Qualitative data collection

Semi-structured interviews was used to obtain primary data, to provide in-depth information from key individuals within both companies. Its adaptable nature allows the interviewer to investigate the interviewee's motives and feelings, ask follow up questions and make sure the answer is completely understood and eliminate answers without content (Bell & Waters, 2014) (Williamssons, 2002). Complex and fully developed answers can be collected, which would not be possible using questionnaires, surveys or more strict interview structures. In addition it will be easier to make sure that the interviewee keep focus and answers the questions with consideration and within the scope of interest, which might not be possible with a more open interview structure (Williamssons, 2002) (Bell & Waters, 2014). This eliminates the pressure of having to carefully formulate the questions, to ensure that the right answered is acquired, which would have been required in a written text-format, such as a questionnaire. It also make it possible for the interviewer to read the interviewee's body language, which can convey meaningful information and increase the validity of the interviewees answers (Bell & Waters, 2014) (Williamsson, 2002).

A total of four interviews was performed, two per company. Both researchers designed the questions in collaboration, but then the interviews were carried out separately by dividing them evenly between the researchers. This decision was made due to the social distance restrictions carried out during the Coronavirus outbreak in the spring of 2020.

The same questions concerning the business relationship between the two companies was asked to all interviewees, while other questions where specialized in accordance with their competency within the organizations. This was to ensure in-dept, specialized knowledge which aimed to complement the quantitative data that had been collected. All interviews were voice recorded using the voice recorder on the researchers phone, to increase the accuracy of the data and increase the quality of the upcoming analysis. Once the interviews were conducted, transcripts and translation of the recorded interviews was created and was to act as the primary data which would undergo analysis. The answers was then summarized and presented in the findings sections below, in accordance with the inductive interview analysis strategy.

3.3.2.1 Interviews with ROL group

The interviews at ROL group was conducted with the organizations purchasing and logistics manager and one of the operative purchasers at the Swedish location. There were similarities in some of the questions asked, while others where based on the participants competence and role within the organization. The operative purchaser where asked 22 questions that was designed to provide insight into the purchasers day to day operations and planning procedures. The manager where asked 23 questions to provide complementary information to the quantitative data collected and insight into how they perceive the relationship with TKL logistics.

3.3.2.2 Interviews with TKL logistics

The interviews at TKL logistics was carried out with two of the owners of the company. One with expertise within transportation from the far east, and the other one being the contact person to the ROL group, and has insight into the European transportation area. This was done to be able to cover as big a portion of the area of interest as possible. Both interviewees was asked the same 19 questions. The purpose of the interviews was to get insight into how they perceive the relationship with the ROL group, how the environment is taken into consideration within the transportation business, what constitutes the future of transportation as well as complement the quantitative data collected.

3.4 Discussion of method

Qualitative data in terms of primary data was collected through interviews. The benefits of using interviews as a data collection technique is that it makes it possible to investigate a subject in debt, and realize how individuals think and feel about the investigated subject. Interviews also contributes with a human dimension to the impersonal data.

The interviews was conducted with key individuals within the area of interest within both companies, and contributed with in-depth knowledge, but also complementary knowledge to the quantitative data previously collected. The key individuals was chosen based on their expertise and company position, to make sure that they possesses the knowledge required to answer the questions. The interviews contributed with information that facilitated the understanding of the companies integration and communication habits.

Other alternatives for qualitative data collection of this sort could have been focus groups or questionnaires. The benefits of using these alternative methods, would be the contribution of more data and the possibility to get a broader set of participant. This alternatives was not appropriate to use, since there was not enough participant with relevant knowledge in the subject area, since both focus group and questionnaires require more than 10 participants.

There was some troubles when scheduling the interviews, due the outbreak of the Corona virus in the spring of 2020. One of the scheduled interview at ROL had to be cancelled and moved forward to the following week and to be carried out by phone, instead of face-to-face, which was the original plan.

In the same manner the interviews at TKL logistics was carried out later in the day, than originally planned, due to distressed customers. Due to all these disturbances, the interviews were divided between the interviewers, instead of being carried out as a team effort. This was compensated by the already planned recording of the interviews, which was successfully carried out and made it possible for both researchers to review the data on a later occasion. It was however not possible to have one conduct the interview, while another made field notes, which was the original plan. Despite this, the interviews generated valuable data, which complimented the quantitative data already collected.

The qualitative data collection provided findings which made it possible to fulfill the purpose of the report, to some extent. It provided insight into the relationship between the companies, but also how the purchasing procedure is carried out and what the transportation decisions are based on. Hence the result from the interviews was used to derive findings which could assist in answering the first and second research questions, se table 1.

To improve the trustworthiness and validity of the qualitative data, all interviews were recorded, transcripted and summarized. A possible negative aspect with recording the

interviews is that it could inhibit the respondents and generate different answers, than if the interview was not recorded. The transcription and translation of the interviews was very time consuming, but necessary since it made it possible to structure and summarize the answers from the respondents and present it in the report. It was from the transcription the interpretation and analysis was conducted.

However, there is a risk that analysis of interviews could results in biased answers, which might compromise the reliability and validity of the study. In fact, bias is an issue that can be seen already during the interview stage, as the interviewer will interact with the interviewee based on its previous experience. This is especially true if the interviewer has a strong, biased point of view on the subject. Therefore it is beneficial to use multiple interviewers, to identify where bias might be appearing. However, since this is the only source of primary data for the research and there was a lack of appropriate participants and time limitations as well as the issue of the Coronavirus outbreak, this was, as previously stated, not possible.

The fact that the interviews was well-thought out to complement the quantitative data, it was recorded, transcribed and then presented as full answers in the appendix, but summarized in the findings section, ensures the internal validity. That is, it accounts for that what was measured, was what the researchers intended to measure. In the same manner the context of the quantitative data was very specific and clear, hence the quantitative data collection was relatively easy to keep on track, which resulted in a high level of internal validity. However, the internal validity could be questioned to a certain extent, since the interviewees at the ROL group often answered from both the external and internal supplier perspective, rather from the perspective of the relationship and activities between the internal suppliers. As mentioned earlier in the discussion, the research has a low level of external validity, since a single-case study cannot be generalized to a population. It was however possible to do an analytical generalization.

Quantitative data was collected from both companies databases in the shape of secondary data. This allowed the researchers to get a numerical overview of the situations of interest at the companies and strengthen the conclusions with descriptive statistics, which also allows the reader to draw their own conclusions from the data. It would however, been advantageously to investigate the process behind the data available in each company, to get a better understanding of the data. This would also have made it easier to evaluate the reliability of the data.

Quantitative data was also extracted from the calculation program NTM calc. This caused numerous problems in the research process, since it was complex and time consuming to calculate the carbon dioxide emissions of each step in every route and transportation example. In addition, a miscalculation was done, since the weight of the container was neglected at first, which forced the researchers to recalculate all routes containing a container.

In the same manner, the determination of the sea-distance was wrong in the first draft, due to a non reliable source which presented contradictory result each time, which also caused a need for re-calculations. A limitation with the NTM calc program, was the fact that it might be so that the route actually taken by the carriers, are not the one represented in the program. This differences should however be a small margin of error, and therefore it can be disregarded. To make sure the data collected from the calculation program was correct, is would have been beneficial to cross check the results with another calculation tool, but since this is the one used by the forwarding company, it was regarded as reliable.

All secondary data collected was carefully evaluated and reduced before being presented in the report, to extract unnecessary raw data. It would have been beneficial to collect primary quantitative data, rather than secondary data as this is the optimal foundation for analysis in research. This was however not possible, due to the time limitation and the nature of the study. Therefore secondary data was used as the foundation of analysis and then complemented with qualitative, primary data when possible.

The quantitative data contributed to fulfill the purpose of the research, since the findings represented the reality of the past three years. It numerically indicated the effects the transportation decisions and purchasing planning has had on delivery precision and the environment during this time period. The data collection method generated findings which contributed to answer the first and third research questions, see table 1.

The research consist of both primary and secondary data that strengthened the quality of the results and hence the reliability of the report. To ensure high reliability of the report the whole process was accounted for in the report, and each step was clearly described in the method. Hence it should be possible to repeat the study under similar conditions. The reliability could be strengthened by having more sources of data of both primary and secondary data, to be able to check the consistency of the result. It would also have been beneficial to cross check the results from different case studies to verify the reliability even furthur.

3.5 Reflection of the validity and reliability of the research

The quality of the data provided relies on the validity and reliability of the report. The validity and reliability of this research are in turn dependent on the transparency and trustworthiness of the report and data presentation. It was clearly stated in the method section how the investigation was carried out and the conditions required to do so, to ensure high reliability of the research. This will allow the reader to repeat the research and attain similar result, if it is performed under similar conditions. Furthermore the reliability of the data is enhanced even more through the voice recording of the interviews and full transcripts, which increases the accuracy of the raw data.

To ensure a high internal validity it was crucial to carefully chose the most appropriate research methods, both qualitative and quantitative, to make sure the findings was relevant and answered the correct research questions. To further strengthen the internal validity a study protocol were followed, where all quantitative data collection was planned in advance, followed a specific procedure and the data was carefully documented. To ensure that the researchers measured what they intended to measure during the collection of qualitative data, semi-structured interviews with well thought out questions was conducted. This ensured that the topics of interests was covered and any uncertainties was made clear.

The research also has external validity. However not in the traditional sense, where it can be statistically generalized to a population, since this is not possible through a single-case study. However, an analytical generalization is possible, since the findings in the case study can be used to expand and generalize existing theories. The findings in the report is used to support or challenge the existing theory, and could be used to generalize theoretical propositions rather than generalized to populations, which would require a larger number of studied units.

The data quality can also be enhanced by applying both quantitative and qualitative methods for data collection. This ensures that the analysis is not based merely on one source of data and provide a more comprehensive understanding of the phenomenon. Even though the methods does not collect the same data and provide triangulation, is was used to complement each other and not restrain the study to the limitations of one method.

The reader will be able to judge the reliability and validity of the report by themselves, since the report is presenting the whole research process, and the raw data is presented in the appendix, as a substitute to the summarized data in the findings sections.

4 Findings and analysis

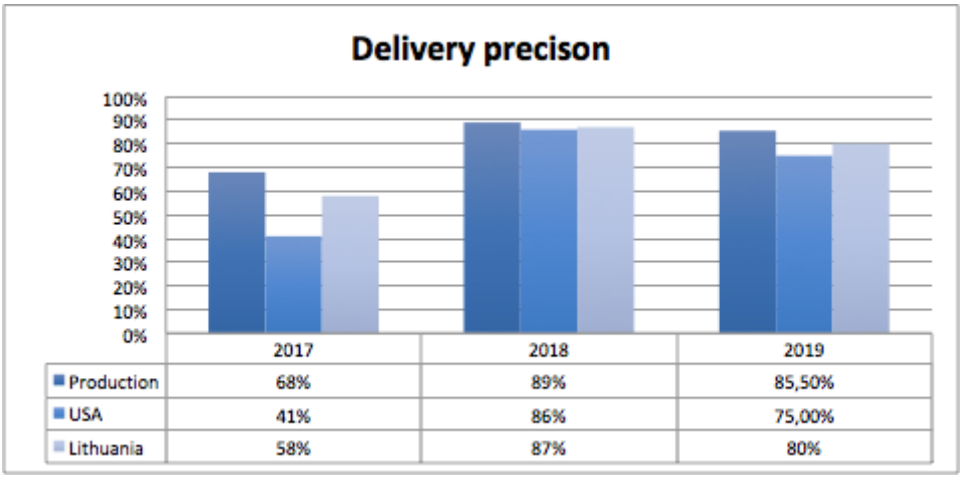
The findings in the study contributed to answer the three research questions. Certain data did merely contribute to answering one research question, while others could be used to answer more than one. To facilitate the readers understanding, the findings are categorized in accordance to the research questions they are contributing to answer.

4.1 How can the relationship between the purchasing department and its forwarding company contribute to more environmental friendly supply chains?

Quantitative data was collected as secondary data from the companies databases and through calculations using the online tool NTM Calc 4.0.

The first data collected was from ROL's database and expressed the number of deliveries between the four locations within the ROL group, and the delivery precision associated with these transportation routes.

No deliveries are ever made to China, hence the delivery precision only covers deliveries to ROL production (in Sweden), USA and Lithuania. As shown in figure 1, there was a random improvement of the delivery precision in 2018 for all locations, it did however not last in 2019, where it can be seen that the delivery precision decreased for all three. The highest delivery precision was observed in 2018 and was at 89 % and the location experiencing the best overall delivery precision was to ROL production. The location experiencing the worst delivery precision was ROL USA, at a delivery precision at 41 % in 2017. This data provides insight into research questions two, concerning how the relationship between the purchasing department and a forwarding company can generate more environmental friendly supply chains.



	2017	2018	2019
Production	68%	89%	85,50%
USA	41%	86%	75,00%
Lithuania	58%	87%	80%

Figure 1: The result from the yearly delivery precision to the three different locations within the ROL group that does receive deliveries. This indicates that the delivery precision is flawed and there is room for improvement.

The data collected from ROL was then related to the data collected from TKL logistics database, to calculate TKL's share of the transportations within the ROL group each year. This data provided further insight into how to answer the second research questions, by determining the current extent of the relationships between the two companies. It is clear that TKL logistics handles a small portion of the transportations within the ROL group, which is presented in figure 2. There it is clearly stated that the portion of ROL group's internal transports is handled by TKL. In fact, it is so small that the total yearly percentage is considered to be 0% in 2017 and 2019, and is only 0,01% i 2018. It is however clear that the number of shipments handled by TKL in fact has increased during the last three years, from 43 shipments in 2017 and 351 and 541 shipments in 2018 and 2019 respectively when studying table 3.

Table 3: Showing the share TKL logistics has of the yearly internal transportation between the four different locations in the ROL group. All data shows the number of deliveries to the four locations. This indicates the influence TKL has on the delivery performance of the different internal transportation routes.

		Production	USA	Lithuania	Total:
2017	Number of transports within ROL group:	1192	1741	3757	6690
	Number of transports handled by TKL:	2	33	8	43
2018	Number of transports within ROL group:	1058	1946	3351	6355
	Number of transports handled by TKL:	16	253	82	351
2019	Number of transports within ROL group:	1513	7459	6825	15797
	Number of transports handled by TKL:	20	384	137	541

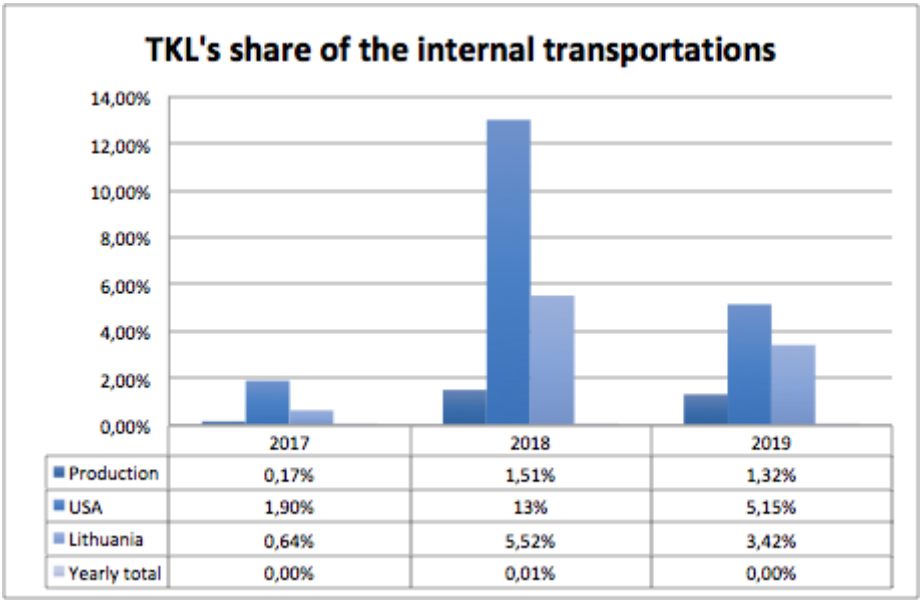


Figure 2: Showing the share TKL logistics has of the transportations between the ROL group locations during the past three years, expressed in percentage. The diagram indicates how small portion of the internal transportations within the ROL group is actually handled by TKL.

4.2 How could changes in transportation modes contribute to more environmental friendly supply chains?

The distribution of transportation modes each month was also determined for all routes between the locations in the ROL group. This provided data that support an analysis which could answer the first research questions, concerning how purchasing planning can generate more environmental friendly supply chains, and the third question on how the changes in transportation modes can generate more environmental friendly supply chains.

This was summarized to present the total yearly distribution of transportation modes during 2017, 2018 and 2019 in figure 3. There it clearly shows that the most commonly used mode of transportation is sea, and especially dedicating entire containers to only ROL cargo. It can also be read from figure 3 that train started to represent a transportation mode from China first in 2019, and only for transporting cargo to Lithuania. There was also an increase in the use of air shipment in 2019, where it was at 18 percent, compared to the two past years, where it was below 10 percent.

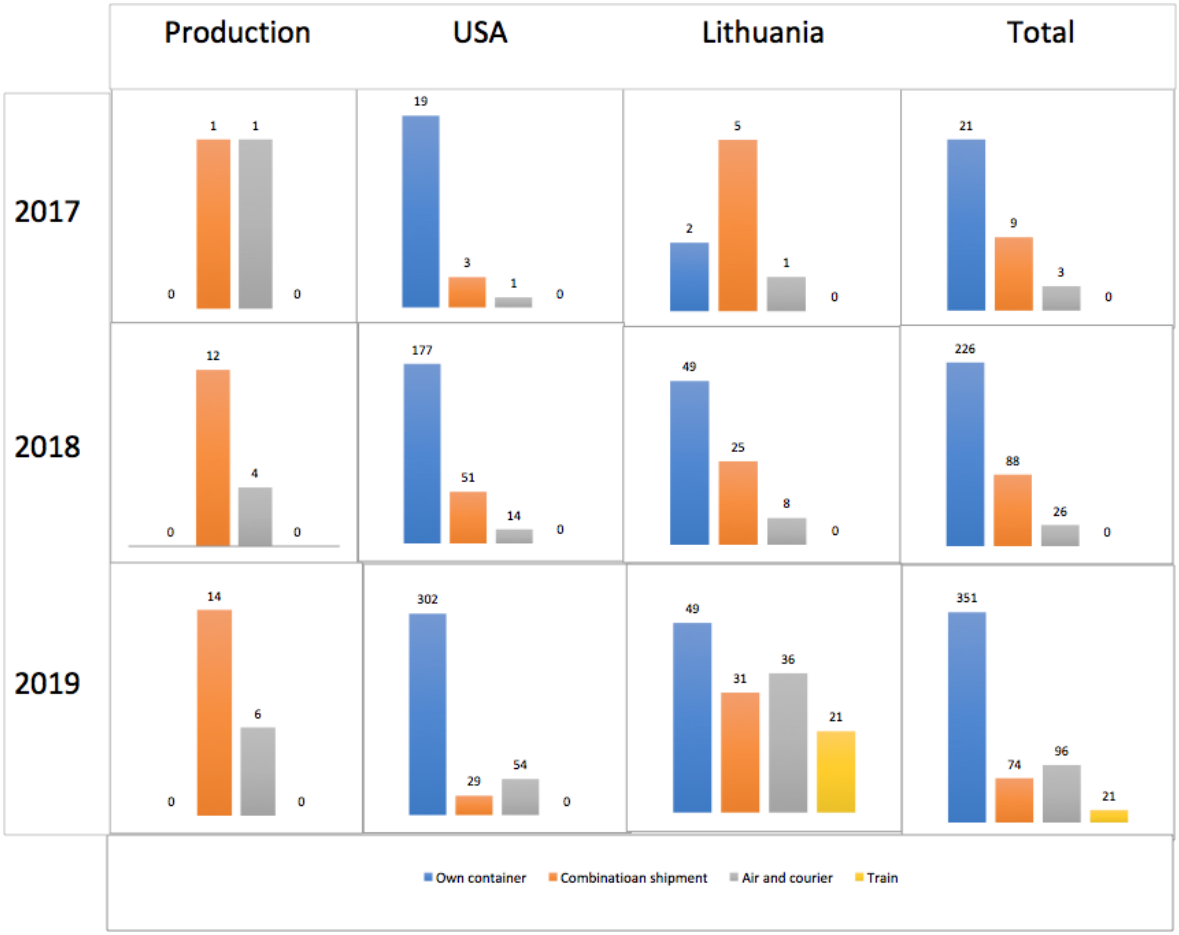


Figure 3: A summarize of the distribution between the transportation modes used when transporting to the four ROL group locations during 2017, 2018 and 2019. An Own container reflects when ROL rent an entire container for themselves, this does however not mean that the container is fully utilized. Combination shipments is when a forwarder combines the cargo from ROL with other customers, to fully utilize the capacity of the container.

NTM Calc 4.0 was used to calculate the carbon dioxide emitted by the utilized transportation mode for different shipments, and the carbon dioxide that would have been emitted if an alternative transportation mode had been utilized. This provided information which could be used to answer the third research question.

In the case where cargo has been transported alone in a 20-foot container, despite not filling it, the remaining amount of goods required to fill the container was determined and that cargos carbon dioxide emissions was calculated. These was then added together to indicate the amount of carbon dioxide that is emitted when using two shipments to ship cargo that could have fitted in one container. This was then compared to the amount of carbon dioxide emitted if the cargo in fact would have been transported in a single container.
The result from these calculations clearly shows that it is possible to decrease the carbon dioxide emissions by utilizing the containers at maximum. In fact, it is possible to reduce the carbon dioxide emissions with at least 360 kg when using one container instead of two, when transporting 21 000 kg. Depending on the route it is possible to reduce the emissions even more, up to 2 806 kg, see appendix 3. Presented in table 4 are a summarize of the average

amount of carbon dioxide possible to reduce if utilizing one container, instead of using two, when transporting between the four different routes investigates.

Table 4: Showing a summarize of the average amount of carbon dioxide emissions which could be reduced when utilizing an entire container, rather than using two containers, when transporting between the different ROL group locations.

Route	Change	Number of shipments	Average carbon dioxide difference (kg)
China to USA	Two containers to one	11	855
China to Lithuania	Two containers to one	8	2257
Sweden to USA	Two containers to one	12	356
Lithuania to USA	Two containers to one	8	465
USA to Lithuania	Two containers to one	5	473

In the same manner a comparison was made when exchanging the air mode for sea and/or train mode, which is presented in appendix 4 and summarized as an average for each route in table 5.

The data clearly indicated that companies can decrease their carbon dioxide emissions by choosing alternative transportation modes, with as much as 164 425,3 kg when changing from air mode to sea mode, see appendix 4. It does however also indicates that when the cargo weight is low (below 105 kg), it is not always beneficial to change from air mode to sea mode, see figure 5.

Exchanging air mode for train mode when transporting from China to Sweden and Lithuania does however always generate a smaller carbon dioxide emission, which can be as low as 773,89 kg or as high as 3 562,26 kg, see appendix 4.

The larger the cargo weight, the larger carbon dioxide savings will be achieved when substitute air mode for train och sea mode. It can also be read from table 5, that when transporting cargo up to 784 kg, from China to Lithuania, it is on average possible to reduce the carbon dioxide emissions more when exchanging air mode for train mode, compared to exchanging it for sea mode. This was however not the case when transporting from China to Sweden. Here the average reduced carbon dioxide emissions are greater when exchanging air mode for sea mode, instead of train when the cargo weight is above 116 kg.

Table 5: Showing the average amount of carbon dioxide emissions which could be reduced when substituting air mode for sea or train mode when transporting cargo within different weights intervals between the four locations of the ROL group.

	The average difference in carbon dioxide emissions (kg) for different routes when cargo weight is within below stated intervals			
Route	7 kg - 105 kg	116 kg - 784 kg	1134 kg - 6424 kg	7194 kg - 15306 kg
Air exchanged for sea				
China to USA	441	30	64551	0
China to Lithuania	-490	2293	0	0
China to Sweden	-285	2429,5	0	0
Lithuania to USA	153	2493	18247	0
Sweden to USA	239,5	0	22442	347260
USA to Lithuania	19	7458	24208,5	0
Air exchanged for train				
China to Lithuania	505	2588	0	0
China to Sweden	521	2165	0	0

4.3 How can better purchasing planning contribute to more environmental friendly supply chains and how can the relationship between the purchasing department and its forwarding company contribute to more environmental friendly supply chains?

A total of four interviews were conducted. The full presentation of the questions and the answers are presented in the appendices. A summary of the result are presented in below sections, categorized in accordance to relevant topics covered.

4.3.1 Interviews at ROL group

The interviews at the ROL group was with an operative purchaser and the purchasing and logistics manager at the ROL group , located at the Swedish office. They were asked 22 respectively 23 questions, which are presented together with the raw data in appendix 5a and 5b. However, a summarize is presented in this section.

4.3.1.1 Sustainability and environmental aspects

The purchasers at ROL have noticed a difference in the corporate approach towards sustainability in the last years. The sustainability manager at ROL are currently working with providing the purchasers at ROL with a framework which can be applied to their daily work activities. This was initiated after close collaboration between the sustainability manager and the purchasing and logistics manager at ROL. There are some customers that puts sustainability pressure on ROL, and to be able to meet these demands ROL have made several changes during the last years. After 2016, 90 percent of ROLs suppliers were exchanged, from a large number small suppliers to a few, but world leading suppliers. The main reason for this exchange was to increase the product quality and to have suppliers that could handle big volumes. According to the interviewees it was easier to achieve their customers sustainability demands after this change; “After doing this change we could achieve the customers demand on sustainability and we got a lower price” says David Magnusson head of purchasing and logistics at ROL group.

The strategic purchaser have a big responsibility in terms of sustainability, since they are the ones that make the decision regarding which suppliers ROL are to use, to be able to meet the customers demands. There were some contradictions between the interviewees concerning the sustainability performance of the strategic purchasers at ROL. The operative purchaser stated during the interviewee that the strategic purchasers neglects the environmental and transportation aspects when negotiating with suppliers. “The category leaders are not negotiating with the suppliers how things should be delivered, they are not prioritizing it”

says Heather Viklund Zhao. The logistics department at ROL have established client numbers at DHL for all parties to use, that help the supplier to make better delivery decisions. The interviewees had different opinions about the usage of this, one of the interviewee thought it was seldom used while the other thought it was used frequently.

Currently, there a some environmental commitments in the purchasing department, which is conducted by the operative purchaser, in terms of joint loading when it is possible. The operative purchasers at ROL are combining orders to the same delivery point if the delivery dates are close. This is done to reduce the delivery costs, but also to reduce the environmental impact of the transports. The operative purchasers only follows the sustainability directions from the strategic purchasers, but still have the responsibility to optimizing the transportation and to fill containers as much as possible etc. David Magnusson; “The operative purchasers only follows the recommendations from the strategic purchasers and hence are not so involved in this”. The purchasers at ROL also think it would be beneficial to get a deeper understanding about the packaging of different products, and how they can plan the purchasing activities to increase the possibilities to use joint shipping.

4.3.1.2 Plant position and the environmental aspect

In China the position was chosen since there was a need to be situated close to Shanghai, and to find a place where the employment costs were lower. The location in Lithuania was chosen randomly. There is currently a free-trade zone there, but according to the interviewees that is not the reason why the location was chosen. The main reason was instead that they found a well functioning partner in Lithuania, and ROL decided to develop a partnership with them. The location in USA was chosen since at this place is considered to be a furniture mecca, many different furniture manufacturers have their headquarters there. The founders of ROL are born and raised in Jönköping hence this is where ROL headquarter is situated.

4.3.1.3 Purchasing activities at ROL

An order has to be placed by the purchasing department the same day as the request are received from the client, or at the latest the following morning. Hence the focus is to handle the daily tasks in a timely manner.

The daily activities for the operative purchasers includes; handling new purchasing requests and make prioritizations, handle order confirmations in the ERP system and having an ongoing contact with suppliers. “The most important is the purchasing request, I need to consider which one to take first and place the orders that are the most important” says Heather Viklund Zhou. The purchasers are also in charge of handling delays and finding the root cause of delays from suppliers. Everyday purchasing decisions are made at the different ROL group locations in Lithuania, China and Sweden (ROL production). The strategic purchaser are focusing on the relationship with suppliers (external and internal ones) and the

possibility of finding new suppliers. They are also responsible for negotiating with the different suppliers about sustainability actions and transportation methods.

The possibilities for planning within the purchasing function at ROL is currently limited. There are only a few products and parts which ROL group are producing, which are based on forecasts or purchasing prognoses. Most of the purchasing activities happened after the daily purchasing requests and are not based on forecast. “There are only prognosses available for some items that we are purchasing” says Heather Viklund Zhao. No methods or frameworks are used by the purchasing department at ROL, to facilitate the planning procedure. Heather Viklund Zhao; “I’m doing fine without any of those (planning methods/frameworks), I think it depends on which kind of task you have. My tasks is not so dependent on any planning method, that is maybe needed for example the strategic purchasers”.

4.3.1.4 Transportation decisions

There are transportation decisions made at ROL that aren’t in line with the sustainability perspective. Among them are the occurring shipments from ROL that are not conducted in a smart manner. This occurs when an entire container is used instead of utilizing a combination shipment, despite a small amount of cargo. According to the interviewees the reason for this, is often the lack of time and that it is not possible to wait with a shipment until it can be combined with another. When asking about why there are a large number of shipments transported in a ROL dedicated container, despite not being able to fill it up, Heather Viklund Zhao stated that “It is when there is a time limit, and we need to ship fast”. David Magnusson on the other hand says that “I think it is mainly due to ignorance, we do not know how to use combination shipment, so this is an optimizing operturinity”. The environment is not taken into consideration in situations like this, since time and money is at focus.

Another transportation decision made by ROL, is to put all samples on airplanes, which has a very large environmental impact. According to the interviewees, this has to do with the time limit and the importance of the samples. The reason why samples are needed to be transported fast, is since they are crucial for the R&D or prototype department, to be able to proceed with their activities. If theses activities are due to a quality problem or similar reasons, there is a great need to get the process going fast. “If we decide something, it takes many weeks for it to get on the shelfs, so we want to hurry up the process”, says David Magnusson when asked about the large number of air shipments carrying samples. The purchasers also look at samples when evaluating a new supplier.

There have been an increase amount of air shipments from ROL during the last year, this is due a new contract with a customer in USA that ordered huge amount of products. In order to manager these, ROL needed to use air shipments to get the product there on time. Hence, the reason for the increased use of air transportation is due to a lack of capacity and planning.

There is currently a better balance in supply and demand to the USA location, hence ROL is planning to decrease the overall air shipments to that location.

ROL have a few standing transportation bookings every week from China to Lithuania, that simply follows a predetermined schedule. It is possible for ROL to cancel them if their demand decreases. Most transports are booked after the current demand. There are no set logistics arrangements at ROL which are missed at some occasions.

4.3.1.5 Integration and collaboration

Both of the interviewees agreed that there is to little integration between the different departments at ROL. The purchasers at ROL feels that it would be beneficial to have better integration with the logistics department to understand what they do, and work together in some situations. According to Heather Viklund Zhao “I think it would be beneficial to sit down and talk with each other about what we are doing, and have the possibility to ask questions”.

The purchasing department have no control over deliveries and very limited knowledge on how different transportation methods affect the lead time. The only time the purchasers receives any information about the deliveries, is when a transport is very important, or if there will be a delay. In these situations, the logistics department gives a tracking number to the purchasing department, or inform them by email of the delay. The delivery time has a big impact in the purchasing activities hence it would be beneficial for the purchasers to get more knowledge and understanding about the logistics activities.

The purchasers want more visibility from the logistics departments to be able to do a better job and give more accurate information to their customers. Heather Viklund Zhao; “For example when I get information about delivery it can be one to two days before, but I need more exact information”.

The logistics department provides weak delivery information to the purchasing department. One day earlier or later in delivery could therefore make a huge difference for the purchasing activities. More exact information and tracking possibilities are needed for the purchasers. An integration system would be beneficial, where one could monitor the transportation process and track orders etc. This would minimize the need to chase different suppliers and to be able to give more accurate information to customers.

4.3.1.6 Influence and Requirements on suppliers

The strategic purchasers at ROL are sending out a code of conduct to new suppliers with different kind of demands and frameworks to follow. These are sent out to the external suppliers, but not the to internal suppliers. The purchasers at ROL feel like there have been a change in power distribution, since more of the production have been moved from Sweden to Lithuania. The Lithuanian plant acts more independently and follows their own rules, especially in terms of delivery dates. The purchasers at ROL have been informed that there is limited possibility to impact the internal suppliers, and that they just need to accept the situation.
There has been more problems with the internal suppliers during the last years, in terms of quality and delays, but the purchasers have no information about how this is being dealt with. There are better possibilities to influence the external suppliers and put pressure on them. If an external supplier is not behaving accordingly the purchasing department feel like they have the possibility to exchange them.

4.3.1.7 Business relationships between the ROL group and TKL Logistics

ROL considers TKL as their biggest supplier in terms of sea shipments both from China to Europe and from Europe to USA. They are very satisfied with the collaboration, and think it is possible to have a closer and more extended collaboration with TKL in the future. David Magnusson; "We feel that they are a good supplier (forwarder) that are easy to collaborate with …. I think you should have partners you could have close relationships with and basically go and marry the supplier and be extremely transparent with them".

The most important thing for ROL is to find the right forwarder, for the right transportation flow. The purchasers at ROL have no relationship with TKL. The purchasers have no information about the services TKL are providing for them, and some have never even been in any contact with them. Only a few people at ROL know in detail what TKL does, and what kind of service they are providing ROL. The limited contact the purchasers have had with TKL is believed to be be good and transparent.

ROL would like to decrease the number of forwarders in the future, the reason for this is to have fewer forwarders that ROL can fully trust and develop good business relationships with. "Yes I would like to have as few suppliers (forwarders) as possible, it is comfortable to have few suppliers that one can trust. It is the obvious thing for me to do in the future, but it's very important to find the right supplier for the right flow", David Magnusson. It would be possible to reduce the amount of forwarder with 50 percent in the future but it is crucial to have the right forwarder, to the right logistically flow. ROL thinks that TKL could be used in several situations, but not all. Logistics are very complicated and everyone is not experts at shipping everywhere. It is important to have the most appropriate partner in every situation according to ROL.

4.3.1.8 Future improvements

The purchaser who was interviewed at ROL would like to have more collaboration and information sharing with the logistics department. The purchaser would like to learn more about how to plan the purchases, to be able to use combination shipments when it is possible. ROL think it would be very beneficial to understand how they can minimize their environmental impact from transports.

ROL's purchasers currently have no information on how to handle the shipments in a more environmental friendly manner, but they believe that TKL and other forwarders could help to improve this. When asking about ROL's knowledge concerning the environmental impact of transports, David Magnusson says; "We need more knowledge about this since we from the beginning have no information about this. We need TKL and other forwarders to help with this". If ROL know how to combine shipments in a more effective way to reduce the number of containers, this would lead to a win-win situation. It would also be beneficial to look at the current packaging method, since according to the purchasing department this aspect is neglected today at the company.

The interviewees think that partnerships deeper than just between the customer and supplier, will be very important in the future, in order to improve all aspects of the organisation. ROL would like to see that in the future one goes and "get married" with a business partner to be able to be as transparent as possible. It would be good if TKL would have the possibility to have an insight in ROLs ERP system to see their prognoses and see how they communicate with their suppliers and customers. ROL think that TKL could help them in a better way with this additional information.

Both of the interviews thought that it is important to find the right competence outside the company since it is not possible to hire every competence inside the company, hence that expanded partnerships could lead to improvements in the future.

4.3.2 Interviews at TKL logistics

The interviews at TKL logistics were conducted with two of the company owners. They were asked 19 identical questions, which are presented together with their answers in appendix 6. A summary of their answers are presented below and categorized in relevant headlines.

4.3.2.1 Sustainability and environmental aspects

According to TKL, the environmental aspects has become growingly important in the last three to four years and therefor it has become important for forwarders to do their part. The best thing they can do is to purchase products which allows them offer more environmental options to their customers. “The environmental aspect has been much more important for last two to three years at TKL… Our customers sometimes does not want to pay to be better in terms of sustainability, but TKL tries to find products that are better for the environment that our customers would like to buy” says Oscar Lundgren.

In today's society, the best option is often to use sea transport, but it is often the result of customer asking for the lowest price. In fact, it is unusual that customers ask for environmental friendly options, instead of low prices, even if it does occur on occasions, due to its growing importance. “ I would say that it is very rare that the customer ask for this (environmental friendly transportation), it is mostly the price they are worried about” says Magnus Claesson. However, low prices and environmental friendly transportations presents a dilemma in the industry. The forwarder can only provide suggestions and guidance based on their expertise, in the end the decision lies with the customer and if they need their cargo immediately, they rather choose air than sea.

TKL has contributed to more environmental friendly supply chains by promoting train as a transportation mode from China to Europe. In fact, they are one of the few forwarding companies that has been part of promoting this transportation mode as a mean to transport cargo from China to Sweden.

In addition, they are able to provide emissions reports to their clients, which they believe to be important, since companies need to see the differences their choices will make, for them to take action. Oscar Lundgren; “We are providing our customers with reports about their current emissions, to make them more conscious about their environmental impact. I think that it is easier to make changes if you are aware of your current situation”. Informing and finding environmental friendly and economic solutions, is the contributions they can do to make more environmental friendly supply chains, since they do not own any transportation vehicles themselves. More often than not, this result in sea transportation

There where some contradictions between the interviewees concerning questioning the customers choice of transportation mode. One stated that if a customer ask for air mode, they

might ask if it really is in a hurry or can be delivered in a few weeks instead, hence train could be a better option. While the other did not believe that they questions the customers choice of transportation mode, as they often prioritize price over environmental impact. Instead they do transportation analysis to identify solutions that might result in less transportations, which will save the customer money, while being a more environmental friendly option.

Since the forwarding company has multiple customers, they also create combination shipments which allow them to combined for example 10 shipments, from 10 different containers, instead of having the customers purchasing an entire container by themselves. They try to promote this, even if it is close to the weight point where the cost between using a combination shipment, or an entire container is minimal. They also made it clear that they are not ISO 14000 certified.

One sale pitch they use to encourage more environmental friendly options are the price, since train is cheaper than air. However, this was according to one of the interviewees. The other one stated that no encouragements are made, but they offer environmental analysis if the customer is demanding it.

They believe that insight into their customers full transport needs could allow them to optimize the transportation planning, and allow for more environmental friendly transportations for the whole company. If they cannot see all shipments, they cannot assist in creating as environmental friendly transportation habits as possible for the customer. They could create combination shipments and minimize the number of shipments, and even reallocate air shipments to sea, or in the case of emergency, to train. “If we would have better control over all transportations we could make more combination shipments and better decisions in the supply chain” says Oscar Lundgren. This would however require a tighter relationship between customer and forwarder. However, the maturity of the customers might influence how perceptive they are to different transportation modes and their environmental impact. There might be aspects that make it impossible to make choices from an environmental perspective every time.

4.3.2.2 Transportation decisions

The weight or cubic limit determines if the cargo should be placed in its own container or in a combination shipment, since this influence the price. They do however always strive to fill the containers as much as possible, since it often will be cheaper, but also more environmental friendly. It does however present an additional risk to the cargo, when using combination shipment, since it has to be loaded and off-loaded at multiple terminals, and cannot be sealed during the whole transportation. Hence, valuable or sensible cargo might require its own container. Therefor it could be possible that containers are transported half-full, since it has to be protected, even if the price is higher. Oscar Lundgren states that

“There is always a risk when choosing combination shipments, since it needs to go through a terminal and be loaded into a container and then into a terminal in Gothenburg etc. Many customers want their cargo to stay in the container the whole distance and keep the container sealed. So in terms of safety they choose a whole container instead of combination shipment”. It could also be due to the suppliers decisions. They might order a full container, and the forwarder will not know the amount of cargo until the container is loaded and packing list and invoice has been sent to them, hence they cannot influence the decision.

In a similar manner the decision regarding which transportation mode should be used, lies with the customer. The forwarder can give recommendations, but in the end it is primarily the lead time that guides the decision, even if it might be expensive and emit large amount of emissions. Secondly it is the price that guides the decision, while the environmental aspects rarely is prioritized over these two other factors.

During the transportation route analysis, it was noted that the sea shipments to USA arrive to different harbours, depending on where the shipment was from. According to the interviewees this is the result of the forwarding company always striving to find the best transportation solutions for their customers. What is the best transportation solution does however change over time. If something better comes along, or one actors goes bankrupts, they have alternative solutions available. This is the same reason why combination shipments from China to Lithuania is transported by Sweden, it is cheaper and faster.

4.3.2.3 Business relationship between ROL group and TKL logistics

TKL logistics find that the relationship with ROL group is very transparent. They have meetings concerning how routines are changing. TKL has one sales man (one of the interviewees) and two operatives that has regular contact with parties at the ROL group. When the best transportation routes are determined, ROL takes part in that decision and if there are any disruptions, ROL is informed as soon as possible. However, TKL does not receive any information until the time of shipment, meaning that they do not know anything about any problems that could have occured in production. In light of disturbances that occured in the winter of 2019/2020 and spring of 2020, due to protests in Hong Kong and the Coronavirus, they received information about shipments a month in advance, it is however not clear if what was ordered was what was needed or if it merely was estimated.

The communication is also believed to be good. In fact, both of the interviewees has visited the Chinese location, while one have visited all the locations. The aim is to develop personal relationships and understanding, which are important for smooth transportations. However, communication can always be better, and hopefully the new customer portal will facilitate the communication further. The earlier they can get information about ROL’s bookings, the better, but on an overall level the relationship is very well developed and everyone seem satisfied.

In the same manner the trust between the companies is high, according to TKL. The collaboration is tight, and both parties seem to trust the others work and any problems that arise are discussed, and ROL take part in all decision making regarding their transportations. Magnus Claesson says that “now we have settled that we can trust each other. We always do our best and if something comes up we will have a discussion about it”.

4.3.2.4 Future innovations and environmental compensation

TKL sees that transportation from China by train is an innovative solution that substitutes many air shipments, in a more environmental friendly manner. In addition, new techniques are developed. Self driven trucks, better engines, electrical trains etc might contribute to more effective transportations.

In addition more effective loading and less empty trucks and containers would lower the environmental impact. They also state that larger ships has also been developed, the questions is how much larger they can become. The also believe that the industry is very conservative and the innovations that will be put into action might be limited. In addition, they believe that ships and airplanes runned by electricity will not happen, and other alternative energy sources will have to be developed, which those are, they have no idea.

TKL has a case where they have done environmental compensation, but they would like to see collaborations with their customers where they work towards minimizing the carbon dioxide emissions produced during the transportations. According to Oscar Lundgren “There has been one case where we have been doing some climate compensation on the transports we made, but we would like to see that our customer will contribute as well. Then we could reduce the carbon emissions even more” On their own they are planning to start doing donations to organizations that works to improve the environment, but this has not yet been realized in march 2020. In today's world they do not believe they can do much else than to do those donations and inform their customers about more environmental friendly transportation options.

4.4 Analysis of quantitative data

4.4.1 Delivery precision and TKL's proportion of delivers

The data collected indicated that TKL only stood for a portion of the internal transportations within the ROL group, despite the increase in overall transportations the last three years. This does indicate a development in the relationship between the two companies, but unfortunately it is still not large enough to link the unsatisfactory delivery precision to the collaboration between ROL and TKL logistics. It did however indicate that ROL in fact does have problems with their overall delivery precision, but it is very unlikely that TKL logistics is a significant factor to this, considering their small contribution to the overall delivery activities.

4.4.2 Transportation modes

The allocation between the transportation modes in figure 3 indicates that train is a newly discovered mode for ROL when using TKL logistics. In fact, it was only utilized for transportations from China to Lithuania 21 times in 2019, while being neglected for transportations to Sweden. Figure 3 also shows that there was an increasing amount of air shipments to USA in 2019. This was the result from a new customer segment that requested bigger volumes than ROL could handle in a time frame that would allow for sea transport. Hence the usage of air transport was needed to be able to meet those increasing demands in a timely manner.

4.4.3 Carbon dioxide emissions

When analysing the differences in carbon dioxide emissions in table 4, it is indicated that more carbon dioxide will be emitted when using more containers, instead of utilizing the available capacity of one container. It can also be concluded that the biggest contributing factor to the difference in carbon dioxide is the weight of the container. One 20-foot containers weights 2 300 kg, hence transporting two containers rather than one will result in larger emissions, since 2 300 kg more has to be transported for every extra container.

In the same manner it is clear in table 5, that transportation by train is more beneficial than transporting by air, even if the weight of the cargo is small. This is not surprising due to the large amount of carbon dioxide that are emitted by airplanes, 4,2 kg per kg cargo when transporting 8 200 km, compared to trains which emit 15 grams per kg cargo when transporting 20 000 km.

The same was not true when changing from air mode to sea mode. When analyzing the differences in carbon dioxide emissions, it was observed that when the cargo weight is 105 kg or below, it is not always beneficial to substitute air mode for sea mode, when transporting

from China to Sweden or Lithuania. This could be a result of the weight of the container used to transport the cargo by sea and the distance of the route. As the container weights 2 300 kg the carbon dioxide emission for the shipment will increase considerably, compared to when transporting 105 kg or less by air. Important to note, is that this container most likely will be utilized to ship cargo for multiple companies, hence the carbon dioxide emissions generated as a result of the container weight will be distributed between all the cargo within the container. Therefor an assumption can be made that in reality it will be more beneficial to transport the cargo by sea, even if the weight is 105 kg or less.

The distance also seem to play an important role when determining whether or not lower cargo weights are beneficial to ship by sea. As seen in table 2, the distance from China to Sweden and Lithuania for combination shipments by sea are approximately 20 588 km and 21 337 km respectively, while the distance for sea shipments between USA and Lithuania, China and USA and Sweden and USA approximately are 9317 km, 14 203 km and 8 850 km respectively. These distances could be a contributing factor to why air shipments at 40 kg between Sweden and USA saves at least 18,87 kg carbon dioxide when switching to sea mode, while a shipment at 105 kg from China to Sweden emitted 53,3 kg more when changing to sea mode, see appendix 4.

The distance between China and Europe is longer than between China and USA. This be one of the contributing factors to why the data indicates that substituting air mode with train from China to Lithuania will reduce the carbon dioxide emissions more, compared to when substituting with sea transportation. However, the same was not observed when studying the carbon dioxide emissions when transporting cargo within the weight interval 116 kg to 784 kg from China to Sweden. This could be the result of the long distance which the cargo need to be transported by truck from the train station in Hamburg to ROL production in Sweden.

4.5 Analysis qualitative data

4.5.1 Cost and lead time prioritization in transportation

When studying the data collected from the interviews with TKL, it was clear the transportation sector still is neglected in sustainability efforts, despite there being a growing pressure from end customers for sustainability. Most companies prioritize lead times and cost, rather than ask for more environmental friendly transportations. Even if they would prioritize the environmental impact, there is only so much the forwarders can do, until alternative transportation modes have been developed.

Today, forwarders can create combination shipments when required, find the best available route and provide transportation services that emit less carbon dioxide, such as train and sea. They can also work actively to inform their clients about their environmental impact, by providing them with environmental reports regarding the emissions related to their transportations. This is to ensure that the clients are aware of the impact their transportations have, and have access the information required to make more sustainable and environmental friendly transportation decisions. This is crucial, since it in fact the clients who makes the transportation decisions, the forwarder merely provide advice and information, as well as carries out the transportation activities.

4.5.2 Internal integration within the ROL group

The interviews also showed there is a need for a more comprehensive collaboration and integration between the different departments within the ROL group. The work conducted at the different departments are currently done independently, with limited collaboration and information sharing across departments. It was also clear that the planning process within the ROL group is limited or even non existing, and there is no available tools to assist the purchasers in the planning process.

There also a need for better communication with the internal suppliers, to clearly state the achievements required from all parties in the ROL group. This could be improved according to the interviewees, by the usage of integration systems were all parts of the organizations is visible to all parties, and make sure that they all fully understand and are able to find the relevant and available information. Another alternative is to openly reach out to co-workers in the other departments and ask for advice or assistance, when it could facilitate and improve the purchasing and logistics activities.

4.5.3 Sustainable business relationships

The interviews also suggested that it is important with close and sustainable business relationship that has a high level of transparency, trusts and clear communication to create seamless transportations. By getting further insight into clients transportation needs, it is possible for forwarders to plan the transportations holistically and thereby create to more environmental friendly transportation habits. These habits includes combination shipments, reducing the number of transportations and choosing less carbon dioxide emitting transportation modes. This would however require that the forwarding company have greater influence over what transportation modes to use, but also when cargo should be shipped, to be able to utilize the available carriers as much as possible.

There does however seem to be limitation to what forwarders can do to contribute to more environmental friendly supply chains. They can inform and assist companies in making more environmental friendly choices, but until they have created a seamless relationships where they are responsible for companies whole transportation chain, they are limited. What they can do is contribute with environmental compensation, at least until the technological advances allows for smaller carbon dioxide emissions.

In the last years ROL group has focused on reducing the amount of suppliers, and are in the future willing to expand this trend and reduce the amount of forwarders as well. It seems as there is a positive attitude towards developing sustainable business relationships that would last over a longer time period, from both parties. This could generate higher visibility between the business partners and could lead to that seamless relationship which the forwarding company require, to be able to provide more environmental friendly transportations.

4.5.4 Innovations and the future of transportation

It seem to be a common understanding that innovations within the transportation sector will take time. Despite there already has been progress in the transportation sector, such as self driven trucks, it seem to be accepted that the implementation of innovative solutions will be restricted, due to the conservative nature of the industry. Instead they seem to believe that the innovative solution which will contribute to more environmentally friendly transportation, is the one that has been re-invented in the last few years, the train. Even though train has been available for hundreds of years, it has not been used to transport cargo from China to Europe before this new era of the train mode. As noted in the result of quantitative data, it is possible to reduce the carbon dioxide emissions immensely by substituting air mode for train mode, which strengthen this belief.

4.5.5 Efforts towards more environmental friendly supply chains

When studying the interviews from ROL, it was clear that sustainability is demanded by multiple customers, and the changes made during the last years have merely been implemented to meets these demands. The changes has mainly been in the purchasing department, in terms of exchanging suppliers and implementing different protocols from customers. The interviewees made it clear that the activities that had a negative impact on the environment, was made out of ignorance, or the lack of time. Without the customer demand on sustainability, the environmental improvements would be limited.

The interviews with the ROL group indicated that there are various potential improvement opportunities possible to implement, These primarily concerns effectiveness, environmental impact and performance of the internal suppliers. Since both of the interviewees at the ROL group showed great willingness to learn and improve, this is hopefully an accepted belief within the organization and presents a great foundation to realize these improvement opportunities in the future.

Most improvements could be done in transportation and especially in regards to utilization of space. It is not uncommon that containers is not filled to their maximum capacity, and the least appropriate transportation mode in terms of sustainability is often used to save time. Even though improvements are possible with some shipments, there still needs to be some transportation by air, since time is of essence in certain situations. This is especially true for samples, since they are key features in improvement activities and has to be delivered as soon as possible, or the improvement and development process will be put on hold. Thereby samples will most probably be transported by air in the future, despite their environmental impact.

5 Discussion and conclusions

5.1 Discussion of method

In the report a mixed method was used and it could be argued that this approach could increase the complexity of the analyzing processes. This was however not a problem in this research scenario, as the qualitative data acted as a complement to the quantitative data. It's main purpose was to answer questions and insecurities developed during the quantitative data analysis, but also provide insight into the business relationship. By choosing a mixed method a methodological flexibility was realized, together with the possibility to adapt the chosen methods to specific situations. This approach provided the research study with rich and comprehensive data, that made it possible to get a deeper understanding of the situation.

A case study was conducted, since it was considered the optimum option for the complex phenomenon studied. This approach allows the research to study a real-life scenario using multiple research methodologies, and thereby making it possible to collect more comprehensive information about the phenomenon studied. A few number of units where studied, to instead focus on a larger number or variables, which increases the relevance of the research.

However, this approach makes it hard to generalize the result to a population, since this would require a more extensive investigation of many units. Hence it is hard to achieve a high level of external validity. Instead it is possible to conduct an analytical generalization, where the result from the case study could be used to extend and generalize a specific theory. The findings from the case study can be used to verify or question the existing theory, and thereby assist in the generalization of existing theories and argue that they are applicable in other, similar situations as well. If the desire would be to generalize the findings to an entire population, a different research method would have been more appropriate. This method would have to be able to study multiple units that make up a representative sample of the population.

It would also have been beneficial to apply method triangulation, where multiple methods are used to collect data concerning the multiple units. This would have increased the validity and reliability of the research, since multiple methods would generate similar result. It would also be beneficial to conduct more than one case study to be able to compare the findings among different companies and thereby get more reliable results. Due to the limited time and possibility to find similar companies as the investigated ones, only one case study was conducted.

5.2 Discussion of findings

The purpose of this report was to determine how a purchasing department and its forwarder can promote a more environmental friendly supply chain by answering the three main research questions.

5.2.1 RQ 1: How could better purchasing planning generate more environmental friendly supply chains?

As mentioned in the analysis of the quantitative data, the main reason for the large differences in carbon dioxide emissions when utilizing a container at maximum, instead of using two containers, is the weight of the containers. The result thereby indicates the importance of a well thought out purchasing planning practise, to be able to create more environmentally friendly supply chains that generates lower carbon dioxide emissions. If it is possible to plan ahead and make sure that the containers are utilized at maximum, either by waiting for more cargo, or using a forwarder to create combination shipments, the carbon dioxide emissions can be reduced considerably. This is strengthened by the result of this study in combination with the collective information from Abassi and Nilsson (2016) and Hedvall, Dubois and Lind (2017).

According to the interviews the purchasing activities at the operational level is made on a daily basis, since there is very few prognosis of purchasing forecasts to take into consideration. This indicates that the company follows a dynamic purchasing approach, which allows for high flexibility, but can result in less environmental friendly supply chains. This is strengthened by the definition presented by Kerstholt and Pieters (1994) in the theoretical framework. Hence the planning could be improved tremendously from an environmental perspective, by working towards a more static purchasing approach, where forecasts are used. This approach would reduce the number of shipments, as it is easier to combine different orders when basing the purchases on forecasts, which in fact was indicated in the interview with the operative purchaser.

A static approach in combination with the theory of a “conceptual purchasing framework”, could thereby assist in using purchasing planning to generate more environmental friendly supply chains, which is supported by Meehan and Bryde (2011). The implementation and practise of a conceptual purchasing framework would guide the purchasing department in their purchasing decisions. The framework could then facilitate in the implementation of a more environmentally friendly approach. In the same manner, more environmentally friendly supply chains could be realized by basing the purchasing decisions on forecasts, rather than the just-in-time approach that seem to be the standard today. This could increase the possibility to utilize less containers, but at full capacity, rather than a large number of containers which are not fully utilized.

To further reinforce environmental friendly purchasing practises, it would be favorable to complement the static purchasing approach and the conceptual purchasing framework with an ISO 14001 certification. According to Meehan and Bryde (2011), this is an additional purchasing framework that will assist the purchasing department in the integration of the sustainability concept into the purchasing strategy.

It was also concluded that there was an increase in air shipments to ROL USA in 2019. The reason for this were an increase in demand from an external customer in USA, which exceeded the available capacity at that time. It could be argued that better purchasing planning would allow the cargo to be transported with the larger, regular shipments, instead of being transported separately by air. This change in procedure could generate more sustainable supply chains, as the overall number of transports would be reduced, together with the number of air shipments. This would consequently reduce the carbon dioxide emissions, as sea transport emits smaller amounts of carbon dioxide than air shipment. This argumentation is supported by Bowersox, Closs, Cooper and Bowersox (2013) and the website of the forwarder in the case, TKL (2020).

5.2.2 RQ 2: How can the relationship between the purchasing department and its forwarding company generate more environmental friendly supply chains?

Even though the delivery precision could not be analyzed into depth, it did represent a problem within the ROL group. A lack of delivery precision makes it difficult for companies to create more environmentally friendly shipping habits when they are to forward the products to their external customers. These irregularities causes uncertainties about when the products from their internal suppliers will arrive, and make it challenging to combine cargo from multiple shipments before forwarding it to their clients. If companies cannot trust the scheduled delivery date, it will be likely that more transportations than necessary will be required. This is to be able to meet the customers cost requirements, which generally is of higher priority than reducing the amount of carbon dioxide emissions which is in accordance with Berg and Langen (2017), and Abassi and Nilsson (2016).

This error in delivery precision could be the result of a lack of integration which was observed between the purchasing department and the logistics department within the transportation buying organization, which is in alignment with Fabbe-Costes and Nollet's (2015) contribution. Especially in combination with the fact that they are using multiple forwarders for their transportation activities, something that the study indicated is a practise the transportation buyer wish to terminate. According to Schiefer et al., (2009) it could be beneficial to develop long lasting sustainable relationships with the forwarders, to ensure

high value creation. In fact, they state that a sustainable supply chain can not be developed without sustainable business relationships.

This lack of integration between the buyer organizations purchasing and logistics department represent a larger problem than an error in delivery precision. It is important to create seamless and transparent communication within the own organization and ensure that all functions work towards similar objectives, which is strengthened by Ashenbaum and Maltz (2016). If the functions are working towards contradictory objectives and information is ineffective shared, it will according to Pagell (2004) be difficult to maximize value creation and decisions will be made without having access to all relevant data. As a result there is a risk for implementing practises that are not in alignment with the objectives.

Furthermore, according to Fabbe-Costes and Nollet (2015) it will not be possible to create sustainable business relationships with other companies, if integration has not been achieved within the own organization. According to Pagell (2004) and Ashenbaum and Maltz (2016) creating effective information flows, where relevant information is available to everyone who requires it, is crucial to ensure the organization becomes integrated and the supply chains will run smoothly, since transportation and purchasing planning procedures will be facilitated by the additional information.

The study shows that the two organizations find themselves in what they consider a well developed business relationship. Both argues that there are transparency, trust and good communication between them. According to Mol (2013) and Capaldo and Giannoccaro (2015) transparency and trust is crucial to develop sustainable business relationships, while Schiefer, et al., (2009) states that it is important to ensure clear and effective communication between the parties. Once again, Pagell's (2004) statement about information flow being crucial for organizational integration and smooth running supply chains can be applied. It will not be possible to create sustainable business relationships before the own organizations has been able to integrate their own functions through transparency, trust, effective communication and information sharing.

In addition Ashenbaum and Maltz (2016) express that discrepancies in relevant information sharing can cause a collaboration to fail, since decisions and actions will be based on incomplete information and not in alignment with the objectives. According to Abassi and Nilsson (2016) this does also apply when outsourcing certain business activities, such as transportation. It is crucial that the relevant information is shared in a transparent and clear manner between the organizations, to ensure that flexible, adaptable and efficient supply chains are developed. As the forwarding company in the study is responsible for a very small portion of the transportation buying organization internal transportation, it is hard to argue that the information sharing is at the high levels required for a sustainable business relationship.

Developing these deeper relationships takes time. Therefore it could be beneficial to do as the study indicated and use one or a few forwarders, rather than a larger number of forwarders. The qualitative data also indicated that if the forwarder could have access to their customers entire transportation needs and be responsible for all transportation activities, they would be able to create more environmental friendly supply chains. The forwarder would be able to plan, combine and re-adjust shipments to minimize the overall number of transportations, but also prioritize the most environmentally friendly transportation modes. This approach can be supported by Schifier et al,. (2009) statement that sustainable business relationship can facilitate higher value creation through trust, transparency and clear effective communication and information sharing, which are important factors, not only according to Schifier et al., (2009), but also to Mol (2013) and Capaldo and Giannoccaro (2015).

Having fewer forwarders will also make it easier to identify trends and root causes for unsatisfactory delivery precision, since it will be clearer which forwarder the issue lies with. In addition, the forwarders might feel more motivated to improve the transportation activities for the client, if they handled a larger portion of their transportations. This would benefit both parties, which according to Capaldo and Giannoccaro (2015) is what sustainable business relationships is about. Creating value for both parties, trough their common resources.

For the sustainable business relationship to succeed in generating more environmental friendly supply chains, it would require that the clients start to prioritize the environmental impact, rather than cost and lead time, which is the general practise today according to Berg and Langen (2017), Abassi and Nilsson (2016) and the interviewees at the forwarding company of the study. Even though end-customers have started to demand sustainability, transportation is often neglected due to time and cost pressures. For this to change, the mentality of sustainability has to change first. Sustainability has to become as important as price and lead-times. It should not be about being sustainable on paper, it should be about being sustainable in practise. Forwarders has to take responsibility in informing their clients about alternative transportation solutions and provide cheap alternatives that emits smaller carbon dioxide emissions. An example of this, according to the interviewed forwarding company, would be to transport urgent cargo by train, rather than air from China.

An alternative way for the relationship to contribute to more sustainable supply chains are according to Persson (2013) environmental compensation. Until alternative power sources are available, which emits minimum carbon dioxide emissions, it is possible for companies to make contributions to organizations who focus on environmental issues. This could be achieved separately or in collaboration with the business partners, to ensure that the efforts are realized. An argument could me made that environmental compensation should be compulsory for companies that are limited in their choices of alternative, more environmental friendly solutions to their activities, such as actors in the transportation sector. At least until innovative, reasonably priced transportation solutions has been developed and commercialised.

5.2.3 RQ 3: How could changes in transportation modes generate more environmentally friendly supply chains?

The quantitative data analysis revealed that it is possible to generate more environmental friendly supply chains. Either by substituting certain transportation modes with others, or utilizing available containers at maximum. It is however, crucial to consider the weight of the cargo and the length of the route, when determining which main transportation mode is the best alternative for different routes. The study shows that air mode generates large amount of carbon dioxide emissions, no matter the weight of the cargo, which is supported by the theoretical framework. If possible one should always avoid air transport and instead use train or sea mode, since these according to the case forwarders website and Bowersox, Closs, Cooper & Bowersox (2013) generate lower levels of carbon dioxide emissions.

When shipping cargo from China to Scandinavia and Eastern Europe, the distance could result in it being unbeneficial to ship by sea if the cargo weight is low, and especially if the cargo is not put in a combination shipment. This is caused by the excess weight of the container, which increases the carbon dioxide emissions to the point where it exceeds the emissions that would be emitted if shipping the small cargo by air. In this case it would be more beneficial to exchange the air mode with train mode, as this is an available transportation mode between China and Europe. This would emit lower carbon dioxide emissions, since no container is dedicated to a single customers cargo. This indicated that sea does not always generate lower carbon dioxide emissions than train, which contradict the information presented in the theoretical framework. This information, from TKL (2020), states that train generates 15 g of carbon dioxide per kg cargo transported 11 000 km, while sea generating 10 g of carbon dioxide per kg cargo transported 20 000 km. This could be the result of the theory not taking the weight of the container in consideration, which was done in this study.

The qualitative data indicated that there are potential for companies to have more effective and environmental friendly transportations, by being open to forwarders advice, and plan the purchasing activities in advance. This could according to Fabbe-Costes and Nollet (2015) be achieved through improved communication and higher level of integration between the logistic department and the purchasing department within the own organization. It will also require enhanced communication with the forwarding company, which correlates with Schifier et al. (2009) beliefs that clear and effective communication is crucial in sustainable business relationships.

It is not only possible to generate more environmental friendly supply chain when using a forwarder. It can also save money. A forwarder can provide expertise and guidance concerning the optimum transportation routes and modes from both an economic and environmental point of view. By using intermodal transportations, a forwarder can also

ensure door-to-door deliveries, no matter if they are transporting entire containers or combination shipments. The use of combination shipments allows them to combine the cargo from multiple companies, to prevent that every company buys one container each, despite not being able to utilize it fully. As the study has shown, this approach is key to reduce the environmental impact of transportation. It minimizes the number of shipments, but also prevent companies to ship by air, when they do not want to pay for a container they cannot completely utilize.

In the future it could also be possible to utilize transportation modes with alternative power sources, but as noted in the qualitative data it is hard to determine what these sources will be. Electricity will most likely not be able to power airplanes and big ships, hence other alternative energy sources has to be developed. At the moment, the best alternatives available are sea and train mode, where it is possible to transport cargo from China to Sweden in 45 days respectively 24 days. However, the emissions are still high, and there is a need for further research in the alternative energy sector. There are development undergoing within this sector that will contribute to more sustainable alternative in the future which correlate with (PIARC, 2018).

5.3 Limitations

As the research progressed, there were certain limitations that influenced the data collection and scope. One limitation is the number of years investigated. To increase the trustworthiness of the results, it could have been beneficial to study the transportation routes for a longer time period than three years, which potentially could increase the credibility of the conclusions. This was however not possible, as the relationship between the parties started three years ago. As a result a second limitation was developed. Some routes did not occur more than one time per year, while others only occurred once in three years, which made it difficult to draw reliable conclusions.

5.4 Conclusions

It is invalid to state that there is one best transportation mode from an environmental standpoint. A conclusion can be made from the research that the optimum transportation mode will depend on the length of the route, the available transportation modes, the weight of the cargo and weather or not it is possible to create combination shipments. However, it can be stated that sea and train mode, always will generate less carbon dioxide than air mode.

It will not be possible to completely remove air as a transportation mode. There will always be a need for organizations to be able to ship cargo between different countries in a fast fashion, to be able to keep up with the rapid changes in consumer requirements and response to unpredictable events. It is however clear, that there is a need to reassess the possibilities to replace unnecessary air shipments with sea or train mode.

Even when choosing a transportation mode based on above characteristics, it will not be enough in the long run. The purchasing department has to plan their purchases in advance, which requires a static purchasing approach. This should be combined with a conceptual purchasing framework and an ISO 14001 certification, to ensure sustainability is taken into consideration. As long as containers are not fully utilize and small shipments are sent regularly as a result of bad planning, it will generate unnecessary carbon dioxide emissions, no matter what transportation mode is used.

In the same manner, unnecessary carbon dioxide emissions will be generated if the delivery precision is unsatisfactory. This could obstruct the transportation planning for goods that will be combined from different shipment, before being forwarded to external customers. Therefore, it is beneficial to develop sustainable business relationships with one or a limited number of forwarders. This will make it easier to track, control and improve the delivery precision, keep the number of transportations down and make more environmentally friendly transportation choices.

To be able to create sustainable business relationships, which are transparent, trustworthy and has a effective communication and information sharing, it is crucial to achieve integration within the own organizations first. By making sure that all functions in the organization has a high level of information sharing and communication, they are more likely to work towards the same objectives and make smarter, more environmental friendly decisions.

There are limitations to what efforts forwarders can do to create more environmental friendly transportations. The innovative solutions which generates small or non pollutions are still not a reality, and in the end it is the clients that decide how the transportation should be carried out. Therefore the main contribution forwarders can do to contribute to more environmental

friendly supply chains, is to environment compensate and advice their clients to choose more environmental friendly transportations.

In conclusion, a purchasing department and its forwarder could be able to generate more environmental friendly supply chains, by developing a sustainable business relationship, plan ahead and make smart transportation choices based on the characteristic of the cargo.

5.5 Future research areas

The first future area of research worth to mention, is that the study should be repeated, but in different situations, to examine the reliability and applicability in reality. Focus should also be on developing alternative transportation modes and examine the carbon dioxide emissions associated with these. A comparison of the result has to be done, to determine if it exist a statistical significant difference between the carbon dioxide emissions when substituting traditional transportation modes with alternative ones.

It would also be beneficial to perform several case studies, to study the outcome from implementing an integration plan within an organization followed by the endeavor of creating a sustainable business relationship. This could confirm the conclusion that an integrated organization is more likely to create sustainable business relationships with their forwarder, and trough that relationship generate more environmental friendly supply chains.

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7 Appendices

Appendix 1

A summary of the yearly delivery precision to the different ROL group locations in 2017, 2018 and 2019.

		Production	**USA**	**Lithuana**	**Total**
2017	Number of transport within ROL group:	1192	1741	3757	6690
	Number of transports on time:	815	716	2368	3899
	Delivery precision:	68,4%	41,1%	63,0%	58,3%
2018					
	Number of transport within ROL group:	1058	1946	3351	6355
	Number of transports on time:	946	1678	2915	5539
	Delivery precision:	89,4%	86,2%	86,9%	87,2%
2019					
	Number of transport within ROL group:	1513	7459	6825	15797
	Number of transports on time:	1294	5587	5735	12616
	Delivery precision:	85,5%	74,9%	84,0%	79,9%

Appendix 2

The calculations of the transportation mode distributions, which are summarized in figure 3,4 and 5 in the findings sections of the report.

			Production	Usa	Lithuania	Total	Allocation
2017	Sea	Own container:	0	19	2	21	63,6%
		Combined shipment:	1	3	5	9	27,3%
	Air & courier		1	1	1	3	9,1%
	Train		0	0	0	0	0
	Total:		2	23	8	33	
2018			Production	Usa	Lithuania	Total	Allocation
	Sea	Own container:	0	177	49	226	66,5%
		Combined shipment:	12	51	25	88	25,9%
	Air & courier		4	14	8	26	7,7%
	Train		0	0	0	0	0
	Total:		16	242	82	340	
2019			Production	Usa	Lithuania	Total	Allocation
	Sea	Own container:	0	302	49	351	64,8%

		Combined shipment:	14	29	31	74	13,7%
	Air & courier		6	54	36	96	17,7%
	Train		0	0	21	21	3,9%
	Total:		20	385	137	542	

Appendix 3

Presenting the carbon dioxide emissions when using two containers to transport goods by sea which could be transported in one, compared to if it was transported in one container

2017		Example 1	Example 2	Example 3	Example 4
China to USA	Combined weight:	17020 kg + 3980 kg + 2*(2300 kg)	9889 kg + 11 111 kg + 2*(2300 kg)	14713 kg + 6287 kg + 2*(2300 kg)	
	Combined CO2:	10 472,5 kg	10 467,5 kg	10 471,2 kg	
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	
	A full container CO2:	9797,9 kg	9797,9 kg	9797,9 kg	
	Difference:	674,9 kg	669,6 kg	673,3 kg	
China to Lithuania	Combined weight:	9430 kg + 11570 kg + 2*(2300 kg)			
	Combined CO2:	16 241 kg			
	A full container weight:	21 000 kg + 2300 kg			
	A full container CO2:	14 680 kg			
	Difference:	1 560 kg			
Sweden -> USA	Combined weight:	18931 kg + 2069 kg + 2*(2300 kg)	15084 kg + 5916 kg + 2*(2300 kg)	4396 kg + 16 604 kg + 2*(2300 kg)	12040 kg + 8960 kg + 2*(2300 kg)

	Combined CO2:	6764,9 kg	6 792 kg	6 760,3 kg	6 760,7 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg
	A full container CO2:	6 399,7 kg	6 399,7 kg	6 399,7 kg	6 399,7 kg
	Difference:	365,2 kg	392,3 kg	360,6 kg	361 kg
2018					
China to USA	Combined weight:	12463 kg + 8537 kg + 2*(2300 kg)	18090 kg + 2910 kg + 2*(2300 kg)	10182 kg + 10818 kg + 2*(2300 kg)	5300 kg + 15700 kg + 2*(2300 kg)
	Combined CO2:	10627,7 kg	10514,7 kg	10946 kg	10736 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg
	A full container CO2:	9 797,9 kg	9 797,9 kg	9 797,9 kg	9 797,9 kg
	Difference:	829,8 kg	716,8 kg	1148,1 kg	938,3 kg
China to Lithuania	Combined weight:	7908 kg + 13092 kg + 2*(2300 kg)	10279 kg + 10721 kg + 2(2300 kg)	16788 kg + 4 212 kg + 2*(2300 kg)	4 067 kg + 16 933 kg + 2*(2300 kg)
	Combined CO2:	16 218,9 kg	16 294,2 kg	16 203 kg	16 131,7 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg

	A full container CO2:	13700 kg	13700 kg	13700 kg	13700 kg
	Difference:	1 601 kg	1 614,2 kg	1523 kg	1451,7 kg
Sweden to USA	Combined weight:	15536 kg + 5 464 kg + 2*(2300 kg)	13 240 kg + 7 760 kg + 2*(2300 kg)	100800 kg + 10920 kg + 2(2300 kg)	8346 kg + 12654 kg + 2*(2300 kg)
	Combined CO2:	6 762,1 kg	6 759,8 kg	6 769,8 kg	6705,7 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg
	A full container CO2:	6 399,7 kg	6 399,7 kg	6 399,7 kg	6 399,7 kg
	Difference:	362,4 kg	360,1 kg	370,1 kg	306 kg
Lithuania to USA	Combined weight:	8913 kg + 12 087 kg + 2*(2300 kg)	17280 kg + 3720 kg + 2*(2300 kg)	11131 kg +9896 kg + 2*(2300 kg)	16818 kg + 4 182 kg + 2*(2300 kg)
	Combined CO2:	7 287,6 kg	7 278,9 kg	7 284,7 kg	7 269,31 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg
	A full container CO2:	6 808,4 kg	7 808,4 kg	8 808,4 kg	9 808,4 kg
	Difference:	479,2 kg	470,5 kg	476,3 kg	460,9 kg
USA to Lithuania	Combined weight:	18 824 kg + 2 176 kg + 2*(2300 kg)	19 731 kg + 1 269 kg + 2*(2300)		

	Combined CO2:	7226,3 kg	7284,7 kg		
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg		
	A full container CO2:	6 809,1 kg	6 809,1 kg		
	Difference:	473,6 kg	470,6 kg		
2019					
China to USA	Combined weight:	13697 kg + 7303 kg + 2*(2300 kg)	10300 kg + 10970 kg + 2*(2300 kg)	17540 kg + 3460 kg + 2*(2300 kg)	8771 kg + 12229 kg + 2*(2300 kg)
	Combined CO2:	10 737,5 kg	10 674,3 kg	10 862,8 kg	10 671,2 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg
	A full container CO2:	9797,9 kg	9797,9 kg	9797,9 kg	9797,9 kg
	Difference:	939,6 kg	876,4 kg	1064,9 kg	873,3 kg
China to Lithuania	Combined weight:	15405 kg + 5 595 kg + 2*(2300 kg)	9332 kg + 11668 kg + 2*(2300 kg)	5558 kg + 15442 kg + 2*(2300 kg)	2222 kg + 18778 kg * 2(2300 kg)
	Combined CO2:	16 504 kg	16 232,2 kg	16 149,2 kg	16 506,5 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg

	A full container CO2:	13 700 kg	13 700 kg	13 700 kg	13 700 kg
	Difference:	2 804 kg	2449,2 kg	2243,6 kg	2806 kg
Sweden to USA	Combined weight:	17485 kg + 3 515 kg + 2*(2300 kg)	13975 kg + 7025 kg + 2*(2300 kg)	12371 kg + 8629 kg + 2*(2300 kg)	14798 kg + 6292 kg + 2*/2300 kg)
	Combined CO2:	6 760,9 kg	6760,2 kg	6 715,8 kg	6 760,4 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg
	A full container CO2:	6 399,7 kg	6 399,7 kg	6 399,7 kg	6 399,7 kg
	Difference:	361,2 kg	360,4 kg	316,1 kg	360,7 kg
Lithuania to USA	Combined weight:	15085 kg + 5915 kg + 2*(2300 kg)	13 707 kg + 7 293 kg + 2*(2300 kg)	17 280 kg + 3 720 kg + 2*(2300 kg)	14 147 kg + 6 853 kg + 2*(2300 kg)
	Combined CO2:	7226,3 kg	7 282,1 kg	7 278,8 kg	7 281,8 kg
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg
	A full container CO2:	6 808,4 kg	6 808,4 kg	6 808,4 kg	6 808,4 kg
	Difference:	417,9 kg	473,7 kg	470,4 kg	473,3 kg
USA to Lithuania	Combined weight:	18710 kg + 2290 kg + 2*(2300 kg)	17 690 kg + 3310 kg + 2*(2300 kg)	16 329 kg + 4671 kg+ 2*(2300 kg)	

	Combined CO2:	7 285,7 kg	7 281,8 kg	7 286,1 kg	
	A full container weight:	21 000 kg + 2300 kg	21 000 kg + 2300 kg	21 000 kg + 2300 kg	
	A full container CO2:	6 809 kg	6 890 kg	6 890 kg	
	Difference:	473,6 kg	472,7 kg	477 kg	

Appendix 4

Calculations of carbon dioxide emissions for air shipments compared to how much they would emit if transported by train or sea. Calculations of sea emissions, have taken into consideration a container weight at 2300 kg during the primary mode distance.

2017		Example 1	Example 2	Example 3	Example 4
China to Lithuania	Air shipment weight	79 kg			
	CO2 emission:	990,8 kg			
	If by train CO2:	20,4 kg			
	Difference air to train	907,4 kg			
	If by sea CO2	1 407,6 kg			
	Difference air to Sea	-416,8 kg			
China to Sweden	Air shipment weight	105 kg			
	CO2 emission:	1 367,4 kg			
	If by train CO2:	39,9 kg			
	Difference air to train	1 327,4 kg			
	If by sea CO2	1 420,7 kg			
	Difference air to sea	-53,3 kg			

China to USA	Air shipment weight	3 506 kg			
	CO2 emission:	65743 kg			
	If by sea CO2	2 141,1 kg			
	Difference air to sea	63 601,9 kg			
2018					
China to USA	Air shipment weight	93 kg	86 kg	784 kg	610 kg
	CO2 emission:	1 717,2 kg	1 587,1 kg	14 446,4 kg	11 256,1 kg
	If by sea CO2	707,3 kg	704,3 kg	999,9 kg	935,1 kg
	Difference air to sea	1 009,9 kg	882,3 kg	13 446,1 kg	10 321 kg
China to Lithuania	Air Shipment weight	102 kg	45 kg	83 kg	65 kg
	CO2 emission:	1 279,6 kg	564,3 kg	1 040,8 kg	815,2 kg
	If by train CO2:	26,3 kg	11,6 kg	16,8 kg	21,4 kg
	Difference air to train	1 253,3 kg	552,7 kg	1 024 kg	793,8 kg
	If by sea CO2	1424,0 kg	1 385 kg	1 398,7 kg	1 411,3 kg

	Difference air to sea	-144,4 kg	-820,6 kg	-358 kg	-596,1 kg
China to Sweden	Air Shipment weight	180 kg	79 kg		
	CO2 emission:	2 411,9 kg	1 058,6 kg		
	If by train CO2:	33,7 kg	20,4 kg		
	Difference air to train	2 378,2 kg	1 038,2 kg		
	If by sea CO2	1 467,5 kg	1 403,8 kg		
	Difference air to sea	944,3 kg	-345,2 kg		
Lithuania to USA	Air shipment weight	7 kg	272 kg	216 kg	95 kg
	CO2 emission:	87,1 kg	3 383,4 kg	2680 kg	1 181,6 kg
	If by sea CO2	469,5 kg	547,2 kg	530,7 kg	494,2 kg
	Difference air to sea	-382,3 kg	2 836,3 kg	2 149,3 kg	687,4 kg
Sweden to USA	Air shipment weight	54 kg			
	CO2 emission:	598,7 kg			
	If by sea CO2	359,2 kg			

	Difference air to sea	239,5 kg			
USA to Lithuania	Air shipment weight	2926 kg	40 kg	649 kg	
	CO2 emission:	36 421,6 kg	497,9 kg	8 078,5 kg	
	If by sea CO2	1 320,6 kg	479 kg	193,8 kg	
	Difference air to sea	35 100,9 kg	18,9 kg	7 884,7 kg	
2019					
China to USA	Air shipment weight	138 kg	6 424 kg	1 542 kg	2 948 kg
	CO2 emission:	2546,8 kh	118540,7 kg	28 451,8 kg	54476,3 kg
	If by sea CO2	2 455,7 kg	3 348,8 kg	1 214,2 kg	1 903 kg
	Difference air to sea	91 kg	115 192 kg	27 237,6 kg	52 573,3 kg
China to Lithuania	Air shipment weight	63 kg	245 kg	387 kg	290 kg
	CO2 emission:	790,2 kg	3073,1 kg	4853,4 kg	3637,2 kg
	If by train CO2:	16,3 kg	63,3 kg	99,9 kg	75 kg
	Difference air to train	774 kg	3009,837 kg	4753,4 kg	3 562,3 kg

	If by sea CO2	1 395,8 kg	1 520,1 kg	1 550,1 kg	1 615,2 kg
	Difference air to sea	-605,7 kg	1 553 kg	3 303,2 kg	2 022 kg
China to Sweden	Air shipment weight	75 kg	79 kg	142 kg	116 kg
	CO2 emission:	1 005,4 kg	1 058,6 kg	4 972,1 kg	1 554,8 kg
	If by train CO2:	19,4 kg	20,4 kg	36,7 kg	30 kg
	Difference air to train	986,1 kg	1 038,2 kg	4 935,4 kg	1 524,8 kg
	If by sea CO2	1 401,6 kg	1 403,8 kg	100,6 kg	82,2 kg
	Difference air to sea	-396,2 kg	-345,2 kg	4871,5 kg	1472,6 kg
Lithuania to USA	Air shipment weight	1 284 kg	1 789 kg		
	CO2 emission:	16 062,5 kg	22 265 kg		
	If by sea CO2	990,9 kg	843,1 kg		
	Difference air to sea	15 071,7 kg	21 422 kg		
Sweden to USA	Air Shipment weight	15 306 kg	7 451 kg	2126 kg	7194 kg
	CO2 emission:	169 804,4 kg	82671,6 kg	23 592 kg	80 0318 kg

	If by sea CO2	5 379,2 kg	2 858,5 kg	1 149,6 kg	2 775,5 kg
	Difference air to sea	164 425,2 kg	79 813,1 kg	22 442,1 kg	797 543 kg
USA to Lithuania	Air Shipment weight	617 kg	1134 kg		
	CO2 emission:	7 679.4 kg	14 114,2 kg		
	If by sea CO2	647,3 kg	798,1 kg		
	Difference air to sea	7 032,1 kg	13 316,2 kg		

Appendix 5a

The interview questions that was asked at ROL. The questions below were asked to the logistics/ purchasing chief.

Interview with logistic/purchasing chief David Magnusson

1. **What kind of guidelines regarding sustainability, do you have at the purchasing department?**

   The main goal for us is to achieve our customers demand on sustainability, primarily customer xx and the other documents from customers we need to follow. It is the strategic purchasers that have the main responsibility to make sure we as a company are following this. The operative purchasers only follows the recommendations from the strategic purchasers and are hence not so involved in this. On the other hand the operative purchasers have an important job to make sure that we transport optimize and that we are sending as many full container as possible.

2. **Do you think that there is a high level of integration between the logistic department and the purchasing department?**

   No, I think it could be much better.

3. **What are your thoughts of the potential of integration between departments? Pros an cons?**
   - I think it will be a necessity if we shall succeed. There is a lack of integration between all departments.

4. **How are the purchasing and logistics department sharing information between each other?**

   Mostly by phone or by email but also that they go and speak to each other. We have no system to support this.

5. **Are there information updates occurring between this departments?**
   - Same as above

6. **When the plants positions was determined, what was the purpose of their placements?**

   In china the place was chosen due to the need to be situated close to Shanghai and a need to find a place with lower labour costs. When it comes to Lithuania the place was chosen randomly. I know that today there is a free trade zone, but I don't think it is the reason for choosing the decision. The main reason was probably that we found a good business partner to work with there and chose to go for it. The place in USA was chosen since it is a furniture mecca for many different furniture manufacturers, many different furniture companies like Herman miller or Hay work, have their headquarters where our plant is. It it a good place to be. The position in Jönköping Sweden was chosen due to the living place of the founders.

7. **Are there any plans to move the plants to have a more sustainable internal logistic?**

   We will not move the plant in Lithuania since we have invested much money on that factory. I do not think the headquarter will move from Jönköping, we have made a lot of investment her as well. We had the opportunity to move the plant in US but we chose not to since it is a strategic position. Kina on the other hand feels more insecure. It is possible that we will move to another place in china or that we will choose another country, or maybe skip to have an own production and instead only buy from suppliers. from a strategic point of views I don't see the reason for having a factory in China, but this mainly due to the strategy from the owner family of having as much own production as possible. In the coming year i think the situation in China will change.

8. **Which kind of changes have you made the last years to meet the sustainability demands?**

   We have done a lot of changes within the purchasing department, oh yes! We have since I started in 2016 changed all of our smaller suppliers to bigger suppliers that can live up to our customers sustainability demands. We have moved about 90 % of our suppliers to world leading suppliers. The environmental improvements came as a bonus since the main reason for thing change was to improve the quality of the products and find suppliers that had the ability to produce higher quantities. After doing this change we could achieve the customers demand on sustainability and we got a lower price. It become a good situation for us and that was needed in order to keep deliveries to our customers.

   We have a few auditors that are traveling around to the different suppliers to make sure they are achieving our demands. I would like there to be more of them. It would

also be beneficial if we could have someone that would market our sustainability efforts, that would have been god.

9. **How big influence do you have on the internal suppliers decisions regarding sustainability?**

    - No information about this

10. **How do you see on an expanded collaboration with TKL in the future, we have seen that they stand for a small part of you transport between the internal suppliers today?**

    They are our biggest supplier on sea transport, both from China to Europe and from Europe to USA. It have worked very well, it is important that we have used the right transporter and suppliers to the right flows. Nothing is impossible, we could be having a deeper collaboration with TKL in the future.

11. **Are you booking a container after demand or are you using a fixed schedule?**

    We are booking after our demands but have a few cars to Lithuania but will cancel theses if it is not possible. We don't have any typical logistical arrangements, which I miss sometimes.

12. **Why are all samples sent on air, instead of putting them together with other cargo on other modes?**

    Often is it really important for our R&D department or quality department to take a decision if it is right or wrong, therefore it is crucial to get the samples here on time. Often there is a change in terms of quality etc, that we want to implement as soon as possible. Since the delivery times are long, from ex China it is 13 to 18 weeks independent on the supplier. If we decide something it takes many weeks for it to get on the shelves, so we want to hurry up the process.

13. **We have noticed that there are many FCL shipments with very little cargo in it,why was this used instead of a joint shipment?**

    I think it is mainly due to ignorance, we don't know how to use joint shipments so this is an optimizing opportunity. One reason could be that we are shipping bulky goods but I don't think we have that much bulky goods.

14. **We see that there has been an increased amount of air shipments to USA in 2019, what is the reason for this?**

    We have got an old customer in USA that have started to order new products, this volumes are very big and we couldn't handle theses volumes on a short notice like in this situation. We needed to use air shipments to get started with this, due to planning and capacity problems. Now have the situation got better.

15. **How transparent do you think the relationship with TKL is?**

    I don't see that relationship so much, but the part I have seen have been very transparent and good.

16. **Do you know what TKL does for ROL on a detailed level?**

    I think that some people at ROL know this, as our logistics assistant and many people in Lithuania. Most of the purchaser have no idea of this.

17. **Do you think the relationship between ROL and TKL is good? Hur upplever ni kommunikationen mellan ROL och TKL?**

    Yes, i think so.

18. **What do you think could hinder the communication?**

    Yes, we are different companies so of course there are things we don't share with each other. We can't be 100 percent transparent against an supplier. We might want to do a negotiation or pressure the prices etc.

19. **Which kind of consequences due to lacking communication?**

    We think that the communication is very good and that we don't have a complete transparency, don't matter. They know it, we know it, there is no reason for us to change this situation. This is the way business is made and everyone is on board with it. We have an open business relationship but it is a business relationship.

20. Do you think that there is a high level of trust between ROL and TKL?

Yes, we have a good trust between each other, they get to handle our transport very much and that is a confidence form us. We feel that they are a good supplier that are easy to collaborate with.

21. What do you think about reducing the number of forwarders you use?

Yes I would like to have as few supplier as possible, it is comfortable to have few supplier that one can trust. It is obvious thing to do for me in the future, but it is very important to find the right supplier to the right flow. We could reduce the amount of forwarders with 50 % in the future i think. Logistics is complicates and everyone is not appropriate for every flow. I think TKL is appropriate for many flows but not all. Most of our suppliers use a predetermined transportation deal we have set up with our forwarders.

22. How do you think the collaboration with your forwarder could contribute to a more sustainable supply chain?

It is important for us to understand how we can minimize our environmental impact through choosing better transportation alternatives.Is it better for us to gather shipments and let TKL handle joint shipments for us? How should we do that in a smart manner? We need more knowledge about this since we from the beginning have no information about this. We need TKL and other forwarders help with this. If we know how to make an order when we don't have enough cargo to fill a container, and by that reduce the number of containers we use it would be a win-win situation.

23. **Which improvement do you think are needed in the future, to create more sustainable supply chains?Vilka förbättringar tror ni behövs i framtiden?**

I think you should have partners that you can have close relationships with, more than just supplier and customer. You basically goes and marry the suppliers and get extremely transparent with them. It should be possible for them to have an insight into our ERP system and see our prognoses and how we communicate with our customers, in order to help us to make good transportation solutions. You need to find the right competence outside the company since it is not possible to hire all competences inside of the company.

Appendix 5b

The interview questions that was asked at ROL. The questions below were asked to one of the operative purchasers at ROL

Interview with operative purchaser Heather Viklund Zhao

1. **What kind of guidelines regarding sustainability, do you have at the purchasing department?**

   Before we had none, now i feel like it is increasing. Now are our sustainability manager on her way to produce some kind of guidelines for us. I know that the sustainability manager have conducted meetings with the head of purchasing.

2. **What do you take into considerations when you are planning the purchasing activities?**

   Since I work at an operational level the planning is conducted on a day to day basis, we are solely looking at the daily purchasing requests. There are only prognosis available for some items that we are purchasing.

3. **Which of the following plannings-methods are you using when your are planning future purchasing activities?**
   - Kraljic klassifikations
   - Dynamic or static planning
   - Generalized conceptual framework
   - ISO 14001
   - Non above

     I'm doing fine without any of those. I think it depends on which kind of task you have, my tasks are not so dependent on any planning method. That is maby needed for example the strategic purchasers.

4. **How are you considering the environment when conducting purchases?**

   I do consider the environment to a small extension since i try to gather purchases to reduce the amount of shipments, this is mainly done to reduce the transportation costs but also for the environmental aspect.

5. **What do you take into consideration when you are planning your daily work?**

   The most important is the purchasing requests, I need to consider which ones to take first and place the orders that are most important**.** My colleague puts orders for the production I assist her to some extent, and I also have a few purchase I have to do since they always have to be in stock. I also need to do order confirmations in our ERP system, hunt suppliers to ask them which delivery date we can expect, find out the reasons for delays etc. I also have a long excel sheet for each week, with orders to organize for some external customers, they have items that needs to be in stock. It is a time consuming manual work that I think is stupid. There are some items that I can look up in a prognosis for and use MRP planning, and after that place orders.

6. **How are you considering sustainability in you everyday work?**

   Joint shipping when possible.

7. **How would you think the purchasing department could be more sustainable?**

   Delivery methods needs to be more negotiated from the strategic purchasers part, since they are the ones that have the contact with the suppliers. Many suppliers have different forwarders even though our logistics department have established customer accounts with our own forwarders for them to use. I would like to see that someone that have knowledge within this, could ask the suppliers if they could use these predetermined delivery terms. The category leaders are not negotiating with the suppliers how things should be delivered, they are not prioritising it. They are also purchaser and need to take this into consideration, maybe they can ask the suppliers what their opinion about this are since it feels like we don't care.

   It would be more good to get more knowledge about packaging, we don't care about it now and i would also want to learn more about how we could fill trucks better by adding more things together to be more environmental friendly. Right now we don't consider this, I think this is bad in the purchasing department, we need to take this into consideration in the future.

8. **Which kind of demands can the purchaser put on the suppliers?**

   Our strategic purchasers sometimes send out a code of conduct to our suppliers, when they take in new then they especially need to fill those out. The strategic suppliers are negotiating with different suppliers about different demands.

9. **How big influence do you have on the internal suppliers?**

   We have moved more production to Lithuania now, so it feels like they have more power and make more decisions on their own, especially in terms of delivery time and transportation. My boss have said that since the problem is internally there is not so much to do about it. We can put more pressure on external suppliers since we can replace them.
   The internal suppliers need to follow ROLs requirements but now when there are more problems occuring, I don't know who will deal with it? It feels like when something happens with the internal supplier they just say oups..!

10. **How often do you need to order from the same supplier each week?**

    I order each day from Lithuania, ROL production and Kina. Distribution orders are in the system that can be done each day, there are some continuous orders from production, China and Lithuania. There are limited planning that are possible to make for purchaser in the long run.

11. **Are you combining purchases from the same supplier during a week?**

    If we have many purchasing activities from the same place at the same week, then we combine the shipments for this.

12. **We have noticed that there are FCL shipments with very little cargo, what are the reasons to ship like this instead of using joint shipments?**

    It is when there is a time limit and we need to ship fast. If we can not wait then we need to do this, we don't need to fill it since we only consider the time aspect and cost.

13. **Which are the guidelines on how fast a purchase needs to be made after you have received a purchase request?**

    The same day, or the lastest the next day in the morning. If i don't make the purchases in time i will get questions from other employees why I don't do my work.

14. **Is there any possibilities to wait to purchase a product?**

    No, not more than the next day in the morning.

15. Do you think that there is a high level of integration between the logistics department and the purchasing department.

I think it is to little, sometimes it feels like we just puts orders, we hunt suppliers, but have no information about the transportation. I only ask for the tracking number if the delivery is very crucial.

16. What is your thought about the integration between different departments at ROL?

There is bad communication we don't know how one another works, we only contact each other when we really need to. I think it would be beneficial to sit down and talk with each other about what we are doing, and have the possibility to ask questions. For example when i get information about a delivery it can be before 1-2 days but i need more exact information.

17. Do the purchasers get help from the logistics department in their daily work?

The people at the logistics department tells us when something is delayed and sometimes when there is something really urgent I can contact the logistics department. The main contact is about public holidays for the internal suppliers etc.

18. How does the contact between the purchasing department and TKL work?

There is no contact at all.

19. Why are the samples always transported by the air mode?

Since there is a lack of time, the R&D or the prototype need it fast, so it is very important that the samples are sent here fast. It is not like an ordinary order, it is much more important, if we have a new idea that needs to be tested in reality then we need a sample.

20. How do you think the purchasing department could work together with the logistics department in the future?

We had an integration system in my last workplace, were we could see all purchasing activities and transporting activities at one place. In that system we could write in tracking numbers and order numbers so we could track shipment without needing to hunt all suppliers all the time.

Sometimes the purchasers only have contact with the suppliers but don't have any information about the shipment, it feels like we need to integrate in a better way. I think we should use this kind of a system but I think it is a strategic decision so I can't decide this.

21. Which improvements could be made in the purchasing department that could lead to more sustainable supply chains?

I would like if the strategic purchasers would negotiate more with the suppliers about more things than price. Take more considerations to sustainability.

22. Which general improvements are needed in the future to be more sustainable

Maby ask the logistics department how they are packing cargo and ask her how to put orders together. It would be beneficial to stop doing everything separately.

Appendix 6

The questions asked to the interviewees at TKL. One of the interviewees had expertise from transportation from the far east, and the other one being the contact person to the ROL group, and expertise insight into the European transportation area. Both interviewees was sked the exact same questions and their answers is presented below

1. **How important is the environmental aspect for you as forwarders?**

   Oscar Lundgren
   The environmental aspect have been much more important the last three or four years and at TKL we try to take our part of the transports to try to improve the environmental work with our clients. it is also a dilemma with the environment when you are comparing with the cost and what you get for it. This is a dilemma in many different branches including the transportation sector. Our customer sometimes doesn't want to pay more to be better in terms of sustainability, but TKL tries to find products that are better for the environment that our customer would like to buy.

   Magnus Claesson

   We as forwarders often does not decide or steer about the environmental spect at all, it is always the customer that make the decision and there are many different alternatives to choose between. The best thing we do is to use the See mode, it it not possible to make it in another way since it cannot be much better than this. Most often it is the price that steers this and this is the way it is. We can give alternatives but if it in a hurry then that is it, then the customer rather choose the air mode than waiting.

2. **How are you contributing to develop more sustainable supply chains?**

   Oscar Lundgren

   We started with train transports from China, that is a big part were we have been very active with implement this in Sweden, we were one of the first in Sweden to start with train transports from China, we have promoted this very much to our current customers but also to the market that it is possible to choose the train instead of the air mode. We have seen that this have had big effect on the carbon dioxide emissions, and we are providing our customers with reports about their current emissions to make them more conscious about their environmental impact. I think that it is easier to make changes if you are aware of your current situation. If you don't have any idea about you action then it is hard to make good decisions and there we feel like we are contribution since we make our customers more conscious. Information is the main

thing we can do since we don't own the transport ourselves. We are trying to find the best solutions both in terms of sustainability and cost.

Magnus Claesson

Since we have tools that makes it possible for the customer so see the different transportation costs, and we are weighing the cost against lead time all the time this is the main things we do , and to make it possible for the customers to choose sea transport.

3. **How are you helping your customers to be more environmentally friendly?**

Oscar Lundgren

We are asking why they want to take the air transport, if it is necessary and how fast they need the cargo? We ask this questions to see of we can solve the transportation in another way. We are doing joint shippings so our customers does not have to hire an entire container but can instead buy the space they need. Hence we can combine different customers cargo and maximize the capacity of an container.

Magnus Claesson

No we dont today, we are not certified with ISO 14000, but we can help them to make better decisions and give them sustainability reports about their emissions. it is also possible to measure the flow of goods to see of they can coordinate their shipments in another way to reduce the amount of transports. The main thing is that most customers does not look at the environmental aspect they only care about the price.

4. **How can you encourage you customers to make more sustainable transportations decisions?**

Oscar Lundgren

We can encourage them by showing that it is cheaper to choose another mode than the air mode, for example the train, instead of paying 30 000 SEK for one tonne on the air mode they can choose to take the train which is only 8 000 SEK. So there is a possibility to encourage by price. *(note, this is not the actual prices, just an example to demonstrate the difference).*

Magnus Claesson

No encouragements are made but environmental analysis perhaps, the only thing we do for the customers os to re-coordinate their flow of goods of they want.

5. **How do you think a collaboration between you and your customers can contribute to more sustainable supply chains?**

Oscar Lundgren

It is good to get a better overlook at the customers transportations and we are trying to promote that we want to have more basis for the transportations to be able to make better decisions. If tóur customers have other forwarders we can only see what we get and can only make joint shipments with this cargo, but if we would have control over all transportations we could make more joint shipments and better decisions in the supply chain. We would like to have a closer relationship with our customers to be able to find better ways in terms of sustainability in the transportation. Maybe it is possible to combine a few thing and take the remaining thing that needs to be transported quickly by air. If we are not aware of the air shipments we can't come with a better solution.

Magnus Claesson

This is hard since it depends on how mature the customers is for it. We can show the difference between the different transportations and their environmental impact but it is always up to the customer to make the decision. In most cases it is the customers customer that are the problem and not our customers. There are many thing that makes it hard to make a decision based in the environment.

6. **Which are the weight-limit you are recommending you customers to use FCL instead of joint shipments?**

Oscar Lundgren

There are some limits but there is most often the price that decides when it is appropriate to choose LCL and that is around 13-14 kubik meters then it is about the same price as choosing LCL, but we have a few customers that we give discounts just to be able to get in those last 17-18 kubik meters. There is always a risk when choosing LCL since it needs to go threw a terminal and be loaded into a container and then into a terminal in Gothenburg etc. Many customers want their cargo to stay in the

container the whole distance and keep the container sealed. So in terms of safety they choose to have FCL instead of LCL.

Magnus Claesson

It is the price that are deciding this. We recommend that the customer have their own container of theri cargo is bulky are fragile, but elsewhere it is chaeper to choose a LCL. In that perspective we are weighting the price against the volume, say that you have 15, 16, 17 cubic meters in a 20 foot container, then it is better for the customer to have their own container since they get it directly to them.

7. **We have noted that there are some FCL shipments with very little cargo, what can be a joint shipment wasn't used in these situations?**

Oscar Lundgren
Safety reasons or that some customer have a routine to book FCL, maybe they don't understand that it is cheaper to use joint shipping, but there is a possibility to save money for the customer here, so we in most cases try to get the customers to book LCL both to get it cheaper and to be more environmental friendly.

Magnus Claesson
It is not always we that make the decisions but instead the customer, if they say they want a 20 foot we give them that. We have no further information until we receive the packing list and invoice.

8. **Is it the customers or you that make the decision on which transportation solution to choose?**

Oscar Lundgren

It is the customers

Magnus Claesson

Number one is the customer then we can come with recommendations, it can be that we mention that is is better to choose a curier instead of an air transport but it is always a price perspective that leads the decision. Then we can also choose rail instead of air etc, but the time is an important factor for this. Often not even the customer themselves know how fast the transportation need to be made and then it is hard for us to provide a good alternative.

9. **If you take the decision, what is it based upon?**

Oscar Lundgren

We don't take the decision.

Magnus Claesson

The decision is based upon, cost and lead time mostly, it is possible to ship a 40 foot container by air but is will cost a fortune for example, We have had many air shipments from Lithuania with ROL but it is only the customer that can decide when the time is at essence. For a couple of weeks we had a few shipments with 18-19 cubic meters which is awful but not our decision. We only give the alternatives, but if the customers really needs the transportation to be fast we can't give any other alternative than air. There is often a reason for it like delays in the production or an order that needs to be made fast. The difference is big between for example 3-5 days by air and 4-5 weeks at sea

10. **If you take the decision, can the customer say something about it?**

Oscar Lundgren

We don't take the decision

Magnus Claesson

We don't take the decision

11. **Are there customers that are demanding sustainable transportation solutions, or is it always the price that is the most important factor?**

Oscar Lundgren

We have both, we see that there are a trend that more people are getting more conscious about the environment and that some are demanding more sustainable transports. We had a customer from Germany to Södertälje that had a demand for the transport to be by train and not truck even though it was more expensive. We don't have so many customer that are demanding more sustainable transportation and don't consider the price, but it is getting better.

Magnus Claesson

I would say that it is very rare that the customer are asking for this. It is mostly the price that they are worried about.

12. **Why are there deliveries to and from USA that goes to different port for every delivery distances? DVS Litauen <-> Montreal, Kina <-> Oakland, Sverige <-> Halifax.**

    Oscar Lundgren

    It is our job to find the best solutions, that is why we exist. It is a jungle to sort everything out and we have managed to find the best actors for each specific flow and we are working with many different actors but sometimes it is the customs feed that impact the transportation decisions made. This changes all the time and depending on new actors that might come up with better or improved solutions for transport, then we might change actor for that flow. Or maybe someone goes to bankruptcy and then we change to another actor.

    Magnus Claesson

    First we transported via New york and then it went to Chicago by rail but that was not good in terms of lead time and it was very tight at the rail so many delays occurred. We chose to ship through Canada and that was better for the environment since the transportation goes further on sea than on train, and the lead time is shorter. The only negative aspect with this is that it was more expensive. it was a decision we made together with ROL since there were some problems in the New york flow from before. When it comes from China to USA there are not so many alternatives, they will arrive at the west coast in USA and go by rail through USA. It is more expensive to use the sea alternative on this route.

13. **Why are the joint shippings to ROL Lithuania through Sweden?**

    Oscar Lundgren
    It is possible to use joint shipments for the goods that are going to Sweden instead of having two containers which makes it cheaper. it is also very good to take the transports through Sweden instead of taking it to another harbour in Europe that later will take it through a feeder and then to Klaipedia by car. This is better in terms of cost and effectiveness.

Magnus Claesson

Since it is both cheaper and faster through Sweden since the composition that goes to Lithuania is very limited, so we combine it with the shipment we have in Lithuania with the Shipment we have to Sweden so environmentally this is better since we fill a whole container with ROLs cargo but we transport it through Gothenburg to Klaipeda. Nordicon goes through Sweden as well and there are some other co-loader as well we can use to Klaipedia but the lead time get to long and that is not acceptable.

14. How are you experiencing the relationship with ROL?

Oscar Lundgren

I would say that it is very transparent, we often have meetings and goes through how the routines is conducted, Magnus is the sell contact and Kurt and Johan is the operative contact that have direct contact with the people that are the decision makers in the transportation flows. Rol can be a part of the decision making and decide about the routes how they should be divided etc. If something happens with a shipping company we are there and informing ROL about the possible alternatives and then we together will find the best alternative. I would say the relationship is very transparent and open.

Magnus Claesson

I think it is good, it is quick decisions and it is a rather messy company that does not have total knowledge about what happens in the world all the time. We don't see it until it is our turn to take over so it is hard to know what happened in the fabric until we get the booking. We have no idea but maybe it is hard for the to inform about this as well. A while ago when there was a problem we got a booking with a months notice, from Lithuania to USA, it was problems about Corona and there was no equipment coming to Lithuania where they could load in. So orintas in Lithuania booked a whole month in advance to make sure there was no problem in the future transports. Previously ROL couldn't book more than a few days in advance but now they could book a whole month in advance, I don't know if that was the real situation or if they booked just in case.

15. How are you experiencing the communication with ROL?

Oscar Lundgren

The communication is very good, I have meet ROL in China with their people there and Magnus have been in Chicago and meet them several times, and we have been in Lithuania and they have been and visited us. We fell that it is really important to have personal relationships so be able to have a smooth transport.

Magnus Claesson

Yes we have a very good dialogue with our agent in Lithuania and all companies within the ROL group. I have been around and visited all units both in Lithuania, China and USA and we have a very good dialogue.

16. What do you think could hinder the communication?

Oscar Lundgren

The communication could always be better, there are many things that could be done better, we are going to make a new portal were we could make the communication better in terms of tracking. Bookings that are made more in advance are always better, we need to be very neatly with mishandlings since the information needs to come through. I think that the relationship is very good today and everyone i very happy about it.In the beginning there were of course some situations that was a bit harder to handle but that is very well sort out now.

Magnus Claesson

No.

17. Are you realizing some problems due to lacking communication?

Oscar Lundgren

No.

Magnus Claesson

No.

18. Is there a high level of trust between ROL and TKL?

Oscar Lundgren

I think there is a high level of trust, we have a close collaboration were we could trust each other and feel safe with each other that we will do a good job. We feel like ROL stand behind TKL and it feels very secure from our side at least.

Magnus Claesson

Yes there is, in the beginning it felt a bit insecure and both parties wanted to test each other, we started about 2,5 year ago. Now we have settled that we can trust each other. We always do our best and if somethings comes up we will have a discussion about it.

19. Which innovative transportation solutions do you think could contribute to more sustainable transportation ways in the future?

Oscar Lundgren

For example from China the train transportation are increasing and we are noticing that the volumes from the air mode are decreasing, that is very good in terms of sustainability. Then there are always new techniques coming like self driving cars, better engines and electric trains etc, and maybe in the future it will be even more effective loading with trucks and containers. I think there will be development within all branches including ours.

Magnus Claesson

Bigger boats is already built, the questions is if it is possible to build it even bigger? maybe it is possible to build the train longer? It is hard to say that the transports will be reduced since it probably will increase due to the consumption pattern. I think some are working on it and that it is not so far away to find alternative fuels for the different transportation modes. I don't think a maersk boat will ever be able to run on electric fuels and there are many electric alternatives available now but they are not very effective and can handle longer distances. The transportation industry is rather conservative and today there are no very many things happening in terms of innovative solutions, maybe new diesel fuels or gas fuel, but for longer distances there is no good alternative solutions.

20. What is your opinion about climate compensations?

Oscar Lundgren

I think it i relatively positive and there have been one case where we have been doing some climate compensation on the transports we made but we would like to see that our customers will contribute as well, then we could reduce the carbon emissions even more. We are working on a environment project this year to invest in different sustainability projects by using some of our profits and give to different organisations to improve the environment. I also believe that it is crucial to involve our customers to be more sustainable.

Magnus Claesson

We have not decided yet how to proceed with our sustainability efforts but it it on its way, there are an interest to start this soon.