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Driving ecological sustainability through the adoption of road-rail intermodal transport

A European MNE case study

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ABSTRACT:
Road-rail intermodal freight transport is prominently advocated in the European Union climate and transport policies as an ecologically sustainable and low-emission alternative to exclusive road freight. Despite the European Union's carbon-reduction targets and the accelerating sustainability commitments of multinational enterprises (MNEs), the use of road-rail intermodal transport remains limited in the EU. This study aims to fill this gap by exploring how institutional, economic and social/human factors influence the adoption of road-rail intermodal transport among MNEs operating within the EU to achieve ecological sustainability. In doing so, the study differentiates between factors that inhibit or enhance the adoption.

The research was conducted as a qualitative case study of an MNE with a strong strategic focus on long-term sustainable development. Semi-structured interview, informal interviews, observations and secondary data were used to collect the data. The sample consists of two case company representatives and three case company stakeholder representatives of logistics companies. The findings were analyzed using thematic analysis guided by institutional, economic and social/human factors of the theoretical framework.

The findings suggest that the adoption of road-rail intermodal transport among MNEs is primarily determined by economic and, thus, operational feasibility, while institutional and social/human factors play important but indirect and mediating roles. Institutional factors shape long-term strategies within MNEs through ecological sustainability goals and generate strategic incentives, legitimacy, and organizational attention for modal shift, but are not sufficient as standalone drivers for adoption. Instead, decisions remain dependent on economic factors, which, once acceptance thresholds are exceeded, tend to outweigh ecological objectives. Social/human factors such as collaboration with logistics service partners mediate how sustainability ambitions are translated into operational practice by enabling knowledge transfer, coordination, as well as implementing and operationalizing intermodal solutions.

Institutional inhibitors at the system level, such as infrastructure fragmentation, create operational constraints. Economic inhibitors include longer door-to-door transit times, and decreased punctuality and reliability, which, in turn, connect with social/human inhibitors such as decision-makers' preference for established road routines. Institutional enhancers include firm-level governance, but their influence remains indirect unless supported by favorable economic conditions such as long-distance, high-volume flows, and acceptable service performance. Social/human factors include coordination, trust and knowledge among actors that allow for the implementation of road-rail intermodal transport.

KEYWORDS: intermodal, institutional theory, triple bottom line, ecological sustainability

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TIIVISTELMÄ:
Euroopan unionin ilmasto- ja liikennepolitiikassa intermodaalista maantie-rautatiekuljetusta kannatetaan laajasti ekologisesti kestävänä ja vähäpäästöisenä vaihtoehtona pelkälle maantiekuljetukselle. EU:n hiilidioksidipäästöjen vähentämistavotteista ja monikansallisten yritysten kasvavasta kestävyys sitoutumisista huolimatta intermodaalin kuljetuksen käyttöönotto on kuitenkin käytänössä edelleen rajallista. Tämä tutkimus pyrkii tarkastelemaan miten institutionaaliset, taloudelliset ja sosiaaliset/inhimilliset tekijät vaikuttavat intermodaaliseen maantie-rautatiekuljetuksen käyttöönottoa EU-alueella toimivissa monikansallisissa yrityksissä ekologisen kestävyyden saavuttamisesksi. Tutkimusasetelma rakentuu miten nämä tekijät estävät ja edistävät intermodaalista maantie-rautatiekuljetuksen käyttöönottoa.

Tutkimus toteutettiin laadullisena tapaustutkimuksena monikansallisessa yrityksessä, jonka toiminnassa korostuu vahva strateginen painotus pitkän aikavälin kestävään kehitykseen. Aineisto kerättiin puolistrukturoidulla haastattelulla, epämuodollisilla haastatteluilla, havainnoinnilla ja toissijaisella aineistolla. Otos koostuu kahdesta tapausyrityksen edustajasta ja kolmesta logistiikkayrityksen tapausyrityksen sidosryhmän edustajasta. Tulokset analysoitiin temaattisen analyysin avulla, jota ohjasi teoreettisen viitekehtyksen institutionaaliset, taloudelliset ja sosiaaliset/inhimilliset tekijät.

Tutkimustulokset osoittavat, että intermodaalien maantie-rautatiekuljetuksen käyttöönottoa monikansallisissa yrityksissä määrittävät ensisijaisesti taloudellinen ja siten operatiivinen toteuttamiskelpoisuus, kun taas institutionaalisilla sekä sosiaalisilla/inhimillisillä tekijöillä on epäsuora ja välittävä rooli. Institutionaaliset tekijät muovaavat monikansallisten yritysten pitkän aikavälin strategioita ekologisen kestävyyspäämäärien kautta ja luovat strategiesia kannustimia, legitimeettiä sekä organisaation sisäistä huomiota kuljetusmuodon muutokselle, mutta ne eivät yksinään riitä muutokseen. Sen sijaan kuljetusmuodon käyttöönottoon koskevat päätökset ovat edelleen riippuvaisia taloudellisista tekijöistä, jotka hyväksymiskynnysten ylittäessä syrjäyttävät usein ekologiset tavoitteet. Sosiaaliset/inhimilliset tekijät, kuten yhteistyö logistiikkapalveluntarjoajien kanssa välittävät kuinka kestävyyteen liittyvät tavoitteet käännetään operatiiviseksi toiminnaksi mahdollistamalla tiedon siirron, koordinoinnin sekä käyttöönoton.

Institutionaaliset tekijät järjestelmätasolla, kuten hajanainen infrastuktuuri aiheuttavat operatiivisia rajoitteita. Taloudellisia estäviä tekijöitä ovat pidemmät kuljetusajat sekä heikompi täsmällisyys ja luotettavuus, jotka puolestaan kytkeytyvät sosiaalisiin/inhimillisiin tekijöihin, kuten päätöksentekijöiden mieltymykseen vakiintuneisiin maantiekuljetusrutiineihin. Institutionaalisia edistäviä tekijöitä ovat yritystason hallintokäytännöt, mutta niiden vaikutukset jäävät epäsuoriksi ilman suotuisia taloudellisia olosuhteita, kuten pitkiä kuljetusmatkoja, suuria volyymeja ja hyväksyttävää palvelutasoa. Sosiaaliset/inhimilliset edistävät tekijät, ovat toimijien välinen koordinointi, luottamus ja osaaminen.

KEYWORDS: intermodal, institutional theory, triple bottom line, ecological sustainability

Artificial Intelligence (AI) disclaimer: Two AI Tools, ChatGPT (OpenAI) and Grammarly, were used in the writing of this study. ChatGPT (OpenAI) was used to brainstorm sub-headings, identify alternative wording and synonyms, and improve sentence flow, structure, and clarity. Grammarly was used for proofreading and grammatical correction to improve linguistic quality.

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Abbreviations

CO_2	**Carbon dioxide**
CO_2e	**Carbon dioxide equivalent**
EU	**European Union**
GSCM	**Green supply chain management**
TBL	**Triple bottom line**
TEN-T	**Trans-European Transport Network**

1 Introduction

This introduction chapter introduces background and research topic of the study, along with the research gap. A brief presentation regarding the case company is included next. The chapter then moves on to the research question and the sub-research questions. Then the chapter proceeds to examining the delimitations of the thesis, followed by the thesis structure explanation.

1.1 Background of the study

Sustainability has become a central focus for industries worldwide due to increasing environmental pressures and evolving regulatory frameworks. At the global level, the United Nations' Sustainable Development Goals (SDGs) are a widely recognized framework for sustainable development, adopted by all UN member states in 2015 (United Nations Global Compact, 2024). The 17 SDGs aim to protect the planet, erase poverty, and ensure equality. At the regional level, the European Union has established an extensive regulatory framework, most notably the European Green Deal, which intention is to achieve climate neutrality in the European Union by 2050 (European Commission, n.d.). The European Green Deal is written into the European Climate Law, which establishes a long-term path toward carbon neutrality by 2050 through policy integration that ensures social equity and economic efficiency (European Commission, n.d.). The law further sets a medium-term target for 2030 of a minimun 55% reduction in greenhouse gas emissions compared to 1990 levels. In order to achieve these targets, the European Climate law seeks to ensure a stable regulatory environment, monitor progress and protect the integrity of the decarbonization process. Furthermore, these legislative measures are in line the Paris Agreement.

In 2022, transport accounts for approximately one-quarter of the EU's total greenhouse gas emissions (European Environment Agency, 2024). Since the majority of the transport in the EU happens by road, road transport accounts for 73.2% of total transport GHG emissions in 2022 (European Environment Agency, 2024). In fact, road freight transport

has been found to be one of the most carbon-intensive modes, emitting an average of 137 g CO_2 per ton-km, compared with 24 g CO_2 for rail and 33 g CO_2 for inland waterways (European Union, 2023). In response, the European Green Deal sets a target to decrease transport-related emissions by 90% by 2050 compared to 1990 levels (European Commission, n.d.).

Modal shift policies are therefore central to the EU's decarbonization agenda, with the aim of redirecting freight flows from road toward more sustainable modes such as inland waterways and rail (European Environment Agency, 2024). Within this framework, road-rail intermodal freight transport, which includes combining road and rail modes with the mode transfers occurring at dedicated terminals in order to maximize rail utilization (Crainic & Kim, 2007), has been recognized as a strategic pathway for reducing greenhouse gas emissions in freight transport (European Environment Agency, 2024; Janic, 2008; Lammgård, 2012; Pinto et al., 2018). Road-rail intermodal transportation can reduce pollution by up to 77.4% compared to road-only freight (Pinto et al., 2018). However, although intermodal freight transport by rail increased by 25 % between 2013 and 2018 (UIC/UIRR, 2024), rail continues to account for a small share of total freight activity in the EU. In 2022, maritime transport accounted for more than two-thirds of freight activity (67.8% of ton-km), followed by road (24.9%), while rail represented only 5.5%, with inland waterways (1.6%) and air transport (0.2%) making up the smallest shares (European Commission, 2024).

Hence, it is evident that underutilization of rail as a freight modal choice raises questions about how transport modes are selected in practice and to what extent sustainability considerations influence these decisions. Prior research on transport mode choice have focused mainly on economic and service factors, which include transport cost, reliability, frequency, flexibility, and transit time (Danielis & Marcucci, 2007; Dekete et al., 2010). Although the importance of sustainability is gradually being acknowledged within academia research (Arencibia et al., 2014; Bask et al., 2017;Eng-Larsson & Kohn, 2012; Islam et al., 2013; Stockhammer et al., 2021; Tavasszy et al., 2020), they play a marginal

role role in freight transport decision-making and are often seen as a co-benefit, not a primary driver (Bask et al., 2018; Eng-Larsson & Kohn, 2012; Stockhammer et al., 2021). Supporting this argument, Bask et al., (2017) have in their systematic literature review of the role of environmental sustainability and intermodal transport in transport mode decisions, highlighted that only recently has environmental sustainability been considered an important key performance indicator in intermodal studies.

Similarly, Eng-Larsson and Norman (2014) show how the selection and implementation of new transport modality require the involvement, knowledge and coordination of various logistics actors. The prior literature advanced that trust and contract stability between shippers and transport providers are crucial factors for the initiation and maintenance of rail-based solutions (Rogerson et al., 2021; Lammgård, 2007). As the case company in this study relies on external transport providers, these factors are of interest.

Importantly, Bask et al. (2017) highlight several propositions for further research. On the shipper side, they highlight a lack of perspectives into how environmental objectives in transport services can be operationalized and how they may serve as a source of competitive advantage. Indeed, a small body of research has highlighted that modal choice is not chosen solely by cost and service factors, but also by contextual and strategic considerations. Eng-Larsson and Kohn's (2012) study focused on how external stakeholder pressure, corporate sustainability policies, and broader logistics strategies can enable intermodal shift while maintaining service reliability. Nevertheless, to my knowledge, their work stands out as one of the few studies that adopt an explicitly shipper-centric perspective.

In addition, as suggested by Bask et al. (2017), institutional or stakeholder-based approaches are rarely used to examine the connection between environmental sustainability goals and concrete transport procurement practices in shipper decision-making. Indeed, while Institutional theory has been widely applied in studies of green

supply chain management and operations management (Chua et al., 2023; Chu et al., 2017; Kauppi, 2013; Layaoen et al., 2024; Lin & Sheu, 2012; Tate et al., 2011; Wen et al., 2023; Zhu & Sarkis, 2007) as well as corporate social responsibility (CSR) research (Lee et al., 2024; Risi et al., 2022), its direct application to freight transport mode choice from the shipper's decision-making remains limited. One notable expectation is Jazairy and von Haartman (2020), who applied institutional theory to compare how regulatory, market, and competitive pressures, moderated by firm and market characteristics, influence shippers' green logistics purchasing decisions and LSP's provision of green logistics services. However, their study does not explicitly focus on modal choice decisions, therefore leaving open questions on how institutional pressure translates into the adoption of specific modes such as road-rail intermodal transport.

However, prior research suggests that large and global shippers such as multinational enterprises are typically exposed to stronger external pressure to adopt greener transport practices due to their visibility, regulatory exposure, and stakeholders' scrutiny (Bask et al., 2018; Jazairy & von Haartman, 2020; Rogerson et al., 2016). In addition, larger companies such as MNEs often hold greater organizational resources and a stronger strategic view toward long-term sustainability objectives, which in turn may increase their capacity to engage with greener transport solutions (Rogerson et al., 2016).

Therefore, while the adoption of road-rail intermodal freight transport offers environmental potential complemented by the EU's policy ambitions, the literature suggests that freight transport decisions are shaped by the interaction of economic performance criteria, social and organizational relationships within logistics networks, and institutional pressures related to sustainability and legitimacy. While each of these dimensions has been studied separately, this thesis aims to connect how they jointly influence transport mode choice at the shipper level, and to understand why the adoption of road-rail intermodal transport remains limited in practice despite strong sustainability ambitions and regulatory frameworks.

1.2 The case company

This study will utilize a case company to explore the inhibitors and enhancers for the adoption of road-rail intermodal in one of the company's business units operating in Europe. The case company is a multinational chemical and consumer goods enterprise that prioritizes sustainable development and has applied various initiatives to encourage environmentally responsible practices. This thesis aims to clarify the challenges and opportunities for improving ecological sustainability in their downstream transport activities across Europe in one of their operating business units by examining their sustainability strategies and initiatives.

1.3 Research question and limitations

This study examines multinational enterprises (MNEs) operating in the European Union to improve their ecological sustainability through the adoption of road-rail intermodal transport as a pathway for reducing greenhouse gas emissions. By identifying that transport mode choice is shaped by a combination of institutional pressures, economic considerations, and social and human factors, this study aims to answer the following research question:

> "How do institutional, economic and social/human factors influence the adoption of road-rail intermodal transport among MNEs operating within the EU to achieve ecological sustainability?"

To address this main research question, this study is structured in two sub-questions that differentiate between factors that inhibit and those that enhance adoption.

> Sub RQ1: "How do institutional, economic, and social/human factors inhibit the adoption of road-rail intermodal transport within the EU to achieve ecological sustainability?

Sub RQ2: “How do institutional, economic, and social/human factors enhance the adoption of road-rail intermodal transport within the EU to achieve ecological sustainability?

This study is subject to several delimitations that define its scope and focus. This study is geographically limited to the European Union (EU) and examines the adoption of road-rail intermodal freight transport, as well as discusses modal shift from road-only to road-rail intermodal freight transport within the EU policy and regulatory environment. The research scope is limited to road-rail intermodal freight, meaning that other transport modes such as maritime, inland waterways, and air freight will be acknowledged but not further analyzed.

Empirically, the data used in this study are from a single MNE case company and its European business unit’s logistics operations. Furthermore, this study aims to examine experiences, challenges, and the potential for implementing road-rail intermodal transport on the case company’s strategically important freight lanes, and in addition, to consider perspectives from their external logistic service partners. While the findings may offer insights relevant to other large firms with climate targets in complex supply chains, they are not intended for statistical generalization.

1.4 Key concepts

Intermodal

Intermodal involves using two or more transport modes to move goods within a single loading unit, with mode transfers taking place at terminals (Crainic & Kim, 2007).

Modal shift

Modal shift means transitioning from one transportation mode to another, typically towards a more sustainable option (Pastori et al., 2018).

Road-rail intermodal

Road-rail intermodal freight transport involves combining road and rail modes to maximize rail utilization (Crainic & Kim, 2007).

1.5 Structure of the thesis

This thesis is organized into eight chapters. Chapter one provides an introduction that includes background and scope and frames the study's relevance by identifying the research gap. This chapter also presents the description of the case company, the research question, delimitations as well as terminological definitions used in this study.

The literature review is presented across three chapters. The first part introduces the theoretical background by defining and discussing the triple bottom line framework and institutional theory. The second part describes the economic and social/human factors in freight transport modal choice literature and examines the factors that inhibit or enhance the adoption of road-rail intermodal transport. Finally, the third part focuses on institutional theory by reviewing freight transport and modal choice literature related to the theory and examining the institutional inhibitors and enhancers. In addition, it concludes the theoretical background and literature with a summary of the theoretical framework.

The fifth chapter explains the study's methodology using the Saunders et al. (2023) research onion to describe the research process. The sixth chapter presents the findings of this study. Then, chapter seven provides a discussion in which the findings are analyzed in relation to previous literature, and the revised theoretical framework is presented. The final chapter is the conclusion where key findings, theoretical contributions, managerial implications and limitations with future research suggestions are discussed.

2 Theoretical background

This chapter presents the theoretical background used in this study. First, the concept of the Triple Bottom Line (TBL) is described, and its application to company performance and sustainable freight transport is discussed. Then, institutional theory is defined and explained using key concepts, and its use in green supply chain management is discussed.

2.1 Triple Bottom Line framework

Sustainability is defined by the World Commission on Environment and Development (1987) as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." One of the widely used frameworks for achieving sustainability is the triple bottom line (TBL), introduced by Elkington (1994). He argues that a company's performance should be assessed across three dimensions, namely economic prosperity, environmental quality, and social justice. These three dimensions are often described in the academia literature as the "three Ps": profit, planet, and people (Heizer et al., 2017; Swink et al., 2020).

In general terms, the environmental dimension of TBL focuses on minimizing the ecological footprint of business activities (Swink et al., 2020). In organizational terms, these effects are often measured by means of parameters like energy consumption, resource use, and greenhouse gas emissions. In terms of freight transport literature, environmental sustainability is often attained by reducing CO_2 emissions in organizations operations (Gandhi et al., 2022; Gandhi & Kant, 2023; Gohari et al., 2022; Gupta et al., 2025; Kumar & Anbanandam, 2022; Gohari et al., 2022).

The economic scope of TBL refers to the ability of the organization to ensure financial sustainability and competitiveness over a long period (Heizer et al., 2017; Swink et al., 2020). This entails the ability of the organization to generate long-term economic value while ensuring business performance without compromising the environmental or social resources on which it depends (Crane & Matten, 2010). From this standpoint,

organizations have been known to measure their economic value in terms of cost efficiency, profitability, risk management, as well as long-term profitability (Heizer et al., 2017; Swink et al., 2020). Furthermore, organizations must have the resources and the ability to deliver their value propositions effectively to maintain corporate sustainability (Swink et al., 2020).

The social aspect of the TBL framework includes the organization's responsibility for organizational activities toward stakeholders, including customers, employees, suppliers, and local communities (Heizer et al., 2017; Swink et al., 2020). This social responsible behaviour include for example, the organization's dedication to provide safe and fair working conditions for employees and equitable stakeholder interaction. According to Swink et al. (2020) organizations develop codes of conduct for themselves, and therefore collaborate with suppliers in their supply chains who share similar values in terms of fair practices to promote trust and compliance, both which are important assets for achieving sustainability objectives.

According to Elkington (1994), the TBL is a guiding principle for organizations to balance economic performance with environmental and social responsibility. Indeed, organizations' efforts to be more environmentally and socially sustainable can improve its value proposition (Swink et al., 2020). Hence, improved value proposition will attract customers, leading to improved profitability. In a similar way, this is evident in research by Gupta et al. (2025), who applied TBL to identify optimal multimodal strategies in India's public distribution system. Their findings show that integrating rail lowers distribution costs while reducing CO_2 emissions and enhancing community well-being. However, some sustainable practices may involve trade-offs between higher costs and higher environmental and social sustainability. Laosirihongthong et al. (2019) argue that if adopting certain sustainable practices has a negative impact on profitability, companies may be hesitant to adopt them. Their study found that the economic dimension is the most valued, followed by the environmental and social dimensions.

Within freight transport literature, TBL is commonly applied to assess sustainable performance and evaluate transport systems. For instance, Gandhi et al., (2022) applied TBL-based model to evaluate rail sustainability across 12 indicators covering environmental dimension that included indicators such as ghg emissions and energy efficiency, economic dimencions such as indicators freight market share, freight operating margin, unit costs, average speed of freight trains and social dimensions that included indicators such as employment, accident rate and average annual wage per employee. Building on this work, Gandhi et al. (2023) proposed an expanded index-based assessment framework using the TBL framework, which categorizes 36 indicators into six measures across the environmental, economic, and social dimensions. While this framework allows for the identification and comparison of sustainability performance across individual indicators, the study is primarily subject to government policymakers and railway officials.

2.2 Institutional theory

Institutional theory explains how organizations' structures and practices are shaped by their broader institutional environment. Although there is no universally accepted definition of institutional theory, its foundations are well established by scholars Meyer and Rowan (1977), DiMaggio and Powell (1983), Scott (2001), and North (1991). In sustainability and green supply chain management academia, DiMaggio and Powell's (1983) work is widely used when studying the implications of institutional theory. They define institutional theory as an approach that explains how external pressures influence and shape organizational practices, thereby creating increasing homogenization among organizations that work in similar environments.

A central concept in institutional theory is the definition of what constitutes an institution. North (1991) defines an institution as "the humanly devised constraints that structure political, economic, and social interaction" (p. 97). He divides institutions into formal and informal institutions. Formal institutions comprises the constitutions, laws, rules, and policies (North, 1991), and, according to Peng and Meyer (2019), they are

commonly set by national governments and other supranational authorities, such as the European Union (p. 35). Informal institutions, in contrast, include customs, traditions, and ethics (North, 1991) that pressure companies to act beyond legal requirements, in ways considered morally right and important in society (Peng & Meyer, 2019, p. 35).

In addition North (1991) explains that the primary purpose of these mentioned institutions is to “create order and reduce uncertainty in exchange” (p. 97). He explains that institutions define the “choice set” available to economic actors, influencing the economic profitability of different courses of action. Hence, differences in institutional arrangements affect whether economic changes lead to growth in one setting but recession or stagnation in another.

In contrast, Scott (2001) suggests an understanding of institutions as social structures that shape organizational behavior and can be divided into three pillars. Laws, rules, and sanctions that constrain and regulate individual and organizational behavior are a part of the regulative pillar. These are set by governments and regulatory authorities and according to Peng and Meyer (2019) largely correspond to formal institutions as defined by North (1991). In comparison, the normative pillar consists of values, norms, and social obligations that define appropriate conduct and moral legitimacy (Scott, 2001). The third pillar is cultural-cognitive pillar, which includes shared beliefs and symbols, frames of reference, and taken-for-granted assumptions, that provide construct meaning and normalize organizational practices. Peng and Meyer (2019) explains that these latter two pillars explained by Scott are closely in line with Noth’s (1991) definition of informal institutions.

Organizational institutional theorists explain that the survival and success of organizations depend on the ability to gain and maintain legitimacy in their institutional environment (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). Meyer & Rowan (1977) define institutionalization as the process by which organizational practices and structures become taken for granted as legitimate and rule-like, driven by external social

expectations. From this perspective, organizations adopt formal structures and policies to signal conformity to their environment and demonstrate legitimacy, which functions as a symbolic resource. Furthermore, Scott & Meyers (1983) explain that institutional theory seeks to explain "the elaboration of rules and requirements to which organizations must conform if they are to receive support and legitimacy". According to new institutional theory, organizations may prioritize social legitimacy over purely operational or technical efficiency by adopting formal structures that reflect with external pressures and environmental expectations to ensure survival and access to resources (DiMaggio & Powell, 1983; Meyer & Rowan, 1977).

DiMaggio and Powell (1983) introduced the concept of organizational fields, which refers to groups of organizations that collectively form a recognized area of institutional life, such as companies producing similar products, their suppliers, customers, and regulatory bodies. These organizational fields share common structures, symbols, and motivations and are often exposed to similar institutional pressures, which drive them to seek legitimacy among stakeholders. When these organizational fields mature, the organizations in them tend to become increasingly similar, a phenomenon known as isomorphism. This phenomenon is driven by three types of institutional pressures called coercive, normative, and mimetic.

As per DiMaggio & Powell (1983), coercive pressures generally arises from the need to comply with legal and regulatory requirements, laws, and demands from government authorities and influential stakeholders. According to Rivera's (2004) study, coercive pressure is often in the from of government regulations, laws, fines, and trade barriers that force organizations to adopt environmentally responsible practices. Lin and Sheu (2012) found in their study that inter-firm dependencies with legal and regulatory pressures, positively influence the adoption of green certifications and supply chain practices by driving both environmental and operational benefits in study's sample companies. In the logistics and freight transport industry, Chu et al. (2023) have found that regulatory pressure encourages shipping companies to adopt sustainable shipping

management practices. Similarly, these environmental complince pressures have been found to positively influence the green performance of transport and logistics companies (Layoaen et al., 2024). Also, powerful customers can exert coercive pressure on companies to drive environmental initiatives (DiMaggio & Powell, 1983; Kallionpää et al., 2026).

Normative pressures originate from professional and industry standards, expectations, and norms and are set by professional bodies and trade associations (DiMaggio & Powell, 1983). Also, normative pressures encourage organizations to engage in voluntary environmental initiatives through industry associations, professional networks, and academic institutions (Rivera, 2004). These pressures can encourage organizations to act in a morally and environmentally conscious way (Kallionpää et al., 2026). In fact, Campbell (2007) found that companies are more likely to act in socially responsible ways under favorable economic conditions. Such companies tend to engage with NGOS and maintain stakeholder communication to signal accountability. Similarly, Layaoen et al. (2024) found that CSR and environmental performance are improved by normative pressure resulting from socio-cultural obligations. These obligations are defined as voluntary commitments made by transport and logistics companies (TLCs) to align with social norms. On the other hand, normative pressure is frequently classified as market pressure from customers in GSCM literature (Chua et al., 2023; Chu et al., 2017; Jazairy & von Haartman, 2020; Zhu & Sarkis, 2007). Zhu and Sarkis (2007) found that market pressures drive organizations to improve their environmental performance, especially in eco-design and green purchasing practices.

Mimetic pressures occur when organizations facing uncertainty imitate the practices of successfully perceived peers by copying their structures or strategies to reduce risk and increase legitimacy (DiMaggio & Powell, 1983). In several studies of green supply chain management, researchers find that these pressures are often recognized as competitive pressure, where firms benchmark their environmental initiatives against rivals (Chua et al., 2023; Chu et al., 2017; Jazairy & von Haartman, 2020; Layaoen et al., 2024; Lin &

Sheu, 2012; Zhu & Sarkis, 2007). For example, Lin and Sheu (2012) found that such mimetic pressures motivated firms to adopt green certifications in response to competitors implementing similar practices, thereby illustrating how organizations benchmark their environmental strategies against industry peers to address uncertainty and meet stakeholder expectations. Similarly, Wehn et al. (2023) found that institutional pressures drive the adoption of GSCM practices in the chemical industry, whereas mimetic pressure from competitors was found to be most influential by imitating them to gain environmental and economic performance benefits through an optimized supply chain structure. However, Kauppi and Hannibal (2017), in their study of social sustainability assessment initiatives, found that mimetic pressures are generally weaker than coercive or normative pressures and are primarily found by targeting influential supply chain actors and publishing best-practice cases to create benchmarks for other firms to imitate.

3 Economic and social/human factors

This chapter explores the economic and social/human factors that influence the adoption of road-rail intermodal transport. First, it discusses the factors shaping a firm's transport decision, then it explores the economic and social inhibitors, and finally, the economic and social enhancers.

3.1 The multidimensional nature of freight modal choice

Road-rail intermodal transport is widely recognized in literature as a lower-emission alternative to road-only freight transport due to rail's lower energy intensity and emissions per ton-km (European Environment Agency, 2024; Janic, 2008; Lammgård, 2012; Pinto et al., 2018). However, evidence shows that its adoption remains limited in the European Union, while road transport continues to dominate freight movements (European Commission, 2024). According to prior studies, the gap between road-rail intermodal's ecological potential and actual implementation is primarily explained by several operational and service attributes that shape firms' transport decisions (Danielis & Marcucci, 2007; Eng-Larsson & Kohn, 2012; Gohari et al., 2022; Stockhammer et al., 2021).

For instance, Lammgård (2007) found that most shippers agreed that selecting rail or intermodal transport is important for improving environmental performance and would consider increasing its use if operational conditions allowed. According to shippers, transport costs have consistently been identified as the most influential criterion in intermodal-related studies (Arencibia et al., 2015; Gohari et al., 2022; Tavasszy et al., 2020). However, cost structure definitions vary across studies; for instance, Arencibia et al. (2015) calculated transportation costs using the per-shipment door-to-door service cost for shippers.

Transit time or door-to-door time, defined by the total duration from origin to destination, and punctuality or reliability, defined as the ability to deliver within the

promised window, are often highly valued criteria's when shippers are evaluating whether road-rail intermodal solutions are perceived as viable alternatives to road-only transport (Arencibia et al., 2015; Gohari et al., 2022; Tavasszy & Loui, 2020). In fact, Arencibia et al. (2015) found that shippers rate transit time and punctuality, along with transport cost, as highly important selection criteria, with all three scoring above four on a five-point scale when selecting a transport provider. Similarly, Tavasszy & Liu (2020) discovered that on-time reliability is the second most crucial criterion in freight transport choice, just slightly less than transport cost.

Literature also mentions service frequency (Arencibia et al., 2015; Gohari et al., 2022; Tavasszy & Loui, 2020), which means the number of shipments being offered by a transportation company within a specific timeframe (Tavasszy et al., 2020), and operational flexibility (Gohari et al., 2022; Tavasszy et al., 2020), which is the transport provider's capability to efficiently respond to changing shipper requirements (Tavasszy et al., 2020).

Previous studies show that implementing and sustaining a sustainable transport modal shift requires the active involvement and coordination of multiple actors, including shippers and transport providers (Eng-Larsson & Normann, 2014; Sallnäs, 2016). Several studies highlight that trust, power, and contractual stability are important factors in these relationships and in intermodal transport decision-making (Rogerson et al., 2021; Sallnäs et al., 2022).

3.2 Economic and social/human inhibitors

The literature identifies a range of economic, service-related, and social/human factors that may inhibit the adoption of road-rail intermodal transport. Transit time, reliability, frequency, and flexibility are often discussed as service characteristics. However, Arencibia et al. (2015) used stated-preference techniques to quantify shippers' willingness to pay for improvements in service quality, thereby providing an economic valuation of non-market attributes such as transit time and reliability. Their study found

that when intermodal solutions perform poorly on these service factors, the resulting "economic penalty" increases the perceived cost of intermodal transport and limits its competitiveness compered to road-only alternatives.

Similarly, trust and accountability concerns between shippers and logistic service providers increase the perceived risk associated with intermodal solutions (Eng-Larsson & Normann, 2014; Rogerson et al., 2021; Sallnäs, 2016; Sallnäss et al., 2022; Stockhammer et al., 2021). As a result, decision-makers often favour familiar road-based solutions that provide clearer control and accountability, even when intermodal alternatives present potential environmental advantages. The following subsections review the inhibiting factors identified in prior research.

3.2.1 Cost-structure, distance, and accessibility inhibitors

The cost-effectiveness of road-rail intermodal freight transport is highly sensitive to transport distance and the structure of intermodal operations. According to the European Commission (2022) study, road-rail intermodal solutions were generally more expensive than road-only transport for door-to-door distances below 600km. Likewise, in short-distance road-rail intermodal transport, the first and last legs, which are typically carried out by road, tend to generate disproportionately high costs compared to longer-distance operations (Bergqvist & Behrends, 2011). This is because those segments account for a disproportionately large share of the total transport distance, which in turn reduces the cost-efficiency of the rail leg. It is estimated that up to 40% of total road-rail intermodal transport costs can be attributed to these initial and final segments (Escudero et al., 2013). Additionally, empty hauls may further increase operational and environmental costs (Pieters et al., 2012).

In addition to distance thresholds, the efficiency and location of terminal infrastructure can act as economic inhibitors. Saeedi et al. (2019) used a modified network DEA model to analyze ten chains of intermodal freight transport in Europe and found that terminal divisions were the primary source of inefficiency. It was observed from the study that

terminals require adequate capacity to operate efficiently. However, from the results of the study, it is evident that though larger terminals met this condition, most of terminals lacked the necessary capacity to do so. To improve rail connections, they highlighted that terminal and infrastructure investments are needed. Additionally, the majority of road-rail freight terminals are concentrated in central Europe, whereas many peripheral areas lack the terminal density for efficient operations (Pastori et al., 2018). This creates an accessibility gap that discourages shippers in less connected areas from adopting road-rail solutions since terminals should ideally be accessible in 120 minutes to remain competitive.

3.2.2 Transit time and reliability constraints

Moving from road-only to road-rail intermodal typically increases door-to-door time, which could lead to a trade-off between transportation and inventory costs (Dekete et al., 2010; Eng-Larsson & Kohn, 2012; Zhang et al., 2020). In fact, for high-value goods, the capital tied up in goods-in-transit can generate inventory-related costs that outweigh transport cost savings when moving from unimodal to intermodal (Eng-Larsson & Kohn, 2012). Similarly, high-value cargo with short lead-time requirements was found to be more suitable for air transport due to its superior transit-time performance (Zhang et al., 2020).

Reliability or punctuality is arguably a significant barrier to implementing road-rail intermodal in the European Landscape. According to a study conducted by the International Union of Railways and the International Union for Road-rail Combined Transport Committee (2024), the on-time delivery rate for combined transport trains in Europe was reported to be 31%, although 81% of trains arrived within a 15-minute delay window operating during the period from September 12 to 18, 2023. In addition, punctuality rates vary significantly by country, and is exacerbated by infrastructure limitations, congestion on shared passenger-freight lines, and operational differences between countries (International Forwarding Association, 2024).

Transport chain punctuality is often lower than train-level punctuality statistics indicate. Geischberger et al. (2025) applied an agent-based simulation of the German rail network and found that delays that accumulate across multi-segment transport chains increase the likelihood of missed transshipments and late deliveries. Their results show a strong negative relationship between transport chain length and reliability, with each additional segment reducing the probability of on-time delivery.

In fact, punctuality in delivery was found to be highly valued in customer deliveries and in just-in-time (JIT) companies (Danielis et al., 2005; Dekete et al., 2010). Therefore, such companies often opt for road transport, which retains a clear punctuality advantage over intermodal solutions.

Reliability has been found as decisive factor for transport decisions in industries where production is tightly synchronized, such as automotive and chemical sectors (Elbert & Seikowsky, 2017). This is because late deliveries can lead to economic consequences that exceed transport costs. As a result, shippers in these industries may be willing to pay a premium for higher delivery reliability. Similarly, Eng-Larsson & Kohn (2012) found that increasing inventory levels for high-value goods led to a significant increase in overall logistics costs, so companies opted to widen delivery windows to maintain service levels during potential delays.

3.2.3 Flexibility and frequency friction

Arencibia et al. (2015) study conceptualizes frequency and flexibility as alternative-specific attributes that differ between road-only and intermodal transport. In their study, road transport is assumed to be highly flexible because it operates on demand and without fixed schedules. In contrast, road-rail intermodal transport is characterized by predefined timetables and limited service frequencies, which constrain flexibility. Because these attributes are challenging to measure consistently across modes, the author defines frequency and flexibility qualitatively rather than quantitatively.

Studies identify the low frequency of freight trains and restricted terminal operating hours as disincentives to modal shift (Islam et al., 2016; Beil et al., 2025). Freight trains are usually scheduled to operate during nighttime hours, because passenger rail services are prioritized to operate during daylight hours. (Bontekoning & Priemus, 2004; Cavallaro et al., 2020; Racunica & Wynter, 2005). This creates a fundamental confict between terminal operating hours and actual freight operations, which may negatively impact the service frequency of intermodal services. To better align with just-in-time logistics operations and increase the service frequency of intermodal solutions, shippers and logistics service providers (LSPs) have repeatedly called for extended terminal opening hours to include nighttime and weekends, as proposed by Beil et al. (2025). These inconsistent service schedules limit accessibility, especially in rural areas with long distances to the nearest intermodal terminal. While the European Union's TEN-T policy aims to establish intermodal terminals at major hubs by 2030, rural and economically disadvantaged regions risk being excluded from improved connectivity (European Union, 2024).

In addition, road-rail intermodal transport requires coordination across multiple stages, including pre- and post-haulage, terminal handling, and rail operations, and often involves several service providers (Pastori et al., 2018; UIC/URR, 2024). Therefore, Stockhammer et al. (2021) found that when the first and final legs of a journey are completed by road, decision-makers generally prefer to maintain the same mode for the entire route to avoid friction from mode changes.

3.2.4 Social/human, organizational and relational inhibitors

Several studies identify that resistance to modal shift also results from social and human factors, which can be found in organizational routines and decision-making practices. In fact, road-only transport is often perceived as familiar, reliable, and operationally safe, whereas road-rail intermodal solutions are associated with uncertainty and with potential distribution (Elbert & Seikowsky, 2017; Stockhammer et al., 2021). As a result, intermodal transport is often not considered a default alternative, even when

environmental or cost advantages are acknowledged. Commonly, authors interpret this reluctance through behavioural concepts such as status quo bias, in which decision-makers tend to favour established practices, and loss aversion, which leads decision-makers to overemphasize the perceived risks and costs associated with change.

Nevertheless, many companies prefer to prioritize other environmental measures before adopting rail or intermodal transport, because they perceive the current service levels of these modes as often inadequate (Lammgård, 2007). Indeed, Eng-Larsson & Kohn (2012) found that shippers place a high value on service-mindedness when choosing carriers and often prioritize overall carrier performance over transport quality, whereas Lammgård (2007) found that, when shippers select transport providers, price and service quality are both influential, but service factors often outweigh cost.

In addition, higher rail shipment volumes compared to road are often viewed as increasing the likelihood of delays, which in turn increases the perception of rail as riskier and less reliable (Stockhammer et al., 2021). Logistics service providers (LSPs) report that customers frequently demand transport modes that avoid any risk of delay, even at the expense of environmental performance. As a result, shippers and LSPs often reject rail transport when prior experiences with delays have compromised customer trust and satisfaction.

3.3 Economic and social/human enhancers

In contrast to the inhibiting factors discussed above, the literature also identifies economic and social/human factors that could enhance road-rail intermodal transport. According to Eng-Larsson & Kohn (2012), the success of modal shift depends on the shipper's willingness to modify its operational system to align with the chosen transport mode. Thereby, empirical studies suggest that intermodal adoption is more likely to happen when economic scale effects (European Commission, 2022; Janic, 2008; Lammgård, 2012; Macharis et al., 2010; Samimi, 2011), operational predictability (Elbert and Seikowsky, 2017; Rogerson et al., 2021), and service integration (Rogerson et

al.,2021; Sallnäs,2022) improve the competitiveness of rail-based solutions, and when shippers and logistics service providers are able to collaborate and coordinate effectively through trust-based and long-term relationships (Rogerson et al., 2021; Sallnäs et al., 2022).

Accordingly, the following subsections review the economic and social factors that enhance the adoption of road-rail intermodal transport.

3.3.1 Scale and distance economies

As discussed in the inhibitors section, while road-rail intermodal transport was found to be less competitive for shorter hauls, the European Commission (2022) found it to be competitive for door-to-door distances of around 1,000 km, thereby enhancing its adoption for longer routes. Janic (2008) studied economies of distance by analysing two primary types of rail-road intermodal trains operating along the TEN-T network: conventional intermodal freight trains (CIFs) and long intermodal freight trains (LIFTs). Their analysis found that a breakeven distance at which road-rail intermodal transport becomes more cost-effective than road-only transport is approximately 700 km for both CIFs and LIFTs. Similarly, Samimi et al. (2011) conclude that rail-based solutions are more likely to be chosen for long routes despite higher base prices, due to scale economies. However, Limbourg and Jourquin (2009) find competitiveness beyond 300 km in some cases, such as in the Milan/Lyon relation.

Studies show that as the weight of the transportation unit increases, the cost decreases (Lammgård, 2012; Macharis et al., 2010). Therefore, rail is found to be more cost-effective in this manner, as it is able to carry heavier cargo more efficiently than road. Additionally, the risk of traffic congestion is increased by large volumes of road freight transit which improves rail operations in this sense (Jahn et al., 2020).

Study by Pinto et al. (2018) found that road-rail intermodal freight transport can be 64–80% less expensive than road-only transport due to the fuel efficiency of rail sections.

Moreover, since rail often relies more on electricity than fossil fuels, road-rail intermodal transport is less sensitive to fuel price fluctuations than road (Lammgård, 2012; Macharis et al., 2010).

In addition, road-rail intermodal and road-only transport result in external costs, including emissions, noise, accidents, and congestion that negatively impact the environment and society (Janic, 2008). However, studies have shown that external costs are considerably higher for road transport than for rail (European Commission, 2019; Janic, 2008). In the EU, the total external costs have been estimated at €60.3 billion for heavy-duty vehicles (road), compared to €5.1 billion for electric freight trains (European Commission, 2019). Empirical evidence further supports the environmental effectiveness of intermodal solutions. A case study from the Madrid region by López-Acevado et al. (2024) found that shifting around 6% aggregate transport from road to intermodal rail-road systems can reduce carbon emissions by around 10%, whereas larger intermodal volumes can lead to reductions up to roughly 25% compared to road-only transport.

3.3.2 Transit time and punctuality tolerance

The impact of increased transit time on overall logistics costs is highly context-dependent; inventory costs do not necessarily correlate with higher transport costs, thereby enhancing the benefits of intermodal transport. Despite increasing inventory to maintain customer service levels for an increase in transit time when shifting from road to intermodal, the cost penalty is conditional: in one case, the company's increased inventory costs did not exceed the decrease in transportation costs achieved by the intermodal solution, whereas in another, the emphasis was on emission reduction as the primary gain (Eng-Larsson & Kohn, 2012). Increasing inventory was possible for companies with lower value goods (Eng-Larsson & Kohn, 2012), which corresponds to Zhang et al. (2020), who found that low value cargo with high time-sensitivity, meaning short lead-time demand, such as apparel via rail, had the cheapest logistics costs compared to air, and faster transit time compared to sea. Consequently, they found that

high-value cargo with a long lead time of two weeks transit time was also found to be the most cost-effective option for rail transport, whereas low-value goods with the same two-week transit time were found to be the second-best option to transit via rail.

In addition, a shipper's tolerance for deviations in transit time and punctuality can vary. Danielis & Marcucci (2007) found that shippers evaluate services against minimum acceptable thresholds. Minor deviations in transit time and punctuality are tolerated, but once these thresholds are exceeded, these factors become decisive. Shippers may then consider intermodal alternatives if service quality can be assured. Similarly, shippers often need to accept earlier pick-up times and later delivery times than with road-only transport, which requires a willingness to relax just-in-time expectations to realize potential cost savings (Rogerson et al., 2021). In some cases, some shippers are also willing to pay a modest premium for rail, with acceptable increases typically in the range of a few percentage points (Lammgård, 2007).

3.3.3 Flexibility enhancers and planning tolerance

Transshipment, which is the process of unloading and reloading cargo between modes, is often perceived as overly complex and time-consuming (European Commission, 2022; Stockhammer et al., 2021; Truschkin & Elbert, 2013). However, technological improvements in transshipment systems, standardization of loading units, and horizontal transfer of trailers enhance interoperability between road and rail and have the potential to increase operational flexibility (European Commission 2022; Truschkin & Elbert, 2013) and rail-road network performance (Dekete et al., 2010).

According to Rogerson et al. (2021) study, shippers often seek integrated door-to-door solutions, which position intermodal-capable transport providers in a stronger position than single-mode transport providers. By offering door-to-door solutions to their customers, intermodal-capable transport providers can plan and manage intermodal services without requiring shippers to coordinate with multiple logistics actors.

3.3.4 Power dynamics in transport mode decisions

In a study by Rogerson et al. (2021) the authors examined on how power dynamics and trust between shippers and transport providers influence the transition from road transport to a more sustainable alternative option like rail or sea transport modes. From the findings of the research, it is evident that balance of power usually favours transport providers during the initial phase of the transport mode shift, given their greater knowledge of the available solutions. They call this knowledge a expert power that allows providers to influence and guide shippers' transport decisions. For instance, the findings of the research reveals that the transport providers servce as the primary source of information for the shippers with regard to the available alternatives for transport modes and their implementation process. Therefore, transport providers are often in a position to make initial recommendations for modal shift, thereby shaping the direction of change from the outset. Also, when shippers are less concerned with transport execution details, transport providers may independently choose an environmentally preferable option, such as rail or sea.

On the other hand, the shippers can also demand use of specific sustainable transport modes, such as rail-based options during the process of procurement processes with transport providers (Rogerson et al., 2021). This phenomenom is especially evident in larger organizations, where the shippers act as the contracting authorities (McKinnon, 2014). In such cases, shippers often choose logistics service providers who offer both environmental and economic benefits.

3.3.5 Trust and long-term commitment

Literature has identified trust and long-term commitment between shippers and transport providers as essential elements when the modal shift process is underway (Lammgård, 2007; Rogerson et al., 2021; Sallnäs, 2022). Building trust to establish partnerships between them requires an initial investment in resources and coordination. However, once the partnerships have been established, will contribute to the

development of lower transport costs by lowering transaction risks and creating more predictable logistics arrangements (Lammgård, 2007). In this sense, Rogerson et al. (2021) have identified the role of long-term commitment in providing the required confidence for undertaking significant operational changes and capital investments. Indeed, establishing long-term commitment is shown to signal trust and be a key mechanism for supporting modal shift (Sällnas, 2022). In contrast, short-term contracts may discourage risk-taking in the implementation of new transport solutions (Rogerson et al., 2021).

Rogerson et al. (2021) argue that guaranteeing transport volumes, frequent flows, securing locations near key distribution hubs, and agreeing long-term contracts with transport providers are all indicative of commitments for transport investments from shippers. In their study, they conceptualize these measures as contractual trust that can improve transport service reliability and signal credibility, which, in turn, encourage transport providers to invest in rail-based solutions.

Rogerson et al., (2021) study also found that improvements in environmental performance can also generate reward power (Rogerson et al., 2021). This takes place when both the shippers and the transport providers benefit from the reputational gains of implementing a sustainable transport mode. Collaboration thus becomes a vital driver, as transport providers who adopt a proactive role in co-developing innovative solutions can reduce environmental impact while at the same time differentiating themselves in the market (Lammgård, 2007; Rogerson et al., 2021). Under specific cirmunctances, the transport providers may also exercise leverage over shippers that are reluctant to adopt modal shift, potentially withdrawing services to enhance their own reputational gains (Rogerson et al., 2021).

3.3.6 Shipper characteristics and workforce drivers

Prior research indicates that certain shipper characteristics can increase or decrease openness to modal shift (Rogerson et al., 2021; Stockhammer et al., 2021). Rogerson et

al. (2021) found that shippers who are new to their role, have relevant prior experience, or have a personal interest in sustainability are more inclined to adopt rail or sea. Stockhammer's (2021) behavioural study on modal shift found that the majority of the samples agreed that positive experiences with environmentally friendly transport modes, such as inland waterways or rail, have been shown to increase the likelihood of their future use.

Finally, structural labour constraints in the road freight sector may indirectly support intermodal adoption. According to the IRU (2023), around 7% of driver positions in Europe were unfilled in 2022, with the gap projected to rise to 17% by 2028. Since road-rail intermodal operations require fewer truck drivers than road-only transport, transport companies may view modal shift as a practical solution to mitigate labour constraints (Elbert & Seikowsky, 2017). Additionally, intermodal transport often provides more favorable working conditions for drivers, potentially improving job attractiveness and retention.

4 Institutional theory

This chapter first discusses institutional theory in the freight transport and modal choice literature. Then it explores institutional inhibitors, followed by institutional enhancers that influence the adoption of road-rail intermodal transport. Finally, it concludes the theoretical background and literature review with a summary of the theoretical framework.

4.1 Institutional theory in freight transport and modal choice literature

Institutional theory has been applied primarily within the green supply chain management (GSCM) (Chu et al., 2017; Kauppi, 2013; Lin & Sheu, 2012; Tate et al., 2011; When et al., 2023; Zhu & Sarkis, 2007) and green logistics research (Layoaen et al., 2024; Chua et al., 2023). Within this literature, organizations are understood to respond not only to the aim of maximizing profit, but also to conforming to pressures arising from their institutional environment to maintain legitimacy (DiMaggio & Powell, 1983). For example, Layoaen et al. (2024) found that institutional pressures have a positive influence on the green performance of transport and logistics companies, while Chua et al. (2023) found that shipping companies were motivated by institutional pressures to adopt sustainable shipping management practices.

However, the evidence on the effect of institutional pressure on shipper transport mode choice remains limited and mixed. For instance, Eng-Larsson & Kohn (2012) studied six case companies that had already successfully transitioned from road-only to road-rail intermodal transport and found that only two faced pressure from political and financial stakeholders, while another faced customer pressure to market low-carbon transport alternatives. In the case of the remaining companies, cost competitiveness and service performance were identified to be decisive factors that influence transport procurement decisions. Environmental improvements were described in most cases as a secondary aspect of the decision-making process rather than the main driving force.

Prior research suggest that environmental factors are often embedded in the internal sustainability strategies of the shipper's rather than directly applied to the operational transport decisions (Eng-Larsson & Kohn, 2012; Jazairy & von Haartman, 2020). For instance, Jazairy & Von Haartman (2020) found that institutional pressures mainly influence core business activities of the shipper's, while their logistics purchasing decisions continue to prioritize cost and service levels. Indeed, several other studies have also found that these mentioned factors remain decisive factors when implementing a transport mode, while the aspect of ecological sustainability is being viewed more as an added benefit than the main driving force (Bask et al., 2018; Eng-Larsson & Kohn, 2012; Stockhammer et al., 2021).

However, literature suggests that the level of exposure to institutional pressure varies across shippers. Large, well-known, and globally operating shippers tend to face greater external pressure to adopt green logistics practices (Bask et al., 2018; Jazairy & von Haartman, 2020; Rogerson, 2018). Bask et al. (2018) found that such shippers face greater customer pressure, particularly in the chemical industry, whereas Jazairy & von Haartman (2020) found that large shippers in their study experience increasing external pressure to adopt GSCM and green logistic parties due to their large market share. In their study, one global company already implemented rail transport because of this. Furthermore, they found that shippers are more likely to face greater external pressure to adopt green logistics when operating in environmentally conscious countries. Indeed, larger companies are easily exposed to negative publicity if they fail to comply with environmental demands (Bask et al., 2018; Jazairy et al., 2020).

4.2 Institutional inhibitors

While institutional pressure exists, several institutional factors inhibit its translation into the adoption of road-rail intermodal transport. These inhibitors help explain why policy ambitions and sustainability targets have not led to substantial modal shifts in practice.

4.2.1 The policy-market gap

Within the European freight transport context, the European Union serves as a central institution in transport and climate policy (Islam et al., 2016; Peng & Meyer, p. 35). According to Cavallaro et al. (2020), harmonizing the push measure, which includes restrictions, fines, and taxes for road vehicles, with the pull measure, which makes alternatives more attractive through exemptions, subsidies, supportive policies, permits, and infrastructure development, could increase the appeal of road-rail intermodal transportation. In contrast, Beill et al. (2025) found that pull measures which aim to strengthen road-rail intermodal by expanding infrastructure and accessibility, harmonizing regulations in safety, operational, and technical standards for cross-border transport, and improving efficiency through equipment standardization, digitalization, incentive programs, security and safety enhancements, and quality measures are significantly preferred over push measures. Furthermore, respondents are more inclined toward incentives that provide tangible advantages rather than punitive actions.

Yet in the European transportation sector, the translation of measures into modal shift outcomes has been modest. Grzelakowski (2024) examined decades of regulatory efforts aimed at promoting green transport transformation and found that despite long-standing policy frameworks, including the 1991 White Paper and subsequent initiatives such as environmental taxes, infrastructure charges, subsidies, and targeted programs, including the Marco Polo initiative and TEN-T corridor development, the modal split in the EU has remained essentially unchanged. For example, the share of rail and inland waterway freight transport in the European Union in 2023 was estimated at 7.14% divided into 5.5% rail and 1.6% inland waterway and has stayed around the same for 5 years compared to road, with 25.3% of the total share when taking into consideration of road, rail, inland waterways, air and maritime freight transport (Eurostat, 2025). These mentioned percentages strenghten Grzelakowski (2024) argument that current policy tools remain ineffective in terms of market response.

One of these transport iniatives Grzelakowski (2024) mentioned in his work is the revision of the Trans-European Transport Network (TEN-T) regulation (European Union, 2023). This regulation requires the development of high-capacity and sustainable freight corridor network that would connect highways, railways, inland waterways, and short-sea shipping routes. The updated TEN-T is expected to do this through improving multimodal connectivity of major urban centers, ports, airports, and logistics hubs removing cross-border bottlenecks and upgrading infrastructure. These initiatives are intentended to increase economic activity and support the EU's climate objectives. Focusing on rail sector, the TEN-T policy aims to establish interoperability and infrastructure standards across core train corridors by 2030 to support a modal shift from road to rail. However, the European Court of Auditors (2020) found that many of the train corridors are unlikely to be fully operational by 2030.

The TEN-T regulation is one of the initiatives of the Sustainable and Smart Mobility which sets quantifiable targets, including increasing rail freight by 50% by 2030 and doubling it by 2050, and expanding inland waterway and short-sea volumes by 25% by 2030 and 50% by 2050 (European Commission, 2020). In addition to promoting modal shift, the policy also supports broader decarbonization of freight transport by eliminating high-emission trucks and instead advocating for trucks that run on renewable and low-carbon fuels. In conclusion, all of these mentioned policies take part of the Green Deal's objective to reduce transportation-related greenhouse gas emissions by 90% by 2050 compared to year 1990 levels (European Environment Agency, 2021; 2022).

Indeed, LSPs find that the EU does not appear to have a well-defined transport environmental strategy that effectively pressures modal shift towards environmentally sustainable options (Bask et al., 2018; Jazairy & von Haartman, 2020). For instance, in Italy, third-party logistics service providers identified a lack of clear legislation and financial incentives as the most influential obstacle preventing the adoption of green logistics operations (Evangelista et al., 2017). Therefore, stricter environmental

legislation and policies would encourage shippers to demand more green practices from LSPs (Jazairy & von Haartman, 2020).

4.2.2 Infrastructure and technical fragmentation

As discussed earlier, EU policies aim to strengthen rail networks (European Commission, 2020; European Union, 2023). However, research shows that administrative, operational, infrastructure, and technical constraints hinder the development of a competitive intermodal freight network (Pastori et al., 2018). In detail, Pastori et al. (2018) in their study found that infrastructure fragmentation in the EU is evident in variations of rail track quality that can disrupt transport flows, leading to slower operations and higher operating costs. Similar effects are experienced due to a paucity of interoperability in rail tracks during cross-border operations

Beside this, they also mention technical barriers in EU rail operations including a lack of harmonized digital and control systems (Pastori et al., 2018). As an example, the incompatibility of train control software that manage train movements to operate safely and in time are found as major challenges to integrated and interoperable European rail network. The European Rail Traffic Management Systems (ERTMS) is one of these train control systems, and although it is a standard for the TEN-T policy, its implementation is uneven across the EU.

European Commission (2022) research found that transhipment capacity in intermodal terminals in the EU will not be able to meet the demand of the projected growth in network capacity. Moreover, the terminals within the TEN-T network will require further investments to be compatible with both ends of the rail link.

4.2.3 The compliance divergence

Grzelakowski (2024) found that compliance with regulations primarily falls on carriers and logistics providers (LPs) rather than shippers. For instance, regulations such as the

Renewable Energy Directive (RED II, Dir EU 2018/2001) or the CO_2 emission performance standards for heavy-duty vehicles directly influence carriers' fuel choices and fleet composition, but do not require shipper to modify their transport mode selection.

Moreover, these regulations may strengthen the environmental performance of road transport rather than incentivize a modal shift to rail. For instance, the increasing uptake of biofuels, renewable electricity, and other low-emission alternatives has contributed to a rise in the share of renewable energy in EU road and rail transport from 6% in 2013 to 10.1% in 2023 (European Environment Agency, 2024).

As a result, even intense regulatory pressure at the system level often fails to affect shipper operational decisions (Grelakowsky, 2024; Jazairy & von Haartman, 2020). Furthermore, Jazairy and von Haartman (2020) found that shippers place little emphasis on environmental policies when outsourcing their logistics functions.

4.3 Institutional enhancers

While traditional EU transport policies have had limited impact on modal shift outcomes (Grzelakowsky, 2024) and regulatory pressure has been directed at carriers rather than shippers (Grzelakowsky, 2024; Jazairy & von Haartman, 2020), research indicates that firm-level governance mechanisms operate at the organizational level and directly influence corporate accountability, transparency, and legitimacy (Kallionpää et al., 2026; Lee et al., 2024). As discussed previously, according to institutional theory, organizations respond to coercive, normative, and mimetic pressures to maintain legitimacy within their organizational field (DiMaggio & Powell, 1983).

As discussed earlier, large and global shippers are typically under stronger external pressure to adopt greener transport practices (Bask et al., 2018; Jazairy & von Haartman, 2020; Rogerson et al., 2016). Rogerson et al. (2016) further argue that larger companies typically possess greater organizational resources and a stronger strategic focus on long-term sustainability goals, which makes it easier for them to invest in greener transport

solutions. This suggests that firm-level governance frameworks, and not than transport regulations alone, are increasingly becoming a key mechanism through which, external pressures are converted into operational practice (Lee et al., 2024; Kallionpää et al., 2026).

Therefore, the next subchapter will examine how coercive pressures are reflected in regulatory and mandatory frameworks, how normative pressures occur through standards and voluntary initiatives, and how mimetic pressure functions through industry benchmarking and peer imitation.

4.3.1 Coercive pressure

Institutional pressures,as noted by Lee et al. (2024), drive multinational enterprises to reconsider their economic, social, and environmental performance (ESG). The ESG approach allows companies to systematically identify, manage, report, and disclose their environmental, social, and governance impacts (Heizer et al., 2017). The frameworks is a tool for screening and enganing with investors and stakeholders by increasing the visibility of corporates sustainability performance. The ESG framework is a stratetic avenue for achieving holistic sustainable performance improvement (Lee et al., 2024) which encourages companies to move their practices forwards in these three areas (Heizer et al., 2017).

For instance, the European Union has implemented ESG principles under the Corporate Sustainability Reporting Directive (CSRD) (European Commission, n.d.). This directive requires large and listed companies to regularly disclose the impact of their operations and risks they face on these three dimensions starting from the 2024 financial year. The reporting must follow the European Sustainability Reporting Standards (ESRS). Sharma (2025) examined CSRD in German companies' sustainability reporting practices and found that large, publicly traded firms with prior initiatives view it as a systematic expansion to strengthen transparency and investor confidence. Their findings show that MNEs are generally able to integrate CSRD requirements, such as the double materiality

requirement, more than small and medium-sized enterprises. In fact, it was found that SMEs struggle with methodological inconsistencies reducing comparability across firms in terms of investor screening.

Disclosure of Scope 3 emissions is one of the most resource-intensive challenges under the CSRD and requires extensive supply chain data collection beyond companies' direct operations (Kallionpää et al., 2026; Sharma, 2025). The collection of scope 3 is often hindered by inconsistent measurement tools (Sharma, 2025) and multiple inconsistent emission data sources (Kallionpää et al., 2026). To understand Scope 1-3 emissions, the Greenhouse Gas (GHG) Protocol is a globally recognized standard for emissions accounting that defines Scope 1 as direct emissions from owned or controlled operations (World Resources Institute & World Business Council for Sustainable Development, 2004). Scope 2 is indirect emissions from the generation of purchased energy, and Scope 3 is all other indirect emissions across the value chain. In detail, outsourced logistics activities and freight transportation emissions are under scope 3.

Kallionpää et al. (2026) found that logistics emissions reporting has become increasingly significant for signalling accountability among shippers and LSPs. The reason is current regulations and customer demand for transparent data sharing. Also, shippers are becoming more environmentally conscious. Indeed, coercive pressures, such as regulatory and mandatory standards, were found to be the most effective in developing and implementing such emission reporting among larger shippers. Shippers use this emissions data to monitor their transport targets and optimize operational routes to reduce carbon emissions.

Kallionpää et al. (2026) study refers to the Global Logistics Emission Council (GLEC) Framework as an example of tools used in practice to support emission accounting. The GLEC framework, which aligns with ISO 14083, is an international standard that offers a methodology for measuring and reporting greenhouse gas emissions from logistics

operations (Smart Freight Centre, 2025). In the framework, emissions from freight transport are commonly expressed as grams of CO_2-eq per ton-km (gCO_2e/tkm).

Similar logistics reporting tools include EcoTransIT World (EcoTransIT World, 2025). It is used to calculate companies' transport emissions across multimodal supply chains and evaluate modal shift scenarios. To do so, it can follow a well-to-wheel approach that accounts for both upstream emissions (fuel extraction, production, and distribution) and direct operational emissions from vehicle use.

Institutional theory suggests that organizations may comply with regulatory requirements through symbolic or procedural alignment, adopting formal structures while decoupling them from core operational practices (Meyer & Rowan, 1977). Indeed, mandatory environmental regulations and reporting increase transparency and awareness; they rarely override economic and operational criteria in modal choice decisions (Eng-Larsson & Kohn, 2012;Bask et al., 2018; Jazairy & von Haartman, 2020)

4.3.2 Normative pressure

In supply chain management literature, Tate et al. (2011) found that suppliers are more inclined to implement environmental practices when they are supported by industry coalitions associated related to their own or their customers' operations. For example, EcoVadis is a sustainability assessment platform that rates companies based on their environmental, social, and governance (ESG) performance, and provides a score and a medal (platinum, gold, silver, or bronze) depending on the company’s performance on four areas: environment, labour and human rights, ethics, and sustainable procurement (EcoVadis, 2025). In operations, the EcoVadis ratings have been mostly utilized as a tool to evaluate and monitor the sustainability practice of the suppliers, thus promoting sustainable procurement across global value chains.

Kallionpää et al. (2026) found that all interviewed firms had set emission reduction targets. To meet the targets, the study refers to the Science-Based Targets initiative (SBTi),

a voluntary framework that is a collaboration among several non-governmental organizations (NGOs) (SBTi, 2025). It provides standards, tools, and guidance for companies to set greenhouse gas (GHG) emission-reduction targets that are aligned with the Paris Agreement's 1.5°C trajectory and net-zero by 2050. It defines net-zero as a reduction of scope 1, 2, and 3 emissions by at least 90% before 2050.

Indeed, such voluntary target-setting frameworks encourage firms to internalize environmental responsibility through self-imposed goals and standardized metrics (Kallionpää et al., 2026). However, consistent with prior logistics research, the influence of such normative frameworks on transport mode choice remains indirect and depends on whether sustainability targets are translated into concrete logistics procurement requirements (Jazairy & von Haartman, 2020; Layaoen et al., 2024).

4.3.3 Mimetic pressure

Wehn et al. (2023) found that the adoption of GSCM practices in the chemical industry is driven by institutional pressure, with competition's mimetic pressure having the greatest impact as businesses copy those that benefit economically and environmentally from optimized supply chain structure. Similarly, Layaoen et al. (2024) found that competitive (mimetic) pressure encourages transport and logistics companies to adopt green practices to maintain their market position and corporate image. Furthermore, these green practices are associated with measurable improvements in environmental performance, including reductions in emissions and waste, and have the potential to innovate green practices further.

Indeed, large global shippers are more likely to adopt environmental measures to strengthen their competitive position (Bask et al., 2018; Kallionpää, 2026). Kallionpää (2026) categorizes competition as mimetic pressure and finds that both shippers and LSPs tend to mirror the emission-reporting practices of industry leaders or competitors to avoid being perceived as less sustainable. In some cases, shippers that position themselves as environmental leaders also experience external pressure to demonstrate

their sustainability performance actively. In a similar vein, Touratier-Muller and Ortas (2021) report in their case study that the main drivers for global shippers to participate in FRET21 charter voluntary freight transport initiative are the pursuit of competitive differentiation and associated financial benefits.

In behavioural studies, Stockhammer et al. (2021) emphasize that sharing successful business cases for environmentally friendly modes such as rail can help reduce cognitive biases that favour road-only transport. Learning from peers who have already implemented intermodal solutions may lower perceived risks and demonstrate feasibility, thereby encouraging the modal shift. Similarly, Touratier-Muller and Ortas (2021) found that one reason shippers joined a voluntary freight transportation programme was the opportunity to observe, internalize, and subsequently apply other shippers' CO_2 reduction practices.

4.4 Summary of the theoretical framework

The presented theoretical framework, as seen in Figure 1, brings together the theories and concepts to address the study's research question: How do institutional, economic and social/human factors influence the adoption of road-rail intermodal transport among MNEs operating within the EU to achieve ecological sustainability? In doing so, the theoretical framework presents this influence as manifesting either negatively, by inhibiting the adoption of road-rail intermodal, or positively by enhancing its adoption in pursuit of ecological sustainability.

The TBL framework assesses a firm's performance across three areas: economic, environmental, and social dimensions (Elkington, 1994). Environmental dimensions include minimizing the ecological impact of business activities (Swink et al., 2020). In freight transport, environmental sustainability is primarily achieved through reductions in CO_2 emissions (Gandhi & Kant, 2023; Gandhi et al., 2022; Gohari et al., 2022; Gupta et al., 2025; Kumar & Anbanandam, 2022), which is the goal of this study. On the other hand, economic dimensions refers to an organization's ability to remain financially viable

and competitive over time (Crane & Matten, 2010; Heizer et al., 2017; Swink et al., 2020;) and social dimension includes companies impact and responsibility for stakeholders and stakeholder engagements (Heizer et al., 2017; Swink et al., 2020), which in this study includes organizational routines and coordination between shippers and LSPs (Eng-Larsson & Normann, 2014; Rogerson et al., 2021; Sallnäs, 2016; Sallnäss et al., 2022; Stockhammer et al., 2021).

Institutional theory is closely linked to sustainability performance across supply chain studies. The theory explains how external pressures shape organizational behaviour beyond economic rationality (DiMaggio & Powell, 1983). A core assumption of organizational institutional theory is that organizational survival and success depend on the ability to gain and maintain legitimacy within the institutional environment (Meyer & Rowan, 1997; DiMaggio & Powell, 1983). From an economic institutional perspective, institutions consist of formal and informal institutions that reduce uncertainty and structure economic interaction (North, 1991), whereas from a sociological perspective, institutions are understood as enduring social structures that shape organizational behaviour through regulatory (coercive) rules, normative expectations, and shared cognitive (mimetic) frameworks (Scott, 2001). Building on DiMaggio and Powell's (1983) concept of organizational fields, their framework distinguishes between three key mechanisms through which institutional environments influence firms. Coercive pressure arises from laws, regulations, and powerful stakeholders. Normative pressures stem from professional standards, industry associations, and shared values and norms that institutionalize sustainability as a moral or professional expectation, and mimetic pressures occur when organizations under uncertainty imitate competitors or industry leaders perceived as successful.

Based on both theories, Figure 1 presents the theoretical framework guiding this study. The framework integrates institutional theory (DiMaggio & Powell, 1983; North, 1991; Scott, 2001) with the Triple Bottom Line (TBL) framework (Elkington, 1994) to explain how institutional, economic, and social/human factors influence the adoption of road-

rail intermodal transport among multinational enterprises (MNEs) operating within the EU to achieve ecological sustainability. First, the institutional factors include institutions that generate coercive, normative, and mimetic pressures on a firm, thereby shaping expectations for environmentally responsible logistics practices. However, consistent with prior literature, these pressures do not necessarily translate directly into transport mode choice decisions. Instead, institutional pressures are filtered through firm-level decision criteria that include the economic and social/human dimensions of the TBL framework.

The framework differentiates between institutional, economic, and human/social factors that act as either inhibitors or enhancers of road-rail intermodal adoption, hence addressing the study's sub-research questions. Below is presented the summary of these inhibitors and enhancers.

Institutional inhibitors include the European Union's policy-market gap (Bask et al., 2018; Eurostat, 2025; Evangelista et al., 2017; Grzelakowski, 2024), infrastructure and technical fragmentation of rail freight (European Commission, 2022; Pastori et al., 2018), and the compliance divergence, thus policy compliance primarily falls on carriers and LSPs rather than shippers (Jazairy & von Haartman, 2020; Grzelakowski, 2024), which limits the effectiveness of road-rail intermodal adoption and sustainability-oriented regulation at the operational level.

Economic and social/human inhibitors include that road-rail intermodal is generally more expensive than road-only in door-to-door distances below 600km (European Commission, 2022), high costs occur on the first and last legs via road (Bergqvist & Behrends, 2011; Escudero et al., 2013), and the risk of empty truck hauls (Pieters et al., 2012). Insufficient terminal capacity (Saeedi et al., 2019) and gaps in geographical accessibility further constrain the competitiveness of road-rail intermodal transport (Pastori et al., 2018). Intermodal rail transport often involves longer transit times compared with road-only transport (Dekete et al., 2010; Eng-Larsson & Kohn, 2012;

Zhang et al., 2020), creating inventory cost trade-offs (Eng-Larsson & Kohn, 2012) for high-value and time-sensitive goods (Zhang et al., 2020), which reduces shippers' willingness for modal shift (Eng-Larsson & Kohn, 2012). Reliability or punctuality constraints, delay propagation across multi-segment transport chains (Geischberger et al., 2025), delivery sensitivity affects customer deliveries (Danielis et al., 2005; Dekete et al., 2010), and lateness cost sensitivity in synchronized industries (Elbert & Seikowsky, 2017). In terms of flexibility and frequency, the literature identifies restricted terminal operating hours and low train frequency as barriers to adoption (Islam et al., 2016; Beil et al., 2025). In fact, rail freight is often concentrated during nighttime operations (Racunica & Wynter, 2005; Bontekoning & Priemus, 2004; Cavallaro et al., 2020), and its operational complexity discourages firms from combining multiple modes (Stockhammer et al., 2021). From a human/social perspective, preference for established road routines, thus road is often perceived as familiar, reliable, and operationally secure (Elbert & Seikowsky, 2017; Stockhammer et al., 2021), service dominance leads firms to prioritize other environmental measures (Lammgård, 2007; Eng-Larsson & Kohn, 2012), perception of rail as riskier and less reliable (Stockhammer et al., 2021).

Institutional enhancers support the translation of sustainability pressure into the adoption of green logistics practices, especially among large, internationally operating shippers that are more exposed to external scrutiny and stakeholder expectations (Bask et al., 2018; Jazairy & von Haartman, 2020; Rogerson et al., 2016). These enhancers include firm-level governance mechanisms that increase accountability and internal coordination (Lee et al., 2024), such as coercive pressures such as the CSRD (Sharma, 2025), which requires disclosure of scope 3 emissions (European Commission, n.d.; Kallionpää et al., 2026 ; Sharma, 2025). Furthermore, normative pressures operate through voluntary target-setting initiatives (Kallionpää et al., 2026) and industry associations (Tate et al., 2011), which encourage firms to internalize sustainability as a professional and moral obligation. Mimetic pressure includes benchmarking against competitors and industry leaders (Layaoen, 2024; Kallionpää et al., 2026), sharing

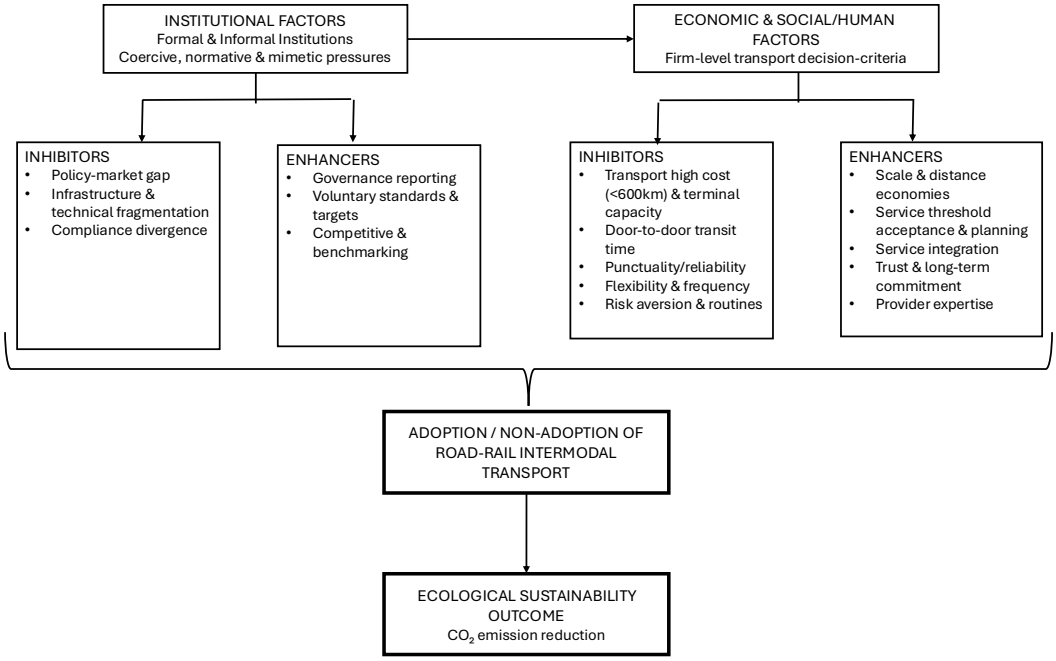
successful environmentally friendly business cases (Stockhammer et al., 2021), supporting competitive differentiation (Rouratier-Mueller & Ortas, 2021), and strengthening the firm's competitive position (Bask et al., 2018; Kallionpää, 2026).

Economic and social/human enhancers include cost-effectiveness beyond a certain distance threshold, ranging from 700km (Janic, 2008) to 1000km (European Commission, 2022), and with heavier loads, as rail can handle larger cargo volumes more efficiently than road (Lammgård, 2012; Macharis et al., 2010; Pinto et al., 2018). Road-rail intermodal has lower external costs than road (Janic, 2008; European Commission, 2019; López-Acevado et al., 2024). Inventory flexibility and time tolerance allow firms to absorb longer transit times without disproportionate cost penalties for lower-value goods (Eng-Larsson & Kohn, 2012; Zhang et al., 2020) and for high-value cargo with low time sensitivity (Zhang et al., 2020). Similarly, service threshold acceptance (Danielis & Marcucci, 2007), JIT relaxation (Rogerson et al., 2021), and limited price tolerance (Lammgård, 2007) further enable the adoption of road-rail intermodal transport when service quality remains within acceptable bounds. Technology improvements, standardization of loading units, and horizontal transfer reduce transshipment complexity and increase operational flexibility (European Commission 2022; Truschkin & Elbert, 2013) and network performance (Dekete et al., 2010). Shippers value door-to-door solutions by reducing coordination burden (Rogerson et al., 2021). Provider expertise enhances intermodal implementation (Rogerson et al., 2021) and trust and long-term commitment between transport providers and shippers sustains intermodal operations (Lammgård, 2007; Rogerson et al., 2021; Sallnärs, 2022) reducing overall transport costs, and creating more predictable logistics arrangements (Lammgård, 2007). Guaranteed volumes and frequent flows demonstrate shippers' commitment to transitioning to sustainable transport modes (Rogerson et al., 2021) and long-term contracts help to reduce intermodal uncertainties and allow the operational adjustments needed for consistent rail use (Rogerson et al., 2021; Sallnäs, 2022). Environmental improvements generate reward power that benefits both shippers and transport providers by enhancing their reputations (Rogerson et al., 2021). Cooperation

becomes an important factor for differentiation in the market (Lammgård, 2007; Rogerson et al., 2021). Shipper characteristics, like personal ecological motivation (Rogerson et al., 2021) or prior positive experience with rail (Rogerson et al., 2021; Stockhammer et al., 2021), are identified to improve sustainable transport adoption. Additionally, ongoing driver shortages in road transport (IRU, 2023) increase rail's potential to alleviate labour constraints, as intermodal solutions often provide more regular working hours and improved conditions for drivers (Elbert & Seikowsky, 2017).

The interaction of these factors influences the firm-level decision to adopt or not adopt road-rail intermodal transport, which in turn determines the ecological sustainability outcome, operationalized in this study as CO_2 emission reduction.

Figure 1. Theoretical framework.



5 Research methodology

This chapter explains the study's research methodology. The research design is structured according to the "research onion" model, which includes the research philosophy, theory development approach, methodological choices, research strategy, time horizon, and the techniques and procedures used for data collection and analysis, including access and sampling decisions (Saunders et al., 2023). Additionally, the study's reliability, validity and generalizability are evaluated.

5.1 Research philosophy and approach

According to Saunders et al. (2023), research begins by addressing the philosophical foundation that guides the generation and understanding of knowledge. In other words, researcher will make a set of assumptions at each step of the research. These can include ontological assumptions that relates to the nature of reality the researcher encounters, epistemological assumptions about acceptable and legitimate knowledge and axiological assumptions of researcher's values and ethics in the research process.

Among the five dominant research philosophies in business and management studies, namely critical realism, positivism, pragmatism, postmodernism, and interpretivism, this study adopts the latter (Saunders et al., (2023). Interprevitism approach understands that people are separate from physical phenomena because they create meanings. Interpretivism research aim is to develop new understandings and interpretations of social environments and situations and is best understood through individuals' subjective experiences and perspectives. Hence, this philoshophy support the aim of this thesis, which is to understand how institutional, economic and social/human factors influence the adoption of road-rail intermodal transport among MNEs focusing on in-depth decision-making processes instead of purely measurable variables. In detail, subjective ontology in interprevitism acknowledges that nature of reality is complex and socially constructed. From epistemological perspective, knowledge is created by focusing on individual's narratives and axiologically interprevitism acknowledges that

the researcher's values and beliefs are linked to the research and influences the interpretation of its findings.

Saunders et al., (2023) explain, the researchers are expected to choose either deductive, inductive, or abductive approach in the study's theory development. The deductive approach begins with the already fixed theory or hypotheses, which are later put to test through data collection. This approach is customarily used in quantitative research, the purpose of which is to confirm or falsify theoretical hypotheses. In opposition to the deductive approach, the inductive approach develops theory from the study's empirical findings and is on average used in qualitative research when existing theory is limited or insufficient to explain a phenomenon in question. Hence this study uses combination of these two approaches called an abductive approach that according to Eriksson and Kovalainen (2016) allows for an iterative movement between theoretical propositions and collected data. In this current research, this approach is used by first analyzing existing theory related to the research gap, and after new themes are found from initial observations at the case company the theoretical framework is established to undergo the testing.

5.2 Research design

Research design includes the overall plan for addressing the research questions and fulfilling the research objectives (Saunders et al., 2023). In other words, the design guides how the research will be conducted in practice by deciding the data collection and analysis procedures while also considering ethical issues and potential limitations of the study. In order to do so, the researcher chooses an exploratory, descriptive, explanatory, or evaluative research design (Saunders et al., 2023). The exploratory design is used to investigate a problem with limited prior knowledge. On the other hand, descriptive design intends to provide a detailed profile of a phenomenon or events. Explanatory research attempts to understand causal relationships. On the contrary, evaluative research measures the effectiveness of policies, programs, or interventions. This study adopts an exploratory design as it aims to attain an in-depth understanding of

the factors influencing the adoption of road-rail intermodal transport in a real-world organizational setting. In addition, exploratory design aims to answer ”What” and ”How” research questions (Saunders et al., 2023), the latter which is the focus in this study.

Researchers select between quantitative, qualitative, or mixed-methods approaches. Qualitative research involves non-numerical data, such as texts, interviews, or observations (Saunders et al., 2023). On the contrary, quantitative research is distinguished by numerical data and statistical analysis. A multimethod approach incorporates more than one data collection technique. This can be either a qualitative or quantitative technique. In mixed methods research, data collection integrates both techniques. This study employs a multimethod qualitative design, which is commonly aligned with the interpretivist philosophy. In addition, qualitative methods are suitable for exploring perceptions and complex decision-making processes. This method aligns with the aim of this study and is appropriate for studying context-bound phenomena.

In terms of research strategy, six common qualitative strategies include: ethnography, grounded theory, narrative inquiry, archival research, case study, and action research (Saunders et al., 2023). This study follows a case study strategy. The focus is on the European logistics of an MNE business unit. Yin (2002) defines a case study as an empirical investigation that explores a modern and complex phenomenon within its real-life organizational context. Similarly, Creswell (1998) defines a case study as a bounded system that involves multiple contextually rich sources of information collected over time. More specifically, this research follows intensive case study research, which emphasizes interpretation (Eriksson & Kovalainen, 2016). It focuses on the perspectives, conceptions, experiences, interactions, and conceptualization processes of the people involved in the study. Furthermore, the aim is not to produce knowledge that could be generalized to other contexts.

Finally, the study's time horizon is explained. A longitudinal time horizon analyses changes and development over a longer period (Saunders et al., 2023). On the contrary,

a cross-sectional time horizon examines a phenomenon at a specific point in time. Given the scope and timing of this research, a cross-sectional design was used, with data collected during a defined period in 2025.

5.3 Research sample, data collection and analysis

Data selection for this study was conducted through sampling, rather than a full census. Sampling involves selecting a subset of a population to draw conclusions about the whole (Saunders et al., 2023). It is used when studying a specific subgroup that is meaningful for achieving the research objectives. While a census involves examining every element within a population, this approach is often impractical and unnecessary in qualitative research.

According to Saunders et al., (2023), sampling methods can be typically classified as either probability or non-probability. While former ensures that every unit in a population has an equal chance of selection by using randomization, the technique does not necessarily fit qualitative research. Thefore, this study utilizes non-probability sampling that aims to comprehend a phenomenon instead of generating statistical data. Consequently, a non-probability approach aligns best with the qualitative case study design adopted here.

Within this framework, purposive sampling was selected. This method allows the researcher to choose information-rich cases most relevant to the research question and objectives. Purposive sampling is appropriate when working with small samples Saunders et al., 2023). This method is beneficial in case study research, where the focus is on depth of understanding rather than breadth. In this study, purposive sampling was used to select a case company with a well-defined sustainability strategy and an interest in reducing carbon emissions in logistics.

Snowball sampling was used to select logistics service providers that operate the case company’s current intermodal freight routes in the EU. Furthermore, these participants

were recommended by the case company and were chosen to provide information on standard industry practices, common operational challenges, and logistics decision-making processes. In addition, snowball sampling is applied when it is challenging to find members of the target population since it allows the researcher to find more participants through referrals from initial contacts who are relevant to the research topic (Saunders et al., 2023).

The following is the data collection technique. Four qualitative research techniques were used to collect data: semi-structured interview, informal interviews, observations, and document analysis. Semi-structured interviews follow a thematic guide with pre-formulated questions but allow the interviewer to modify the question order, ask follow-ups, and explore emerging themes based on participants' responses (Saunders et al., 2023). Additionally, in-depth interviews are often the main source of empirical data for case studies in business research (Eriksson & Kovalainen, 2016). The semi-structured interview in this study was conducted with a representative of the case company's long-term freight forwarding partner, which specializes in road-rail intermodal transport within the EU. The interview took around 45 minutes and was carried out online via Microsoft Teams. However, due to confidentiality restrictions, the session was not audio-recorded, and instead, detailed notes were taken following a semi-structured interview format.

In addition, informal interviews were held with the case company and its partners. These discussions were conducted in two settings, following a thematically guided format, and documented in detailed field notes. The first setting was a site visit to the case company's business partner's warehouse, where discussions were held with the warehouse representative and two managers from the case company. The second setting was a visit to the road-rail transshipment terminal used for the case company's shipments, where the terminal's representative was interviewed. An overview of interviewees is presented in Table 1.

Table 1. Overview of interviewees.

Interviewee	Method	Place
Case company manager 1	Informal	On-site
Case company manager 2	Informal	On-site
Warehouse contact	Informal	On-site
Freight forwarder	Semi-structured	Microsoft teams
Road-rail terminal contact	informal	On-site

Moreover, Eriksson and Kovalainen (2016) explain that in case studies other data sources than interviews can provide substantial evidence to complement the study's findings. Therefore, participant observation was employed as a third method during the same two site visits described above and at the case company. Participant observation method allows the researchers to take part in the situation being studied to gain an inside view in given settings (Saunders et al., 2023) and in this study it was utilized by observing case company activities and behavioral as well as its logistics partners operations. These observations were documented in field notes.

Finally, secondary data was collected from the case company and its logistic partners. The secondary data consisted of various documents from the case company, which included publicly available documents and internal documents, such as the Annual corporate sustainability report 2024 and KPI documents. In addition, the data consisted of the transport performance dashboards, organizational communications, including emails, and the operational briefings. Furthermore, the freight forwarder's monthly CO_2 and green-fuel reporting were included in the data. According to Saunders et al. (2023), secondary data can be used independently or integrated with primary data to improve the reliability. In this research, the secondary data is recognized as equally valuable as the primary data. An overview of the secondary data is presented in Table 2.

Table 2. Overview of the secondary data.

Documents	
Publicly available documents	Annual corporate sustainability report 2024
Internal documents	KPI documents, transport performance dashboards, freight forwarder's monthly CO_2 and green-fuel reporting
Organizational communications	Emails, operational briefings

As the approach of this thesis is abductive, the data analysis in this study followed a thematic analysis, combining both deductive and inductive coding (Eriksson & Kovalainen, 2016). This ensured that the analysis was both theory-informed and open to new insights grounded in the data (Fereday & Muir-Cochrane, 2006). The analysis process began by familiarising the data by reading the detailed field notes and documentary material, thereafter the data were coded into similar meanings. The deductive codes were first provided base on the existing literature on economic, social/human and institutional factors influencing road-rail intermodal transport adoption. During the coding process, additional codes that were of social/human nature of decision-making were inductively developed out of the data. The resultant codes were grouped into broader categories depending on similarity and conceptual meaning. Thereafter, the categories were organized into broader themes corresponding to 1) institutional, 2) economic, and 3) social/human aspects of road-rail intermodal transport adoption. The findings chapter is structured around these three themes.

5.4 Quality of the data

According to Eriksson and Kovalainen (2016), the three key concepts of reliability, internal validity, and external validity provide a fundamental framework for evaluating research in the field of business studies. In theory, case studies can be assessed

according to the same standards as other forms of research (Eriksson & Kovalainen, 2016). However, the three evaluation criteria have sometimes been criticized for failing to generate generalizable, reliable, and theoretically significant insights (Flyvbjerg, 2011). In addition, reliability and validity are often discussed in relation to quantitative research and are often inappropriate for qualitative research based on interpretive assumptions as adopted in this study (Saunders et al., 2023). Therefore, Saunders et al., (2023) suggest using parallel version of assessment by Lincoln and Guba (1985) who substituted dependability for reliability, credibility for internal validity and transferability for external validity which this research adopts as well.

The degree to which research process has been logical, traceable and documented is referred to as dependability (Eriksson & Kovalainen, 2016). This assessment is the qualitative equivalent to reliability and according to Saunders et al., (2023) refers to ensuring consistency during research project by explaining the chosen data collection procedures and analysis techniques. Therefore, this research follows this recommendation by following the “research onion” by Saunders et al., (2023) to systematically document all steps of the research process.

Moreover, the lack of standardization in semi-structured interviews may introduce bias and raise reliability concerns that should be addressed (Saunders et al., 2023). First, interviewer bias appears when the interviewer's answers are influenced by the interviewer’s perspectives or expectations, which can lead to their responses being influenced in a specific way. Second, interviewee bias appears from how participants interpret and respond to questions. Third, individuals' willingness to participate in the interview process is linked to participant bias. To help prevent these problems, researchers should remain neutral, use a steady tone, avoid sharing their own opinions, and ensure that everyone who takes part does so by choice. In this thesis, trust is built by keeping both the interviewers' and the company's names anonymous. Nevertheless, it is important to consider cultural bias, especially since the interviewees come from

countries other than the author's. To reduce this, the author familiarized the cultures and norms before proceeding with the interviews.

According to Saunders et al., (2023) credibility is the degree to which research findings accurately represent or explain the participants' experiences. It ensures that the conclusions are supported by evidence. Triangulation is one of the commonly used methods for strengthening credibility. It is commonly used in case study research (Eriksson & Kovalainen 2016; Saunders et al., 2023). A well-designed case study should consider multiple perspectives and examine evidence from different angles, rather than relying on a single viewpoint (Eriksson & Kovalainen 2016). In this thesis, credibility is enhanced through several forms of triangulation. Therefore, method triangulation is used by combining multiple qualitative research approaches. These approaches include semi-structured interview, informal interviews, observations, and document analysis. In addition, applying data triangulation strengthens credibility. This study interviews multiple participant types and combines the findings with secondary data. These include case companys' and their logistics partners' internal and external documents. Finally, the study employs theoretical triangulation by interpreting its results using a variety of frameworks, such as institutional theory and triple bottom line.

Transferability refers to the extent to which research findings can be applied in similar settings (Saunders et al., 2023). This study adopts an intensive case study approach with small sample size typical to qualitative study, and, according to Eriksson and Kovalainen (2016), does not seek to generate knowledge that can be generalized to a larger population. To justify the findings, this study aims to investigate and understand the specific dynamics of the selected topic. In addition, by establishing connection between the study and previous research, it allows the reader to judge transferability of the research (Eriksson & Kovalainen, 2016).

6 Findings

This section presents the research findings, following the three themes, namely 1) institutional, 2) economic, and 3) social/human themes emerging from the interviews, observations, and document analysis. Firstly, the findings focus on institutional factors influencing the adoption of road-rail intermodal transport, which are further divided by coercive, normative and mimetic pressures. Economic factor findings are presented in five categories, which are infrastructure, terminals, flexibility and frequency, transit time and reliability, and transport costs. Finally, the social/human findings are outlined in 4 categories, which are power and expertise in intermodal adoption, trust and long-term commitment, collaboration and co-development, and individual-level openness that influence the adoption of road-rail intermodal transport.

The findings are based on qualitative data triangulated from the semi-structured interview, informal interviews, observations, and secondary data from company documents. Evidence was collected from the case company and its logistic partners. The roles are referred to as case company manager 1, case company manager 2, warehouse contact, freight forwarder, and road-rail terminal contact.

In addition, secondary data are presented from the company documents, including the annual corporate sustainability report 2024, EcoTransIT World (ETW) output files covering 2024 modal shares and Jan–Apr 2025 monthly aggregates, and key performance files (kgCO_2 &t sold, ttw/wtw, CO_2 tonnes). Supplementary secondary data evidence was collected from the case company's freight forwarder's monthly CO_2 and green fuel reporting.

6.1 Institutional factors

This section presents the findings on institutional factors. It is organized around three thematic categories: (1) coercive pressures, (2) normative pressures, and (3) mimetic pressures. The evidence is drawn from the case company manager 1, manager 2, and its

logistics partners, including freight forwarder, and road-rail terminal contact. In addition, secondary data listed above was used.

6.1.1 Coercive pressure

This section presents findings related to coercive pressure. These include regulatory requirements, mandatory disclosure obligations, and internal measurement practices.

Regulatory context and reporting requirements

The case company has implemented the Corporate Sustainability Reporting (CSRD) directive for the first time for the 2024 corporate sustainability report. The report represents the initial step in an ongoing process, as the company applied the European Sustainability Reporting Standards (ESRS) requirements for the first time. The report follows the general standard ESRS 2 (General Disclosures), and each of the ten topic-specific ESRS standards is addressed. In addition, voluntary data points and disclosures subject to the transition provision are excluded.

The Corporate Sustainability Reporting Directive (CSRD) and its European Sustainability Reporting Standards (ESRS) require the disclosure of Scope 1, Scope 2, and Scope 3 greenhouse gas (GHG) emissions. The case company states in its sustainability report that its GHG inventory is prepared in accordance with the Greenhouse Gas Protocol. Scope 1 emissions represent direct emissions from the case company and scope 2 represent energy-related indirect emissions. Scope 3 emissions include all other indirect emissions not included in scope 2 and is categorized into 15 categories. The present work focuses primarily on category 9 in Scope 3, which covers downstream transportation and distribution.

The case company’s Sustainability Report discloses that the accuracy of its Scope 3 greenhouse gas (GHG) emissions data is considered low to medium. This is due to the

use of generic emission factors and global averages. Furthermore, Category 9 in scope 3 are calculated using EcotransIT World, which is based on global averages for modes of transport and fuel types, an internal routing algorithm, transport-specific GIS data, distances, and sales volumes. The company applies an energy-based bottom-up well-to-wheel (WTW) approach in their calculations.

Additionally, the 2024 annual sustainability report of the case company also utlines its alignment with various regulatory frameworks for sustainable development. Firstly, the company has committed to the Paris Climate Agreement of limiting the global temperature increase to 1.5 celcius above pre-industrial levels. Furthermore, the case company has expressed its intention to achieve net zero emissions before the 2050 deadline stipulated in the European Climate law. These commitments are consistent with the objectives of the European Green Deal.

Emission measurement and internal data systems

In order to exercise control and monitor transport-related emissions, the case company employs a number of key performance indicators (KPIs) which are defined in internal documents. At the external reporting level, the key performance indicator kilograms of CO_2per tonne sold ($kgCO_2$/t sold) is the central control variable. The model establishes a correlation between transport emissions generated and external sales quantities (ESQ), thereby facilitating an assessment of performance in relation to sales volumes with regard to emissions. Furthermore, the kilograms of CO_2per tonne sold ($kgCO_2$/t sold) and absolute CO_2 emissions in tonnes are documented. The performance of these key figures is evaluated on a monthly basis at the level of the individual business unit.

At the operational level, the calculation of emissions is conducted by EcoTransIT World. Transport related emissions are determined on the basis of energy consumption and fuel type, routing-based distance calculations, transport-specific GIS data and sales volumes. The data thus generated is incorporated into the central sustainability reporting process

and used to analyse emission trends by mode of transport, transport corridor and business unit.

Pursuant to internal company calculations, road-rail intermodal transport has been determined to be the transport option with the lowest emissions when compared to the other alternatives that were examined. It is therefore considered to be a lower-emission transport option.

Empirical performance evidence (ETW data)

Monthly data from the case company's European business unit include EcoTransIT World (ETW)- generated emissions outputs for transport shipments. Table 3 presents the ETW data for a representative road-rail intermodal intercompany shipment. According to the ETW output file, the shipment weighed approximately 22.5 tonnes and included a pre-leg by road, a main rail leg, and a final leg by road. ETW calculations showed that the main rail leg transport generated approximately 9,74 CO_2 g/per ton-km, whereas pre-leg and last-leg road segments emitted 72,24-82,81 CO_2 g/per ton-km. Overall, the rail segment accounted for the majority of the transport distance but contributed a relatively small share of total emissions. According to the freight forwarder's CO_2 report for the same shipment, the recorded weight was 21.9 tonnes, with a reported CO_2 savings of 678kg.

Table 3. EcoTransIT World (ETW) data results

Transport segment	**CO_2 (WTW) Equivalent Original (t)**	**CO_2 (WTW) Original (t)**	**CO_2 [g/tkm] (WTW)**	**CO_2e [g/tkm] (WTW)**	**Distances (km)**
Pre-leg (road)	0,00541	0,00530	72,24	73,77	3,26
Main-leg (rail)	0,21997	0,20388	9,74	10,50	931,38
Last leg (road)	0,01041	0,01019	82,81	84,55	5,47

Operational observations and reporting limitations

Observation at the case company revealed ongoing improvements in the emissions calculation methodology. Specifically, for road-rail intermodal transport, the company moved from a delivery-based to a shipment-based logic and shifted from tank-to-wheel (TTW) to well-to-wheel WTW reporting. Furthermore, the shipment-based approach increases transparency into actual transport movements and reduces the need for "intermodal" workarounds, where rail was previously sometimes counted as a road due to data gaps. However, observations revealed limited visibility into freight forwarders' operational practices. The case company mentioned that they lack a clear understanding of whether a transport company is using rail instead of road, which may lead to misclassification of model data and underreporting of rail use. Observations also revealed that in Europe, road-rail intermodal transport is primarily used on intercompany lines and, to a lesser extent, on consumer lines.

Interviews and observations at the case company indicate that while sustainability is considered important, service level remains the primary key performance indicator (KPI). When discussing road-rail intermodal transport, case company managers 1 and 2 identified more disadvantages than benefits and expressed a preference for investing in alternative fuels. Case company manager 1 mentioned that EU transport policies were more visible at the level of logistics service providers than in their own transport mode decisions.

6.1.2 Normative pressures

Normative pressures were identified through the case company's participation in voluntary sustainability frameworks, professional rating systems, and external expectations related to environmental performance. Table 4 shows the case company's commitment to various voluntary frameworks.

Table 4. Voluntary frameworks

Framework	Type
Science-Based Targets initiative (SBTis)	NGO-led framework
United Nations Sustainable Development Goals (SDGs)	Global policy framework
Ecovadis	Supplier sustainability rating
ISS ESG Corporate rating	ESG rating agency
FTSE4Good Index Series	ESG index
MSCI ESG Ratings	ESG rating agency

The case company is committed to the Science-Based Targets initiative (SBTi) and follows the SBTi's Corporate Net-zero standard. The Corporate Net-Zero Standard defines net-zero as a reduction of scope 1, 2, and 3 emissions by at least 90% before 2050. According to the case company's 2024 sustainability report, the company aims to reduce scope 1, 2, and 3 emissions by 90% by 2045. The reduction target of the Science Based Targets initiative (SBTi) for Scope 3 greenhouse gas emissions is set at 30% by 2030, based on the base year 2021. According to the case company, a reduction of approximately 20% had already been achieved by 2024.

Within the third-party scope, category 9 encompasses the domain of downstream transport and distribution. However, a slightly opposite trend is evident in this area, with emissions rising marginally. Concurrently, the reduction target for Scope 3.9 is considerably lower than the overarching Scope 3 target, at a mere 2% by 2030.

In order to reduce emissions in Scope 3.9, the case company is pursuing two key strategic approaches: improvements in operational efficiency and adjustments in the choice of transport modes (modal shift). The efficiency measures are aimed in particular at making existing logistics structures more emission-friendly through improved capacity utilisation and optimised planning processes. The modal shift strategies also focus on structural

changes in the transport mix, for example by shifting from pure road transport to rail or combined road-rail transport as part of intermodal solutions.

6.1.3 Mimetic pressure

Mimetic pressures were identified of securing competitive positioning and industry-specific benchmarking processes.

Informal interviews and observations revealed that the case company considers its leading position in sustainability to be a significant corporate strength. Despite the company's self-perception of its advanced status in relation to its competitors, case company manager 1 emphasised the continuous search for further potential to reduce emissions in its logistics processes. Indeed, the objective is to first keep their leading position and second, to continue to develop it further.

The semi-structured interview with the freight forwarder revealed that customers in the chemical industry are demanding more low-carbon transport options, including road-rail intermodal solutions. This development has been characterised as part of a broader industry trend towards greater emission reduction. The issue of sustainability is becoming an increasingly significant competitive factor between logistics service providers. Concurrently, there is increasing pressure to innovate, as service offerings must be aligned more closely with customers' environmental objectives.

During the terminal visit, the road-rail terminal contact said that competitors' investments in new intermodal terminals are viewed positively rather than as a competitive threat. These investments were framed to meet the European Union's Green Deal goals for freight decarbonization and as a shared understanding that industry-wide collaboration supports long-term modal shift objectives.

6.2 Economic factors

This section presents the economic factors findings. It is organized around five thematic categories. (1) infrastructure, (2) terminals, (3) flexibility and frequency, (4) transit time and reliability, and (5) transport costs. Furthermore, the evidence is drawn from the case company manager 1 and manager 2 and its logistics partners, which are warehouse contact, freight forwarder, and road-rail terminal contact.

6.2.1 Infrastructure

Infrastructure barriers were a consistent theme in the semi-structured and informal interviews. During the semi-structured interview, the freight forwarder mentioned bottlenecks in the German rail network, where ongoing construction works and strikes add considerable uncertainty to intermodal operations. Similarly, during an informal interview, the case company manager 2 expressed that infrastructure limitations reduce punctuality and the attractiveness of intermodal transport. The case company manager 2 made a particular reference to a single-track system, which was seen to significantly restricts operational flexibility. Furthermore, the road-rail terminal contact drew attention to the ongoing fragmentation of the European rail network in an informal interview. The numerous national systems, a paucity of interoperability, and extensive track renovations in multiple European countries have regularly led to delays and congestion in the network.

Furthermore, the freight forwarder highlighted that the allocation of available train slots were frequently expedited, often within a short timeframe. This dynamic made it particularly challenging for new market entrants to access capacity. The situation described was then compared with similar bottlenecks in road freight transport.

6.2.2 Terminals

In addition to the rail network structure, the interview data identified terminal capacities as another key bottleneck. The issue of existing capacity limits was addressed in two of

the three interviews. In the semi-structured interview, the freight forwarder emphasised the necessity for additional transhipment points in order to facilitate the growth of intermodal transport operations. The road-rail terminal contact also confirmed that demand for intermodal transport solutions has already surpassed current capacities. However, they mentioned that it is not feasible to undertake a physical expansion of their existing site. In light of these developments, investments by competitors in new terminal infrastructure are encouraged, with an aim to reduce network congestion.

In addition to considerations of physical capacity limits, technological and connectivity deficits were also addressed as inhibitors to expand intermodal operations. The freight forwarder indicated the presence of persistent issues with digital systems and interfaces, as well as a lack of standardisation in operational processes. There is a particular expectation for the development of more harmonised digital solutions. New infrastructure projects such as the terminal in Barcelona were mentioned as strategically important steps towards strengthening the intermodal network.

A site observation at the road-rail intermodal terminal revealed the infrastructure's both enhancers and inhibitors. The scale of operations was evident from the over thirty trains that passed through the site each day, and the presence of several parallel tracks. Concurrently, operational constraints became evident, notably in the management of non-craneable semi-trailers. These trailers necessitate long transhipment times and augment storage requirements due to their incompatibility with stacking configurations.

6.2.3 Flexibility and frequency

The issues of flexibility and frequency were identified as recurring themes across the interviews and observations. It was emphasised by the warehouse manager and the case company managers 1 and 2 that extended dwell times at terminals reduce responsiveness compared to road transport. It was explained that the period between arrival at the terminal and final delivery by truck was a challenge.

The operational scheduling of freight trains, which predominantly operate during night-time hours, creates a fundamental conflict with the logistics processes that are organised during daylight hours. In order to alleviate the resulting bottlenecks, the road-rail terminal relies on financial control mechanisms, such as incentives for night-time pick-ups or storage fees for delayed pick-ups. These measures were described as a key tool for overcoming transshipment bottlenecks and terminal capacity constraints.

Concurrently, cooperative models such as train pooling were emphasised as a means of enhancing flexibility by the freight forwarder. The distribution of track capacity amongst transport providers can facilitate the continuity of connections, even in circumstances where individual players do not possess adequate loading volumes. Furthermore, it became evident at the road-rail terminal that digital tools, including online booking systems and ETA tracking, can enhance transparency and optimise planning processes.

6.2.4 Transit time and reliability

Participants of this study consistently raised concerns about transit time and reliability intermodal transport. During the informal interview at the warehouse, the warehouse contact and the case company managers 1 and 2 emphasised that intermodal solutions generally entail longer transit times than road only transport. While the paramount significance attributed to sustainability objectives, case company manager 2 asserts that service reliability remains the foremost operational performance indicator. Consequently, in day-to-day decision-making, punctuality frequently ouweights environmental concerns. In this context road transport was highly valued option.

At the same time, both the case company managers 1 and 2 and the warehouse contact agreed that not all shipments are equally time-sensitive. Although customer deliveries require strict adherence to delivery deadlines, intercompany flows may be better suited to rail transport.

Delays on the rail network were found as another primary concern in sense of uncertainty. During the informal interview, the warehouse contact and the case company's managers 1 and 2 highlighted that delays on the primary railway line have been shown to extend transit times and compromise punctuality and reliability. The freight forwarder described situations such as strikes or network disruptions as virtually impossible to influence once the goods are already on the train. The options for intervention are then very limited, which makes such events particularly cost-intensive. Furthermore, the planning of intermodal transport was described as complex and resource-intensive. A semi-structured interview revealed that the freight forwarder described unexpected process disruptions as a critical challenge.

During observations at the road–rail terminal, dedicated driver platforms provided real-time updates on delays and strikes, reducing uncertainty in transport execution.

6.2.5 Transport cost

All participants agreed in the interviews that rail-road intermodal transport is most cost-effective on longer routes with large shipment volumes. During the semi-structured interview, the freight forwarder emphasized that rail is particularly advantageous when routes run parallel to highways. This is because it allows carriers to avoid truck driving bans while also benefiting from the train’s ability to carry larger cargo volumes than trucks. Similarly, during informal interviews, both the warehouse contact and the case company managers 1 and 2 highlighted that heavier and fuller shipments improve overall cost efficiency, as consolidation reduces per-unit transport costs.

The road-rail terminal contact added that intermodal transport can further enhance efficiency by reducing the length of truck journeys during an informal interview. This lowers road congestion and enables drivers to work regular day shifts, thereby improving labour conditions.

During a semi-structured interview, the freight forwarder emphasized that customers demanding sustainable solutions should be prepared to share the cost burden of investments such such as alternative-fuel trucks.

6.3 Social/human factors

The section presents the social/human factors findings, and it is organized around four thematic categories: (1) power and expertise in intermodal adoption, (2) trust and long-term commitment, (3) collaboration and co-development, (4) individual-level openness. Furthermore, the evidence is drawn from the case company manager 1 and manager 2 and its logistics partners, which are warehouse contact, freight forwarder, and road-rail terminal contact.

6.3.1 Power and expertise in intermodal adoption

According to internal communication (observation), one significant intercompany flow in Central Europe was shifted from road to rail-road intermodal at the carrier's proposal, rather than at the case company’s as the shipper's request.

In the semi-structured interview, the freight forwarder further expressed interest in expanding additional road-only lines to intermodal in the future, noting that success depends on timing: “You need to be at the right place at the right time when entering rail transport.”

6.3.2 Trust and long-term commitment

During the semi-structured interview, the freight forwarder said that their decision to invest in intermodal more than 15 years ago was not financially motivated or driven by direct customer pressure, but rather by ecological values and a personal commitment to future generations.

Freight forwarder said that they operate intermodal lines where they have access to terminals and daily train connections, and customers have frequent flow. Observations at the case company showed that the freight forwarding company has been a long-time partner.

Freight forwarder identified a potential Germany–Poland connection as a promising intermodal expansion opportunity.

6.3.3 Collaboration and co-development

Collaboration was identified as an essential factor for enhancing intermodal operations and sustainability practices in the semi-structured interview. The freight forwarder mentioned practices such as train slot pooling, in which multiple (carrier) operators share train slots to accommodate fluctuating volumes. Freight forwarder also mentioned that cooperation on sustainability and intermodal practices with customers and industry competitors is important. They believe that everyone should work together for a common goal. For instance, they emphasized that broader adoption of technologies such as alternative-fuel trucks requires customer cost-sharing.

Also, the freight forwarder highlighted numerous challenges that hinder close cooperation in the intermodal context. From this standpoint, the primary concern for many customers is the quality of the service provided, with considerations of sustainability playing a more marginal role. There are reservations regarding the punctuality and reliability of intermodal transport solutions. Hence, the freight forwarder mentioned, that customers should be willing to accept earlier pick-ups or expand delivery windows to gain ecological benefits of rail-based options. Furthermore, external factors, including strikes, operational delays and network diruptions, contribute to the complexity of planning. As the freight forwarder mentioned “ there is little the carrier can do once the cargo is already on the train”. The impact of linguistic and cultural differences, with France serving as a case in point, on cross-border coordination and the augmentation of the complication of operational coordination has been highlighted.

6.3.4 Individual-level openness

The importance of individual motivations for introducing intermodal transport also became apparent. In a semi-structured interview, the freight forwarder explained that the original decision to implement intermodal solutions was not primarily cost-driven, nor was it triggered by specific customer demand. Instead, it was a combination of a personal and organisational commitment to sustainability.

The decision was explicitly linked to the issue of global warming. Moreover, a generational perspective was identified as a contributing factor. The aspiration to ensure a sustainable future for one's children was cited as a predominant motivation. In this context, it was emphasised that younger generations in particular are increasingly addressing the issue of climate change, thereby influencing individual decision-making processes.

7 Discussion

This chapter presents a discussion of the findings by analyzing them in relation to the existing literature. The aim is to develop a comprehensive understanding of how institutional, economic, and social/human factors influence the adoption of road-rail intermodal transport among MNEs operating within the EU to achieve ecological sustainability. The discussion chapter is structured in accordance with the literature review. First, the economic and social/human factors that inhibit the adoption of road-rail intermodal are discussed, followed by the economic and social/human factors that enhance adoption. Then, the institutional factors that inhibit the adoption of road-rail intermodal are examined, followed by the institutional factors that act as enhancers. Finally, the chapter presents an updated theoretical framework.

7.1 Multidimensional nature of freight modal choice

The findings of this study confirm the literature's characterization of freight modal choice as a multidimensional and interdependent decision-making process rather than a function of isolated environmental, economic or human/social considerations. Empirical findings show that economic factors, such as transport cost, transit time, reliability, flexibility, and frequency, as well as social/human factors, are collectively interconnected in practice by decision makers.

Furthermore, the interviews and observations highlighted the necessity of involving, in addition to the case company, its freight forwarder and road-rail terminal contact to obtain a complete picture. Even though the initial idea was to examine the road-rail intermodal shift from the shipper's perspective, as in the case of the company studied, due to a lack of shipper perspective studies, previous research indicates that freight forwarders frequently play a critical role in initiating modal shifts due to their comprehensive market knowledge (Rogerson et al., 2021). This finding was substantiated in the current study, as the case company's adoption of road-rail

intermodal services was initiated primarily by its freight forwarder, which then collaborated with the terminal manager.

7.2 Economic and social/human inhibitors

A central finding of this study is that many of the economic and social inhibitors to road-rail intermodal transport identified in the literature remain highly relevant in practice. The empirical findings largely confirm established inhibitors related to transport cost, insufficient terminal capacity, door-to-door transit time, reliability/punctuality, flexibility, frequency, risk aversion, and routine organizational routines and decision-making. Importantly, these factors were found to be closely interrelated and jointly experienced by the case company in operational decision-making.

In line with this study's theoretical background, infrastructure and technical fragmentation are conceptualized in this study as institutional inhibitors shaped by the European Union's policy frameworks and long-term investment decisions. In practice, however, the findings show that infrastructure and technical constraints are primarily experienced by firms through their economic and its operational consequences, which justifies their discussion in this section. Participants consistently described how delays caused by insufficient infrastructure directly reduced reliability and punctuality, and ongoing rail construction works and strikes add uncertainty to intermodal operations, thereby reducing the attractiveness of intermodal transport.

In addition to the mentioned causally linked inhibitors, limited terminal capacity caused extended dwell times, constrained flexibility, and reduced responsiveness compared to road-only transport. As a result, infrastructure, reliability, and flexibility were closely intertwined in participants' accounts, as they were experienced as mutually reinforcing; thus, poorer service performance raised the perceived risk of disruption, which, in turn, increased the perceived economic "penalty" of intermodal transport (Arencibia et al., 2015).

According to the results, intermodal transport is considered more expensive than road transport on shorter routes. Interviewees reported that road-rail intermodal is the most cost-effective for longer-distance routes with high volumes, thus aligning with previous findings on shorter routes (European Commission, 2022) and empty haul inefficiencies (Pieters et al., 2012).

Findings also confirm inefficient terminal capacity as reported by previous research Saaedi et al. (2019). Road-rail terminal contact explained that demand for intermodal transport already exceeds current capacity. In addition, they acknowledged that their site cannot undertake a physical expansion and is welcoming competitor investments in new terminals to ease congestion. However, to address terminal congestion, the terminal has introduced financial control mechanisms, such as offering incentives for customers to collect goods at designated times (including nights) and applying storage fees for delayed pickups.

The interview data revealed a new possible inhibitor to road-rail intermodal adoption that was not mentioned in previous literature. The freight forwarder explained that allocation of available tran slots was frequently expedited, often within a short timeframe and can be challenging for new market entrants. This capacity issue was described as comparable to capacity constraints in road transport markets. Hence, this finding suggest that insufficient train capacity may prevent companies from expanding intermodal use, even if they are willing to do so.

Intermodal transport usually results in longer transit times than road-only options and is seen as disadvantageous for maintaining proper service levels as explained by case company managers 1 and 2, and the warehouse manager in the interviews. These findings are discussed in previous literature that extended door-to-door transit times in road-rail solutions lead companies to tradeoff between transportation and inventory costs (Dekete et al., 2010; Eng-Larsson & Kohn, 2012; Zhang et al., 2020). Also, interview data revealed that punctuality and reliability inhibit the adoption of road-rail intermodal

transport and according to case company interviewees are especially decisive factors in customer deliveries. The case company's participants in this study identified service reliability as the foremost operational performance indicator. This, in turn, confirms previous studies by Danielis et al. (2005) and Dekete et al. (2010) that on-time delivery is highly valued in customer deliveries.

Flexibility and frequency emerged as recurring themes in interviews and observations. During the informal interview, the warehouse manager and the case company managers 1 and 2 emphasized extended dwell times at terminals before final truck delivery. This, in turn, results in reduced responsiveness compared to road-only transport.

During an informal interview, the road-rail terminal contact emphasized the misalignment between freight train operating patterns and daytime logistics requirements because freight trains primarily operate at night. These findings are consistent with previous research on the low frequency of freight trains and restricted terminal operating hours as inhibitors to road-rail intermodal transport (Beil et al., 2025; Islam et al., 2016) and the tendency for freight trains to be scheduled during nocturnal hours due to passenger trains prioritized to operate during daytimes (Bontekoning & Priemus, 2004; Cavallaro et al., 2020; Racunica & Wynter, 2005).

The findings confirm a strong preference for established road-based routines, as the discussions revolved around how road transport was seen as as more controllable and operationally secure than rail options. Similar patterns have been identified in previous research by Elbert and Seikowsky (2017) and Stockhammer et al. (2021), who found that intermodal transport are rarely considered a default option, even when environmental or cost advantages are acknowledged. In addition, rail was frequently perceived as riskier by the participants of this current study due to limited intervention options once disruptions had occurred. Stockhammer et al.'s (2021) likewise note that rail is often viewed as less reliable and more prone to delays than road transport. However, observation at the terminal revealed that digital driver platforms and estimated tracking

can partially address these uncertainties by improving visibility over delays. The case company's greater interest in alternative fuels rather than intermodal solutions reflects Lammgård's (2007) findings that many shippers view rail as a secondary option due to perceived service limitations.

7.3 Economic and social/human enhancers

In contrast to the inhibitors discussed above, the findings also reveal economic and social/human conditions under which road-rail intermodal transport becomes a viable and attractive option. The findings of this study suggest that road-rail intermodal adoption is enhanced when economic and scale effects are realized, operational predictability, and coordination of operations reduce uncertainty.

Interviewees indicated that intermodal transport is most cost-effective for longer-distance routes with high volumes, and highlighted that consolidation lowers per-unit costs. Similar conclusions are reported by European Commission (2022) and Janic (2008) who agree that rail-based transport modes are cost-effective beyond a certain distance threshold, ranging from 700km (Janic, 2008) to 1000km (European Commission, 2022) and by Lammgård (2012) and Macharis et al. (2010) who agreed that as the weight of the rail transportation unit increases, the cost decreases.

While case company interviewees confirmed that transit time and reliability were particularly critical for customer-facing deliveries, intercompany flows were mentioned to be better suited to rail transport. The reason for this are that intercompany shipments allow for flexibility in transit time and punctuality, which is not possible for direct customer deliveries, as wider delivery windows may compromise the level of service offered by the case company. These findings support prior research by Danielis and Marcucci (2007) conclusion that shippers tolerate minor deviations in transit time and punctuality as long as acceptable thresholds are not exceeded. In addition, these mentioned flexibility methods were emphasized by the freight forwarder who suggested that accepting earlier pick-ups or later delivery windows, could potentially increase

shippers' willingness to use rail aligning with Rogerson et al. (2021) discussion on shipper's willignes to relax just-in time expectations to benefit from intermodal cost savings. More broadly, the interview results support Eng-Larsson and Kohn's (2012) conclusion that the success of modal shift depends on the shipper's willingness to adapt its operational systems and planning practices to fit the chosen transport mode characteristics.

In addition to above, the results of this study suggest that planning by freight forwarders and logistic service providers can enhance road-rail intermodal flexibility. The freight forwarder mentioned that they establish intermodal lines only where frequent customer flows, daily train connections, and reliable terminal access can be ensured to provide profitable services to their customers. Furthermore, they described "train pooling" where freight forwards share their train with each other depending on the lack or size of the cargo to increase flexibility of rail operations and maintaining service levels for customers.

The findings of this study are consistent with a previous study by Rogerson et al. (2021), who found that power and expertise often lie with transport providers rather than shippers when initiating modal shifts. Indeed, observations revealed that a major intercompany flow was shifted from road to road-rail intermodal following the freight forwarder's proposal. This in turn suggests that providers' technical and market knowledge can influence shippers' choices (Rogerson et al., 2021).

Consistent with previous research by Lammgård (2007) and Rogerson et al. (2021), trust and long-term commitment were evident for sustaining intermodal operations. Observations revealed that the case company and the freight forwarder have a long-term partnership. In addition, the case company's internal consolidation practices and stables volumes further reflect the type of commitment for intermodal operations described by Rogerson et al, (2021) in their discussion of shipper-carrier relationships.

In return, the freight forwarder's focus on routes with stable demand and daily train connections signals long-term commitment.

Interview data revealed challenges in shipper's service expectations on road-rail intermodal transport and limited willingness to share the costs of green investments, which according to freight forwarder could constrain collaboration. Despite these challenges, the freight forwarder stressed that sustainability cooperation should extend across both customers and competitors. Based on Rogerson et al. (2021) definition of reward power, the sustainability cooperation as described by the freight forwarder could generate mutual reputational benefits.

New insights also appeared in the findings of this study. The freight forwarder noted that their decision to enter road-rail intermodal markets was motivated by ecological values and concern for future generations rather than financial returns. This suggests that the individual-level trains linked to sustainability-oriented decision-making, such as prior experience or personal environmental interest (Rogerson et al., 2021), may also apply to logistics providers rather than only to shippers. Furthermore, such value-driven leadership can therefore act as a catalyst for intermodal adoption among their customers (shippers).

Finally, the road-rail terminal contact identified labour-related benefits, including the ability for drivers to maintain regular day shifts, which supports previous findings regarding improved working conditions in intermodal transport (Elbert & Seikowsky's 2017).

7.4 Institutional theory in freight transport and modal choice

The findings confirm that ecological considerations are recognized as strategically important, but rarely serve as the primary determinant in transport mode choice decisions. This is in line with the previous literature, which shows that environmental criteria are not among the most critical factors in mode choice (Bask et al., 2018; Eng-

Larsson & Kohn, 2012; Stockhammer et al., 2021). Furthermore, in the case company, sustainability was famed as a core strategic principle, yet operational decisions prioritized service-level performance as their main KPI. This confirms earlier research that environmental aspects are often framed as part of a shipper's internal sustainability strategies rather than directly translated into operational transport decisions (Eng-Larsson & Kohn, 2012; Jazairy & von Haartman, 2020).

Although findings indicate that road-rail intermodal transport is not a dominant operational choice, it is clearly embedded in the case company's long-term sustainability strategy. Internal documents mention rail as the most effective decarbonization option for freight transport and promote a modal shift from road to road-rail intermodal to achieve climate objectives. However, this strategy has not translated into broad operational adoption. At the European business unit level, intermodal transport is primarily used in intercompany flows rather than in customer-facing deliveries. This shows that service level requirements are prioritized in external deliveries.

7.5 Institutional inhibitors

The study's findings suggest that EU-level transport policies are often absorbed at the system and service-provider levels rather than influencing shippers' operational choices. The empirical findings show that the case company aligns its sustainability strategy with the European Green Deal by setting SBTi decarbonization targets for all three scopes. However, the direct impact of EU transport policies remains mixed and difficult to observe. For instance, one of the company's sustainable strategies is shifting from road to rail, but no direct evidence was found linking it to TEN-T or other transport policies. Instead, the modal shift was introduced overall as a low-carbon alternative to road-only transport and aligned with other logistics strategies to achieve a relatively minor of 2% reduction of 30% towards the SBTi 2030 target. In addition, case company manager 1 mentioned that EU transport policies were more visible for LSPs than in their own transport mode decisions. The company's reliance on external transport providers further limits its influence on these policies. Observation results support this distinction,

as the freight forwarder partner referenced future expansions into other European regions and cited the new Barcelona terminal as a strategic step that would strengthen the intermodal network. However, did not explicitly link these plants to the TEN-T or similar EU policy initiatives. All in all, this indicates that transport policy primarily targets logistics service providers rather than shippers (Grzelakowski, 2024; Jazairy & von Haartman, 2020).

The findings indicate that infrastructure limitations constitute a central institutional inhibitor to the adoption of road-rail intermodal transport. Consistent with prior research (Pastori et al., 2018), participants of this study mentioned several rail network bottlenecks like insufficient infrastructure and ongoing rail construction works that reduce punctuality and reliability. These constraints, therefore, reflect a policy-market gap in which EU-level sustainability and modal shift objectives are not matched by sufficient integrated and resilient infrastructure at the operational level (Grzelakowski, 2024).

7.6 Institutional enhancers

The findings reveal that institutional enhancers operate primarily through firm-level governance mechanisms, voluntary sustainability frameworks, and industry benchmarking, which together strengthen the translation of sustainability-oriented pressure into transport-related decision-making. While EU-level transport policies have had limited direct impact on shipper modal choice, institutional pressure becomes more effective when it is internalized within organizational governance structures, particularly large, internationally operating shippers exposed to external scrutiny (Rogerson et al., 2016; Bask et al., 2018; Jazairy & von Haartman, 2020).

Coercive institutional pressure was found to function as an enhancer when sustainability regulation is embedded in firm-level reporting and performance management systems. The case company's implementation of CSRD-aligned reporting and Scope 3 emission disclosure increased internal transparency and accountability for transport-related

emissions, supporting earlier research that a mandatory reporting framework can raise managerial awareness and organizational attention to logistics emissions (Sharma, 2025; Kallionpää et al., 2026). Although such reporting requirements did not directly mandate modal shift, they created a structural incentive to assess, compare, and justify transport-related emissions across modes, thereby indirectly increasing the strategic awareness relevance of road-rail intermodal transport within the organization.

Normative pressures are further enhanced by framing sustainability as a professional and moral obligation. The empirical findings reveal that the case company follows voluntary frameworks such as the Science-Based Targets initiative (SBTI), United Nations Sustainable Development Goals (SDGs), and various ESG ratings and supply assessments reflecting the normative pressure of professional norms and industry standards on corporate sustainability practices (Tate et al., 2011; Kallionpää et al., 2026). In detail, the case company participates actively in the SBTi and has committed to reducing Scope 3 emissions earlier than required by the initiative's corporate net-zero standards. As of 2024, total Scope 3 emissions had decreased by approximately 20% from the 2021 baseline. However, category 9, which includes the downstream transport and distribution, which is the scope of this study, showed a marginal increase in emissions. While this category contributes a relatively small share of 2% towards the intermediate 2030-year reduction target, it remains strategically relevant because shifting from road to rail is cited as one of the case company's emission mitigation strategies. However, consistent with prior research by Jazairy & von Haartman (2020) and Layaoen et al. (2024), the findings suggest that normative pressure influences remain indirect and depend on whether the targets are translated into operational action.

Additionally, the freight forwarder's personal ecological motivation, driven by ethical concern for future generations, represents an example of normative influence, as evidenced by previous research (Campbell, 2007; Kallionpää et al., 2026). Although this study primarily focuses on the shipper's perspective, it is worth noting that value-based leadership among logistics partners can reinforce the sustainability goal and expand rail-

based services, as these partnerships have enabled the introduction of road–rail services on the case company's selected routes.

Findings show that mimetic pressure was evident in industry benchmarking and strengthening competitive position. The case company views sustainability leadership as a a key strength and although it considers itself ahead of its competitors in sustainability initatives, it continues to seek new ways to reduce logistics emissions to maintain its position. This aligns with previous research that indicates that large shippers are more likely to adopt environmental practices to strengthen their competitive position and reputation (Bask et al., 2018; Kallionpää et al., 2026).

Although this study adopts a shipper perspective, the findings show that mimetic pressures were evident across the wider logistics field. The terminal manager's view that competitors' investments in intermodal terminals contribute to collective progress, together with the freight forwarder's emphasis on low-carbon transport as a source of competitive differentiation, reflects competitive imitation of environmentally successful practices. This aligns with previous research showing that mimetic pressure can accelerate sustainability transitions in logistics as firms adopt green practices to maintain competitiveness and legitimacy (Layaoen et al., 2024). For shippers, such peer behavioural helps normalize road-rail intermodal transport and reduce perceived risk when successful business cases are shared (Stockhammer et al., 2021; Rouratier-Mueller & Ortas, 2021).

7.7 Updated theoretical framework

The original theoretical framework presents the relationship between relevant theories, concepts and findings to address the study's research question: How do institutional, economic and social/human factors influence the adoption of road-rail intermodal transport among MNEs operating within the EU to achieve ecological sustainability? This influence manifests either negatively, by inhibiting the adoption of road-rail intermodal, or positively by enhancing its adoption in pursuit of ecological sustainability.

Furthermore, this study developed an initial theoretical framework by integrating the Triple Bottom Line (TBL) framework (Elkington, 1994) with Institutional theory (DiMaggio & Powell, 1983; Scott, 2001; North, 1991).

Building on the discussion of the findings, the updated framework does not introduce new theories. Instead, it refines the relationships between them by incorporating empirical evidence on how institutional factors are internalized within organisations and how some institutional inhibitors directly interact with the economic and social/human inhibitors.

First, the empirical findings support that policy-market gap (Evangelista et al., 2017; Bask et al., 2018; Grzelakowski, 2024; Eurostat, 2025), that EU-level transport sustainability initiatives are often absorbed at the system level and service-provider level rather than becoming direct decision drivers for shippers or sustainability-oriented regulation at the operational level (Jazairy & von Haartman, 2020; Grzelakowski, 2024). Similarly, rail infrastructure and technical fragmentation in the rail sector (Pastori et al., 2018) were confirmed in the findings and found to be highly connected to economic inhibitors. For instance, delays caused by insufficient infrastructure and ongoing construction work, as well as strikes, add uncertainty to intermodal operations. Therefore, the updated framework positions infrastructure-related barriers as a core institutional bottleneck that shapes reliability, uncertainty, and perceived risk of rail-based solutions.

The empirical findings support that coercive, normative, and mimetic pressure drive companies toward legitimacy and sustainability-oriented conduct (DiMaggio & Powell, 1983). Coercive pressure related to CSRD-related reporting and Scope 3 disclosure was found to increase transparency and internal emissions monitoring (Sharma, 2025; Kallionpää et al., 2026, thereby increasing managerial awareness on intermodal assessment within sustainability planning. However, consistent with the institutional decoupling argument (Meyer & Rowan, 1977), reporting obligations do not automatically translate into adoption of road-rail intermodal transport because

compliance can remain procedural if service constraints persist (Eng-Larsson & Kohn, 2012). Normative pressure similarly strengthens sustainability as professional and moral expectations through voluntary frameworks such as SBTi and external ratings, but their operational influence remains indirect unless targets are translated into concrete logistics procurement requirements (Kallionpää et al., 2026; Jazairy & von Haartman, 2020; Tate et al., 2011). Mimetic pressures were found through the case company's competitive position as a sustainability leader, and as learning and seeking additional ways of reducing logistics emissions to maintain its position. These findings align with previous literature that argues that large global companies are more likely to adopt environmental practices to strengthen their competitive positions (Bask et al., 2018; Kallionpää, 2026). This is thus seen in the case company's strategy to increase rail transport. This aligns with evidence that competitive imitation supports sustainability transitions in logistics (Layaoen et al., 2024).

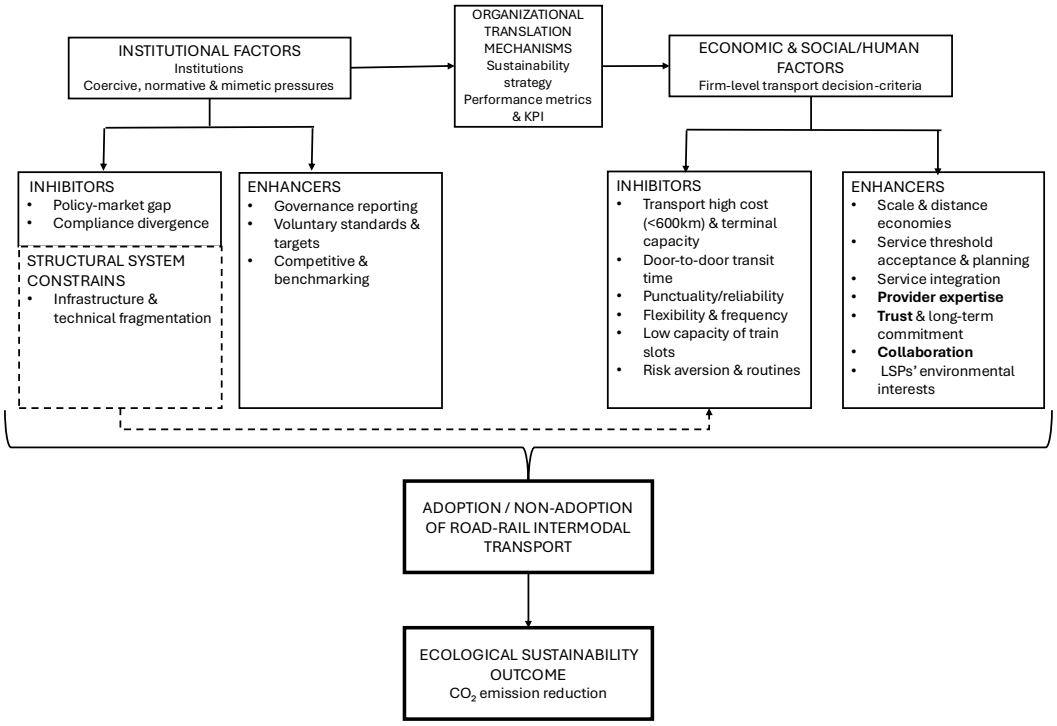
However, the case company evidence, aligned with prior literature, shows that the translation of these pressures does not directly result in operational transport decisions. In the case company, sustainability is framed as a core strategic principle, yet service-level performance operated as the dominant operational KPI, especially in customer-facing deliveries. This implies that institutional pressures may increase attention to emissions and strengthen the legitimacy rationale for modal shift, but adoption only becomes likely when intermodal services meet minimum acceptable thresholds for door-to-door transit time, reliability/punctuality, flexibility and frequency (Danielis & Marcucci, 2007; Rogerson et al., 2021). Therefore, in the updated framework, these institutional enhancers are internalized through governance and target-setting mechanisms and primarily work by establishing sustainability strategies and performance metrics.

The empirical findings support many of the economic and social inhibitors mentioned in previous literature. These include high transport cost on shorter routes (European Commission, 2022), terminal inefficiencies (Saeedi et al., 2019) increased door-to-door

transit time (Dekete et al., 2010; Eng-Larsson & Kohn, 2012; Zhang et al., 2020), and punctuality/reliability constraints when moving from road to rail (Danielis et al., 2005; Dekete et al., 2010; Elbert & Seikowsky, 2017; Geischberger et al., 2025), flexibility and frequency on road-rail intermodal responsiveness (Arencibia et al., 2015), and misaligned rail operations (Beil et al., 2025; Cavallaro et al., 2020; Islam et al., 2016), as well as the case company's preference for established road routes (Elbert & Seikowsky, 2017; Stockhammet et al., 2021) due to participants finding rail riskier to comply with their service KPI. Empirical findings also revealed new insights, such as the low capacity of train slots, which further limit the feasibility of expanding intermodal use even if there is a willingness to shift.

Empirical findings confirm many of the economic and social/human enhancers identified in previous literature. These include rail-road intermodal cost-effectiveness for longer routes (European Commission, 2022; Janic, 2008) with high cargo volumes (Lammgård, 2012: Macharis et al., 2010). Inventory flexibility and time tolerance (Eng-Larsson & Kohn, 2012; Zhang et al., 2020), service threshold acceptance (Danielis & Marcucci, 2007) and shipper’s willingness to adapt its operational systems to fit chosen transport mode (Eng-Larsson & Kohn, 2012) enhances road-rail intermodal adoption especially for intercompany lines at the case company. Trust and long-term commitment (Lammgård,2007; Rogerson et al., 2021) and transport provider expertise (Rogerson et al., 2021) enhances road-rail intermodal adoption as well as ecological motivation and the freight forwarders' own values and concerns for future generations indicates that shipper’s environmental interest (Rogerson et al., 2021) may apply to LSPs as well. In the updated theoretical framework, this finding has been marked as LSPs' environmental interest. In conclusion, the empirical findings indicate that collaboration with freight forwarders and logistics personnel enhances the implementation of road-rail intermodal significantly, as they provide the expertise, coordination, and trust for shippers. Therefore, in the updated framework, provider expertise, trust, and collaboration between logistics actors and shippers have been highlighted as significant enablers of adoption.

Figure 2. Updated theoretical framework



8 Conclusions

This chapter presents the key findings, theoretical contributions, managerial implications, limitations, and suggestions for future research.

8.1 Key findings

This chapter summarizes the study's key findings by answering the main research question and the two sub-research questions guiding the study.

RQ: ***How do institutional, economic and social/human factors influence the adoption of road-rail intermodal transport among MNEs operating within the EU to achieve ecological sustainability?***

The results of this study show that the adoption of road-rail intermodal transport among MNEs is primarily determined by economic factors and, thus, operational feasibility, while institutional and social/human factors play important, though indirect and mediating, roles. Institutional factors shape long-term sustainability strategies within MNEs through ecological sustainability goals and generate strategic incentives, legitimacy, and organizational attention for modal shift, but are not sufficient as standalone drivers of adoption. Instead, road-rail intermodal adoption remains dependent on economic factors, which, once service acceptance thresholds are exceeded, tend to outweigh ecological objectives. In addition, social/human factors, such as collaboration with freight forwarders and logistics partners, mediate how the sustainability strategy is translated into operational practice by enabling knowledge transfer, and the implementation of intermodal solutions that fit the shipper's operational and service (economic) requirements by identifying feasible routes and operationalizing them by coordinating with logistics actors.

Sub RQ1: ***How do institutional, economic, and social/human factors inhibit the adoption of road-rail intermodal transport within the EU to achieve ecological sustainability?***

The findings indicate that adoption is inhibited by a combination of institutional constraints originating at the system level and largely beyond the direct control of shippers, and by firm-level economic and social/human inhibitors. Institutional inhibitors include infrastructure and technical fragmentation in the rail sector, despite the European Union's long-term transport policies and investment decisions. These institutional inhibitors constrain the operational (economic) feasibility of road-rail intermodal transport by reducing reliability and increasing operational risks. In parallel, economic inhibitors include higher perceived costs on short routes, limited terminal and train capacity, longer door-to-door transit times, lower punctuality, and reliability. These economic inhibitors are connected to social/human inhibitors, including decision-makers' preference for established road-based routines and perception of rail as less reliable and uncertain.

Sub RQ2: ***How do institutional, economic, and social/human factors enhance the adoption of road-rail intermodal transport within the EU to achieve ecological sustainability?***

The results indicate that adoption of road-rail intermodal transport is enhanced when institutional pressures align with favourable economic conditions and are actively translated through social/human mechanisms. Institutional factors enhance adoption by providing legitimacy, strategic direction, and accountability for reducing transport-related emissions through sustainability reporting, voluntary sustainability frameworks, and strengthening competitive position. However, their influence remains indirect unless economic enhancers increase the viability of intermodal transport, such as long-distance, high-volume flows, acceptable thresholds for transit time and punctuality, effective planning to enhance flexibility and frequency, and stable demand. Social/human factors, such as provider expertise, coordination, collaboration, and trust among actors, enhance the operationalization of intermodal solutions.

8.2 Theoretical contributions and managerial implications

This study addresses the gap in the literature on sustainable freight transport and modal shift by integrating institutional theory with the Triple Bottom Line (TBL) framework to explain road-rail intermodal adoption at the firm level. Prior research has extensively examined economic, operational, and its service related factors of freight mode choice (Arencibia et al., 2015; Danielis & Marcucci, 2007; Dekete et al., 2010; Gohari et al, 2022; Islam et al., 2013; Tavasszy et al., 2020), as well as a separate streams of studies have focused on shipper-LPS relationship (Bask et al., 2018; Sallnäs, 2016) in RfQs/tenders and contracts (Eng-Larsson & Kohn, 2014), power balance and trust between shippers and transport providers (Rogerson et al., 2021) and logistics service providers (Sallnäss et al., 2022). In pararrel, institutional theory (DiMaggio & Powell, 1983) has been applied to corporate social responsibility (Lee et al., 2024; Risi et al., 2022), green supply chain management (Chua et al., 2023; Chu et al., 2017; Kauppi, 2013; Layaoen et al., 2024; Lin & Sheu, 2012; Tate et al., 2011; Wen et al., 2023; Zhu & Sarkis, 2007), but its use in analysing firm-level transport mode choice remains limited. Thus, by integrating these previously disconnected literature categories, this study provides a theoretically grounded explanation of how they jointly influence the adoption of intermodal transport among MNEs acting as shippers in order to gain ecological sustainability. In doing so, it extends transport decisions and demonstrates its relevance for understanding transport adoption beyond purely economic rationality.

The first theoretical contribution extends to the use of institutional theory by DiMaggio and Powell (1983) in sustainable freight transport and modal shift research. Therefore, based on findings, coercive, mimetic, and normative pressures influence the strategic approach of multinational enterprises (MNEs) acting as shippers, but remain insufficient for road-rail intermodal adoption if service level is not met. These findings in turn provides empirical evidence on decoupling by Meyer & Rowan (1977) where organizations adopt strategies based on institutional expectations and pressures without properly implementing such practices. This was evident in the case company's formal alignment with the sustainability framework, without a corresponding direct

transformation of transport practices. Thus, the study contributes to institutional theory by showing that sustainability initiatives may generate procedural and slow change rather than substantive immediate change in an operational context such as customer-facing transport.

This study extends institutional theory by applying North's (1991) definition of formal institutions to freight transport modal choice decisions. Indeed, the EU can be classified as a formal institution (North, 1991; Peng & Meyer, 2019) that drives sustainability and transport policies, therefore shaping the firm's "choice set" by influencing infrastructure availability and compliance requirements. This clarifies why strong policy ambitions may coexist with limited operational change when institutional factors, such as infrastructure fragmentation, remain misaligned with policy goals.

Third, this study advances the use of the TBL framework in freight transport research by reconceptualizing the environmental dimension as an outcome rather than a direct decision criterion. Indeed, it is widely acknowledged that rail-based transport reduces greenhouse gas emissions (European Environment Agency, 2024; Janic, 2008; Lammgård, 2012; López-Acevado et al., 2024; Pinto et al., 2018). Thus, findings of this study show that economic factors serve as the primary drivers of road-rail intermodal, and social/human factors translate the favourable economic conditions into practice.

8.3 Managerial implications

This study presents multiple implications and recommendations for managers and decisions-makers who are in charge of implementing road-rail intermodal transport in multinational entreprises (MNEs). During the time at the case company, it was observed that case company's representtives attitudes towards road-rail intermodal transport changed as the period went by. At the beginning of of the data collection period, case company participants found more negative factors on rail modes than positive, but as the discussions progressed case company representative 1 mentioned their information on road-rail intermodal transport was party outdated. At the end, they mentioned that

rail based opeations could offer potential solutions on shipments with high cargo volumes, frequent flows and routes where infrastructure was updated according to the TEN-T standards. These observations were party due to discussions with freight fowarders and road-rail terminal contacts and visits to warehouse and road-rail terminal. Therefore, even though the case company has implemented continous learning mechanism, recommended actions could include visits to the intermodal terminal and further engagement and discussions with logistics partners. These actions could strengthen organizational learning and experience-sharing that can help overcome behavioral biases such as status quo bias which were evident on the case company's representative preference for established road-based operations and alternatie fuel over intermodal solutions.

Besides, the results of this study propose that effective sustainable transport adoption requires joint planning among logicstics partners and shippers to find suitable routes and practises that benefit both parties. The case company relies on external logistics service providers and at least one modal shift from road to road-rail intermodal was initated by the case company's freight forwarder. This shift was successful due to the freight forwarder's ability to leverage their technical and market expertise that fit the case company's operational and service requirements. In contrast, from shippers modal shift requires quaranteeing frequent volume shipments and a willingness to accepts possible earlier pick-ups or extended delivery windows as mentioned by the freight forwarder.

8.4 Limitations and future research suggestions

This study has several limitations that relates to qualitative case study method that should be acknowledged. This study consists of a small sample of five interviewees which is common for qualitative study and hence not possible to claim that the results are entirely generalizable outside of the current research sample. In addition the sample selection and composition of this study presented limitations. For instance, the warehouse contact and freight forwarder contact were collected by the case company because of their direct cooperation with the case company. Then, the road-rail terminal

contact was collected by the freight forwarder's recommendation. This snowball sample collection might have introduced biases as participants are most likely to identy other potential participant who share similar views as them. Ideally, it may have been more appropriate to contact the participants indepentently to minimize potential biases but due to a lack of contacts and the nature of the study, it was not possible. With that being said, as explained in the methodology section steps where taken to reduce biases by making certain that everyone participating did so of their own choosing and that personal details remained confidential.

Based on this study's limitations, future research could benefit from a broader sample to strengthen the results. This could be executed by incorporating multiple companies from different industries to gain a broader understanding of the adoption of road-rail intermodal among MNEs. In addition, future research could combine qualitative interviews with quantitative surveys to increase the generalizability of the results. Also, based on theoretical contributions and managerial implications future studies could focus on institutional theory on regards of customer pressure, market response and competitive pressure as factors on influencing the adoption of road-rail intermodal transport among MNEs.

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