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Master's Thesis

Global best practices in combined transports and its applicability to South Ostrobothnia

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ABSTRACT :

This thesis aims to lay out some of the global best practices that can be used for the combined transportation design of Southern Ostrobothnia truck to rail project. The goal is to identify customers' demands and requirements for integrated transportation, as well as the technology that is now making this system efficient in terms of cost, operational efficiency, and environmentally friendly implementations. Other studies have shown that multimodal transportation is on the rise, though its full potential has yet to be achieved. This thesis looked at the following questions: 1. What are the major challenges in the implementation of combined transport? 2. What is the future for heavy goods vehicles? The thesis concludes by outlining the economic evaluations and benefits of having a combined transportation system and the new possibilities for logistics companies within the region.

KEYWORDS: Combined transportation, Truck-Rail, Technologies, Supply chain management, Logistics, environment, sustainability.

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1 Introduction

To effectively build a low-carbon emission environment, combined transportation has been identified as an important solution to achieving environmental sustainability while reducing logistics costs, including heavy traffic congestion in larger cities (Reis, Fabian, Meier, Pace, & Palacin, 2013). The drive to contribute positively towards a healthy environment with measurable actions for carbon emission control, will have a huge impact on the present effort of climate protection endeavours after the industrial revolution. Research has proven over the years that the increase in transportation has contributed towards the total global CO2 emissions of 415 ppm as of 2021 (Kevin Adler, 2021). This outcome clearly shows the challenges and concerns that transportation poses as a sector on the environment, which makes achieving greenhouse gas (GHG) emission reductions exceedingly challenging (Schwanen, Banister, & Ana-Ble, 2011). The general idea behind the implementation of combined transportation is to have more long-haul freight transported in an efficient and effective manner. That will contribute towards the advancement of sustainability and energy usage efficiency in the transportation systems. It is an expectation of the European Union that member countries have a long-term environmental strategic approach, and the implementation must be combined with pragmatic solutions to achieve such development in the transportation sector (Gkoumas, Balen, Tsakalidis, & Pekar, 2020). (Piprani, Mohezar, & Jaafar, 2020).

Recently, there is a big shift in focus when it comes to the truck-rail combined system of transport. This focus revolves around technological enhancements that will pave the way for a smooth transition from road haulage of products by heavy trucks to rail. The emphasis on emission-reduction technology is completely compatible with ecological modernization. Schwanen et al., 2011 stated that the 1992 EU directive on transportation placed a premium on combined transportation in order to boost the transportation sector's competitiveness and suggested that more products should be transported by rail, rather than by road-only truck transportation. The directive was set as a benchmark for the continuous development and sustainability of the implementation of clean transportation of products with the aim of making it attractive through economic incentives. (Pape, Wolfgang et al., 2019) also claim that the truck-to-rail strategic roadmap are essential guidelines for rail transit research and innovation and the goals are clear, enabling members of the railway sector and the European Commission (EC) participate in this synergy and find common ground for future development for the transportation industry.

There is an increasing desire for more sustainable, intelligent, diversified, and efficient supply chains among manufacturing enterprises and traders in South Ostrobothnia, due to the region's strategic location and role as a vital network link between Helsinki and Oulu in Finland's transportation. Many of the region's manufacturers, merchants, and exporters currently rely on heavy vehicles (Trucks) as their primary way of transporting goods. The purpose of this study was to identify the most pressing problems with current means of transportation systems and to present a solid plan to get manufacturers to switch to a greener mode of delivery. This thesis is in collaboration with (Etelä-Pohjanmaan) the regional council planning on building a dry port terminal which will be linked to the major rail network given access to more efficient ways of transporting goods in and out of the region while aiming to reduce the environmental impacts caused by fossil fuel.

1.1 Research Gap

The concept of a dynamically combined systems for truck and rail transportation has become a worldwide phenomenon. For the fact that containerization is critical to globalization's success. It has fundamentally altered international freight distribution chains over the last 50 years. Increasing vessel size have led to bigger scale of economies and lower costs per transported product, thereby creating a virtuous cycle of rising transportation volumes. Researchers are becoming more interested in this expanding use of a combined mode of transportation, which has prompted them to look into more sustainable methods of implementation. More so, a comprehensive understanding of best practices in the area of new technologies and digitalization contributing to this system of transportation seems to be absent from the combined system of transportation works of literature or at the very least not considered in its current state. As a result, there is a greater tendency to learn more about what customers expect from logistics companies in the process of implementing an intermodal system, and how to address the identified challenges during the transformation. (Frémont & Franc, 2010) note that roads are mainly used for hinterland services in Europe. However, ongoing port development is a major challenge to the road's dominance in surrounding services due to rising costs, congestion, and increased environmental restrictions. Large quantities of goods are transported across the hinterland by rail, road, or water. In a competitive environment, transportation operators need to have the capability to transport goods from the location at which the lowest possible cost can be achieved, while a dependable and consistent service is a necessary condition for gaining or maintaining an advantage among logistic companies. The Figure 1 below is the illustration of gap in this research paper.

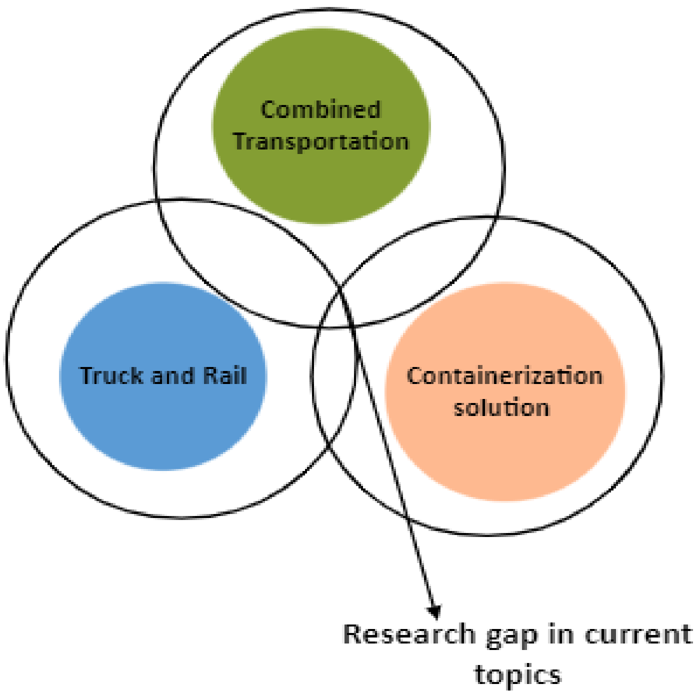

Figure 1: The research gap fulfilled by this thesis paper.

1.2 Research questions and objectives.

Despite the absence of considerable expertise in this particular topic, this work makes a step into new terrain and tries to bring major empirical and theoretical additions to the existing literature. Broaden the field of intermodal transportation and define the overall introduction of new technologies implementation in the area of combined.

transportation with guidance to ensure a comprehensive literature evaluation and in-depth study. This thesis aims to understand the global best practices of combined transportation that can be applied to the development of a combined transport system of truck and rail in Southern Ostrobothnia.

Q1. What are the major challenges in the implementation of combined transports?

In the first question, this research endeavors to look deeply into some essential details such as:

- Intermodal terminals (Understanding local problems and operating costs)
- Railway's connectivity (Links to major railway networks)
- Requirements and suitability of employees (What are the government regulations regarding sustainable logistics and supply chains? What experiences are the workers' daily implementation of sustainable goals to achieve profitability?
- Higher cost and prolonged transportation time concern (How could the service be better improved to eliminate delays and attractive costs for users?
- Technologies and environmental policies
- Collaborations. (Companies or users' interests).

Q2. What is the future for heavy goods vehicles? This second question examines the following:

- Sustainability implementation (The Finnish Ministry of Transport and Communications plans in connection with European Union goals for railways transport)

- Road freight and cargo capacity (What is the expected amount of road freight that will be transferred to railways by 2045).

1.3 Thesis structure

The paper structure begins with a review of the existing literature on intermodal transportation systems. After defining each sustainable mode of transport, the paper discusses the general concept and implementation of the various stages of intermodal transport as a way to delve deeper into the topic and form an in-depth perspective. This is followed by a review of the motivation for identifying global best practices for combined transportation systems. After defining combined transportation, its impact on the environment, and the logistics and supply chain as a whole. Finally, the paper discusses the benefits of implementing good practices in the South Ostrobothnia intermodal transport system.

The third part that follows elaborates on the research methods, strategies and philosophical assumptions made. In addition, this section describes the case selection process and explains the execution of the analysis. The fourth section discusses the results of the research. The fifth and final section concludes the paper by discussing the implications of the study and the validity and reliability of the study.

Figure 2: The structure of this thesis.

2 Literature review

In terms of economic efficiency, the transition of Truck-Rail (TR) research examines factors that contribute to rail's competitiveness. Optimizing the use of existing rail infrastructure, advancing the development of innovative rail transportation technologies, enhancing intermodal transportation control, and digitizing supply chains are few examples of possible starting points (Klompmaker et al., 2019).

Within the domain of transportation research, the transition from Truck-Rail (TR) transportation represents a compelling area of investigation, particularly concerning its implications for economic efficiency. Rail transport, celebrated for its environmental sustainability and potential cost advantages, stands as a prominent alternative to road-based transportation. However, realizing the full potential of rail transport and positioning it as a competitive choice necessitates a comprehensive examination of various pivotal factors. This scholarly endeavor conducts an exhaustive literature review to elucidate the central themes identified in prior research that are pivotal for enhancing economic efficiency in the TR transition. Specifically, this inquiry scrutinizes the significance of optimizing rail infrastructure, advancing innovative rail transportation technologies, improving intermodal transportation control, and digitizing supply chains.

Analysis:

A critical analysis of extant scholars reveals the salience of these four facets in the context of transitioning from Truck-Rail transportation. Klompmaker et al. (2019) have astutely identified these factors as foundational elements. A nuanced review of the literature yields the following key insights:

Optimizing Rail Infrastructure:

The condition and capacity of rail infrastructure have consistently emerged as determinants of rail's competitiveness. Researcher’s investigations underscore the detrimental consequences of aging infrastructure, capacity limitations, and deferred maintenance, which manifest as delays, heightened maintenance expenses, and diminished reliability. Empirical evidence supports the positive impact of investments in infrastructure modernization, expansion, and maintenance. This body of research underscores the necessity for judicious resource allocation to revitalize rail infrastructure (Smith et al., 2020).

Developing Innovative Rail Transportation Technologies:

The integration of innovative technologies into rail transportation commands considerable scholarly attention. Studies elucidate the potential benefits of automation, electrification, and advanced signaling systems in optimizing rail efficiency. These technologies not only demonstrate the capacity to curtail operational costs but also exhibit the potential to enhance safety and reduce the environmental footprint of rail transportation. Researchers have conducted exhaustive feasibility assessments, cost-benefit analyses, and assessments of the challenges surrounding technology implementation. These endeavours furnish valuable insights into the potential advantages and impediments tied to these technological advancements (Brown & White, 2021).

Enhancing Intermodal Transportation Control:

The optimization of intermodal transportation control emerges as a pivotal factor in the pursuit of TR transition efficiency. Researchers' consensus highlights the potential for substantial cost reductions and heightened supply chain reliability through streamlined coordination among diverse transportation modes, such as trucks and rail. The literature delves into strategies encompassing synchronized scheduling, efficient container handling, and the implementation of real-time tracking and monitoring systems (Roe et al., 2018).

Digitizing Supply Chains:

The digital transformation of supply chains stands as a relatively nascent but rapidly evolving domain of inquiry. Prior research underscores the transformative potential of digital technologies in augmenting TR transportation efficiency. Digitalization facilitates real-time data sharing, predictive analytics, and demand forecasting, all of which contribute to the optimization of route planning and inventory management (Liu & Wang, 2022).

Conclusions from Previous Studies:

The previous studies have proven that there combines transportation is becoming a new way of thinking. Logistics companies and supply chain managers are gradually making vital decisions which essential in the meeting customers' demands and achieving cost efficiency in running of their businesses.

The collective scholars examining the TR transition underscores the incontrovertible significance of these factors. It is apparent that the optimization of rail infrastructure, the integration of innovative technologies, the enhancement of intermodal transportation control, and the digitization of supply chains are interconnected facets crucial for achieving economic efficiency. Klompmaker et al. (2019) appropriately identify these as foundational starting points. Future research endeavors informed by these studies hold the potential to engender more efficacious strategies and policies for facilitating the transition from Truck-Rail transportation.

2.1 Sustainability of combined transportation

As a result of the high levels of greenhouse gas emissions, traffic congestion, and pollution, road transportation is widely seen as being unsustainable for moving products across Europe. Railway has fewer externalities than road transport and therefore shifts from one type to another is necessary, which is widely regarded as a policy goal of a more environmentally friendly and more competitive transportation system (Muñuzuri, Onieva, Cortés, & Guadix, 2020). For long-distance transportation, combined transportation is only competitive, so the potential for the modal shift is limited according to (Bergqvist & Behrends, 2011). Therefore, it is an obligation for businesses using a multimodal strategy to set up the optimal distribution of their freight among the various modalities. The combination of transportation methods increases the number of available modes, allowing companies to combining multiple models in multiple ways on a single route has complicates deciding which model to use. Dong argued that the emergence of synchronicity complicates this issue, it also increases the opportunities for companies to benefit from transportation other than the road only means of transportation (Dong, Boute, McKinnon, & Verelst, 2018).

Due to the fact that a large portion of the world's rail network is already electrified, its decarbonization potential is inextricably linked to that of the energy industry (Kaack, 2019). However, diesel-electric locomotives are almost exclusively used in the United States rail transportation, which is an exception in this regard. According to Hoffrichter et al., the diesel-electric locomotives currently used in the United States emit 1.02 kg of carbon dioxide for every kilowatt-hour of traction energy transmitted, while in 2008, Carbon dioxide emissions from locomotives powered by the United States grid are 0.9 kg. Given the fact that the present United states grid is 20% cleaner than it was in 2008 (Kaack et al., 2018), switching to electric means of transportation would provide a higher return on investment. If greenhouse gas emissions are not regulated, nevertheless, the economic benefits of electrification remain unattractive in countries such as the United States where long-distance travel is common (Kaack, Vaishnav, Morgan, Azevedo, & Rai, 2018).

In the Netherlands a study on the cost of transmitting unmet demand in the network performance value for public transportation was calculated in the city mobility department by utilizing robustness indicators to identify the link criticality and degrading rapidity indicates a connection (Cats, Koppenol, & Warnier, 2017) (Dampier & Marinov, 2015). In addition, the results and instructions of this publication are also applicable in the shift for the use of truck-rail network functions.

Intermodal transportation networks provide adaptable, dependable, and ecologically friendly modes of transporting large volumes of commodities over vast distances. The most compelling justification for multimodal transportation is the opportunity to increase the amount of flexibility and reliability throughout the shipment's lifecycle.

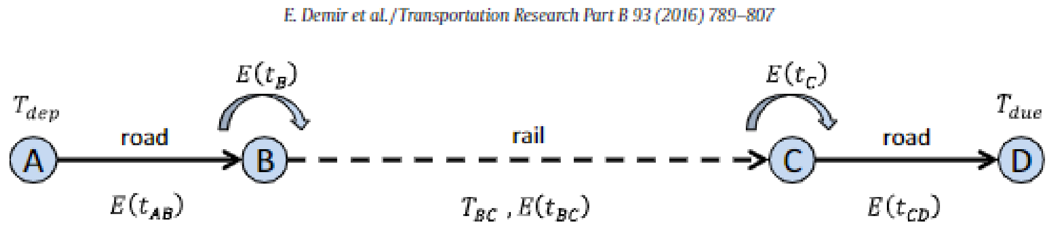

Figure 3: A sample intermodal transportation route (Demir et al., 2016)

According to Demir et al., combined transportation illustration above states that because intermodal transportation networks operate on fixed timetables and some services operate on fixed schedules, it is not possible to wait for late containers due to unanticipated transportation delays. The transportation network diagram above illustrates one possible multimodal path for an order with origin A and destination D. Thus, the pickup time is T_{dep}, and the destination's due date is T_{due}. The provided path transports the containers by truck from A to B, where they are trans-shipped to a train (with an expected duration of $E(t_{BC})$). This train transports containers from B to C, then transfers them back to trucks and finally to D (Caris et al., 2008).

In addition to the well-known adaptability provided by intermodal transportation, intermodal transport has many advantages. Faster shipping and lower packaging costs are essential advantages for high-volume shippers. (Jennings & Holcomb, 1996). However, the number of intermodal transports has increased dramatically globally over the past decade as it offers a quick alternative to long-distance single-modal vehicle transport. As a result, shipping containers arriving at European ports are therefore transported to their final destinations through efficient intermodal transportation. Rail freight, in particular, plays a significant role in environmentally friendly transportation (Jahn et al., 2020).

2.1.1 Sustainability development and the Economy importance of EU (CT)

According to the UIC report (2020) on combined transportation and economic development, which are enhanced through sustainable implementations, findings show that over the years, the combined system of transportation has become one of the propellers of the European economy's success in terms of macro and micro-economic indicators, which influence the overall position of combined transportation success in the region.

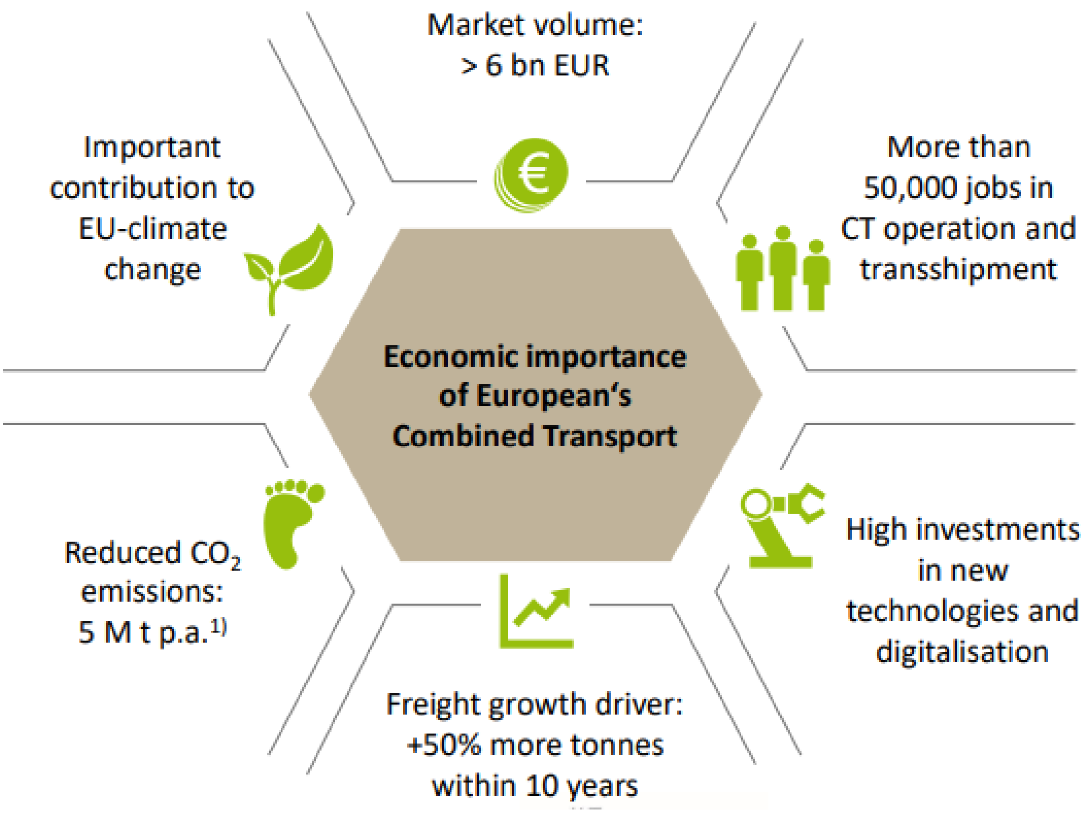

Figure 4: The Macro-economic impact of the Combined Transport sector (UIC *2020 Report on Combine Transport (CT))*.

The main indicators in the figure 4 above show that the market volume has increased on the basis of the industry-wide high, creating more employment opportunities for more than 45,000 people in operation and trans-shipment. While the main purpose of intermodal transport is to advance European Union initiatives to reduce emissions by 2030, it also fosters innovation and facilitates economic investment in new technologies and digitalization.

2.1.2 United Nations transportation goal

The United Nations' objective of universal access to sustainable mobility includes increased safety, reduced environmental and climate impact, and increased resilience, all of which contribute to the overarching goal of sustainable development efficiency. In addition to providing services and infrastructure for the mobility of people and goods, sustainable transport can serve as a cross-cutting accelerator, accelerating progress towards other key goals, such as ending poverty in all its forms, reducing inequality, empowering women and reducing climate Variety. The 2030 Agenda for Sustainable Development and the Paris Climate Agreement must be achievable.

These goals, according to the United Nations, can only be achieved if there is a relationship between sustainable transportation and the Sustainable Development Goals (SDGs), and their targets are clearly understood and actively exploited to resolve trade-offs and make use of potential synergies. This will necessitate not only overcoming the transportation sector's historical fragmentation but also improved collaboration among varied actors at all levels.

Transformative action is urgently needed to accelerate the global transition to sustainable mobility. COVID-19 has further hampered progress on the Sustainable Development Goals, especially as climate change continues to accelerate. In 2020, 120 million people were estimated to be facing extreme poverty globally. In the same year, global temperatures have soared compared to the perilous proximity to the Paris Agreement's 1.5°C goals, global temperatures have risen by 1.2°C above pre-industrial levels (United Nations, 2021).

Although the carbon emissions of road freight vehicles are expected to decline over time, the IEA predicts that by 2030, rail freight will still have significantly less CO_2 emissions and be more environmentally friendly than trucks.

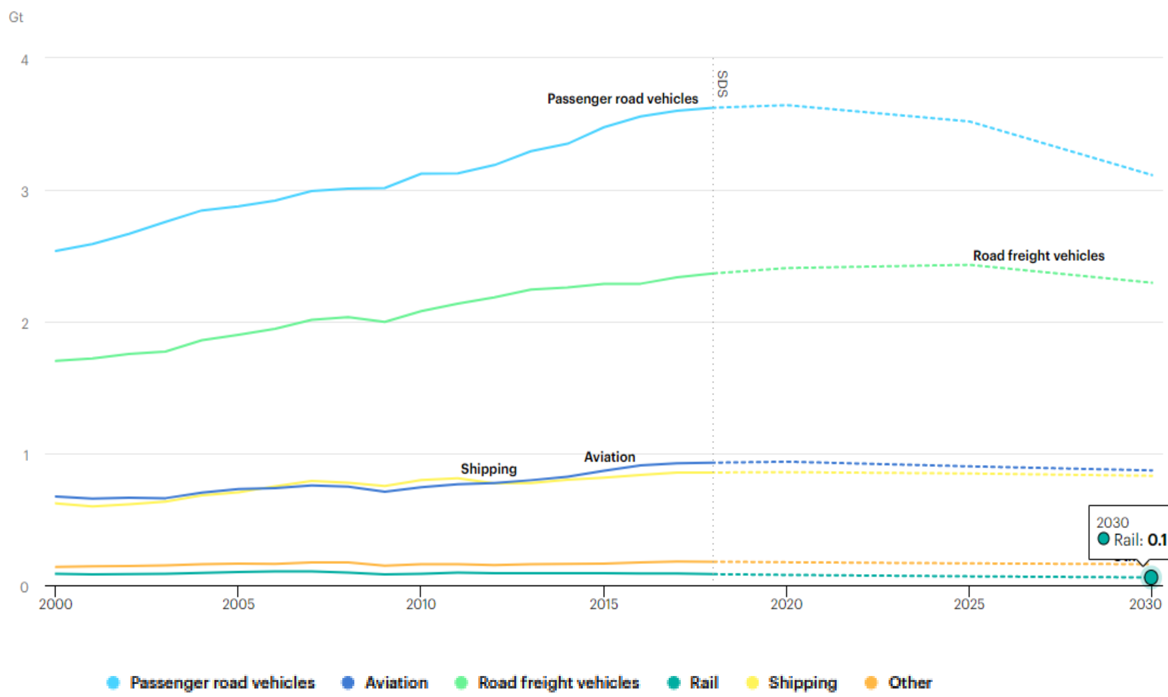

Figure 5: Transport sector CO2 emissions by mode in the Sustainable Development Scenario, 2000-2030 (IEA, 2022)

Aviation and shipping emissions have risen more quickly than those of any other mode of transportation in the last few years, but energy use and emissions have risen across all modes of road transportation, including cars, trucks, buses, and two- and three-wheelers. This fact is particularly the case for heavy-duty road freight transport.

2.1.3 Environmental responsibility

The Corporate environmental responsibility means that the multimodal business must operate in a way that protects the environment, nature and natural resources while minimizing its impacts on the environment. When it comes to environmental responsibility, these companies' influence on the environment is taken into consideration and they must accept the responsibility on behalf of their customers. The International Union of Railways (UIC) elaborates on different categories of combined transportation and types of equipment used for shipment in Europe. Multimodal transport can be a combination of freight between Unaccompanied Intermodal Transport (UCT) and Accompanied Intermodal Transport (ACT). To carry out shipment activities in any of these categories in the southern Ostrobothnia terminal, environmental consciousness has to be taken into account since the new terminal is a few kilometres away from the residential area and the city is open for future development (Jahn et al., 2020). Figure 6 below explains different categories of Intermodal loading unit (ILU)

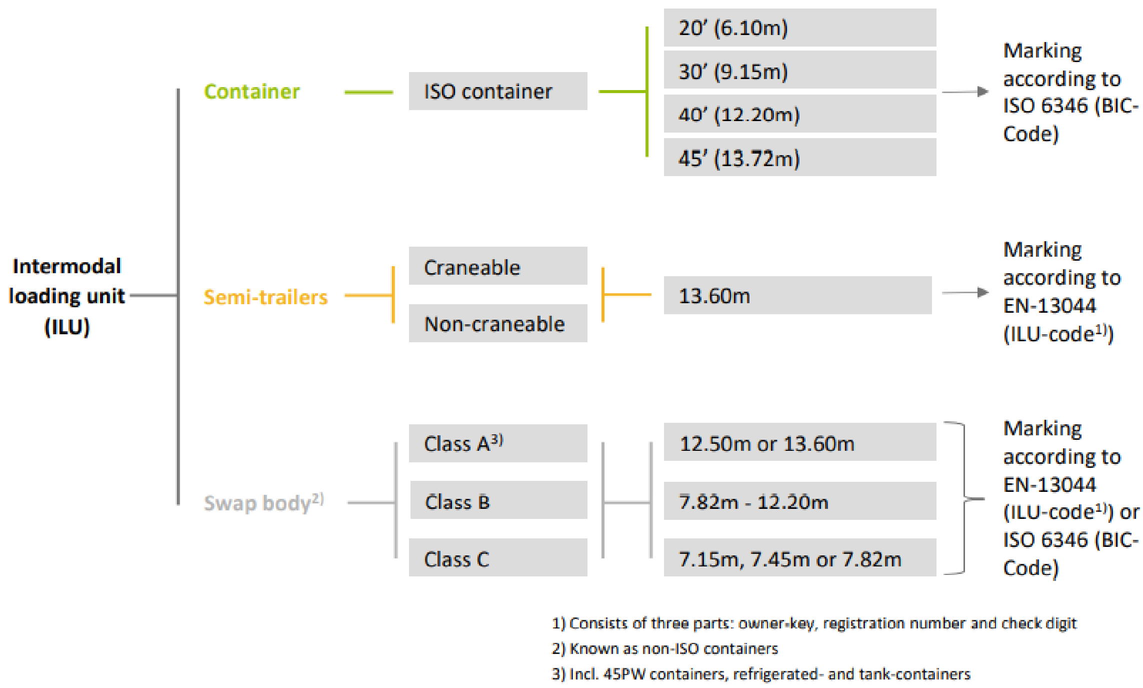

Figure 6: Classification of intermodal loading units for unaccompanied CT (UIC *2020 Report on Combine Transport (CT))*.

2.1.4 Responsibility and creating value.

It is possible that a new level of environmental and economic sustainability might be achieved through collaboration amongst logistics companies. As a part of a "grid" of supply, distribution, and retail chains, companies can improve their competitive position by looking at the value streams in which they are currently operating as well as additional parallel ones. While the "supply" view contends that the maximum volume may be produced by ensuring that information and material flow linearly, this premise differs fundamentally. Overstocks, bullwhip effects and long lead times should be avoided at all costs (Horvath, 2001; Sahay, 2003). Consequently, I will argue that these assumptions are complementary rather than mutually exclusive.

2.1.5 Rethinking transportation implementation

From the recent war in Ukraine, COVID-19, e-commerce to Brexit and U.S.-Chinese tariffs, there has been a lot of bad news in the market over the last years. There has also been more regulations and bad weather. Companies have been reacting to these problems over the last years by focusing on negotiating with carriers to get more space at competitive prices, shifting the distribution mix to cheaper modes of transportation, and building inventory in key product lines and inputs. They have also been aggressively moving inventory closer to customers without delaying delivery of orders (Bulkeley & Betsill, 2005; Limb et al., 2020; Zheng & Kim, 2017).

However, in the longer run, a more deliberate and meticulous approach to freight management will be required to optimize value generally, improve operational excellence, and increase robustness. As market volatility persists, strategies must evolve from focused initiatives to a more comprehensive approach that strikes a balance between cost efficiency and long-term supply chain resilience (Bontekoning & Priemus, 2004). These long-term projects will focus on enabling real-time visibility of shipments, increasing the flexibility to act quickly in the face of exceptions and bottlenecks, and using analytics that keeps an eye on the freight network to predict disruptions and measure performance.

2.1.6 Creating new opportunities for investment

Thus, the primary goal of establishing a combined transportation system in South Ostrobothnia is to improve the quality of city life by developing a model that can assist businesses and policymakers in reducing greenhouse gas emissions, traffic congestion, and the danger of significant road accidents. Therefore, rethinking freight transportation and implementation is a potential way to create new opportunities through industrial collaboration with established logistics companies with the goal of developing a more energy-efficient system of transportation. More specifically, reducing the number of heavy-duty trucks circulating in the city not only makes South Ostrobothnia cleaner, but also enables the government to develop smarter plans for a safer and more efficient public transport system.

2.2 Sustainable implementation and intermodal benefit

As the second section of the literature review, this section analyzes all information related to the sustainability of intermodal transportation while also responding to the thesis' research questions.

Baykasolu and Subulan (2016) stated that, a supply chain is composed of three components (pre-haulage, long-haulage, and end-haulage), each of which is connected to a method of transport. While trucking is the preferred mode of transportation for pre- and post-transportation, most long-distance shipments are done by ship, train or air. (Awad-Núñez et al., 2015; Badurina et al., 2017; Baykasoğlu & Subulan, 2016). Even though intermodal transportation has the potential to cut emissions when implemented properly (EngLarsson & Kohn, 2012; Lenfers et al., 2021), one finding of the first phase of the literature review is the rarity of the benefits of best practices of intermodal transportation in the literatures. In this case could be two probable explanations.

Firstly, because the authors searched for the keyword such as "intermodal transportation and sustainable logistics", at this point the benefits of sustainable transportation and green logistics are most likely to be self-explanatory, as are the benefits of literatures on integrated transportation or sustainable logistics. Secondly, research has not quantified many of the business benefits associated with intermodal solutions. The most commonly reported benefit of intermodal transportation systems is the cost savings that transportation businesses and factories experience when switching from road to rail transit (Baykasolu & Subulan, 2016; Limbourg & Jourquin, 2009).

Logistics organizations in Europe and Asia have seen significant improvements in the efficiency and effectiveness of their long-haul shipments due to technology deployment. An increasing number of technologies are being implemented in the transport sector, which has a significant impact on the profitability and sustainability of the industry, although many of them are costly to implement. There are several advantages to intermodal transportation, such as automatic gate systems, automatic loading and unloading of containers and semi-trailers, driverless electric trucks for transferring containers from factories to railway terminals, etc. All of these are some of the sustainable implementations and benefits of intermodal transport.

2.2.1 Challenges in the implementation of combined transportation

Table 1 provides an overview of the problem categories, the difficulties, and the articles that discuss them in order to simplify the explanation of the range of issues.

Table 1: Problems and constraints for intermodal transportation

Classification	Challenges	Sources mentioning challenges
Dependability	Efficiency Reliability	Baykasoğlu, A., & Subulan, K. (2016). Bontekoning, Y., & Priemus, H. (2004).
Emission	Green Port Concept Carrier efficiency	Badurina, P., Cukrov, M., & Dundović, Č. (2017).
	Reduction of carbon emissions	Hoffrichter, A., Miller, A. R.,
	electric, diesel, and hydrogen traction for railways	Hillmansen, S., & Roberts, C. (2012).(Analysis for)
	CO2 emissions	IEA, Transport sector 2022
	Emission Saving Potentials	Jahn, M., Schumacher, P., Wedemeier, J., & Wolf, A. (2020
	The modal shift for greener logistics	Eng-Larsson, F., & Kohn, C. (2012).
	Rethinking sustainability cities)	Bontekoning, Y., & Priemus, H. (2004).
	Decarbonizing intraregional freight systems	Kaack, L. H., Vaishnav, P., Morgan, M. G., Azevedo, I. L., & Rai, S. (2018).
	Global CO2 emissions to rise by 4.9%	Kevin Adler. (2021).
	Air pollution and traffic noise on mental health	Klompmaker, J. O., Hoek, (2019).
	Sustainability and Climate change	Ližbetin, J. (2019).
Products and associated risks	Time Sensitivity	Říha, Z., & Dočkalíková, I. (2021).
User's and stakeholder's requirements	Frequency of delivery	Baykasoğlu, A., & Subulan, K. (2016).
	Quality	Eng-Larsson, F., & Kohn, C. (2012).
	Convenience	Dampier, A., & Marinov, M. (2015).
	Customer demand	Cats, O., Koppenol, G. -., & Warnier, M. (2017).

2.3 Reason for the research

Southern Ostrobothnia is a major transit hub for freight transport between Helsinki and Oulu, and one of Finland's core rail network corridors. The drive for sustainability in logistics and supply chain management in this city has led to new strategy development and approaches for the design of new rail terminals, with high technological capabilities that are environmentally friendly based on global best practices. One of these initiatives is the establishment of ongoing support systems that enable the shift of freight from highways to trains, with the primary goal of fostering a sustainable environment throughout Europe's transportation system, which was also established in the European Union’s strategic document (Říha & Dočkalíková, 2021).

The Finnish Ministry of Transport and Communications plans encompass the present state of the transportation sector and its operating environment, in which changes are expected to be put in place to halve the 1.25 megatons of CO2 emissions by 2030. Nevertheless, the central and local governments have formulated strategic guidelines and action plans for the development of the transportation system, to achieve a sustainable and carbon-free transportation environment by 2045 (Jääskeläinen Saara, 2021).

The implementation of the combined system of truck-rail freight networks in South Ostrobothnia is expected to be attractive and feasible to meet the needs of users and stakeholders through continuous development in terms of standards, quality, interoperability, and capacity, with the ability to further extend services for connection of rail freight services in other cities in Finland. The combined system of transportation should, at its full capacity, meet customers' needs and stakeholders’ requirements. Therefore, monitoring the yearly total truck to rail product transportation is necessary to have a comprehensive policy choice and specific actions needed for further improvement (Hanssen, Mathisen, & Jörgensen, 2012). (Gkoumas et al., 2020). It is important to have a non-road transport mode as an essential factor of the intermodal freight system (Kim & Van Wee, 2011).

The proposal for the design of the new South Ostrobothnia rail terminal is related to the preparation of the identified location for future intermodal rail station area master plan. In this master plan, the terminal design and the track design are based on the development of the entire transportation system, such as vehicles and traffic, connecting the boundaries of the railway terminal operating area. This aims to carefully understand the corresponding factors necessary for the terminal design, and the results will then be applied to the development and implementation of the general operation of the new rail terminal design. The need for a mode of combined transport in the city of South Ostrobothnia is essential for the precondition measures set by the Finnish government towards meeting the sustainable goals for carbon emission-free means of transport, which will also become the propeller for the general planning of the rail terminals.
In the case of passenger rail services, the change in the number of trains can be easier to estimate, but for freight transport, the number of trains would be affected by the general economic situation, industrial needs, or power plant projects. Seinäjoki is a train interchange station, bringing together lines from Tampere, Oulu, Vaasa, Kaskinen, and Haapamäki. From Tampere, Oulu, and Vaasa, electric parts run, while non-electrified sections run from Kaskinen and Haapamäki. Traffic in the direction of Kaskinen consists entirely of trucks transporting goods. The parts connecting Oulu and Tampere are guarded and controlled remotely, whereas the sections connecting Vaasa, Kaskinen, and Haapamäki are unattended and controlled through a radio signals. The majority of the operations of the Seinäjoki railway terminal are devoted to the shipment of raw timber by the forestry sector. For combined transport to be able to fulfil its potential in the future transportation of products, its effective performance must increase at every stage of implementation.

Also, this research can make an important contribution by suggesting some of the best global practices with innovative approaches, new solutions, and modern technologies that are adaptable for further development. For this reason, global actors in the combined system of transportation, which are stated in the case findings (Cargo Beamer, Hub Group and DFDS) were interviewed and a visit to terminals to answer the research questions.

2.3.1 Rail freight statistics in Finland

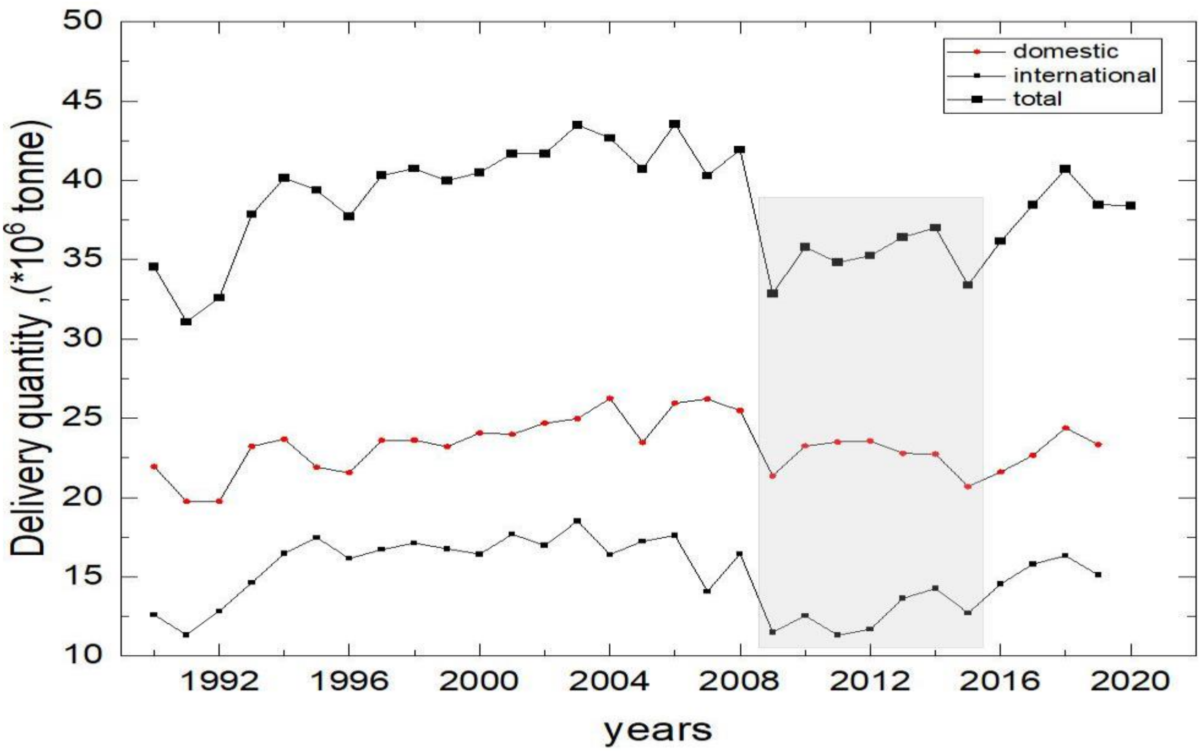

Figure 7: Rail freight transportation delivery quantity between 1990-2020 source:(Vayla)

The data collected from the rail freight transportation of Finland show that between 2008 and 2015, due to the global financial crisis, Finland's economy performed poorly. While Finland's economy initially recovered from the crisis in 2010 and 2011, it fell back into recession between 2012 and 2014 due to weakening foreign and domestic demand for Finnish products. After a while, the economy starts to recover, but the recession was still high (IMF, 2016). According to the IMF analysis, Finland's productivity growth also slowed significantly between 2007 and 2014, it was noted that labour productivity grew by an average of about 2% per year during this period, reflecting slower total factor productivity (TFP) growth in manufacturing and government services, as well as sluggish growth in private services (Etla, 2010).

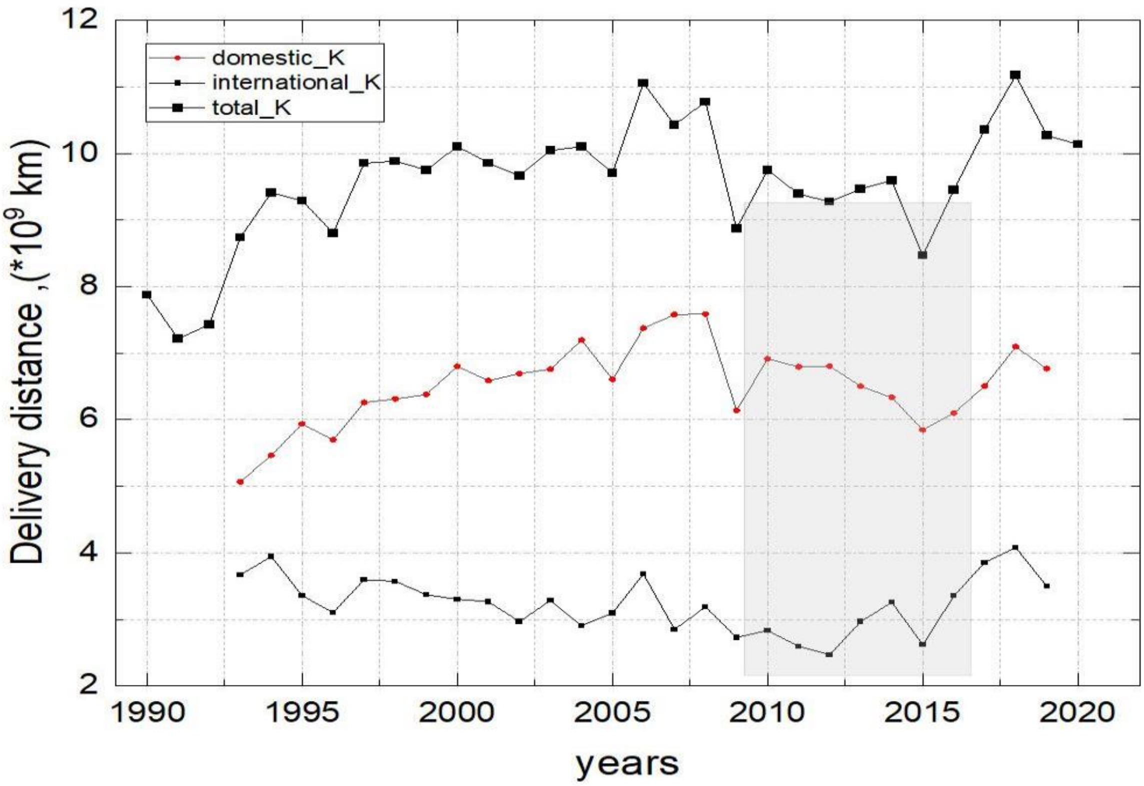

Figure 8: Rail freight transport delivery distance between 1990-2020 source:(Vayla)

There was a dramatic decrease in the number of deliveries and the distance covered between 2007 and 2015 due to the monopolization of rail freight transportation. It was noted in Mäkitalo et al., that there were some competitions for freight; even so, the incumbent's dominance in the railway system organization makes it difficult for new entrants to join the freight market (Mäkitalo, 2011).

2.3.2 Expectations of South Ostrobothnia's combined transportation system

Table 2 provides an overview of the parameter concept and process description for the implementation of combined transportation system in South Ostrobothnia. The Benchmark analysis of customer's and companies' expectation in South Ostrobothnia combined transportation

Parameter Concept	Process Description
Cost efficiency	Operations require a high degree of automation. Example “Company A” daily operations are managed by the automated loading and unloading technology, which is fully digitalized with a data-gathering system. This demonstrates that increasing shipping volume goods while utilizing terminal technologies increases profitability.
Sustainability	If the transportation system uses hydrogen and is equipped with on-board batteries and energy-efficient control systems, it will be completely eco-friendly with zero carbon emissions. The implementation could allow for the development and promotion of renewable energy sources to meet the need for electricity. Nonetheless; at this point, electricity is still an alternative to fossil fuels.
Safety	Rail transportation has proven to be the most secure mode of transportation. However, when it comes to security, it is not a static state. Instead, safety must be constantly improved to make sure it does not change, even if there are changes in technology, law, or society.
Flexibility and Reliability	While some products are time-sensitive and may require strict schedules based on delivery times to their final destination, reliability can only be measured when the entire transportation system is functioning efficiently. Commodities transported by the railway network should be clearly defined.
Traceability and Temperature management	With the emergence of 5G technology, the digitalization of the combined transportation system will provide revolutionary solutions that will go beyond remote monitoring and preventative maintenance. Instead, sensors installed in cargo trains and along tracks could collect real-time data that would enable traceability and regular updates on temperature-based products with the help of artificial intelligence.

3 Methodology

This chapter explains the research strategies, research techniques, and empirical research methods used in this study and justifies the methodological decisions made. There is also an in-depth review of the study's validity as well as a discussion of the study's dependability in this chapter.
To address the major research question regarding intermodal operators, the following data sources and methods have been employed:

Email Correspondence: An analysis of email communications has been conducted. These emails contain valuable insights and information relevant to the research questions.

Phone Conversations: In addition to email, phone conversations have been recorded and analyzed. These conversations can provide a deeper understanding of the perspectives and experiences of intermodal operators.

Online Sources: Information gathered from online research-based sources, such as industry reports, articles, and websites, has been utilized. This data helps in contextualizing the research and provides a broader view of the subject. Therefore, a qualitative research method was used for the analysis of this paper.

The choice of a qualitative approach for this study is appropriate given the nature of the research, which involves a smaller number of participants and a need for in-depth context and accountability. This approach allows for greater insight and flexibility compared to quantitative methods. The use of semi-structured interviews was well-suited for obtaining primary data, and the informal tone during interviews was intentional to encourage open discussions.
The integration of these diverse data sources and methods enhances the comprehensiveness of the research and contributes to a more robust exploration of intermodal operators and their consequences.

3.1 Research Method

Quantitative and qualitative data collection methods exist, with quantitative methods focusing on numerical data and qualitative methods relying on non-numerical data, respectively. This research's nature necessitates a qualitative approach with fewer participants, whose responses provide greater context and accountability for the findings in terms of validity and trustworthiness. Quantitative approaches require large numbers of people to establish their validity, and their answers are limited to specified questions, while qualitative approaches do not require such a large number of people.

It's possible to categorize qualitative data gathering methods into primary and secondary data, with the latter containing a wide range of data sources such as written text, video, audio, speech, and photographs. The researcher acquires primary data that does not already exist, such as through interviews or direct observation. Secondary data is information derived from previously compiled sources, such as documents or promotional materials.

In this study, semi-structured interviews were used to collect primary data because they provide responses with a clear unifying outline, making the results comparable while allowing for open discussion of the fundamental topics in relation to intermodal transportation, logistics and supply chain management, and the essential aspects surrounding them. The interviewee is allowed to expand on the issue by picking the ideal wording for each situation and asking follow-up questions, which may provide additional insight that was not included in the original inquiries. Therefore, a more casual tone was allowed during the interview.

3.2 Case selection and delimitation

The original purpose of this study was to travel to as many intermodal terminals as possible. As a result of ongoing projects and reorganization brought on by the global health crisis during the research, certain intermodal transportation companies were unable to participate in the study. The study's time constraints necessitated the use of an alternate method, in which numerous top executives from specific Intermodal enterprises were sought and interviewed on their own time. Interviewing a wide range of managers allows the results to reflect a broad range of practices, not just a specific set of procedures. This ensures that proven best practices in logistics and supply chain management are replicated at multiple organizational levels.

3.3 Data collection

All interview was conducted between January and February 2022. Semi-structured interviews with a variety of managers, as well as responses to a few questionnaires, were the primary means of gathering data for this study. In light of the difficulties that can arise from virtual meetings, such as interrupted connections, inadequate power, or malfunctioning equipment, the interviews were done virtually using online meeting platforms and voice over internet protocol (VoIP) services. Each participant was asked to keep a cell phone on standby in case they needed to make direct voice calls. To ensure the interviewers grasped the research premise, the interviews began with a description of the research and its domain. Finally, the respondents were asked to explain in more detail what they do on a daily basis in their employment. The interviewees were made aware that they were free to ask questions or bring up relevant topics as long as they were related to the topic at hand. Online meetings and VoIP conversations were used to conduct a total of six interviews. Having the interviews begin in this less formal manner allowed for a better understanding of the research topic and the interviewer's expertise by both parties.

3.4 Data Analysis

Data analysis is carried out through relational content analysis, in which the data obtained is linked to the context of the study. Firstly, the literature is examined from the perspective of current issues related to intermodal transportation, logistics and supply chain, meanwhile the process of transition from truck to rail is carefully looked at in the literature, while observing factors that are associated with implementation issues and successful outcomes of planning and integration of technologies in intermodal transportation. Finally, from the interview, essential information related to implementations and procedures of these companies' intermodal transportation systems approaches was noted. This information allows the case companies to be viewed as its own entity with multiple practices, of which qualitative research method was considered the best type of analysis based on the information gathered.

4 Findings

The empirical study's findings are organized in this section. The presentation begins with an overview of the companies' intermodal operations, followed by a discussion of the differences and similarities between these companies' operations. This was then compared to the literature review conducted in Chapter 2.2.1 to identify important findings for the research idea.

1. Cargo Beamer:

1.

Cargo Beamer is a Germany-based Logistic company that specializes in innovative intermodal transport solutions. They primarily focus on the transportation of semi-trailers and containers through rail. Here are some key findings about Cargo Beamer:

Company Information	Value
Type of Company	Intermodal Transportation Operator
Headquarters	Germany
Products Handled	Semi-trailers and Containers
Transport Volumes	Data on exact volumes may not be publicly available
Transport Flows	Ashford United Kingdom, Calais and Perpignan France, Kaldenkirchen Germany, Domodossola and Bari Italy

Cargo Beamer aims to reduce road traffic congestion and CO2 emissions by shifting freight transport to more sustainable rail options.

2. Hub Group:

Hub Group is a United State of America-based transportation management company that offers a range of logistics services, including intermodal, truck brokerage, and supply chain solutions. Here are some key findings about Hub Group:

Company Information	Value
Type of Company	Transportation Management and Multimodal Operator
Headquarters	United States
Products Handled	Diverse range including intermodal, truck brokerage
Transport Volumes	Volumes can vary significantly; specific data might not be publicly disclosed.
Transport Flows	63 locations in the United States, Guadalajara Mexico, Vancouver and Toronto in Canada

3. DFDS:

DFDS is a Danish international shipping and logistics company with a significant presence in Northern Europe. They provide ferry and Cargo transport services. Here are some key findings about DFDS:

Company Information	Value
Type of Company	Shipping and Logistics Operator
Headquarters	Denmark
Products Handled	Ferry services, logistics, and transport
Transport Volumes	volumes can vary by route; specific data might not be publicly available.

Transport Flows	Routes are primarily focused on Northern Europe; detailed routes can be found on their website

DFDS plays a crucial role in connecting Northern European countries through its ferry services.

4.1 Case presentation

Participants in the research study are from three intermodal transportation organizations: a German operator that specializes in the distribution of manufacturing enterprises' goods as well as individual items across five European nations (Cargo Beamer). A logistics and supply chain enterprise which is also an operator of intermodal transportation based in the United States of America that primarily serves SMEs and Large corporations in the United States, Canada, and Mexico, with a limited offering to people (Hub Group) While (DFDS) operates exclusively for enterprises in Europe and China, with the majority of its shipments originating in Sweden and Switzerland. All of the businesses have been in operation for more than a decade.

4.2 Findings from the case companies

4.2.1 Cargo Beamer

At Cargo Beamer the operation revolves within two aspects in which the frequent criterion of quality in rail freight transit is that the load arrives intact and on schedule. The duration of the transport is secondary. However, this fact is insufficient. To ensure the long-term viability of shipments as a form of transportation, the quality requirement must combine punctuality with short transport times. For economic reasons, rail freight transportation that is on time and efficient is also essential. The Cargo beamer -Rail Freight Automation System (RFAS), has demonstrated that profits depend primarily on distance, while costs depend on factors such as train route, occupancy, wagon rental or hourly wages. Figure 9 below shows how daily rail operations are carried out at every terminal of this company.

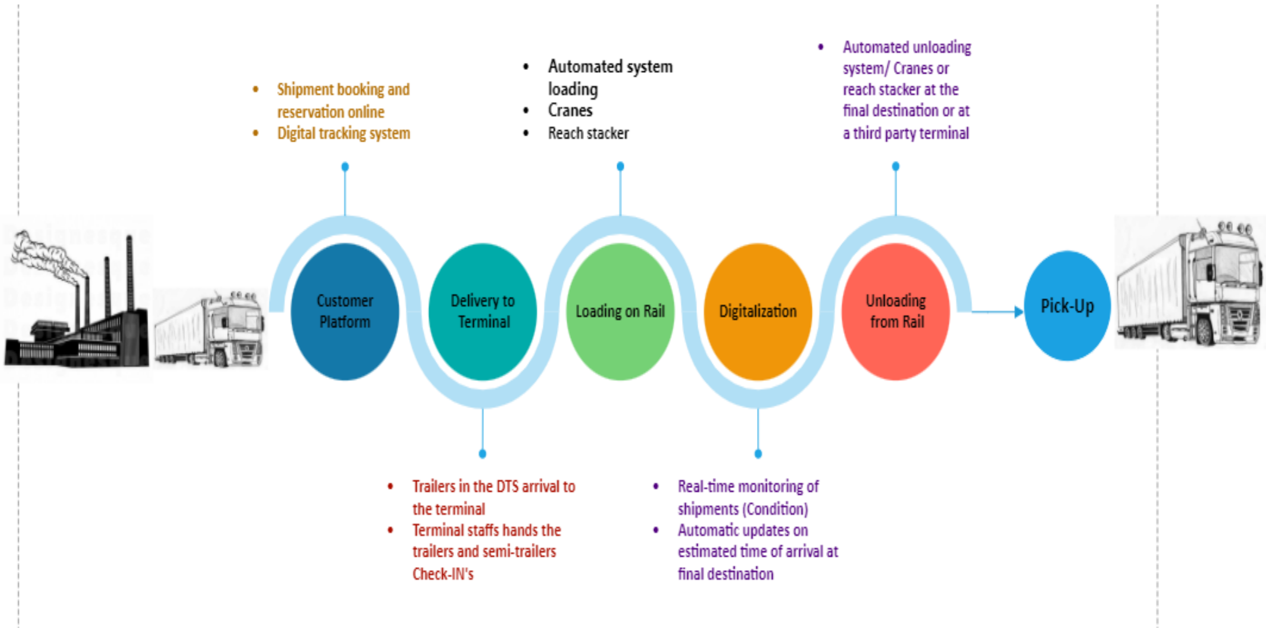

Figure 9: Cargo Beamer Combined transportation activities.

With the equipment and machines available at various terminals and locations, the company’s system is highly automated, as shown in the figure 9 above. Based on-site visits and interviews, the company claims that the cost of an automated terminal is only one-third of the cost of handling an intermodal unit at a conventional terminal that uses cranes or other handling equipment. The company currently has terminals in Poland, Italy, France, Germany, and the United Kingdom. It is the company's long-term goal to expand its routes and terminal network throughout Europe. all credits goes to their approach in innovation, semi-trailers can be transported quickly, cheaply and sustainably around the world by rail. The operation of Cargo Beamer is also easier because of the common European rail-track system which is absolutely different from that of Finland that shares rail-track system with Russia.

The Finnish rail network has a track width of 1524 mm, which is wider than the 1435 mm track width used in most of Europe. The electrified railway runs at a frequency of 50 Hz and a voltage of 25 kV, passenger trains can reach speeds of up to 220 kilometers per hour, while freight trains can reach speeds of up to 120 kilometers per hour, the German law (Straßenverkehrs-Ordnung, StVO) states that priority should be given to freight train because of time sensitive goods and material. Cargo beamer believes Its operations may be difficult to set up and run in a similar business in South Ostrobothnia, but it is possible in the future. One of the many hurdles the company faces is the long wait times for operating licenses in the countries it applies for, given its goal of reaching a pan-European rail freight business.

The company stated that Truck-Rail collaboration is at its pinnacle, so heavy freight trucks will not be completely eliminated, because of the requirement for the last milestone, The respondent further noted that rail transit is obviously first of all when it comes to environmentally friendly transportation. On the one hand, this advantage should be further strengthened compared to other modes of transport. Even with demographic, technological, and social climate changes, it should still be an important part of mobility for the foreseeable future.

4.2.2 Hub group

Hub Group from the United State of America is one of the largest multimodal carriers in the United States, with a network of 19,500 miles covering 22 states and Washington, D.C. The company also ships to the West Coast as well as Canada and Mexico and has connections with rail and freight partners. The company also supports international trade, serving every major seaport on the East Coast, as well as Gulf and Great Lakes ports.

Agricultural and forest goods, automobiles, chemicals, coal, metals, and construction equipment are among the major shipments made by this organization. For domestic shipments, this company's channel partners include intermodal marketing organizations as well as asset-based carriers such as truckload and less-than-truckload carriers. In addition to providing shippers and receivers with a single point of contact, these firms also provide an ease of conducting business comparable to that provided by truck transportation. Through its operating plan and terminal network, with continuous improvement, the company endeavours to prove that its business model is a better alternative to trucks in the transportation industry.

They provide an assured trans-continental service between the West Coast and the Northeast and Southeast, as well as inside its intermodal "Golden Triangle," which includes the cities of Chicago, Harrisburg, and Atlanta, as well as between the West Coast and the Midwest. For quick, efficient, and consistent service in all 22 states that the business serves and east of the Mississippi River into Canada, these facilities are a big part of the network. Rail-owned or privately owned trailers, as well as 45, 48, and 53-foot containers, are also handled by them. A container equipment management plan (EMP) is also offered.

Customer satisfaction is a top priority for the organization, which is why it relies on intermodal transportation for its distinct advantages as well as the competitive advantage that comes from having more capacity, faster delivery times, and higher quality service.

The major challenge for this company is within the agreements that are made with logistics companies in Canada and in Mexico due to different policies that govern these companies outside of the United States of America. Unlike (Cargo Beamer), which has automated loading and unloading equipment at their terminal, Hug Group relies entirely on conventional equipment such as a reach stacker, a portainer, a rail-mounter gantry, a rubber-tired gantry, a straddle carrier, and a front-end loader at most of their terminals throughout the United States of America. Below Figures is how Hub Group operations are carried out.

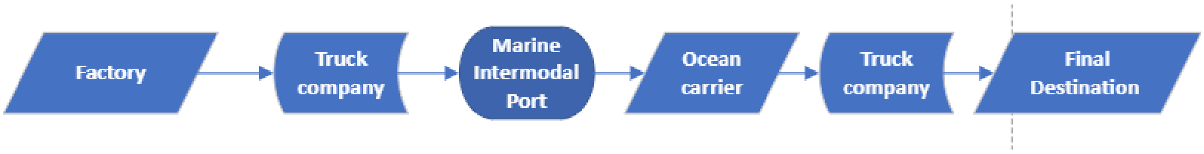

Figure 10: Intermodal transportation from truck to ship

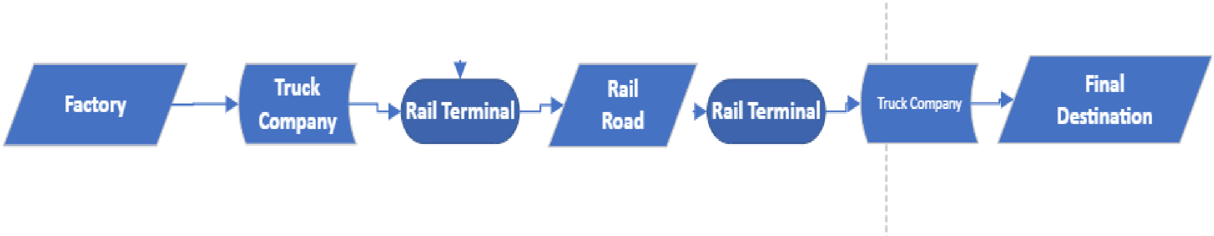

Figure 11: Intermodal transportation from truck to rail

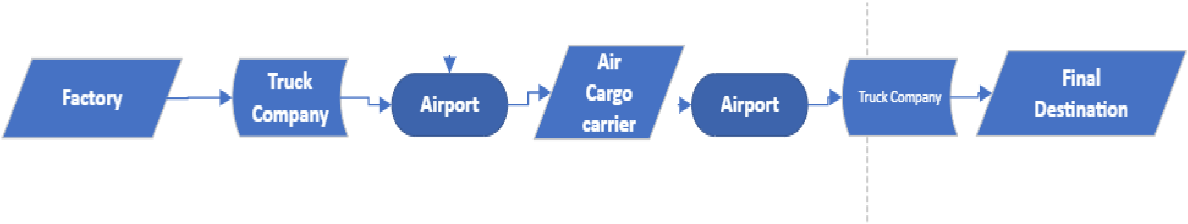

Figure 12: Intermodal transportation from truck to air cargo

4.2.3 DFDS

The Swiss logistics company has over 150 years of combined expertise in supply chain and logistics-related activities. Vera, an electric truck technology, was developed as a consequence of the company's collaboration with Volvo. The autonomous vehicle is part of a comprehensive solution for transporting goods from industry to the intermodal port terminal in Gothenburg, Sweden. The goal is to set up a networked system made up of many Vera cars that are overseen by an operations centre. The purpose is to enable an uninterrupted and continuous supply in response to growing demands for efficiency, adaptability, and sustainability. How it works is shown in figure 8 below.

Figure 13: Volvo electric vehicle (Vera)

4.2.4 The implementation of automation system case (DFDS)

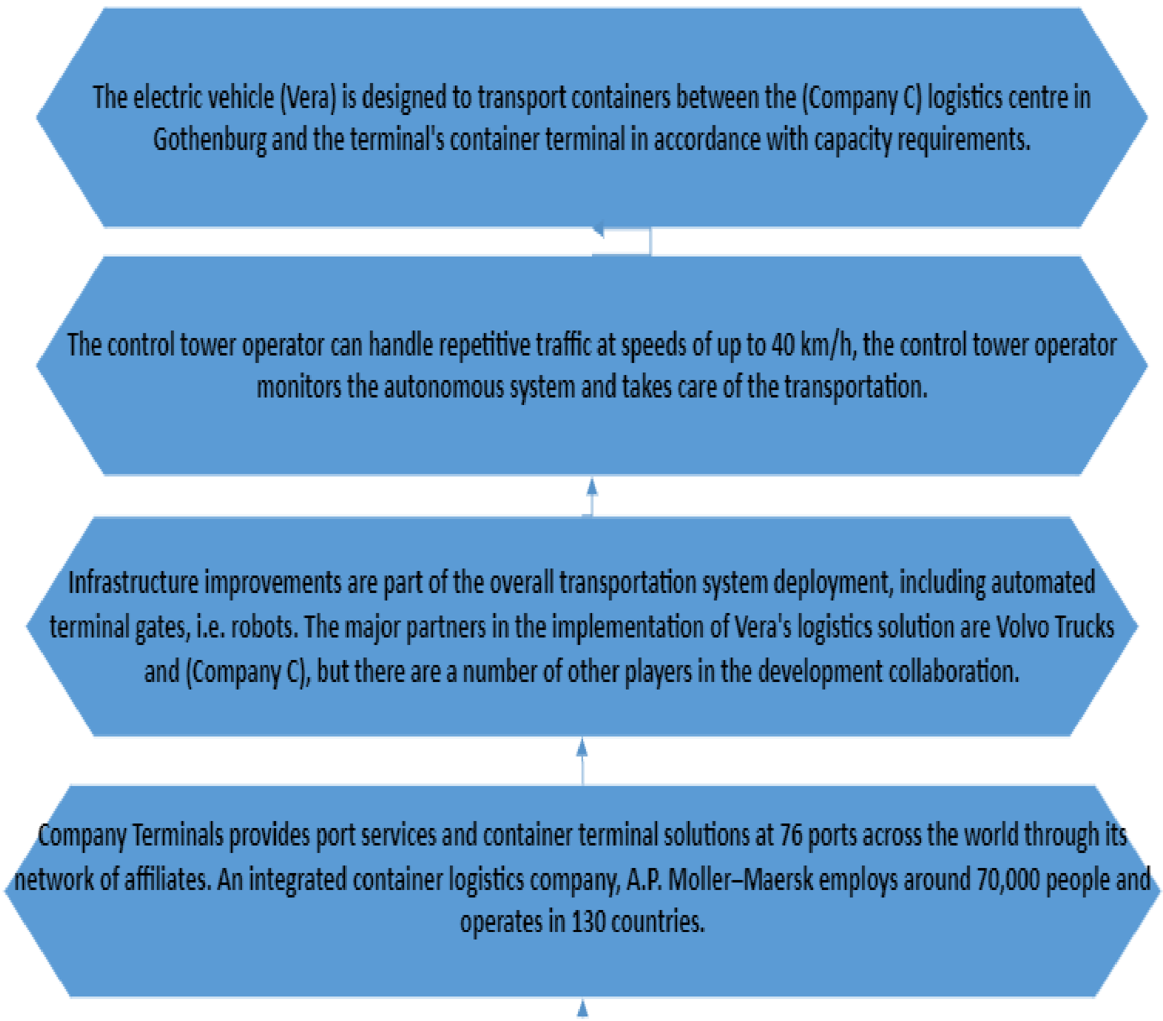

Figure 14: The new implementation for Intermodal solution

4.3 The future of combined transportation from case companies

Rail freight transport is undergoing a technological revolution at the moment, new technologies will help accelerate rail transport, paving the way for rail freight to develop into a reliable, safe and climate-friendly mode of transportation. In order to improve the overall quality of rail freight transportation there must be an increase in the speed at which it moves. It is critical that the infrastructure be better utilized**.**

"*For example, priority is given to passenger transportation in Germany*. While in Switzerland *the priority of a train in case of a delay is determined by computerized timetable forecasts, for example. Priority is therefore given to trains carrying cargo, such as food or mail. Of course, if there were no disputes in the first place, it would be the ideal situation. Passenger transportation is also essential."*

When it comes to best practices for intermodal transport, the solutions and implementations of these case companies were based on their geographic and situational needs for them. An important observation during the interview was ***"TIME,"*** which is what these organizations have in common, and time may be publicly admitted as the criteria for this mode of transportation's efficiency, profitability, and sustainability. In terms of transshipments, different techniques are required for time-sensitive and non-time-sensitive products.

During the interview with the case companies, critical facts about "*What are the primary challenges associated with the adoption of combined transport?*" were elicited. According to one respondent, intermodal freight transportation has gained traction in recent years as a result of road congestion, environmental concerns, and concerns about traffic safety.
"*He explained that the growing recognition of the strategic value of speed and agility in supply chains is forcing companies to reconsider their reliance on traditional logistics services*."

Meanwhile the fear of increased operating costs in rural areas with high shipment volumes, as well as the cost of establishing and maintaining a rail network connection in these rural areas, may also drive users to use heavy trucks to transport their goods from point A to point B, but a balance that becomes a win-win situation can be achieved with government subsidies and support. Another person said that *this challenge could be used to get long-term private investors into the industry*.

Collaborations and investment in technology that leads to environmental improvement are essential to the intermodal industry's success. To advance intermodal transportation, it is important to establish transportation links and networks, which include seaports, airports, and inland dry ports, as well as increase the efficiency of transportation services. *"The government's environmental policy is only a guideline; huge efforts have been made to create an attractive pricing structure for rail freight to excite customers and persuade them to ditch heavy trucks for this mode of transport"* (Cargo Beamer).

According to respondents, large cargo vehicles are significant to the transportation industry and have previously been characterized as the backbone of global trade and commerce. Decarbonizing large, long-haul heavy cargo trucks presents a special challenge. These large vehicles operate for extended periods of time and require a huge amount of power and energy to operate.

Currently, the only near-term possibilities or solutions for completely decarbonizing large goods vehicles are hydrogen and electric road systems, which were implemented in the United Kingdom to promote sustainable freight transportation. Heavy-duty vehicles equipped with hydrogen fuel cells are also equipped with an electric motor. The on-board hydrogen stores energy and is turned into electricity through fuel cells. Electric recharge for the trucks systems entails the installation of infrastructure that enables the direct delivery of electrical energy to a vehicle while it is in motion. Could this be the alternative to the way heavy-goods trucks operate in the future? This is an important subject because logistics and supply chain firms continue to rely on heavy truck vehicles for last-mile freight transportation.

5 Conclusions

The expansion of intermodal freight traffic and the pressure to perform better have raised significant worries about the capacity of ports and terminals, particularly the roadways and rail lines that service them, to handle the continually increasing amounts of intermodal traffic. According to the findings from Cargo Beamer, few ports are prepared to handle the tripling of intermodal container traffic, or the surges caused by mega-ships. The majority of ports and rail terminals are located in crowded urban areas. Additional space for docks, container storage, railroad tracks, and truck highways may be needed for expansion and development, though at a reasonable pace and frequently at a considerable cost.

Throughout metropolitan areas, there are chances to create new, greenfield rail-truck terminals, but they are also costly and have major environmental implications. Most of the increase in intermodal freight traffic will happen at ports and terminals that already exist. This is in reference to the first question of this research paper *(Q1. What are the major challenges in the implementation of combined transports?).*

The difficulties outlined in the classification table in section 2.2.1, which are significant obstacles to the implementation of intermodal or combined transportation, are not limited to the aforementioned observations. The absence of competition in the rail transportation industry is an additional observation. Aside from a few private companies, including the largest private railway company, North Rail Oy, which is a subsidiary of a logistics and transport service provider specializing in freight types such as fertilizers for farmers and materials for the energy industry, VR GROUP is the train regulatory body in Finland.

A total of 9,216 kilometer's (5,727 miles) of track comprise the Finnish railway network. A section of the railways measuring 3,524 mm (5 ft) in width is electrified; this is the same as the track gauge utilized in Russia and is distinct from the European standard gauge. The utmost speed of a goods train is 120 kilometers per hour (75 miles per hour). Depending on the type of train and the segment of track, actual speed limits may differ.

This was also identified as a major reason why some known operators in Europe are not Showing interest in the Finnish rail industry, they believe it will require a huge investment either in new wagons that is compatible with that of Finnish track gauge or an investment in building a different rail network which are of European standard gauge. Nevertheless, Innovative digital technologies and cost-effectiveness could result from robust competition in the Finnish rail industry, thereby enhancing the efficiency of goods transportation throughout the country. As an intermediary between Helsinki and Oulu and other regions of Finland, South Ostrobothnia will significantly benefit from this implementation.

Ongoing project carried out by some of this combined transportation operators addresses the second question of this paper which focuses on (*Q2. What is the future for heavy goods vehicles?)*

It is anticipated that the heavy goods vehicles (HGVs) would see substantial changes in the future, influenced by a range of variables such as technology progress, regulatory modifications, environmental considerations, and alterations in consumer patterns. The future of Heavy Goods Vehicles (HGVs) is being influenced by several significant development and advancements.

The exploration of electrification and other fuels. The adoption of electric vehicles (HGVs) is increasing rapidly due to developments in battery technology, which allow for extended driving distances and quicker charging durations. Additionally, researchers are currently investigating the potential implementation of hydrogen fuel cells and other alternative fuels as a means to mitigate emissions and decrease reliance on fossil fuels. Authorities and industry participants are allocating resources towards developing infrastructure to facilitate the extensive implementation of electric and alternative fuel heavy goods vehicles (HGVs).

The Development of Autonomous and Connected Innovations: Autonomous driving technologies possess the capacity to transform the Heavy Goods Vehicle (HGV) market by enhancing safety, efficiency, and production. The ongoing testing of advanced driver assistance systems (ADAS) and platooning technologies aims to improve vehicle-to-vehicle communication and facilitate convoy driving, thereby mitigating fuel consumption and congestion. The ongoing development of completely autonomous Heavy Goods Vehicles (HGV) present a promising outlook for the future of freight transportation.

Logistics Optimisation: Advancements in logistics and supply chain management are enhancing the efficiency of HGV operations, minimising the number of empty kilometres, and enhancing overall effectiveness. Utilising predictive analytics, route optimisation software, and real-time tracking systems enhances fleet management, load matching, and delivery scheduling, resulting in cost saving and less environmental footprint.

Regulatory Modifications: National governments across the globe are enacting more stringent emissions rules and regulations in order to mitigate pollution and tackle the issue of climate change. This encompasses requirements for HGV technologies that are more environmentally friendly, such as the implementation of Euro VI emissions standards in Europe and the establishment of zero-emission zones in urban regions. Regulatory incentives and regulations are promoting the use of electri and low-emission heavy good vehicles (HGVs). Another significant solution have been in the seamless effort for the solutioon for the last mile delivery of goods.

Solutions for Last-Mile Delivery: The emergence of electronic commerce and the prevalence of online purchasing are fundamentally transforming the landscape of urban freight transportation, resulting in a heightened need for last-mile delivery services. Electric vans, cargo cycles, and micro-distribution centres are becoming viable and environmentally friendly options for urban deliveries, serving as sustainable alternatives to conventional heavy goods vehicles (HGVs). These alternatives help alleviate congestion and reduce emissions in city centres.

Effectiveness of the Supply Chain: The global health crisis outbreak of COVID-19 with ongoing countries iconflites such as (Russia-Ukraine war, Isreal- Palestine conflite ,and China-Tawan tension) has brought to light the weaknesses present in supply chains worldwide, leading corporations to re-evaluate their approaches to logistics. To prevent disruptions and assure continuity of supply, it is necessary to diversify transport modes, reshoring manufacturing, and inverstung in resilient HGV networks.

Ecological Responsibility: There is a growing emphasis on environmental sustainability among heavy goods vehicle (HGV) operators, shippers, and customers. The adoption of green logistics efforts, including carbon offsetting, eco-friendly packaging, and the transition to rail and waterborne delivery, is increasingly being supported by stakeholders who place a high value on sustainability and corporate social responsibility.

In light of the evolving landscape of the heavy goods vehicle business in the 21st century, it is evident that the future trajectory of this sector is marked by a focus on innovation, sustainability, and efficiency. In order to thrive in a dynamic transportation environment, heavy goods vehicle (HGV) operators should strategically position themselves by adopting technological developments, adapting to regulatory changes, and responding to evolving consumer demands.

Finally. The greatest opportunity and solution for managing growing intermodal freight volumes through congested ports, rail terminals, and transportation corridors lies in information integration, which will enable public and private operators to share data in order to optimize flows and better utilize equipment and facilities. At the moment, precise and timely information flow across the intermodal system is just as critical as the freight movement. It acts as the glue that holds the various operations together in an intermodal system.

The best practices that could be suggested at this point for South Ostrobothnia combine transportation project, will be an investment in technologies that will reduce the operation time. However, regardless of the landscape capacity of a rail cargo station, terminal design and future modification plans are very important. It is also essential for the terminal design to have the following attributes which includes how close or far away the terminal is from rail or road infrastructure, as well as how large or small it is. Other factors should be how many handling tracks will be available during operation and what capacity can it handle.

The following are part of the recommendations. The terminal design should have better double-sided rail access. A signal that allows a train to enter with momentum and leave directly from the mainline traction unit. Three to five "railcar-length" handling or transshipment tracks outfitted with rail-mounted gantry cranes or crane-free loading and unloading automation systems which is currently used at Cargo Beamer. There should be one loading lane and one driving lane on both sides of the rail track. Access from the road with a check-in and check-out facility (automated gate system) and parking amenities. Integration of electric vehicles (Vera from DFDS AND Volvo) for zero-carbon emission within the facilities. While further research should be done on the impact of digitalization in intermodal transportation.

The validity of this paper has to do with whether the study measures its intended purpose, while reliability has to do with whether the study can be replicated. According to Golafshani et al. (2003: 8(4), 597-607), semi-structured interviews are not meant to be repeated as data are only repeated at the time of collection and results may change over time. As a way to address this issue, this study covers the data collection and analysis process in great detail so that it can be replicated and the links between theoretical and empirical data can be clearly shown.

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Appendices

Appendix 1. Interview questions.

1. Background question and company history
    - What is your background and work responsibility at the company?
    - When was the company established and what are the main area of operations?
2. Intermodal Implementation and solutions
    - What are the major challenges in the implementation of combined transports?
    - What are the major technologies used at your terminals and how does it comply with environmental policies?
    - What are the customer expectations and stakeholder interest for combined system of transportation?
3. What is the future for heavy goods vehicles?