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Circular economy and digitalisation as enablers of combined transport

Southern Ostrobothnia

School of Technology and Innovations
Master's thesis in Industrial Management
Master of Science in Economics and Business Administration

Vaasa 2022

UNIVERSITY OF VAASA
School of Technology and Innovations
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Title of the Thesis: Circular economy and digitalisation as enablers of combined transport: Southern Ostrobothnia
Degree: Master of Science in Economics and Business Administration
Programme: Industrial Management
Supervisor: Ville Tuomi
Year: 2022 **Pages:** 85

Abstract:
Globalisation, escalating competitiveness, depleting resources, shifting demographics, regulatory changes, and environmental issues have prompted businesses to create sustainable business strategies in the past few years. This thesis examines the current state of circular economy and supply chain digitalisation in Southern Ostrobothnia small and medium-sized companies. The objective is to identify the business opportunities, level of exploitation and foresight brought by the circular economy and digitalisation. As a result, this thesis forms an understanding of the requirements of circular economy and digitalisation in supply chains and combined transport. In the empirical section of the thesis, companies in the South Ostrobothnia region are interviewed using a semi-structured interview methodology to determine the current status of the circular economy, digitalisation and combined transportation. As a result, fifteen themes are identified, which are further categorised into four main categories. The final section of the thesis compares the results of the literature review and the results from the interviews. It turns out that CE and digitalisation are in symbiosis since most of the CE initiatives are aided or enabled through digitalisation. Digitalisation can be seen as a key enabler of CE since technologies lower operating costs, develops collaboration through the supply chain, aid in closing the material loops, helps construct a regenerative economy and harmonises the objectives of environmental, economic, and social benefits. Digitalisation forces businesses to transform fundamentally. Furthermore, CT itself aligns with the CE objectives through TBL sustainability. CT combines elements of both CE and digitalisation in many respects. When the emphasis on mere economic benefit shifts to ecological and social sustainability principles, CT becomes an even more appealing option. Identifying internal and external factors that align with CE and digitalisation will help businesses to make the shift towards new smart, and more sustainable business models. Therefore, both CE and digitalisation should be comprehensive throughout the entire strategy, not merely technology adoption and operation. Thus, seven requirements were identified from the literature and interviews in regard to CT; 1) networking and collaboration, 2) planning, 3) ITS and digital technologies, 4) infrastructure, 5) awareness and paradigm shift, 6) regulation, policies and political frameworks and 7) service and price ratio. These seven requirements ultimately form a strategic framework for CT enabled by CE and digitalisation.

KEYWORDS: Combined transport, intermodal transport, circular economy, digitalisation

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1 Introduction

There are several things to consider when choosing a mode of transportation, including service quality, transportation expenses, delivery time, delivery location, transportation firm, delivery terms, and more. A properly managed transportation system is necessary to foster prospects for global trade and economic development. The transportation system is currently faced with a variety of difficulties, including external costs and maintaining infrastructure quality (Rotaris et al., 2022). The significance of transportation and logistics has grown significantly over the past few years. For example, as a result of the trend toward globalization, the opportunities it has created and the increase in volume of transportations. However, as governments and individuals become more concerned about the environment, pressure is mounting on both public and private activities to consider all of its consequences (Geissdoerfer et al., 2017). Consumers today increasingly demand transparency and accountability, but at the same time the company also reaps cost benefits from accountability.

Therefore, it is important that logistics is developed based on green growth and new smart ways to operate. We must be able to create smart digital solutions that enable the transition from intake and/or push-driven supply chains to circulating circuits. This thesis is based on strengthening digitalisation and developing operating conditions as well as business models in line with the circular economy. Improving competitiveness is based on creating value by for example, making exports more efficient in a sustainable and intelligent way. This thesis examines combined transport, enabling, e.g. a part of truck transportations, to be carried out by rail, utilizing business models based on digitalisation and circular economy.

In South Ostrobothnia the need for services in the logistics chain and its peripheral conditions by enterprise/industry varies and the opportunities for cooperation are not fully known or exploited, for example, for the combination of transport modes between industries. Internationally combined transport is being increasingly used. Rail transport in Finland has been utilized only by few companies, due to for example, operational challenges, but numerous companies have taken an interest in exploiting rail transport as part of their supply chains. Furthermore, national and EU strategies encourage increased rail transport. Finland is also committed to halving transport emissions by 2030 and to be carbon neutral in 2045.

Globally, new business models, especially those based on the circular economy, have been formed and are forming, which not only create new business opportunities, but require exploration and application in order for them to be deployed in companies. The Europe-wide digitalisation of the rail control system (ERTMS) enables, for example, the development of intermodal transport, increased transport capacity and improved control. As a result, the flexibility and speed of transport will also improve and contribute to better response to the needs of the supply chain. ERTMS development also creates development needs for digital integration throughout the supply chain.

This thesis will be concentrating on the Southern Ostrobothnia small and medium sized companies. Furthermore, the focus is on the road-rail transportation combinations of goods and thus excludes other possible modes and will not consider e.g. public transport. In this light the concentration is shed into such topics as the level, benefits, shortcomings and methods of supply chain digitalisation and circular economy in Southern Ostrobothnia. The main focus is on the business and the value chains. Using the identification of key barriers and drivers this thesis explores the practises, challenges and opportunities faced by companies in Southern Ostrobothnia.

1.1 Background

Improving information exchange, effective collaboration between businesses and consumers, aligning logistic infrastructure to the requirements of the circular economy, and developing unique logistic services are the keys to effective future logistics. Materials are not wasted in a circular economy. Rather, they circulate inside and between supply chains, where they are transformed. What comes to circular economy, logistics has a number of obstacles, including material stream predictability issues, small batch sizes, low material financial value, and material variety and quality (Govindan & Hasanagic, 2018). As businesses and consumers shift from ownership to consumption of services (e.g. Product as a Service, PaaS), logistics services will become increasingly important. A functioning circular economy would therefore require cost-effective and environmentally friendly supply chain management. Currently supply chains are often deficient in sustainable and smart services and operators. There is still a lack of collaboration across companies and segments. In several cases, these flaws obstruct emerging circular economy businesses or dramatically reduce their profitability.

The use of digitalisation in all aspects of the supply chain is one of the major elements when sustainability is in question (Ranta et al., 2021). The necessity of efficient material stream control is highlighted by the circular economy: accurate control, traceability, and new logistical solutions. Developing functional logistics necessitates cooperation across all parties, including cross-sector collaboration and competitive cooperation. However, because road haulage offers more flexibility than rail freight does (Rotaris et al., 2022), a combination of the two modes creates a competitive transportation alternative.

1.2 Research gap, objectives and research questions

In contrast to studying the complete system, the most of combined transport-related scientific research focuses on specific combined transport components. This research tries to fill this research gap, by studying the complete system that could be implemented. Therefore, the idea of a business model can be helpful in this situation because it encapsulates the complete logic of business process. This thesis evaluates the current state of circular economy and supply chain digitalisation in Southern Ostrobothnia small and medium sized companies. The objective is to identify the business opportunities, level of exploitation and foresight brought by the circular economy and digitalisation. As a result, this study forms an understanding of the requirements of circular economy and digitalisation in the supply chains and combined transport. Thus, following research questions are examined:

RQ1: What are the requirements of circular economy and digitalisation in the supply chains and for combined transport?

RQ2: How does circular economy and digitalisation enable combined transport business models?

These research questions have two contributions. First, it advances our understanding of circular economy supply chains and offers practical advice for practitioners by empirically examining the connections between different types of circular economy supply chain practices and business supply chain performance. It clarifies how circular economy principles are applied across the supply chain. This study also intervenes in the discussion of whether and how digitalisation might influence supply chains value chain and outcomes by responding to the need for more research on the relationship between the circular economy and digitalisation in supply chains, business performance and combined transport.

1.3 Structure

The structure proceeds as follows. First, chapter 2 introduces the theoretical background. This chapter includes every element and detail related to the thesis's goal and research questions, as well as material needed to comprehend the issue at hand and conduct an empirical investigation. The research approach is presented in Chapter 3. The data gathering procedure is presented together with the research strategy, design, and methodologies. Results from empirical research and interviews are presented in Chapter 4. Chapter 5 compares and connects the theory with the empirical evidence to present an analysis and discussion. A discussion of the validity and dependability of the findings as well as the advantages of the chosen methodologies is also provided. Finally, some conclusions are drawn, and some future research is suggested.

2 Literature review

This chapter presents the theory basis of the thesis in a five-fold manner, each addressing specific issue. First theory addressed is value chain, operation of markets and business models. Second theory addressed is circular economy and the idea behind sustainability. Third, supply chains and combined transport are presented. Fourth, digitalisation is discussed. And finally, some insights and synergizing of the topics are discussed and some critical reflections are presented.

2.1 Value chain, operation of markets and business models

The concept of value chain was introduced in 1985 by Michael Porter. A value chain is a collection of operations that are necessary to create an offering and capture value. As such, it is a technique for ensuring that each task completed adds to the overall value of a product or service (Liao et al., 2017; Porter, 1998). The focus of value chain thinking is on cost reduction and value maximization. Porter (1998) defines inbound logistics, operations, outbound logistics, marketing and sales and service as company's primary activities. These five components are all vital for adding value and creating competitive advantage. Operational effectiveness – doing the same things as others but better – or strategic positioning – giving distinctive value to clients – are two ways to gain a competitive advantage. If the latter is a preferred competitive approach, organizations must adjust their value chains to develop and distribute this distinctive value to customers (Kano et al., 2022; Porter, 1998).

Porter (1998) also talks about support activities. The purpose of support activities is to aid in the efficiency of primary activities. Whenever one of the four support activities become more efficient, it helps at least one of the five primary activities. On a company's revenue statement, these support operations are usually stated as overhead costs. According to Porter (1998) procurement, technological development, human resources management (HR), and infrastructure are categorized as such support activities.

Porter (1998) also introduces five dimensions that describe the competitive forces that affects company, called *five forces*. Five forces is widely used as a business analysis tool, that analyses competition intensity, attractiveness and possible profitability of a market. Operators in the same sector who sell identical goods or services and compete against each other are referred to as industry competition. One of the most important competitive factors is the threat of new entrants, whose magnitude is determined by the industry's market entry barriers. For example, customers buying products or services, as well as providers of industry resources and manufacturing components, are all part of the same logistical value chain. Naturally, suppliers and purchasers want to maximize profits in their businesses, and their impact is determined by their bargaining strength. Other competitive industries or organizations that offer alternative solutions to satisfy the requirement for branch-specific items or services are referred to as substitute products or services. The threat of substitute goods is dependent on the price-quality ratio of other branches or companies' products or services.

Furthermore, according to Osterwalder et al. (2010) business model explains the rationale for how company creates, delivers and captures value. Essentially, it’s a description of how an organization makes profit, the offering the business plans to sell and how it plans to accomplish this (Sjödin et al., 2020). When implemented successfully, it allows companies to meet the customers’ needs at competitive prices and sustainable costs (Bocken et al., 2019). Osterwalder (2004) defines nine business model building blocks; customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. Customer segments are served by a company, which uses value propositions to address customer problems and meet demands of the customers with a product or service. Customers receive these value propositions from customer interfaces such as communication, distribution, and sales channels. Each customer segment has its own set of customer connections and relationships that form a link between the business and customer and must be maintained. Value propositions that are successfully presented to customers generate revenue streams. The assets necessary to provide and deliver the previously specified aspects by carrying out a series of key activities are known as key resources. Some tasks are outsourced, and thus some resources are obtained from outside the company, making these connections partnerships. The value configuration (the arrangement of key activities and resources), capability and partnerships form an infrastructure management. And finally, the results can be seen in the cost structure, since it describes all incurred costs of a business model. These nine building blocks form a tool called the Business Model Canvas, which can be used for example, to model existing business models or to develop new ones.

2.2 Circular economy

Circular economy (CE) refers to an economic activity that seeks to operate in a sustainable manner, ensuring that materials are used and circulated as long as possible (Kirchherr et al., 2017). Despite the common usage of term circular economy, there is some discrepancy on the definition. However, the CE is often presented as the next step in development compared with the traditional linear economy, where raw materials are turned into products for use and eventually disposed (Prieto-Sandoval et al., 2018). CE has three aims which are to be achieved at the same time, which is sometimes also called triple bottom line (TBL). These objectives are environmental quality, economic prosperity and social equity (Kirchherr et al., 2017). Consequently, CE strives towards resource efficient operations, where the process does not waste materials.

Often the term sustainability is also used in this context. Sustainability is built on three pillars of environmental, economic and social sustainability, and can be thus called also as triple bottom line sustainability (Ghobakhloo, 2020). Thus, it involves preserving all three types of resources. Environmental sustainability primarily focuses on preserving the balance of the planet's ecological systems, the harmony between the use and replenishment of natural assets, and preservation of natural resources. Lasting economic growth whilst maintaining social and natural resources is referred to as economic sustainability. According to this viewpoint, financial expectations should not come at the expense of environmental or social capital depletion. Therefore, the balance of the environment, ecosystems, social welfare, and wealth distribution should not be overlooked in the pursuit of economic growth (Ghobakhloo, 2020; Prieto-Sandoval et al., 2019). Recognizing and controlling both positive and negative effects that business, the environment, the economy, and technology have on people is the process of social sustainability (Turoń & Czech, 2017).

Objectives related to the CE have been often set by governments regionally, by industry, on supply chains, and on a company-by-company basis. Governments create regulation for industries and the task is to improve circulation generation (Sarja et al., 2021). For companies, CE projects are about improving the eco-efficiency of their businesses, developing new business opportunities, and sometimes purely cost savings, which could potentially create a competitive advantage for the implementing company (Geisendorf & Pietrulla, 2018). CE is implemented from the top down with policies by governments nationally and internationally, and from the bottom up with company initiatives (Lehtimäki et al., 2020). Therefore, CE should be part of the strategy to build a competitive advantage by adding value to customers with products and services that are more environmentally friendly than their competitors (Prieto-Sandoval et al., 2019).

2.2.1 Implementation

There can be different types of core implementation principles identified in CE literature. Most of them relating to R frameworks and systems perspective. In academia, there are various R frameworks proposed by the scholars, such as 3Rs, 4Rs, 6Rs or even 9Rs. All these different R frameworks share the same hierarchy structure and same core ideas of smarter product use and manufacture, extending lifespan of product and its parts, and useful application of materials. The 9R framework is the broadest of the R frameworks, which includes following strategies: refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover (Kirchherr et al., 2017). The another type of implementation principle is the systems perspective, where CE needs to be implemented at micro (companies and consumers), meso (local ecosystems and industrial networks) and macro (EU, nations, cities, and regions) levels (Prieto-Sandoval et al., 2019).

CE is about turning inefficiencies of current linear value chain model into business value in circular value chain. In other words, CE creates a value shift from current linear model, which has inefficiencies to circular model. Literature recognizes several inefficiencies of linear value chains, such as unsustainable materials, underutilized capacities, premature product lives, unexploited customer engagements, and wasted end of life value. For the businesses to become circular they need to implement new ways of doing their business, by narrowing, slowing and closing and regenerating their material and energy flows (Konietzko et al., 2020). In Figure 1 is illustrated the framework for CE business models.

According to Bocken et al. (2016) to narrow the flows business', need to be resource efficient, which means that they need to use less material and energy, for example through sharing platforms. To slow the flows businesses, need to promote and use products and components longer, which can be done through business models that encourage long product life and reuse, such as product as a service (PaaS), extending product value, classic long-life model and sufficiency models (promoting principles such as durability, upgradability, service, warrantees, reparability, and no sales commissions). To close the loops businesses, need to capture the value from waste and by-products, which can be achieved by extending resource value (by utilizing otherwise wasted value from materials and resources and turning these into new forms of value) and/or by industrial symbiosis where value outputs are utilized by another process or company. And finally, to regenerate, businesses use non-toxic materials, renewable energy and regenerate natural resources. Thus, CE has two main purposes; to create as closed-loop system as possible to minimize resource inputs and also to reduce waste, carbon emissions and pollution.

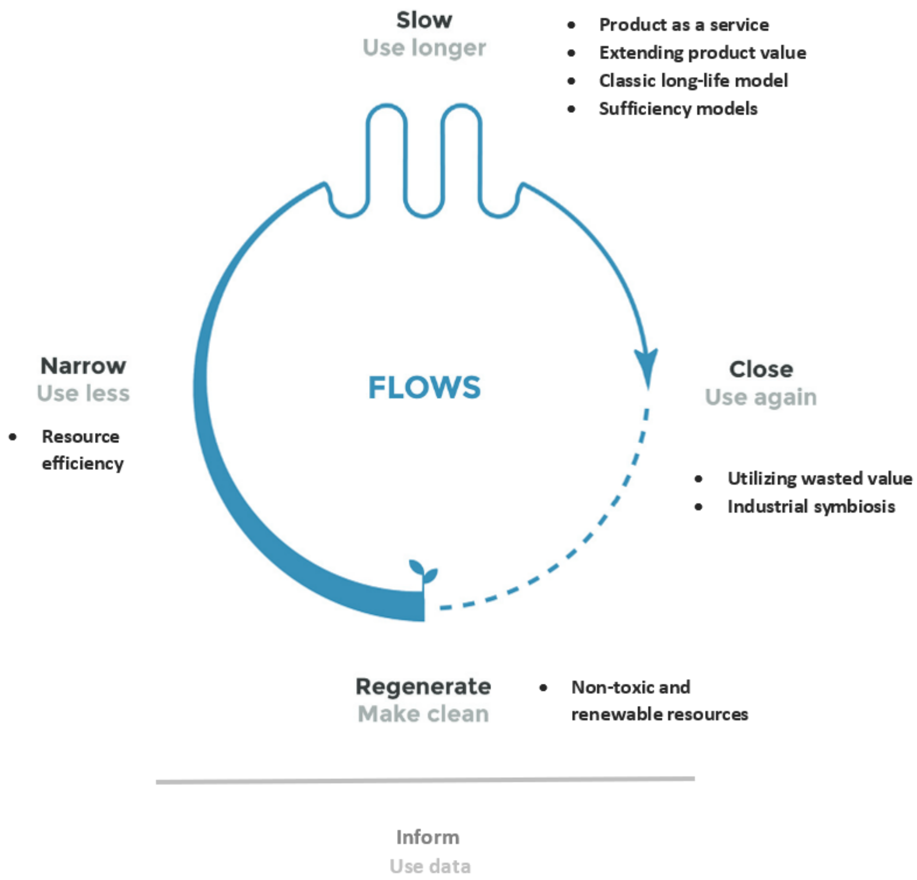

Figure 1 Framework for CE Business Models (adapted from Konietzko et al., 2020)

Consequently, CE helps businesses to capture value, which would be otherwise lost in traditional linear system. By implementing CE, companies create new opportunities, such as cost savings through waste reduction, better supply chain management, decreased sensitivity to resource price volatility, and stronger customer relationships (Lahti et al., 2018). Often business models have different definitions, but most people agree that business models explain how companies create and capture value. Ranta et al. (2018) also add an aspect to this definition by stating that the business model needs to create value for both the customer and the company. Therefore, business model plays a critical role in combining these two perspectives of value creation into one concept. In Figure 2 is illustrated the value shift and competitive advantage model for achieving CE.

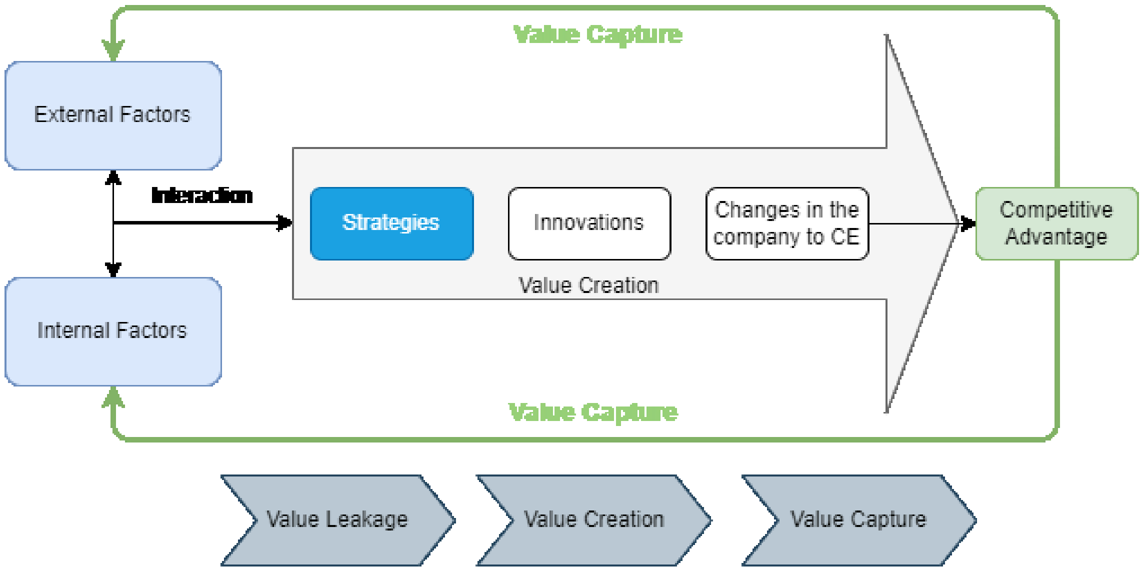

Figure 2 The Value Shift and Competitive Advantage model for achieving CE (adapted from Prieto-Sandoval et al., 2019)

In order to design new business strategy, company should start by examining the relationship between external and internal factors and identify the value leakages i.e. where are the inefficiencies. External factors include stakeholders, technological, political, and economic conditions. Internal factors include organizational resources, capabilities and competences (Prieto-Sandoval et al., 2019; Suchek et al., 2021). In order for the companies to execute the shift towards CE they need to reconfigure their core internal and external factors in line with CE principles. Since top management makes structural alignment decisions, top manager creativity, competence, and commitment are critical factors for considering the transition to CE (Lahti et al., 2018). When innovating new way of thinking and doing business, companies can utilize the CE principles for example, from 9R and/or systems thinking frameworks and apply them into different already existing business model frameworks, such as earlier introduced narrowing, slowing, closing and regenerating of the flows.

For to CE based business model to succeed, reverse logistics (RL) process and networks must be established to improve communications, integrate information across different activities, and to improve responsiveness (Lahti et al., 2018). RL refers to the process of planning, implementing and controlling backflow of raw materials, work-in-progress inventory, packaging, and finished goods from the point of manufacture, distribution, or use to the point of recovery or proper disposal (Geisendorf & Pietrulla, 2018). RL process will play increasingly important role in CE, since these reverse material flows play crucial role in circularity.

2.3 Supply chains and combined transport

Supply chains are traditionally viewed as the way of looking at the creation of business value, explaining the steps required to move a product or service from production to consumption, and showing how to minimise the cost of each step (Hearn & Pace, 2006). Thus, supply chains are seen as important since they allow companies an access to the most cost-effective resources in its system. Globalization has played a significant role in enhancing opportunities for many manufacturers, dealers and other business organizations through supply chains, for example, through outsourcing (Khanna et al., 2005; Schaltegger & Burritt, 2014). Strategies to strengthen companies' competitive advantage is implemented by responding to customers' needs, which is done through supply chain management (SCM).

The supply chain connects the company and its various stakeholders, creating a chain with an emphasis on cost efficiency, customer orientation and added value generation. SCM is normally defined as the integration, planning, guidance and management of key business processes, where different organisations from end to original suppliers collaboratively control and develop material and service flows, and related to these money and information flows, adding value to customers and to other stakeholders (Mustafa Kamal & Irani, 2014; Schaltegger & Burritt, 2014). Chain structure and its development are key themes in supply chain management, which also emphasizes chain transparency, reliability and cooperation between chain stakeholders. To improve competitiveness, the chain costs are aimed at getting as low as possible, as well as delivering the products to customers according to the agreed value proposition (Liao et al., 2017). Therefore, we can state that SCM is predominantly intended as business function.

One of the most known and widely adopted SCM strategy implementation tools is Supply chain operations reference (SCOR) model, which consists of the plan, source, make, deliver and return processes. These processes describe the business processes required to meet the customer demand and are repeated along the supply chain (Wang et al., 2010). SCOR can also be used as supply chain performance metrics tool. Supply chain management is a critical activity because efficient supply chains result in for example, cheaper costs and shorter production cycles (Büyüközkan & Göçer, 2018; Wang et al., 2010). Thus, SCOR provides the general supply chain framework and best practices and it can be used for example to identify inefficiencies of supply chains.

Often definitions of logistics and SCM are mixed up and are therefore sometimes referred as synonyms. However, logistics is separate dimension of SCM that plans, implements and controls the efficient and effective forward and reverse flows, warehousing, services and relevant information for consumer, that meet customer needs (Kozma et al., 2019). Therefore, we can state that logistics supports the material and information flows of the supply chain. Transportation management is part of logistics, when referred to SCM, and it usually comprehends the material flows (Grazia Speranza, 2018). Generally, transportation is seen as a key factor in satisfying customer needs due to its effect on punctuality, timeliness, accuracy, and the ability to offer tracking information (Perego et al., 2011). Effective transportation and good transportation networks are crucial for companies to compete in the global economy.

Usually in regard to competitiveness the key role of logistics and transportation infrastructure of supply chains is acknowledged in literature. Logistics costs are an important and relevant part of business costs, usually surpassing 10% of a company's gross profit (Engblom et al., 2012). Therefore, savings in logistics can contribute to gaining the competitive advantage, since transportation costs correlate directly to the profit margin of the company. However, it should be noted that the logistics costs comprise of multitude of factors, such as fuel prices and market conditions, which is why the cost structures differ from one another. Transportation costs are estimated to be somewhere between 25% and 50% of overall logistics costs (Perego et al., 2011).

Generally, competitive logistics are thought to aim to deliver the right product, at the right time, in the right place and to the right customer. However, environmental and social considerations play a crucial role as well, nowadays (Cedillo-Campos et al., 2022). The transport sector in EU is committed to halving transport emissions by 2030 and to be 90% carbon neutral in 2050. The transport sector alone accounts for approximately 25% of EU emissions. The environmental impact differs significantly between different modes of transport (Rotaris et al., 2022). The market conditions are clearly changing and these growing demands on sustainability and efficiency, growing volumes, customer demands and profit making create a demand for new solutions, especially in the transport sector.

2.3.1 Combined transport

One of the most popular alternative solutions for improving businesses supply chains globally is combining transport methods. The combination of two or more modes of transport to form a transport chain is through and through established practise in transport sector. However, so far, there is no general consensus on a universal definition (Reis et al., 2013). For example, such concepts as multimodal, intermodal, combined, co-modal and synchromodal have been proposed as definitions. All of these concepts for the most part overlap with each other. In the literature, the most used definition is intermodal transport. Even though, there are some discrepancy on the intermodal definitions, most use same definition of "*transporting goods in one and the same loading unit or road vehicle that uses two or more modes of transport successively without handling the goods themselves in changing modes*" (Agamez-Arias & Moyano-Fuentes, 2017; Bontekoning et al., 2004; Mathisen & Hanssen, 2014; Reis, 2015; Reis et al., 2013).

Combined transport (CT) is often seen as a special form of intermodal transport, where sustainability, door-to-door service, railways and EU area are commonly highlighted (Agamez-Arias & Moyano-Fuentes, 2017; Reis, 2015; Reis et al., 2013). CT is a *"form of intermodal transport where the major part of the journey is by rail and any initial and/or final legs carried out by road as short as possible"* (Reis, 2015 ; UNICE, 2001). Essentially, CT is the sustainable form of intermodal transport that focuses on the combination of road-rail transport and door-to-door service in the EU region. CT was originally developed by the European Commission (EC) to incorporate the freight transport business into European Union (EU) policy for sustainable development (Reis, 2015). The core idea behind this concept is to utilize the strengths of both modes in order to achieve the economic and environmental goals.

Often rail is considered as one of the more environmentally friendly options of transportation, with economies of scale when distances increase (Mindur, 2021; Rotaris et al., 2022). However, to this day road has remained as the most used mode of transport, and there are multiple reasons for this. Road infrastructure is by far the most extensive when compared to the other modes, which offers flexibility. Especially, with short distances delivery cannot be transported faster by using other modes, making it in most cases the fastest option. Additionally, roads can be used by almost any vehicle that has wheels and they are usually maintained by the governments making them extremely compatible and cost effective for companies (Reis et al., 2013). However, recently the market conditions have been changing rapidly, especially in EU due to economic volatility caused by the COVID-19 pandemic and Russia-Ukraine war. For example, fuel prices have been on the rise, traffic has been increasing, energy market is facing difficulties, and environmental considerations have become an important aspect of new transportation regulation. All these developments affect road transport, especially the cost and speed aspect, making road less appealing.

Especially, recent years EU has been lobbying for CT e.g. via regulation and environmental goals. Combined road-rail transport utilizes the flexibility of road and the energy efficiency and low carbon footprint of rail (Rotaris et al., 2022). Compared to using single mode of road, it is estimated that CT saves 20% on transportation costs and reaches the equilibrium point of train loading space utilization by 63%. Additionally, CT can minimize the environmental impact by up to 57% in terms of CO2 emissions, when compared to scenario where only mode used is road (Agamez-Arias & Moyano-Fuentes, 2017). In many of the EU countries transportation sector is taxed or will be taxed in the future according to its negative impact. Since road transportation is more polluting it has to pay more taxes compared to rail services. Thus, it can be stated that CT is a key factor in the future in creating competitive advantage for logistics. However, CT still has problems competing with road transport and it is underutilized.

The underutilization or in other words low demand of CT is caused by variety of factors (Altuntaş Vural et al., 2020). In the literature one of the main factor recognized is increased cost due to investments on infrastructure, which is somewhat a political issue (Agamez-Arias & Moyano-Fuentes, 2017; Altuntaş Vural et al., 2020; Russo & Gronalt, 2021). Beuthe et al. (2014) and Reis et al. (2013) both concluded that the demand for CT is quite price inelastic and that it fluctuates according to the distance and commodity type, descending with longer distances and heavier goods. Overall, CT costs can be divided into internal and external costs (Carboni & Dalla Chiara, 2018). CT solution should create some cost reductions or at least meet the costs of truck transportation solution, for CT to be viable alternative.

Another widely recognized factor in the literature is the complexity of coordination of transportation operations and stakeholder network, which affects the entire performance in quality, reliability and transport times (Demir et al., 2019; Eng-Larsson & Kohn, 2012; Rotaris et al., 2022; Russo & Gronalt, 2021). Therefore, CT must be well functioning in terms of quality, reliability and transit time before the cost factor can be fully considered. Other, less frequently, mentioned factors are competition, possible problems with modern forms of business, problems with logistics between modes, and lower flexibility in terms of timetables and price strategies (Demir et al., 2019; Minárik, 2021; Rotaris et al., 2022). It is also good to note the effect of knowledge, perceptions and understanding of CT. For example, often businesses transportation planners prefer modes that they have already experience of and therefore perceive the performance of CT as insufficient (Demir et al., 2019).

Consequently, it can be stated that both effective transportation infrastructure and planning play a key role in success of CT. Value can be created by utilizing technological or operational improvements, which should be reflected also as continuous improvements of service offering so that consumers recognize a value creation (Altuntaş Vural et al., 2020; Reis et al., 2013; Russo & Gronalt, 2021). Integrated information flows, volume, value, transit times, travel-time reliability and cost measures are common across supply chains and these can be scaled up or down with help of digital technologies, depending on the use case (Cedillo-Campos et al., 2022). Not only horizontal collaboration between actors in CT network, but also vertical collaboration is needed between transport modes (Altuntaş Vural et al., 2020). Consequently, the priority of CT is highly dependent on the impact on logistics performance required throughout the supply chain, which requires thorough planning.

Transportation planning happens in three decision levels of strategic-, tactical- and operational-level. CT chain requires more coordination effort than single mode transportation. The reliability of the system can be lower than in single mode transportation such as road, since there is a way to take into account the potential disruptions by creating a robust plan and being able to respond quickly to events that make the plan infeasible (Agamez-Arias & Moyano-Fuentes, 2017; Demir et al., 2019). Moreover, distance, the quantity of transfers, drayage activities, container loading, local delivery, etc. all affect transit time. The level of predictability and the certainty of arrival time are both factors in the reliability of transportation. It is impacted by things including infrastructure upkeep, traffic congestion, accidents, and management errors, as well as by harsh weather or natural catastrophes. In this regard, there are already numerous mathematical models that deals with planning and transportation issues. However, the environmental aspect in this context is still yet to be adequately covered. Additionally, digitalisation offers numerous solutions that allow e.g. identification, localization, visibility, communication, monitoring and sensing of different flows and thus helps to optimize these flows. Optimizing the efficiency both in economic and environmental terms, can be achieved by utilizing digitalisation and CE principles through for example, intelligent transport system (ITS).

CT system consists of shippers who create the demand for transportation, carriers who supply the services, administrators of facilities and physical infrastructure, institutional regulators of the system, and buyers and citizens who place orders for commodities (Crainic et al., 2018). This system is illustrated in Figure 3. Due to the fact that they are often the ones that send the products, shippers create the need for freight transportation. They manage or take role in an organization of where and how their freight should be transported and schedule shipments to meet their consumers demands. Consequently, they specify their logistics plan, which may involve CT. For shippers, carriers handle the transportation. While some carriers operate on the principle of concentration, where each unit may hold freight from several customers with diverse origins or final destinations, others operate on the premise of dedicated services, where a unit serves a single client.

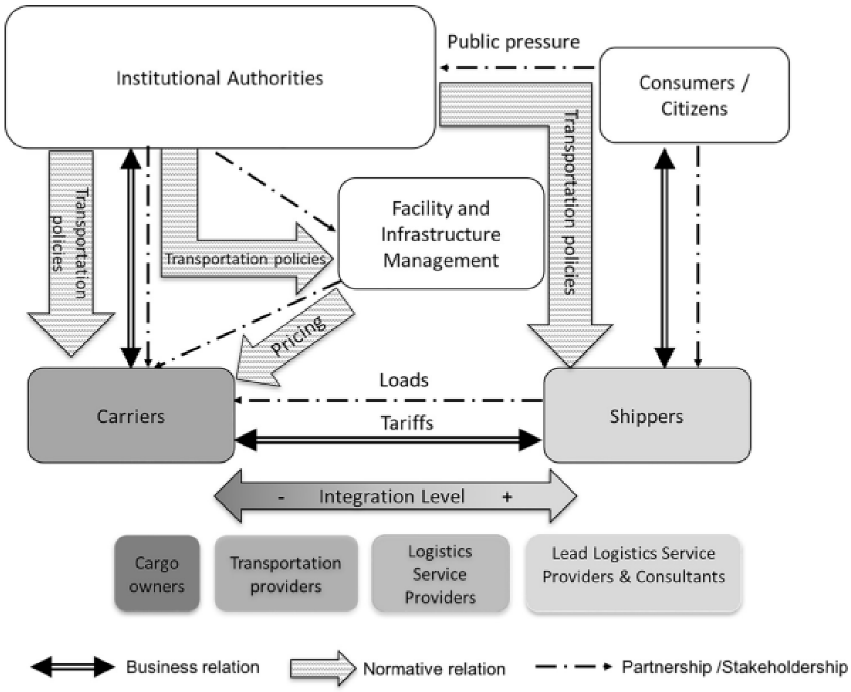

Figure 3 Relationships among the main actors in CT system (Crainic et al., 2018)

In CT system, freight logistics providers (FLPs), particularly third-party logistics service providers (3PLs), carry out many logistics tasks and offer a variety of logistics services. For both nationally and internationally CT activities, FLPs work in conjunction with shippers (Crainic et al., 2018; Giusti et al., 2019). In fact, shippers may outsource logistics functions so they may concentrate on their core operations and get access to FLPs' expertise. However, 3PLs also work with carriers to guarantee prompt transit capacity for their clients. They occasionally could show up as carriers in this sense.

Public or private companies with public stakeholders may manage facilities and infrastructure. Instead of planning, organizing, or implementing freight transportation services, they manage the physical network and infrastructure, such ERTMS, intermodal port terminals, and other elements including roads and highways (Crainic et al., 2018). Thus, they play a crucial role in controlling and maximizing the usage of the infrastructure and facilities by providing effective physical networks as well as the required technology and sensor layers.

The actors who impose taxes, provide incentives, establish regulations, and control transportation operations are institutional authorities (such as governments and public administrations) (Crainic et al., 2018). These actors progressively seek to direct the logistics and transport system to more resilient ways of operation for example, through the policies they establish, such as the use of particular routes, vehicles and fuel types, for instance by switching from road to rail, reducing externalities and taking environmental impacts into account.

Customers represents the packages' recipients. They might be the wholesaler, distributor, retailer, or the end customer. Customers also include citizens; thus, they are concerned about local pollution, safety, and viability, and they have the power to influence institutional authorities by voting. The aforementioned actors are connected to one another by numerous linkages, interactions, and interdependencies. Each actor has their own objectives and makes their own judgments. CT is a complicated system that is made up of many moving parts (Crainic et al., 2018; Giusti et al., 2019). Additionally, uncertainty from a variety of sources, frequently pertaining to demand, transit delays, and handling procedures, may have an impact on these decisions and their interrelations. The interoperability of the operational activities and modes, as well as behavioural factors, are therefore necessary for the efficiency and dependability of the CT system.

2.3.2 Market and Competition of railway

The liberalization and deregulation of EU’s rail freight transport sector has aimed to change the market paradigm from a domestic market and monopolies into a competitive and unified European market. The initial idea behind this was to find a solution to the decline of the rail freight market and its lack of competitiveness when compared to road freight (Laroche et al., 2017). For example, Finland opened its international rail freight transport market in 2003, and domestic in 2007 (Laisi et al., 2012). Yet, Finland has struggled to attract newcomers, and consequently the market share has been static compared to truck transportation, making it highly monopolistic and slow for changes.

According to study conducted by Laisi et al. (2012), the main barriers to market entry in Finland are railway vehicle purchases, access to existing railway company services, and bureaucracy. One of the main finding was that it is virtually impossible to acquire used railroad rolling stock in Finland due to Finland's unique track width. Another finding concerned the access to railway services, since the incumbent rail operator(s) may prevent the access to these services, through for instance price competition and sharing corridors. Recruiting people with needed skills and qualifications is also seen as a barrier in Finnish markets. Additionally, there is a lot of so-called red tape that needs to be tackled before one could operate on rail, which can be quite demanding especially for new entrants.

The Finnish Railway Act (Finlex, 2018) states that rail transport operators must complete following four steps in order to enter the railway freight market. First stage is to apply for the safety certificate granted by the Finnish Rail Agency. The second stage is to apply for the operating license, which is granted by the Ministry of Transport and Communications of Finland. These licenses are valid in the whole European Economic Area. Once these documents have been granted (not more than for five years), the third stage is to request railway capacity from the Finnish Rail Administration. This request needs to be applied at least eight months beforehand and it stands until next capacity requesting period. This means that the entrant railway operator needs to know its capacity and demand almost one year beforehand, which might be difficult to estimate without any previous experience or data. The fourth and final stage is making a contract on rail network usage and on the rail traffic services. After these four stages are completed and all requirements are fulfilled the railway undertaking can start operating.

Furthermore, Porter's five forces model is useful in analysing railway transportation markets. Thus, the forces could be e.g. industry competition, new railway ventures, substitute forms of transportation, the power of consumers choosing to buy transport services, and the supplier's power if applied to rail freight transport. The consumers' influence on the freight transport markets and the creation of competition inside the branch is undeniable. These five forces are illustrated in Figure 4. This means that enterprises entering the rail transport market will compete for other elements of the value chain, such as customers and resources, inside the branch. In Finland's case the most significant market barriers could be e.g. the threat of substitutes and the bargaining power of buyers. Therefore, since there are a number of market barriers, the attractiveness of railway transport market decreases consequently i.e. there are less new entrants for the market.

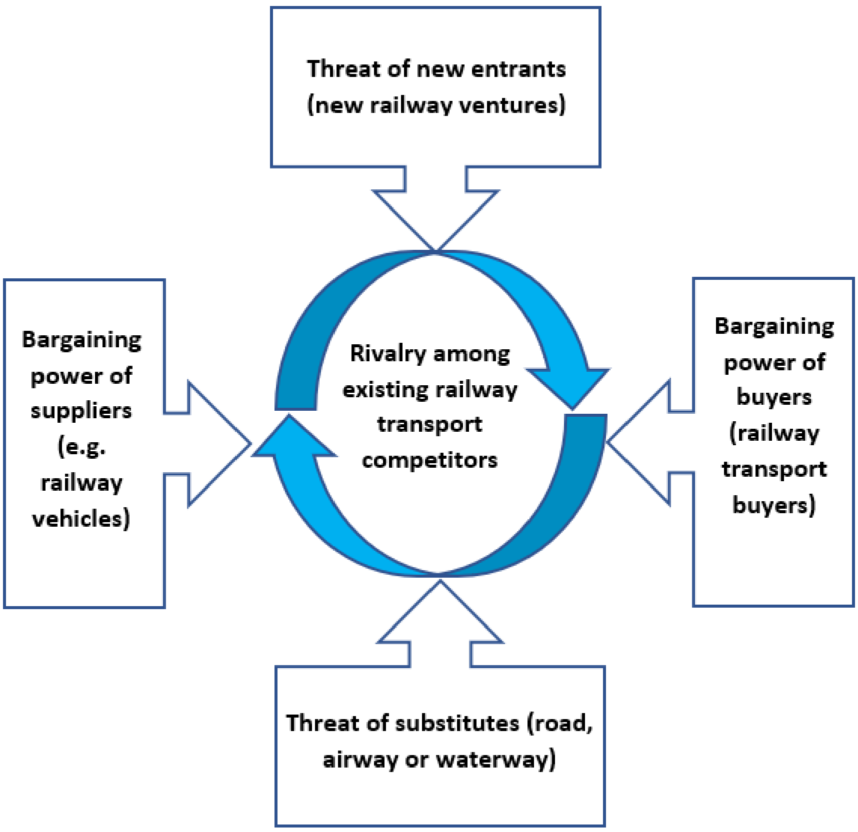

Figure 4 Five forces of rail transport competition

2.3.3 Combined transport Business Models

Since, earlier SCM was defined as a business function, it can be concluded that transportation is also strongly connected to business. Regardless of the various advantages of CT (environment, quality, etc.), CT solutions must be also financially viable to persist. CT necessitates collaboration across various entities, making the creation of a successful business model difficult but necessary for economically viable solutions. Business models are seldom researched in CT or intermodal sector. Lehtinen & Bask (2012) present four business model options for intermodal transport, where maximum of three different modes can be utilized. Nevertheless, the basis is the same as only two modes are used and since the initial and final legs of the CT transportation requires the same number of stops as would three modes. Overall, literature on intermodal or CT business models requires more research.

Business model one, *Operator-3PL Model* is illustrated in Figure 5, where a strategic alliance is formed amidst the actors i.e. 3PL and the rail freight service provider (Perego et al., 2011). The transport conditions are negotiated by the 3PL with the sellers and/or the buyers of the product. In service delivery process, the rail freight operator is responsible of rail operations coordination and it is mostly concerned with train operations between hubs.

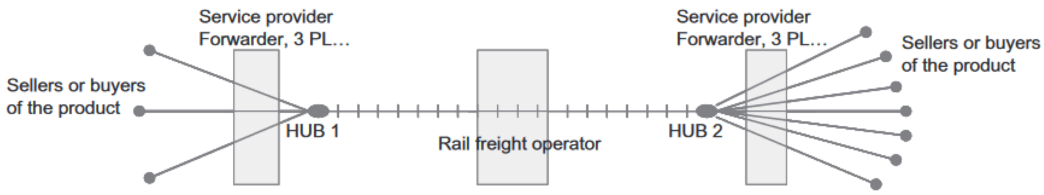

Figure 5 Operator – 3PL Model (adapted from Lehtinen & Bask, 2012)

Business model two, *Anchor Customer Model* is illustrated in Figure 6, where the train freight and other operators have direct contact with the client. The presence of one or a few clients, each of whom supplies a considerable amount of freight for the corridor, is typical in this situation. Customarily, the customer is in charge of overseeing the door-to-door service (modes and related schedule). The rail freight service provider, conversely, takes care of the hub-to-hub service and therefore has no particular interaction with other operators because the client is responsible for coordination. In other words, there is no specific cooperation, rather than each operator concentrates on its own offering. The type of goods that are generally transported are industrial and bulk goods.

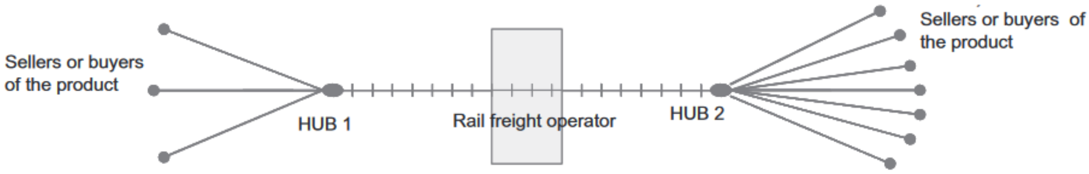

Figure 6 Anchor Customer Model (adapted from Lehtinen & Bask, 2012)

In Figure 7 is illustrated the business model three, the *Agent Model*. In this approach, the rail freight transporter organizes a network of agents to offer customers from each location local services. The rail freight carrier oversees the corridor, while the agents offer regional services and negotiate on the operator's behalf. The agency and 3PL models differ in that the 3PL is generally more self-reliant and offers a wider range of services and possibilities. Agents concentrate on producing services for a certain mode of transportation or chain. The rail operator as well as its network of agents are in charge of providing door-to-door service in this situation.

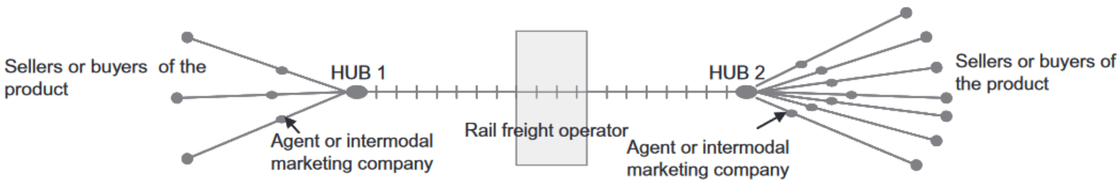

Figure 7 Agent Model (adapted from Lehtinen & Bask, 2012)

And finally, in Figure 8 is illustrated the *3PL Model*, which is the fourth business model. In this model the 3PL plays a crucial role and the railroad operator concentrates on running trains as a member of the 3PL service providers. Customers are in straight communication with 3PL service operators, who handle the entire transportation chain. The fundamental distinction between the Operator-3PL model and the 3PL model seems to be that 3PLs are not bound to any particular intermodal mode, but can select from all accessible possibilities. The 3PLs either work together or compete with one another. They can run a corridor with just a few rail freight operators (identical) if they collaborate. However, more freight operators will be required if they are to compete.

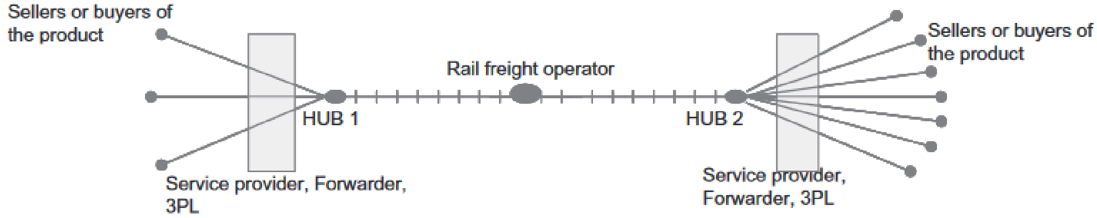

Figure 8 3PL Model (adapted from Lehtinen & Bask, 2012)

According to Lehtinen & Bask (2012) the most commonly used business model of these four in the EU region is the first one, *Operator-3PL* model. They also conducted a survey among potential service users and potential service providers from Austria, Bulgary, Czech, Finland, Greece, Norway, Poland and Romania. The conclusion was that the first business model (*Operator-3PL*) was seen as the most potential one in regards of starting such operations and the business model four (*3PL*) was seen as the model after five years. The *Anchor Customer* and *Agent* models are seen as most suitable for bigger customers that have an interest of establishing their own corridor.

On the other hand, Macharis et al. (2014) describe four business models for intermodal transport as well. The classic intermodal business model is represented by the *subcontractor model*, in which the intermodal actor is a rail operator that works as a subcontractor for the road transport/forwarder actors, which are the target clients. When it comes to end-customer interaction, road transport/forwarders are channel leaders. The *complete transport company model* depicts a scenario in which the multimodal actor assumes the position of channel leader and contacts end customers directly as the target customer. The model includes a full transportation service, including train and road transfer both to and from ports. *The local cooperation model* is one in which intermodal transportation is organized by one or more local players working together, frequently with the help of local officials. This cooperative model focuses on local requirements and run by local industry in collaboration, frequently on a single tiny endpoint which is too small to attract large commercial actors' attention, but is destined for one of the larger hubs or cities. The *own-account transport model* presents a situation in which a large-volume actor employs intermodal transportation in a closed system for the own transportation. In this model, a large company or forwarder with a large volume of freight begins operating its own intermodal transportation services, in which the corporation owns and coordinates the intermodal transportation, such as setting the prerequisites and, most likely, subcontracting the actual transportation operations.

2.4 Digitalisation

Digital disruption is a result of the phenomenal advancement of information and communication technology (ICT) (Queiroz et al., 2019). Traditional business models focused mostly on physical tasks are being challenged and migrating to digitalisation in this setting. All industries are affected by the digitalisation trend (Büyüközkan & Göçer, 2018). As a result, digital disruption has an impact on not only business models but also other aspects of society, including new partnerships and interactions with organizations and people. Digitalisation is trend that is forcing businesses to adapt and develop their digital skills in all areas in order to survive and thrive. It enables businesses to overcome uncertainty and effectively adapt to business demands (Alsufyani & Gill, 2022). Digitalisation is about fundamental transformation in organizational strategy, business processes, organizational knowledge, and the entire socio-technical organizational system, not just technology adoption.

For the term digitalisation, it is challenging to find an accurate and universal description of what it means in itself. In most works, digitalisation is described by its impact on business, society and industry, or by the changes new technologies bring to accustomed practices. Digitalisation is built on the technologies it contains and digitisation (Queiroz et al., 2019). Even though the terms digitisation and digitalisation are frequently used interchangeably, digitalisation should be differentiated from digitisation. Digitisation is the technological process of turning analogue signals into digital form, and then into binary numbers. The impact of these technologies, as a result of their adoption and operation, on organizational and societal viewpoints is referred to as digitalisation (Legner et al., 2017). Thus, digitisation is a subset of digitalisation.

2.4.1 Industry 4.0

The fourth industrial revolution is now taking place and is also referred to as Industry 4.0. Industry 4.0 describes the evolution towards automation and information exchange in a networked environment. Industry 4.0's innovations are not so much physical new devices, but rather intangible phenomena. This includes several disruptive innovations and cutting-edge technologies such as cyber physical systems (CPS), internet of things (IoT), cloud computing, quantum computing, and artificial intelligence (AI) enabling industry 4.0 (Ghobakhloo, 2020). Industry 4.0 allows for a more comprehensive networked and holistic approach as well. By combining physical with digital, Industry 4.0 allows better cooperation and communication between different stakeholders (Queiroz et al., 2019). The network is integrated vertically and horizontally, which considerably improves the whole system's efficiency and production (Gupta et al., 2022). The Fourth industrial revolution could thus be characterised as the phenomenon of the confluence of digital and physical industries, referring to the complete digital transformation of the industrial and consumer sectors, from the introduction of smart production through the digitalisation of all value delivery channels.

New technologies are altering traditional supply chains and expediting the change to digitalized supply chains, according to the Industry 4.0 perspective. The following are some of the top technologies related to the supply chains in this context: Smart sensors (RFID, NFC, Bluetooth), cloud technology, the internet of things (IoT), additive manufacturing (3D printing), augmented reality/virtual reality (AR/VR), big data analytics, artificial intelligence/machine learning, robotics, cyber physical systems (CPS), cyber security, geospatial technologies and blockchain. New technologies are emerging rapidly and therefore it is hard to determine fully comprehensive list of all the technologies involved. However, Pagoropoulos et al. (2017) propose categorization where these digital technologies are divided to data collection, data integration, and data analysis, based on function. According to Han et al. (2021) the corresponding solutions for the functional requirements of companies digital technologies are hardware (data collection), software (data integration), and mathematic modelling (data analysis). Thus, hardware forms the basis, software the next layer and the mathematic modelling the tip of the functional requirements.

2.4.2 Digital supply chains

Digital supply chain is also still developing concept, but the core idea behind this concept is digitalisation, which refers to the adoption impacts and capabilities of new digital technologies. Therefore, Digital Supply Chain (DSC) can be described as an intelligent, value-driven, and efficient mechanism enabling enterprises to generate new streams of revenue and commercial value by leveraging modern technical and analytical tools. DSC is about how supply chain operations are managed with a variety of novel technologies (Büyüközkan & Göçer, 2018). In recent years, the digitalisation process, aided by ICTs, has emerged as a key driver in obtaining competitive advantage for businesses (Queiroz et al., 2019). It can be accomplished by introducing new business models as a result of the adoption of digital technology.

Traditional supply chains, on the other hand, lack key characteristics that are required in today's and tomorrow's company requirements. The typical supply chain is made up of a number of separate, segregated phases. When a typical supply chain is transformed into a DSC, these barriers are broken down, and the chain becomes an integrated system that functions smoothly (Alsufyani & Gill, 2022; Büyüközkan & Göçer, 2018). DSC is about how the supply chain is managed, not about whether the items or services are physical or digital. Supply networks necessitate a large number of complicated actions that must all be coordinated and monitored. As a result, digitalization allows for the growth of next-generation supply chains that are both flexible and efficient (Queiroz et al., 2019). Consequently, businesses have been forced to establish a set of DSC resources and capabilities that will help them support the digitalisation process over time.

Digital technology has changed the internal and external aspects of the organization, as well as their relationships, which may have an impact on business performance results both directly and indirectly. Because of the unknown influence of digitalisation on performance, decision-makers face an arduous task in determining the viability of investing and predicting the desired performance outcomes (Alsufyani & Gill, 2022). However, supply chains becoming a DSC's does not always imply having access to cutting-edge digital technologies. It all boils down to aligning digital activities with supply chain goals and implementing a digital methodology to unlock the underutilized value of the existing resources and capabilities, resulting in improved performance (Büyüközkan & Göçer, 2018).

Therefore, companies need to have a good understanding of its resources and capabilities regarding DSC in order to create new value. Queiroz et al. (2019) identify seven following basic DSC capabilities ; ICT's policies, workers policies, supplier integration, customer integration, warehouse, transportation, and smart production. Since ICT technologies enable digitisation and digitalisation, it is seen as key capability. The worker policies refer to the human factor, management and needed skills and talents. Suppliers integration is seen as fundamental for value co-creation and therefore as positive influence on DSC. Similarly, customer integration is seen as vital factor in organisations performance. Warehouse capabilities and transportation form a substantial proportion of businesses expenses and are therefore seen as key capabilities. And finally, smart production affects the entire value proposition of the company and is therefore seen as key DSC capability.

2.4.3 Circular economy meets digitalisation

The significance of digital technologies in CE business models has increasingly become a research topic of interest (Lopes de Sousa Jabbour et al., 2019). Scholars believe that digital technologies are not only enablers of CE business models, but also triggers and thus promoting a shift in CE practices and innovation (Ranta et al., 2021). Digital connectivity and information development and exchange, may even have paradoxical effects upon triple bottom line (Ghobakhloo, 2020; Sarja et al., 2021). Industry digitalisation allows for more efficient use of fewer resources. Smart solutions allow for lower energy consumption, more effective logistics routes, and higher capacity utilization. Furthermore, digitalisation allows for transparent access to information on product resource usage, allowing for the optimization of product life cycles and so promoting the CE (Antikainen et al., 2018). Large volumes of data are present in CE systems with interconnected cycles. Digitalisation has opened up new avenues for data access. Decisions must be made on product lifecycle stages, how recyclables should be reused, what kind of logistical solutions are required, and who the value network's actors are (including reverse flows).

Efficient coordinating of material and information flows is critical in the CE. The amount and quality of products, as well as the contents of their basic materials, must be collected and stored. Digital technologies make it possible to keep data and materials with in cycle together and to utilise waste as a resource (Antikainen et al., 2018; Ranta et al., 2021). Digital data integration allows for the distribution of knowledge, structure, ownership, and varied levels of customisation. This enables better linked and long-lasting client and end-user interactions. Furthermore, digital technologies enable circular business models by automating resource and material flow monitoring, management, and optimization (Antikainen et al., 2018; Lopes de Sousa Jabbour et al., 2019; Pagoropoulos et al., 2017).

The CE is based on the premise that the ecosystem eventually, not one individual company, closes the loop. As a result, in order to enable CE business models, networking and coordination with stakeholders, as well as new partners, is required (Ranta et al., 2021). While completely new products and services are required, digitalisation has opened up opportunities for co-creation between stakeholders and customers. Digital collaboration platforms using digital mediums play an important role in networking and cooperation (Gupta et al., 2022). Furthermore, as early adopters of new goods / services, customers play a critical role in the shift to the CE. Digitalisation, enables connecting and engaging with consumers, which is necessary when developing creative CE models. Thus, digitalisation can be seen as key enabler of CE since digital technologies lowers operating costs, develops collaboration through supply chain, aids closing the material loops, helps construct a regenerative economy and harmonizes the triple bottom line objectives of environmental, economic, and social benefits. In reality, companies that adopt CE and digitalization tend to transition into service-based businesses by developing service portfolios that include elements such as extended service contracts, performance agreements, etc. For example, big data and the IoT provide businesses rare chances to enhance and diversify their service offerings and provide value to their clients.

2.4.4 Digitalisation meets combined transport

Often, logistics operations are being carried out independently in current organisational structures. Traditional supply chains are made up of physical facilities that are dispersed around the country to aid in the establishment and maintenance of transportation links. However, due to digitalisation, many of these organisational structures and systems are no longer self-sufficient. Across industries, digitalisation seems to have a disruptive transformation effect, generating value and network effects (Büyüközkan & Göçer, 2018). CT's preferability is strongly dependent on its effects on the total logistics performance required from the transportation supply chain. Operating expenses in a specific mode, transit time demands, reliability of the intermodal option, flexibility and ability to meet supply chain responsiveness demands, and communication, collaboration, and information flows between actors who may also be competing with each other in other orders are all determinants of such performance (Altuntaş Vural et al., 2020). Usually, CT has not been factored into the current rail infrastructure’s development process, hence CT operations are hampered by outdated and inflexible systems, infrastructures, and policies.

In order to address the connectivity issue, the Internet of Things (IoT) is offered as a solution that may connect various systems, including a variety of sensors for monitoring and recording enormous volumes of data, thereby assisting in the increase of performance in data-driven logistics (Gupta et al., 2022; Hofmann & Rüsch, 2017). IoT refers to the entirety of objects and things connected to the internet that send and receive information (Büyüközkan & Göçer, 2018). Some cutting-edge IoT technologies, including RFID and sensor technology, offer cognitive capabilities that enable identification, localisation, communication, and sensing, all of which will aid in the optimization of processes. Furthermore, IoT is projected to enable visibility of transported objects by transmitting their current order, content, and position, as well as the inventory status (Leviäkangas, 2016; Pernestål et al., 2021). IoT can also help CT, especially with digital identifiers and sensing technology, which are critical for infrastructure. They aid in the connection of various interfaces in transportation networks, as well as the decision-making and monitoring of various operations while increasing their efficiency. They also make container transportation more secure and transparent (Büyüközkan & Göçer, 2018).

Such interconnected objects will transfer data on a continuous basis, necessitating the management of large data flows. Big data is intended to be utilized for data registration, storage, management, and analysis, enabling for real-time monitoring of supply chain flows and anticipating future events (Del Giudice et al., 2020; Hallikas et al., 2021). LSPs can considerably benefit from the use of big data because it enables much quicker and effective communication between the various modal interfaces, as well as more informed and faster traffic and transportation route decisions (Kine et al., 2022; Legner et al., 2017).

Cloud service providers provide access to a generic system with predefined settings, typically distributed over the internet. Generally speaking, the system includes a variety of services that are deployed in accordance with the needs of the customer organization (Büyüközkan & Göçer, 2018). A ready-made system platform enables deployment quickly and with minimal management needs. Cloud computing enables the outsourcing of the maintenance of information services to an external operator, whereby the enterprise does not have to use its own resources to ensure the operation of information systems, but instead resources can be invested to support the core functions of the enterprise. For example, Cloud logistics, which functions as an intermediary between modal and actor interfaces to avoid disruptions and enhance interconnectivity, is another solution that complements the required connectedness. Cloud services can be deployed and deactivated on demand, allowing for improved service and management performance without the typical setup and maintenance costs associated with a private independent IT infrastructure (Altuntaş Vural et al., 2020). These capabilities meet the demand for on-demand IT tools and allow even tiny actors in transportation networks to connect.

Similarly, blockchain technology, which is a distributed database system used to store and organize a range of transactions and other data, can be used to document and finance exchanges in transportation and logistics networks without the use of middlemen. Such technology enables for the creation of sustainable contracts with improved transparency. Some highlighted features, such as an unchangeable and reliable ledger, blockchain as a tracking service, a smart contract utility, a marketplace, and tokenization and incentives, can be leveraged by blockchain elements and capabilities (Bekrar et al., 2021). Most of all, it is expected to improve the traceability and speed of CT networks. Blockchain technology applications is rather new concept, which might affect the possible adoption since changes in existing policies, practices, beliefs, and norms are required.

Additionally, the CT industry has access to a wide range of automated solutions that have the potential to improve process safety and productivity. The application of automation technology reduces human participation, resulting in better process control, standardization of performance and quality standards, removal of response time ambiguity, and cost savings from operations and human errors (Kine et al., 2022). As a result, automation technology can help to speed up interchange and transhipment across modes of transportation, as well as reduce impediments to CT. One concrete example of automation in transportation is route planning and prediction. Contrarily, a higher pace of production brought on by automation would be accompanied by a larger use of resources and energy as well as increasing environmental problems.

Despite the fact that this is not a comprehensive list of technological solutions for CT it reflects the current literature of logistics industry and digitalisation applications. The above choice is based on earlier research that examines present and emerging technologies related to CT. The choice is further aided by the digital technologies which characterize the Industry 4.0, which, in addition to manufacturing, has substantial implications for transportation and logistics. Every company and business have their own unique value proposition and chain that emphasizes different factors and thus, the required solutions and digital technologies vary. Most of before mentioned technologies have existed several years. However, these technologies have only recently reached such maturity level that is required for digitalisation (Ghobakhloo, 2020). Additionally, new technologies and solutions are constantly emerging. As earlier discussed, one of the categorisations of these new enabling technologies is data collection, data integration, and data analysis (Han et al., 2021; Pagoropoulos et al., 2017). Consequently, the aim was to find at least one key technology from each category. It is also good to acknowledge that none of the above-mentioned technologies operate independently, meaning that these technologies have interoperability feature.

2.4.5 European Rail Traffic Management System

The European Rail Traffic Management System (ERTMS) is unified signalling and speed control system for all of Europe that ensures interoperability between the various national rail networks, lowers the cost of purchasing and maintaining signalling systems, boosts infrastructure capacity and safety levels, and increases train speed (European Union Agency For Railways, 2018). ERTMS aims to make European train travel safer and more competitive. The ERTMS consists of two parts. The first is the European Train Control System (ETCS), a common system for all of Europe that will eventually replace currently in use national train control systems, such as the ATP-VR/RHK in Finland. The GSM Railway (GSM-R), is the second part of ERTMS (European Union Agency For

Railways, 2018). This radio technology enables voice and data communication between rail infrastructure and trains by using the frequency range designated for railroads.

According to European Union Agency For Railways (2018) the ETCS access control system can be implemented in three diverse ways, namely the ETCS level, the functionality of which evolves as they move from one level to another. Where ETCS Level 1 corresponds largely to the current ATP-VR/RHK, new subtleties are introduced at ETCS level 2. From ETCS level 2 onwards, the use of signage can already be largely dispensed with, as well as switching to two-way communication between track equipment and trains over the radio network. Compared to the current state, ETCS Level 2 increases infrastructure capacity, level crossing and personal safety, and rail transport automation. At ETCS level, a Radio Block Center (RBC) is also introduced, which transmits information about access roads to the train via the radio network. Thus, monitoring the position of the train on the network is also greatly facilitated.

ETCS Level 2 will later be upgraded to ETCS Level 3, which's functionality is still being refined in the EU. The biggest novelty of ETCS Level 3 will be the 'moving blocks' principle, which allows you to relinquish control of the freehold of the track using new train safety equipment. With ETCS level 3, trains can be thought closer together and trains can be extended almost to the trailing of the train driving ahead, considering the real-time positions of the trains. This also requires the introduction of a Train Integrity Monitoring System (TIMS), which monitors that the train is unified, for example, the integrity of the configuration.

The renewal of systems and the purchase of replacement systems is not only to achieve more advanced technology, but also because of the costs of maintaining and servicing obsolete systems. Another driver of the change is the need to create a unified rail transport system in Europe. This system is particularly useful in the Central European region, where the common ERTMS system allows agile movement between countries. A test track project using ERTMS technology has already started also in Finland. Following the implementation of the test track and pilot track, ERTMS will be deployed countrywide over the next few decades by 2040 (*Traficom*, 2021). Although Finland is unable to join the European rail network due to its geographical location and divergent track width, the system is beneficial in many ways. A common system offers economies of scale, both in terms of availability and cost of components and systems. It will also enable several existing systems to more effectively monitor train speeds and thus improve the safety of the operation. The system also makes it possible to increase rail capacity by shortening the distance or time between trains moving in a row.

However, when it comes to capacity raising, it is important to consider the own characteristics of the different sections of the line, which have a significant impact on how much benefit can be achieved in terms of capacity. The ERTMS system has set ambitious standards for components and various subsystems. The transition to a unified system guarantees not only high-quality, but also evolving solutions. In addition to quality, ERTMS brings cost savings throughout the lifecycle. When the system moves to Levels 2 or 3, no track-side signage or special track freedom control is required. In this case, the costs of maintaining and servicing trackside installations are avoided. Cost savings are also achieved in construction as the amount of cabling is reduced. As a result, the flexibility and speed of transport will also improve and contribute to better response to the needs of the supply chain. ERTMS development also creates development needs for digital integration throughout the supply chain.

2.5 Digitalisation as an enabler of CE and CT

In this chapter some synergizing connections are drawn and the main ideas from the theoretical proportion. In Figure 9 is illustrated the mode of CT chain and the environment. To sum up the chapters 2.2, 2.3, and 2.4 we can conclude following that for service delivery (such as capacity, pricing, and transit times), the business models of the stakeholders are in dynamic interactions and therefore cannot be merged into a complete model. The business models, nevertheless, also influence the other stakeholders and create interactively evolving cause-and-effect linkages based on how they act and react. Consequently, the CT system is complex and thus requires thorough planning. In Figure 10 is illustrated some of the factors that need to be considered in planning.

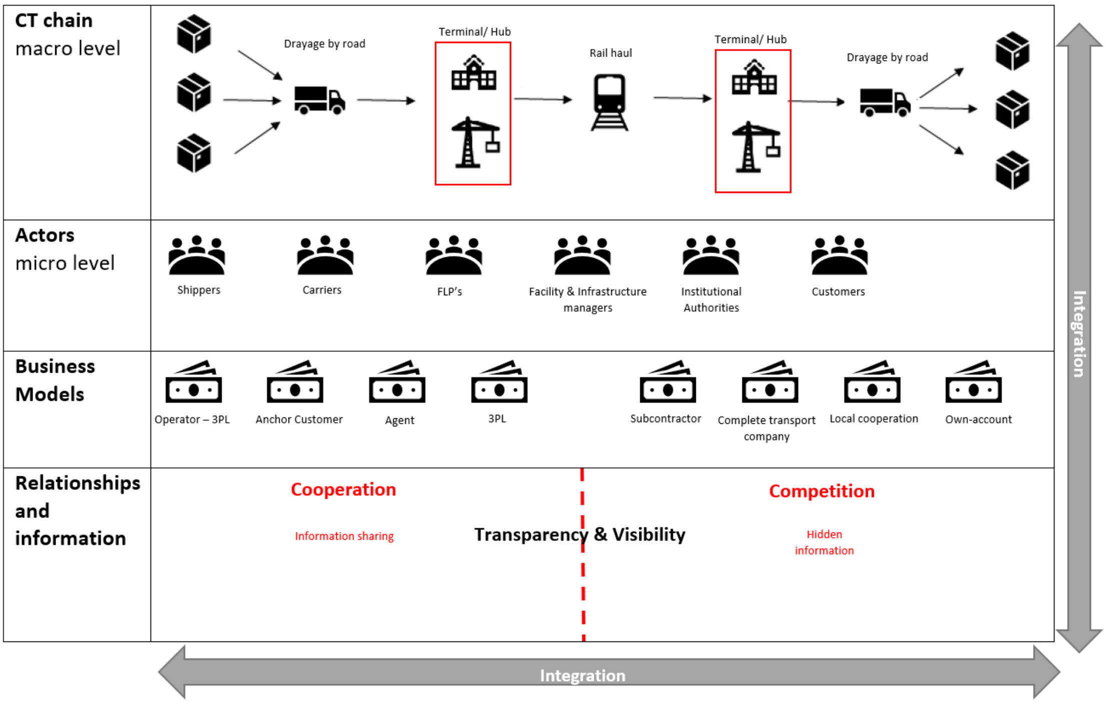

Figure 9 Combined transport chain model

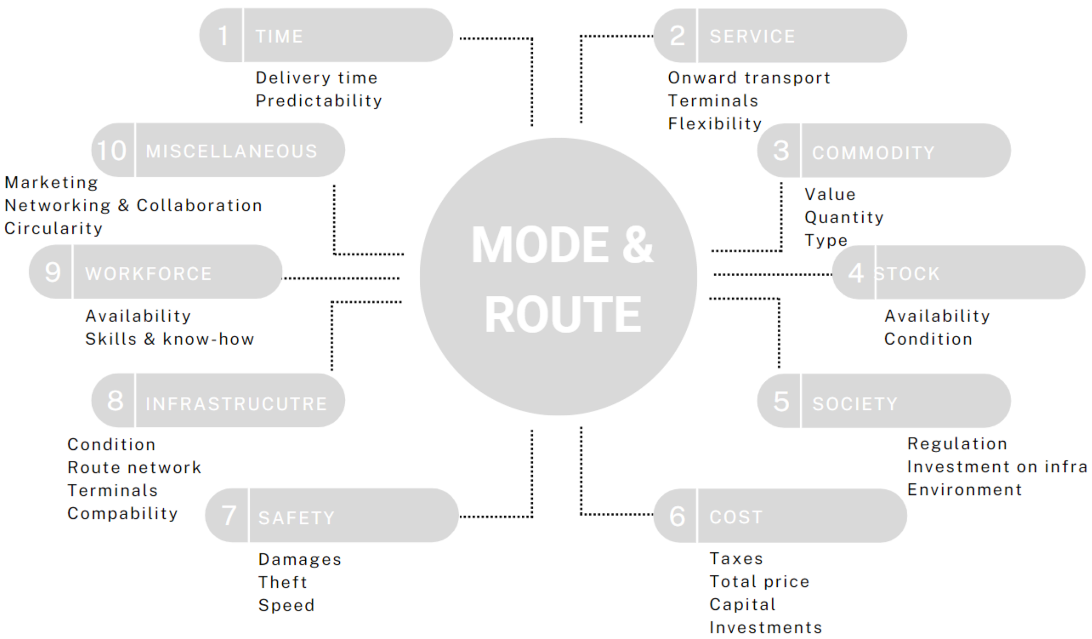

Figure 10 Factors affecting the choice of route and mode of transport

Seven categories can be identified from the CT literature that need to be considered. 1) First leg and last leg (drayage); There is an activity dividing between the modes, with road vehicles handling short-haul, collecting, as well as distribution tasks whereas rail is employed for long-haul and cost-reduction (Agamez-Arias & Moyano-Fuentes, 2017; Carboni & Dalla Chiara, 2018; Minárik, 2021). 2) Rail haulage; It is vital to synchronize the timetables to ensure that any unneeded stops can be prevented (Crainic et al., 2018; Russo & Gronalt, 2021). 3) Standardisation; The effectiveness of the transportation chain is increased as a result of the standardisation of load units, which makes it simpler to transfer units across various modes (Beuthe et al., 2014; Laroche et al., 2017). 4)Transit and corridors; A key component of the coordinated scheduling is transhipment (Altuntaş Vural et al., 2020; Minárik, 2021; Russo & Gronalt, 2021). 5) Cooperation; Given the number of participants involved, there are multiple actors to consider in SCM. In contrast to single mode transport, the management thus more nuanced and fragmented (Altuntaş Vural et al., 2020; Bekrar et al., 2021; Kine et al., 2022; Laroche et al., 2017). 6) Pricing and service strategies; CT aims to increase service quality while reducing, or at the very least sustaining, expenses. Prices also need to be competitive in order to compete with single mode road haulage. For shorter distances, the road often offers a time-related cost advantage, but rail and especially marine transports become more competitive over longer distances (Altuntaş Vural et al., 2020; Beuthe et al., 2014; Russo & Gronalt, 2021). 7) Planning, regulation and policy; The rail-haulage is highly regulated, especially in Finland, which creates impediments for the rail operators. Moreover, the policies on CT transportation seem to be scarce and thus would need some refinements (Gupta et al., 2022; Kine et al., 2022; Lu et al., 2022). Overall, there is a need to redefine and simplify these procedures in order to make CT more competitive alternative.

To conclude, the economic pressure is making businesses more efficient and effective by utilizing technological advances and innovations. Simultaneously, the system is driven by sustainability and environmental goals. The key is the ability to meet current needs without compressing the ability to meet the needs of future generations. The significant impact of logistics costs on the business and transportation to the environment are expected to rapidly transform transportation and logistics sector, along with new business opportunities. Digitalisation is driving circular economy and it is enabling circular economy business models, for instance, by allowing for remote tracking of product placement and consumption. Digitalisation can accelerate the shift toward a circular economy which is more sustainable. By giving precise data on the availability, position, and status of products, it can assist in closing and narrowing the material loops. Additionally, digitalisation allows for more effective business procedures by collecting more, precise, and UpToDate data and by helping to analyse this collected date, digitalisation creates visibility, efficiency and agility, which helps among other things decision making and planning.

3 Methodology

The thesis's research approach is presented in this section. The purpose of the first chapter is to provide a brief explanation of the selected research design, strategy and the rationale for its selection. The second chapter provides a thorough explanation of the data gathering procedure, breaking down each step from choosing the data collection method through conducting interviews. The third chapter describes and provides examples of the data analysis process. The fourth and last chapter examines the study's validity and reliability in order to highlight any potential flaws in the data or methods.

3.1 Research design and strategy

Selecting an appropriate research methodology for the subject was the first methodological decision made in the thesis. Qualitative research is a type of research where the research subject is not commonly operated statistical data, such as number data but written information, such as words and phrases. The objective of qualitative research is to describe, understand and interpret the phenomenon under study (Flick, 2014). The analysis phase of data is a cycle-like process, the conclusion of which does not rank at the end of the study, but goes along with the study of the data in hand. In qualitative research, it is normal for the amount of data to be collected and studied to be unknown and collected up to the point of solving the research problem and understanding the phenomenon (Denzin et al., 2005).

A qualitative study methodology was thought to be the best approach for the thesis since it strives to provide a comprehensive knowledge of expectations, challenges, and possibilities linked to CE, digitalization, and CT implementation in Finnish SMEs. Additionally, as there was not much study focused on CE and digitalization in the combined transport industry, it would be difficult, to gather enough data using a quantitative method. Furthermore, since this thesis does not seek to test hypotheses generated from current theory, it may be said that this study tends toward inductive reasoning. However, it should be emphasized that since this thesis began with a literature study addressing issues pertinent to it, certain aspects of deductive reasoning also apply to it. But rather than providing a basis for theories, it helps the researcher and the reader get familiar with the phenomena's being studied. This thesis looks at the opportunities and obstacles that Finnish SMEs believe CE, digitalisation, and CT application faces, as well as the main expectations that these phenomena are expected to meet. This thesis may be viewed as an exploratory research because its main goal is to collect knowledge and clarify understanding of these phenomenon's.

3.2 Data collection

In addition to secondary material collected from literature, primary material related to the study was collected through interviews. Based on the research problem, it was found that information on the digitalisation of the supply chain and application of CE and CT of SMEs should be collected either through surveys or interviews. However, when examining the theory of data collection methods, it was found that more detailed information can be obtained using the interview method than could have been achieved by a structured questionnaire. The interview method can also be used to find out completely new entities about the phenomenon being studied during the data collection. Interviews were conducted using a semi-structured interview method utilizing aspects of themed interview.

Themed interview as a method allows the interviewer to use flexibility in the interview situation regarding questions and topics to be addressed, but also helps with themes to ensure that all major themes related to the phenomenon will be addressed in the interview. In the thematic interview method, themes are formulated to generate information about the phenomenon being studied, but the actual questions are formed on a case-by-case basis in the interview situation itself, as needed and depending on the role of the interviewee. Interviews are conducted using the individual interview method characteristic of the thematic interview. Consequently, focus on one interviewee at once and ensure that the responses of the interviewees are not limited by the presence of other individuals. The interviews were conducted as virtual interviews through the Teams application, enabling the interviews to be conducted remotely without travel, but using the benefits of a face-to-face interview. The virtual interview also allowed recording of the interview situation, for further processing of the material. The recording allowed the interviewer to focus instead of recording notes, on the interview situation itself, and the answers the interviewee gave.

The purpose was to conduct interviews with South Ostrobothnia SMEs in different sectors and explore the business opportunities of the CE and digitalisation of Southern Ostrobothnia enterprises, the level and anticipation of their exploitation, as well as the current state and potential of CE and digitalisation. It took a lot of persistence to get a few organizations to take part in the study. Some either rejected or did not react to the request to be interviewed owing to a lack of time or interest. It is also good to mention that, the time period in which the interviews were conducted was under national summer holiday season, which might have affected the willingness to participate. Nevertheless, the aim of the analysis is to create a structured description of the characteristics, challenges and difficulties of the SME supply chain digitalisation, circular economy, and combined transport, as well as to enable conclusions to be drawn to identify development needs.

In the data analysis same kind of procedure was used as Flick (2014) describes. First step was to build a coding frame consisting main categories and sub categories, or as the researcher has defined them, themes by reading the material until relevant concept is encountered, checking whether suitable category already exist or if it fits under some of the categories or if it needs to be its own category. The reading and analysing continues until no additional new categories or concepts are found (Denzin et al., 2005). The process of compiling themes for the interview utilized the methods presented in theory. The themes aim to build an understanding of the phenomenon being studied. The phenomena under investigation are circular economy and digitalization as enablers of Combined transport. Themes around the phenomena were formulated based on research problem and questions, which are sought to generate answers through an interview. A basic set of questions was formulated in order to ensure the quality of the interview and for the interviewers help. Questions, to which themes aim to get answers, can be found in full in the appendices at the end of this thesis.

The interview body was designed in such a way that it would deepen knowledge of challenges and needs, step-by-step as the interview progressed further toward the end. The interview would begin by asking general information related to the supply chain, the company and the person being interviewed. It would then deepen information on the topics of supply chain and company management, as well as strategies and objectives in the digital supply chain, CE, and CT. These would then go through the technology solutions, CE solutions and CT solutions that have been introduced and their background. Finally, inquiry about the risks and challenges were identified, and possible needs and aspirations for a model to support the digital supply chain, CE and CT were considered, building on all the issues raised.

The interview was built to include four perspectives, for every major theme being explored. The perspectives were the perspective of the company, the supply chain perspective, the interviewee's perspective, and the perspective of the future. The purpose of determining perspectives was to investigate, among other things, the cooperation between the interviewed company and the activities of the supply chain under investigation. Without forming perspectives, the challenge would have been to identify whether all interviewees see and respond to questions about the theme from the same perspective. Perspectives are aimed at achieving knowledge of the topics that have occurred in reality. A future perspective differs from other perspectives by the fact that it contains, and may produce, hypothetical information, about things that may happen.

The interviews occurred between June 16th and August 31st, 2022. The researcher made sure that no personally identifying information would be shared during the procedure by outlining the privacy policy for the interviews prior to the interviews. The researcher recorded every interview with each interviewee's consent so that they may be subsequently transcribed. All interviews were held in Finnish. In total, 49 companies were contacted and four full interviews were held. To make sure that the interviewee would be equally competent of communicating his or her views, thoughts, and beliefs vocally, interviews were conducted in the respondent's native language. All of the interview excerpts utilized in this thesis were translated by the researcher from Finnish to English because the interviews were held in Finnish.

The proportion of SMEs in interviews was limited so that the selected companies are founded in Southern Ostrobothnia area. The sector or field of the company was not considered as selection criteria, in order to get as objective view as possible. In this study, we aimed to reach people who have information about the supply chain, its flows, related projects, and decision-making. The participants in the interview were contacted first by telephone and additionally by email. At the beginning of the first contact, a description of the interview and related project was briefly presented as well as inquiring about the possibility of attending. When the interest was expressed, an attempt was made to match the most suitable date for the interviewee and also ensured an agreed date by email. The brief description of the interview included theoretically defined pre-interviewees topics, such as contact details, duration, manner, objective, necessary tools, briefing on the use of the recording and processing and publication of information. A link to the related project website was also attached to the message.

3.3 Data analysis

The analysis phase began with the transcription of the material recorded into text format. In transcription, automatized programs were used, such as Word's build in tool for transcribing and build in tool in Teams to help with the process. The transcription was then cleaned from most of the grammatical error and carried out using a selective method, in accordance with the theme areas and carried out as quickly as possible after each interview so that the lessons learned from the interview could be used in the following interview and to be able to refine the necessary information, if necessary, before next interview.

The second step of the analysis was to implement content analysis for the data, i.e. to combine, classify and encode information (Flick, 2014). By combining information, summaries were made of all transcribed interview materials based on theme area and perspective (Denzin et al., 2005). At this point, therefore, the materials obtained from the interviews were combined based on perspectives into a summary, and at the same time the names as well as other confidential information were removed and replaced them with generic names such as “supplier, production company, interviewee” etc.

The third stage of the analysis was to encode, combine and build a coding frame, i.e. to identify concepts from the combined perspectives of the theme areas that describe the content of the interview material and provide information on the research question of the interview, i.e. the content and characteristics of the interview (Flick, 2014). This was done by reading, analysing and recognizing relevant categories and concepts, which were then classified further in phase four. Information was generated by identifying the difficulties, challenges and other factors affecting digitalisation, CE, and CT in the SMEs' supply chain. The fourth phase increasingly combined and classified concepts from the material of the third stage into categories based on their properties and gave them names describing their properties.

The last step in the analysis of the interview material was to apply them to the entire material in consistently. The material was divided based on the identified categories and numbered accordingly per source. The coding framework was also tested on part of the material and established as fit (Flick, 2014). Then the coding frame was applied to the open issues that had arisen from the interviews that had been created in text form, to the section presenting the results of the interviews in the report. Additionally, the data was re-analysed by the researcher to make sure the results are reliable, valid and to see that nothing was left out of the analysis (Flick, 2014).

As a result, 15 themes were identified as a result of the thematic analysis. Subsequently, these themes were further categorized into four main categories of expectation, opportunities, ambivalences and impediments. These categories are addressed one by one. Since the intention was to identify the current status, requisites and possibilities following four categories were identified: expectations, opportunities, ambivalences, and impediments. These categories are in direct relation to the research questions and theoretical base. The coding frame of identified categories and themes related are illustrated in Figure 11.

Expectations
- Financial expectations
- Increase in efficiency
- Increase in quality
- Simplify processes
- Gaining competitive advantage

Opportunities
- Available information
- Co-operation
- New business opportunities

Ambivalences
- Small organization size
- Legislation and bureaucracy
- Business networks

Impediments
- Uncertainty
- Lack of resources
- Lack of financing
- Economic conditions, Covid-19 and Ukraine War

Figure 11 The coding frame of interview result categorization

4 Results

The four previously selected categories and the themes within each are examined in detail in this part to provide the research results. This section also includes the results of secondary research on the foresight of CE, digitalisation, and CT. The findings are evaluated in reference to the study questions in order. As a result, the first section will cover results that are categorized under expectations. The results that are classed as impediments will be covered in the second part. Ambivalences will be covered in the third section. Research results categorized under opportunities will be covered in the fourth chapter. And finally, the interviewees views on combined transport will be covered.

Approximately 20% of the contacted companies felt that they are not qualified or familiar enough with the themes of the interview and therefore declined the invitation to participate. Smaller proportion (approximately 10%) of the contacted companies were unfamiliar of the discussed themes and therefore declined. And rest of the contacted companies that declined were unable to attend due to either seasonal hurry caused by the national holiday season or were not reached. It is also good to mention here that the aim was to reach people who are responsible of the supply chains, decision making and/or related projects, which might have had an effect on the contacting rates. In Figure 12 is illustrated the response of the contacted companies.

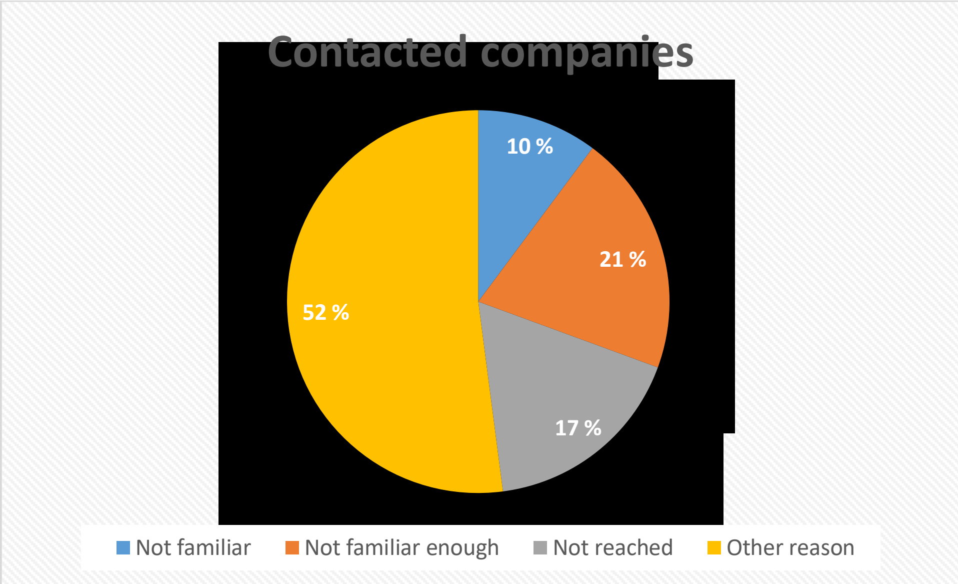

Figure 12 Responses of the contacted companies

CE as a term was recognized by most of the interviewees. For some the term required explanation and clarification. Moreover, there was some discrepancy on the meaning of the term, since some perceived it as synonym for recycling. Most interviewed companies had implemented or thought the sustainability and recycling solutions, but the circularity itself was not considered. Digitalisation was overall better-known topic. However, as with CE, there was some misconceptions of the meaning. Some of the interviewees perceived digitalisation as synonym for digitisation, meaning that for them it meant the transition from analogue to digital. CT was recognized approximately by half of the interviewees. Rest of the interviewees needed some assistance and clarification. Overall, the interviewees had almost all heard of these terms before and considered them as increasingly important themes for the future. However, it is good to mention, that although the terms were more or less familiar to the interviewees the applications for supply chains were not for the most part. It is also good to mention, that in most cases the person who was responsible for supply chains and/development was not also responsible for CE and digitalisation initiatives. Thus, the focus of these initiatives was not necessarily on supply chains and transportation, which could have an effect.

4.1 Expectations

The respondents often indicated financial goals for the CE and digitalisation initiatives while describing their expectations. Meaning that the respondents anticipated financial rewards in the form of revenues or cost savings as a result of their investments in CE and/ or digitalisation inside the firm. Some respondents also mentioned indirect financial advantages in cost reductions as expectations in addition to anticipating a direct economic return on the investment and perhaps an improvement in the company's profitability. For instance, it was anticipated that projects that lowered businesses' energy usage would create cost savings.

The majority of the interviewees mentioned other expectations in addition to direct and indirect financial expectations for the adoption of CE and/or digitalisation. These additional anticipations include potential non-financial rewards. Instead, the other goals include enhancing brand recognition, enhancing customer relationships and customer satisfaction, well-being, and satisfaction of the employees, gaining competitive advantage, enhancing quality, and enhancing efficiency, and streamlining procedures. Many of the interviews touched on these topics in one way or another. A large number of participants appeared to be aware that working on CE and/or digitalisation initiatives does not always lead to financial success; rather, the effects might be observed in other ways. Nevertheless, it is acknowledged that it could take some time before such advantages become concreate or materialize.

Although some interviewees considered the financial gain as key factor, in most of the cases they also emphasized that often the reasoning for investing in CE and/or digitalisation comes from other perspectives. One of the most pursued expectation was to increase the performance by simplifying the processes or by removing bottlenecks. In digitalisation, one of the primary expectations in addition to financial expectations was increased amount of data which would ultimately assist the decision making. What comes to CE Many businesses only wished to increase the sustainability and circularity of their own operations, suggesting that even if it was not often the main goal of the initiatives, they engaged in them with a concern to the environment. Some participants anticipated to be recognized as a pioneer or a leader within their sector by participating in initiatives that improved the circularity of the business and therefore distinguishing themselves from rivals in a favourable way.

The CE and digitalisation were seen as essential to business operations and company values by all participants, with some even defining them as a process that affects all business tasks. Many participants continued to anticipate that adoption of CE and digitalisation will be necessary in the future in order to stay in the competition. Many of the interviewees also stressed that the pursuit of CE and digitalisation must coexist with regular business activities, suggesting that digitalisation or CE cannot be end in itself. For example, one interviewee implied that while not all recycling or digitalisation is done with financial return in mind, the process is still expected to pay itself back or have some kind of attainable benefit, in other words it must be justified in some way. They recognized that by providing data, for example, about the location, state, and product availability digitalisation could open new business opportunities.

4.2 Opportunities

It was clear that most participants saw CE and digitalization as current issues and as business's overall future directions. As a result, some even said that CE and/or digitalization were fundamental to their business practices and core principles. The firms' views on CE and digitalization appeared to encourage them to get involved with and move forward with CE and digitalisation initiatives. One respondent claimed that since the company's management saw digitalisation as the future and had thus been committed to carry out the project before commencing it, implementing digitalisation initiatives had not been difficult for them. Therefore, clearly supporting the implementation of digitalisation.

The availability of necessary knowledge and training was the second subject identified as an opportunity connected to adopting CE and digitalisation inside the companies.

Most companies interviewed had already some kind of enterprise resource-planning system (ERP) in place, which suggests that the most crucial digitalisation foundation has been already laid. Some of the respondents mentioned that CE and digitalisation initiatives were currently under investigation and consideration. Although there is overall a ton of information accessible, some respondents also noted that it is currently relatively fragmented and difficult to utilise, making it difficult to apply to the scope and context of one's organization. Hence, especially digitalisation could create new possibilities in information sharing, gathering, and analysing, which would help the decision making and monitoring. Furthermore, CE and digitalisation were also considered by some as enablers of new business opportunities. Additionally, co-operation and especially information sharing was considered as possible opportunities. By co-operating business could share their expertise across different industries and thus benefit from each other.

The interviewees emphasized especially the importance of data, which should be precise, and transparent for decision-making. The interviewees also stated that as a consequence of digitalisation, new digital platforms could be developed and used as well as new marketplaces. Additionally, networking and cooperation with stakeholders, including consumers, could be made simpler and more effective by digitalisation. The respondents emphasized that digitalisation and CE could also encourage user participation in the processes of development of products and services while also assisting businesses in reaching and interacting with customers more effectively than in the past. One key facilitator for customer engagement and interactive interactions, that was mentioned by the interviewees, was social media. As one of the interviewees stated, as a result of digitalization, marketing has evolved to become more intelligent and interactive.

4.3 Ambivalences

The respondents provided context-specific descriptions of the elements that might both aid and hinder. According to their dual nature, these elements are classed as ambivalences. The study led to the discovery of three ambivalent themes. The small organizational size of the participating enterprises is the first ambiguous theme. The second contentious subject is society, government, and law. Business networks are the third and last ambiguous subject.

During the interviews, the organization size was frequently brought up. Due to the fact that all of the sampled businesses were SMEs, this was rather predictable. The interviewees mentioned the small organization size in a variety of contexts. Few interviewees said it was a drawback for putting CE and digitalisation proposals into action, while some saw it as a benefit making it more agile for changes. It is therefore classified as an ambivalent topic. For example, few respondents believed that a small organization's size would negatively affect the company's capacity to obtain funds. Additionally, many believed it to be the reason there was not enough time or human resources available. It became clear also during interviews that organization size had an effect on how the respondents prioritized their time, although not all of them viewed or acknowledged it as a difficulty. Since the business is smaller, several respondents mentioned that they had broad job descriptions, which may affect how much time they have to devote to advancing CE and digitalisation initiatives.

However, small business size was also seen as boost for the company's agility, assisting the organizations' execution of CE and digitalisation. Because of their small organization sizes, the businesses were often viewed as being better equipped to adopt quick changes to their business processes. Similar to this, one respondent claimed that the small organization size had a favourable effect on the business' capacity to customize the projects in accordance with the various demands of their stakeholders. This would enable them to better integrate each project into their routine business operations and respond to the specific demands of their stakeholders.

Another topic that was labelled as ambiguous and hence tied to the initiative’s setting was laws and bureaucracy in Finland. The majority of the time, this topic's features were explored in terms of Finland. Some respondents, however, also spoke about legislation on the level of EU directives. Nearly all interviewees identified the Finnish laws and level of bureaucracy in some manner as having both a negative and a positive effect on the CE and digitalisation in businesses. The majority of those who participated in the interviews viewed the Finnish and European laws as sufficient and claimed that because it is so strict, they are not necessarily motivated to change their own company objectives, such as those related to sustainability.

While the majority of interviewees saw the present legislation as rational and as a benefit, some pointed out that sometimes the laws and regulations have limitations and can even run counter to what is genuinely pro-environment. However, the most stressed impediment was Finland's bureaucracy for applying for permissions and funds, which was mentioned by few respondents. Some also stated that, for smaller companies the some of the new requirements might be significantly tougher to implement due to the lack of knowhow and resources compared to the bigger businesses.

Business networks was another subject where significance changed depending on the situation. On the one hand, most interviewees mentioned established logistic, supplier, and partner networks when talking about business networks as prospects. According to one, it has a beneficial effect on businesses operating in the same region since it raises business requirements and improves the reputation and self-esteem of local businesses. Overall, partnerships and business networks were seen as opportunities. On the other hand, business networks, or rather a lack of them, were viewed as a hindrance. Finding partners and making sure they engage in initiatives and adhere to the company's requirements was viewed as a problem, especially regarding the supply chains.

4.4 Impediments

One of the most often discussed topics during the interviews was uncertainty, which was brought up by all interviewees in some form. It is interesting to note that the participants themselves did not describe uncertainty as a barrier to the CE and digitalisation initiatives. However, it was clearly stated that it would have a detrimental, if not obstructive, effect on the implementation. Since uncertainty in some circumstances resulted in more effort during the project, such as further research and piloting. Even though the nature of many of the projects varied, uncertainty seemed to be a fairly recurring topic as it was brought up in a variety of contexts and across the whole value chain. Some interviewees talked about client needs as being uncertain, while others talked about investments, human resources, material requirements, and even possible benefits as being uncertain.

According to the interviews, it appears that initiatives that are somewhat new to the company are likely to produce uncertainties because of a lack of expertise carrying out initiatives of a similar nature. Especially if the initiative itself is difficult to implement. One interviewee gave the setting up of a take-back process and reverse logistics as an example. In other words, as one has no prior experience with a similar project, implementing anything for the very first time may be more tedious than executing it for the second. Having no prior knowledge and information could be another explanation. Consequently, most of the interviewees described the availability of information and sharing information as an opportunity rather than impediments.

The scarcity of resources was another barrier mentioned by the interviewees. This theme is closely related to the previously mentioned ambivalent aspect of small organization size. The majority of interviewees also mentioned that they were only able to devote a limited amount of time and resources, for example to their current CE and digitalisation initiatives. This indicates that either the project's implementation was not considered as a priority, and therefore no time or human resources were assigned to it, or that they had a small number of participants and, as a result, did not have the desired time or human resources. It is also good to mention that often the interviewees had several responsibilities outside their job titles and traditional descriptions, which illustrates the use of resources, especially in the smaller businesses.

Given that few interviewees mentioned how challenging and difficult the initiatives were to plan in the first place, both of them may be considered contributing factors to the lack of resources. Consequently, adding more human resources might be necessary to speed up the implementation process. In addition to strengthening the assigned CE and digitalisation initiatives, all interviewees mentioned that they additionally had other job responsibilities inside the organization. As a result, the initiative was not always regarded as having the highest importance, which led to time and personnel being allocated to other daily tasks at the organization. Furthermore, linking digitalisation and sustainability-related competencies was one of the difficulties noted. One interviewee stated that there is a gap in knowledge regarding the significance of digitalization and fundamental CE ideas.

The Ukrainian War and COVID-19 pandemic were topical at the time of this research. Due to their current relevance, COVID-19 and Ukrainian war were also only briefly referenced by a few interviewees. They perceived these as barriers for two reasons. First of all, COVID-19 made face-to-face discussions with prospective investors and other stakeholders more difficult. Consequently, it might be more difficult to have access to things like raw materials and funding, which were frequently thought to be essential for carrying out CE and digitalisation initiatives. This was merely a slight obstacle or inconvenience, though, as there are other ways to conduct these meetings. Second, it was believed that the COVID-19 and Ukrainian war would prevent the implementation of regulations that would enhance the operational requirements for the businesses. Additionally, the side effects of these events the economic situation globally and potential energy crisis were seen as threats, that needed much more attention.

During the interviews, money was also identified as a barrier in one way or another by most interviewees. Many of the ideas that were discussed needed at least some kind of investment; often, the larger the initiative, the larger the required investment. Often the company had to rely, at least in part, on outside financing because of its capacity for investment. This required either locating a private investor or applying a public funding.

The interviewees thought both of these were difficult tasks. Although most interviewees felt that money was a major obstacle, they also concurred that it was not just a problem for CE and digitalisation initiatives. Instead, they perceived finance as a difficulty for any initiative they were working on. One interviewee also mentioned that developing new ideas into feasible business models is a challenge.

4.5 Enabling combined transport

According to the conducted interview's road transport tends to be used by commodities that are time-sensitive such as food products that require temperature-controlled conditions. Another commodity type that was usually transported by road were goods with high value to weight ratio or high damage costs such as furniture. Most of the interviewees considered combined transport as implausible option, while admitting that they did not have much experience from it. The common belief was that by combining different modes the common standards of delivery could not be met. Some believed that time would be wasted in loading and unloading the trains, deeming it as inflexible and slower than current truck transportation. Others believed that the costs would be too high to be competitive with traditional transportation services. Some also believed that the current rail track infrastructure was insufficient for transportation needs. However, most interviewees believed that they would use combined transport if issues relating to flexibility, scheduling and price were solved.

5 Conclusion and discussion

In reference to the theoretical framework that was introduced in Section 2 and the research objectives and questions of this thesis, the findings are intended to be reflected in this section. As a result, the first aim is to address the study's results in light of the previously reviewed literature. On the basis of the interviews, the discussion will then be expanded to include the value of networks in the execution of CE and digitalization projects.

5.1 Conclusion

This thesis provided a comprehensive overview of the state on CT and the effect CE and digitalisation has on supply chains. Objectives of this study was to evaluate the current state of CE and supply chain digitalisation in Southern Ostrobothnia SMEs and identify the business opportunities, level of exploitation and foresight brought by the CE and digitalisation and gain an understanding of the requirements of CE and digitalisation in supply chains and CT. Additionally, in the context of CT the focus was given to the enabling effect of CE and digitalisation and business models. These objectives would consequently contribute by advancing the understanding of CE supply chains, digitalisation in supply chains, and shed a light on the relationship between CE and digitalisation in supply chains and CT.

To conclude, the economic pressure is making businesses more efficient and effective by utilizing technological advances and innovations. Simultaneously, the system is driven by sustainability and environmental goals. The key is the ability to meet current needs without compressing the ability to meet the needs of future generations. The significant impact of logistics costs on the business and transportation to the environment are expected to rapidly transform transportation and logistics sector, along with new business opportunities.

The first research question was; "*What are the requirements of CE and digitalisation for the supply chains and for CT?"* CE and digitalisation are in symbiosis, since most of the CE initiatives are aided or enabled through digitalisation. CE has three aims, which are social sustainability, economic sustainability and environmental sustainability (TBL). The TBL helps companies to identify sustainable practices and requirements that they can integrate to their business model and value chain. On the other hand, digitalisation enables these CE initiatives and helps to achieve greater value across supply chains. Digitalisation can be seen as key enabler of CE since technologies lowers operating costs, develops collaboration through supply chain, aids closing the material loops, helps construct a regenerative economy and harmonizes the triple bottom line objectives of environmental, economic, and social benefits. Digitalisation forces businesses to fundamentally transform, including process-, business model-, organisational strategy and knowledge, and the entire socio-technical organisational system. Thus, seven requirements were identified from the literature and interviews in regard of CT; 1) networking and collaboration, 2) planning, 3) ITS and digital technologies, 4) infrastructure, 5) awareness and paradigm shift, 6) regulation, policies and political frameworks and 7) service and price ratio. These seven requirements ultimately form a strategic framework for CT that is enabled by CE and digitalisation.

From the literature, as well as from the interviews, seven main requirements can be identified that ultimately form a strategic framework for CT that is enabled by CE and digitalisation. First requirement is **networking and collaboration**. Stakeholders should better connect their networks to gain benefits considering collaboration is crucial in CT. It seems difficult to establish confidence and coordinate operations, especially when the entire supply chain and all of the steps are not well known. In that instance, finding the correct balance between stakeholder collaboration and competitiveness should be the primary objective. In the wake of digitalisation, collaboration offers the most significant possibility in system level embrace CE-based business models. A concrete example of this is CT. Current transportation practises inside Finland by large concentrate using one single mode, thus most of the transportations are conducted by a single operator by truck, even though there are other more sustainable options available such as CT. This phenomenon can be seen also from the interviews. All of the interviewees identified collaboration and data sharing (open data) as opportunity and some even expected it in the future.

Moreover, digitalisation can be seen as key enabler and trigger of CE. Digital technologies lower operating costs, develops collaboration through supply chains, aids closing the material loops, helps construct a regenerative economy and harmonizes the TBL objectives of environmental, economic, and social benefits. Effective transportation and good transportation networks are crucial for companies to compete, especially in the global economy. Networking could provide a vertically and horizontally integrated supply chains, in which all value functions interact and communicate with one another in real-time and possibly at in more global level. For example, the development of Product-as-a-Service (PaaS) CE business model and the integration of customers and products into the DSC network enables this level of integration. Which was also recognised as an opportunity by the interviewees.

Second requirement is **planning**. Real-time data and growing network and its complexity necessitate dynamic planning based on network structure. Optimizing decision-making requires taking user preferences, dynamic resource allocation, forecasting, and recalculation whenever latest information becomes available into account at all strategic, tactical, and operational levels. Additionally, the characteristics of CT should be taken into account while designing the infrastructure and services, allocating resources, and planning new initiatives in order to create a strong network with a high degree of synchronization and flexibility. Most companies that were interviewed had already some kind of ERP system in place, which suggests that the most crucial digitalisation foundation has been already laid. As the literature suggested, next layers include investing in software and mathematical modelling to utilize the collected data. In a CT supply chain, stakeholders should ideally be able to observe their activity status and events that have an impact on it globally. With this information, businesses can implement practical planning techniques and respond quickly to unforeseen circumstances. For example, real-time information could be used to manage and reschedule delivery times or to modify the routing and timetable, or even change modes that provide service to customer.

Third requirement is **smart applications and digital technologies**. Information flow is crucial to CT, necessitating ITS systems to gather and distribute data coming from many sources that adhere to common standards. Information must be protected, and access permissions to all data should always be defined for each stakeholder. Information should be gathered automatically wherever possible in a setting where data usage is heavily influenced by other technologies. For example, a neutral party, who collects, manages and shares data with all stakeholders. Strategy can only be implemented if supply chain stakeholders develop a sense of mutual confidence for the sustainability data each partner provides. As a result, CE mandates disclosure of all associated materials including financial flows across the whole life cycles of the system or product. In Europe, as good example is the ERTMS or GS1, which both create a common system and standards for the operators.

The latest information technology, such as IoT, big data analysis, cloud computing, or blockchain, may readily give the necessary transparency in supply chains. These are essential components that could be combined by e.g. IoT tracking and AI-enabled global data matching models to close the actual gap across individual supply chain operations. Modern ERP systems are used by the majority of businesses to coordinate material and cash flows. Within an organization, this facilitates and promotes decision-making and optimization. Although the data is available, the gaps still need to be filled in. The scope of data analysis should include the entire value chain, since only then can a company receive the proper knowledge to assist themselves as well as their supply chain collaborators in realizing the many advantages of a CE and CT.

Fourth requirement is **infrastructure**. To establish intelligent hubs and corridors for CT operations, the infrastructure network configuration should be rebuilt. Additionally, to meet CT objectives, infrastructure design and terminal and production site placement are crucial. In the interviews almost, all highlighted the importance of location of the railways, hubs, and corridors. The common consensus was that in order for CT to be appealing for them, it needed to reach the same level of cost and service of truck transportation, and one of the key impediments that was recognized was lacking infrastructure. As one of the interviewees stated different modes of transport have their own strengths and in an optimal system they are able to utilize them together. Transition from one mode of transport to another occurs at network nodes/hubs, such as, an intermodal terminal.

From the theoretical proportion it can also be seen that infrastructure was listed as one of the support activities that aids at least one of the main activities of the value chain and is often also acknowledged in literature as key factor in creating competitiveness. By utilising CT, business can utilize both road and train infrastructures cost effectively and environmentally. However, in some extent infrastructure as whole is a political issue, which can be seen for example, in Europe in a form of ERTMS/ECTS and building new railway capacity. Previously, CT has not been considered in rail infrastructure's development process, hence CT operations are often impeded by outdated and inflexible systems, infrastructures, and policies.

Fifth requirement is **awareness and paradigm shift**. Customers should only consider the wanted results or needed service, not necessarily the transportation details of how it will be delivered. Additionally, in order to be prepared to respond when disruptions occur, supply chain stakeholders must undergo a mindset transformation to recognize the significance of the TBL sustainability and effectiveness of the network. As also seen in the interviews as well as in the literature, previous good experiences often affect the willingness to try other solutions, such as CT.

The stakeholders' involvement and commitment are necessary for the paradigm shift, as well as the redesign of systems to conform to the principles of business model innovation. CT's real-time information, data, flexibility, collaboration and coordination, and interoperability qualities enable most smart use of the resources at hand. Stakeholder collaboration and coordination are essential for creating a reliable network and increasing information visibility (open data). To improve flow consolidation and maximize total capacity, cooperation on the one hand necessitates comprehensive integration of stakeholder networks. This benefits all stakeholders, especially those involved in planning, forecasting, and risk management. As a result, the supply chain's overall quality and visibility are enhanced. For example, some type of reservation systems or applications could be used to organize and foster teamwork in order to prevent empty load journeys and to lower emissions.

Moreover, it can be seen from the interviews that the environmental, economic, and social factors have different weighs on the business's decision making and expectations. The interviewees gave most weight to economic factors. In Finland this makes sense, since it is stated in Finnish law that the purpose of the company's activities is to generate profits for stakeholders. Interestingly, the second most weight was given to the environmental aspects by the interviewees. This may be because environmental issues are more on the table and even gain a lot of weight here at EU level. The social considerations were often the least thought aspect, and in general, it consisted of mostly of well-being at work. However, some recognized its importance on customers as well. The change in the market condition due to demand for TBL sustainability, forces companies to consider TBL sustainability more holistically in a form of e.g. efficiency, customer demands and profit making. It should be recognised that once an essential resource is lost, the chain will suffer as a whole.

Sixth requirement is **regulation, policies, and political frameworks**. Regulating the new dynamics that CT has brought about is a crucial issue that may also have an impact on other requirements identified. For instance, it is important to have a clear picture of who is responsible in the event of any unexpected disruptions that might happen in CT, since there are more moving parts than in traditional truck transportation. In regard of DSC's, especially ICT policies and worker policies are in key role, which are additionally linked to supply chains performance. Thus, data structures, security and standards need to be established to enable innovative applications.

Seventh and final requirement is to determine **service and price strategies**. Because a CT network must be flexible, pricing services is more difficult since prices are often dependent on e.g. distance, mode, and weight. Prices also need to be competitive in order to attract customers, which was also the consensus among the interviewees. Savings in the logistics and transportation costs correlate directly with profit margin of a company, and thus, savings contribute to the company's competitiveness. The increasing demand for sustainability, has prompted the implementation of more sustainable solutions such as CE. One of the business models of CE is PaaS, which is built on the premises of service offering, and similarly CT business models were often constructed on service offering connecting it to CE. The market conditions are clearly changing and these growing demands on sustainability, efficiency, customer demands and profit making create a demand for novel solutions, especially in the transport sector. Thus, CT solution should create some cost reductions or at least meet the costs of truck transportation solution, for CT to be viable alternative. Additionally, CT offers different kind of service offering and more environmentally friendly option for transportation, which aligns with current customer demands and market conditions.

The second research question was: "*How does circular economy and digitalisation enable combined transport business models?*" CT itself aligns with the CE objectives through TBL sustainability. CT combines elements of both CE and digitalisation in many respects. When the emphasis on mere economic benefit shifts to ecological and social sustainability principles, CT becomes an even more appealing option. Identifying internal and external factors that align with CE and digitalisation will help businesses to make the shift towards new smart and more sustainable business models. Therefore, both CE and digitalisation should be comprehensive throughout the entire strategy, not merely technology adoption and operation.

Digitalisation is driving CE and it is enabling CE business models, for instance, by allowing for remote tracking of product placement and consumption. Digitalisation can accelerate the shift toward a circular economy which is more sustainable. By giving precise data on the availability, position, and status of products, it can assist in closing and narrowing the material loops. Additionally, digitalisation allows for more effective business procedures by collecting more, precise, and up to date data and by helping to analyse this collected data, digitalisation creates visibility, efficiency, and agility, which helps among other things decision making and planning.

The literature on intermodal transport business models is currently insufficient. However, since the business model is often considered as the blueprint of competitive advantage it is generally not fully shared. This might affect the number of current studies on the subject. Another aspect is that the business models might not be developed yet. Even though intermodal transportation is not a new concept, it is not yet fully utilised. Possible causes could be for example the high degree of regulation and high initial investment costs in railway operations. Nevertheless, there are few business models that we can identify clearly from the literature for intermodal transportation. The transportation chain consists of the same actors, operators, hubs and corridors, the difference between the business models is the matter of who is responsible for what.

It can be concluded from the theoretical portion of this paper that improving information exchange, effective collaboration between businesses and consumers, aligning logistic infrastructure to the requirements of the circular economy, and developing unique logistic services are the keys to effective future logistics. Thus, companies aiming to implement CE should also utilize digitalisation. Interestingly, most of the interviewees perceived adopting modern technologies ambiguous due to the uncertainty, which is paradoxical from the theoretical viewpoint of digitalisation enabling businesses to overcome uncertainty and effectively adapt to the ever-changing business demands. Thus, it is apparent that both CE and digitalisation should be comprehensive throughout the entire strategy, not merely technology adoption and operation. CE should be implemented from top-down with policies and bottom-up with company initiatives.

It is not only about transforming existing operating processes into a digital format, but also the opportunity to create value in a whole new way through new types of business models. CT necessitates collaboration across various entities, making the creation of a successful business model difficult but necessary for economically viable solutions. CE and digitalisation are enabling CT. Sustainability demands, that are CE requirements for supply chains, are promoting more sustainable options such as CT. Benefits of digitalisation, have an effect to the sustainability of the supply chain. With the paradigm shift of Industry 4.0, more holistic and networked approach is possible. With digitalisation, DSC's will eventually replace the traditional supply chains.

Thus, it can be stated that, although businesses have recognized the opportunity presented by digitalisation and CE, they are not well-equipped to take advantage of them in SO. There are many technologies accessible, but coordinating, collaborating, and developing business models pose the most challenges. The cost of logistics is significant, both for companies themselves and for society. Digitalisation allows for example, efficiency to increase and thus lower costs (economic sustainability), lower energy consumption (environmental sustainability), more effective route planning (economic, environmental, and social sustainability), and higher capacity utilisation (economic and environmental sustainability). On the other hand, better ways of operating or providing information to customers can also be found, resulting in increased service levels and customer satisfaction (social sustainability). As a whole, society is also concerned with the cost of transport infrastructure, externalities and welfare brought by logistics. One aspect of more efficient design is avoiding driving empty or partial loads and ultimately combining transportations so that road transport can be combined with a more efficient and ecological mode of transportation such as rail.

Receiving quality data in real time is crucial due to the demands and expectations of efficiency, timeliness, and flexibility in transportation. Along the supply chain, several stakeholders require access to the data, but only to a certain extent. Emerging technologies and trends including Big Data, IoT, Blockchain, Cloud Solutions, and AI are all maturing and becoming more and more utilised. In other words, there is a great deal of data available, but it might not get to the correct place in time or be in a form that can be efficiently utilized. Thus, having applicable real-time data would create new possibilities. Furthermore, such technologies will enable digitalisation in supply chains. Since, the applied technologies itself is not the important aspect in DSC's but how the supply chain is managed with these technologies, information systems' intelligence or in other words smart applications are required.

For companies to be able to utilize these technologies they need to have the required resources and capabilities to operate them. The objective is to use the obtained data to improve decision-making, which might occur through many levels in transportation. Such can include either traditional operations research-based mathematical optimization methods or even further advanced AI based solutions that are automatized. Consequently, todays better performance requires intelligence and smart applications, including forecasts, AI, and autonomous technologies, with an environmental consideration, which requires real time data collected with the help of digitalisation.

5.2 Limitations, discussion and future research

This research work shares certain limitations in common with other research works. The sample for this research is relatively constrained because it is built mostly on viewpoints of experts from the different sectors related to supply chains in SO areas SMEs. This kind of sampling might affect the generalisability of the results in a bigger scale. The focus of this thesis is on the business models, which leaves room for other perspectives as well. The researcher has made several efforts during this whole thesis project to reduce any potential limitations or biases associated with the study. By focusing on issues connected to the study's repeatability, credibility and validity, the researcher has sought to ensure the quality of the data and credibility of the research. By carefully documenting the research method, the researcher attempted to ensure the validity of this thesis. Additionally, the thesis' technique was selected based on how well it answered the thesis' research questions. Throughout the thesis process, the methodological choices taken in this work have been carefully clarified. The results of this study are in line with the theoretical portion and previous research concerning CT, digitalisation, and CE.

To achieve appropriate understanding of the subject before conducting interviews, the researcher also conducted extensive study on the CE, digitalisation, and CT before to the data collection, as shown in Section 2 of this thesis. The literature review concentrated on the peer reviewed scientific articles published in last three years in respective fields utilizing ProQuest, EBSCO, Scopus and Emerald data bases. Such keywords were used as “combined transport” and “intermodal transport” paired with “digitalisation”, “digitalization”, “circular economy”, and “business model”. To ensure a representative, competent, and varied group that would yield high-quality data for the study, the respondents were chosen taking all these considerations in account. By considering the overall amount of calls made, the total sampling can be considered as sufficient. Therefore, it can be also stated that the results reflect somewhat the current status of Southern Ostrobothnia. Additionally, the results and answers were tested with weak market test (Lukka, 2003). The weak market test was conducted in additional workshop of six people and it passed the test since respondents accepted the results. The results are also more or less thematically identical with theoretical portion of this thesis, which strengthens the reliability of the results.

5.2.1 Discussion

This research combines in a new way the development of the transport system, the levelling of digitalisation of supply chains in accordance with CE business models. This study enhances our knowledge of CT networks, particularly in terms of business models and the development of their services. The study's findings offer fresh perspectives to academics, decision-makers, and logistics professionals. As a practical implication this thesis provides an additional viewpoint on the difficulties associated with combined transport sector, supports a more comprehensive analysis by considering all variables and their relationships, and thus contributes to the theory and CT literature. Furthermore, it gives a general understanding of the current situation of digitalisation and CE in the SO. The current scarcity of resources was perceived as one of the main barriers by both the academia and the interviewees. While, from the interviewees standpoint the resource scarcity was concentrated on the small organization size, the academia perceived the lack of railroad rolling stock availability and lack of sufficient infrastructure as resource scarcity. The findings also indicate that the costs and prices are another key barrier. The demand of CT is less sensitive to costs, making it price inelastic compared to road transport. These barriers are in line with the Rotaris et al. (2022), who also noted that the optimal methods to induce shift from road to rail are to introduce more high quality train services and decreased transit times.

Furthermore, the results indicate that the logistics sector is intrigued by the more sustainable ways to operate, but the companies in the SO feel that the uncertainty and lack of resources are hindering the change. Thus, this study demonstrated how frequently both shippers and operators are ignorant of the financial and environmental benefits of adopting CT. Even if these benefits are in Finland's case theoretical, the positive evidence can be seen in other European countries, which could have a practical impact for those who buy the transport services. This thesis also has some important ramifications for businesses and their executives when it comes to using new technology in the supply chain industry for resilience. Organizations involved in logistics and supply chains frequently experience uncertainty as a result of industry disruptions, which have become even more complicated as a result of the recent COVID and Ukrainian war issues. In order to deal with these shocks, organizations are working to increase their resilience. However, this is a difficult assignment for management, particularly for SMEs.

5.2.2 Future research

The impact that operators have in the adoption of CT is not been studied sufficiently in the literature. Furthermore, quite few studies have applied an analytical strategy based on actual case studies, despite the fact that several simulation studies have examined the possible impact of infrastructure and policies intended to support the shift to CT. The findings of this research need to be further investigated as they may offer useful data to both operators and governments. Further research of the rather static state of the Finnish rail traffic should be conducted. The benefit of adopting CT is extremely application dependent, such as on the type of delivery (type of good, quantity, and distance traveled), which is why logistical parameters should be considered carefully. Therefore, more microeconomic research focusing on various industrial sectors should be conducted with the intention of illustrating their variances and commonalities related to CT.

The actual steps of entering the CT market as well as the obstacles encountered are still uninvestigated. The industry change could also be evaluated. Analyzing the mechanics of the developing and shifting markets based on assessments, or even observations in other countries, could be beneficial in this context. The results of the competition's opening could be researched subsequently. Thus, the future research could additionally examine the impact of the entrance to the market on costs, transportation volumes, government operations, and the caliber of services and safety, the stock availability, transportation quality and timeliness, and whether these necessitate additional infrastructure expenditures.

Overall the literature on CT business models is insufficient, which is why it could also need some further research. Although, finding data may be challenging due to the nature of high confidentiality of such data, more theoretical frameworks would be beneficial. Further research could also be conducted on the digitalisation of freight logistics sector, especially from the networking and collaboration point of view. Current systems between different companies do not often integrate with each other. These problems in integration cause multitude of direct and indirect effects on the supply chains. The research could concentrate on the ITS, EDI and API applications and usage in the data integration of supply chains. Companies need to identify what kind of data would be beneficial for them and would sharing that kind of information be possible, in order to make the supply chains even more efficient. Furthermore, the digital synergies between different stakeholders and business sectors, could be studied. For example, integration of forward logistics, collaboration and reverse logistics has been rarely addressed.

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Attachments

Attachment 1. Interview questions

BACKGROUND

0. What kind of needs do your customers have for transportation in general?
a. e.g. price, time, reliability

CIRCULAR ECONOMY IN SUPPLY CHAINS

1. Has the company set goals to improve/promote sustainable development/circular economy?
2. What kind of business benefits are you aiming for with these circular economy activities?
3. What circular economy/sustainability measures have been taken in your company from an environmental perspective?
4. How is the circular economy taken into account in the different stages of the value chain? Is there an emphasis on a certain part?
5. Do you recognize problems that prevent the development of circular economy business?
a. internal challenges, external challenges, ecosystem
6. Can you name successful circular economy projects from your own operational sector?

SUPPLY CHAIN DIGITALIZATION

7. How does digitization appear in your supply chains at the moment?
8. At what level do you feel you are in digitalization in relation to your competitors?
9. How important do you think the development of digital capabilities is for the implementation of the entire supply chain strategy?

10. What kind of expectations do you have for digitization in relation to the benefits to be achieved in business?

a. e.g. price, speed, internationality, image, common good/ ecology

11. Which factors are perceived as challenging/obstructive in the digitization of supply chains?

a. What kind of risks do you recognize in the digitization of supply chains?

b. Pitfalls?

12. Which factors have been perceived as positive in the digitalization of supply chains?

13. Are you planning to invest in any new technology or innovation in supply chains in the future?

14. What are the most important factors that made you invest in the digitization of supply chains?

COMBINED TRANSPORTATION

15. Do you see combined transport and/or the utilization of rail traffic as a possibility?

16. What kind of (intangible and material) added value would combined transport bring to your company's operations?

17. Can you define some specific obstacles specific to rail logistics from the point of view of combined transport?

18. What things should be in order for combined transport to be beneficial to you?

FUTURE

19. How do you think digitization and the circular economy will appear in the future in the management of supply chains?

20. What do you think are important themes now and in the future in terms of supply chains and logistics?

21. What kind of development would you like to see in the field in the near future?