CHALMERS
UNIVERSITY OF TECHNOLOGY

Transport Planning of Electric Heavy-Duty Road Freight

Assessing demand for additional system support and how such demand can be met

Master's thesis in *Management and Economics of Innovation* and *Quality and Operations Management*

Thea Kraft
Oscar Julsgård

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SUPPLY AND OPERATIONS MANAGEMENT

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2026
www.chalmers.se

Transport Planning of Electric Heavy-Duty Road Freight

Assessing demand for additional system support and how such demand can be met

THEA KRAFT
OSCAR JULSGÅRD

Department of Technology Management and Economics
Division of Supply and Operations Management
Chalmers University of Technology
Gothenburg, Sweden 2026

Transport Planning of Electric Heavy-Duty Road Freight
Assessing demand for additional system support and how such demand can be met
THEA KRAFT
OSCAR JULSGÅRD

Supervisor: Dan Andersson
Examiner: Dan Andersson

Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Telephone +46 31 772 1000

Gothenburg, Sweden 2026

Transport Planning of Electric Heavy-Duty Road Freight
Assessing demand for additional system support and how such demand can be met
THEA KRAFT
OSCAR JULSGÅRD
Department of Technology Management and Economics
Chalmers University of Technology

Abstract

The transition to electric heavy-duty trucks is a critical component of decarbonizing the road freight industry. In practice, it introduces a fundamental shift in operational logic that traditional transport management systems are ill-equipped to handle. This study explores the emerging demand for additional system support in Swedish electric road freight planning and investigates how these needs can be met. Employing a qualitative approach with interviews across carriers, shippers, and transport management system providers, the research applies the Multi-Level Perspective, Activities-Resources-Actors model, and platform ecosystem theory to address these objectives.

The empirical findings indicate that manual planning is perceived sufficient for current small-scale operations on static routes. However as fleets scale and operational complexity increases, two distinct system support categories become critical. The first one being Route and Charge planning for operational flexibility, and the second one being Charge Management Systems for energy orchestration. Broader demand remains fragmented due to road freight actors' divergent perceptions and operational priorities, such as a focus on predictable transport corridors and a lack of immediate scaling plans, alongside a general skepticism regarding whether digital tools can effectively outperform the expertise of experienced planners and drivers.

The study concludes that a gap exists between the desired unified transport management system workflow and the current prioritization of system providers who wait for broader market demand before developing specialized features. Consequently, road freight actors work in parallel systems and a few early adopters have instead developed internal solutions to satisfy complex operational needs. By mapping how operational challenges translate into software needs, this research contributes to navigating the systemic hurdles inherent in large-scale heavy-duty freight electrification. Such a mapping offers a foundation for coordinating the necessary alignment between transport actors and system providers to facilitate the industry's electrification transition.

Keywords: *Heavy-duty transport, Heavy-duty electrification, Transport planning, Transport Management Systems, Charge Management Systems*

Acknowledgements

We would like to thank our supervisor and examiner at Chalmers, Professor Dan Andersson, for his continuous support and guidance throughout this thesis. Your feedback and encouragement have been truly appreciated. We also want to extend our thanks to the commissioning company of this thesis and all the employees involved for their great collaboration and trust during this project. A special acknowledgment goes to our supervisor at the company for his engagement, expertise, and valuable insights.

We would also like to express our gratitude to the representatives from all participating carriers, shippers, and TMS providers who generously shared their time and expertise. This research would not have been possible without their openness and valuable contributions.

Thea Kraft & Oscar Julsgård, Gothenburg, 2026-05-22

Contents

List of Figures

List of Tables

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

AC	Alternating Current
AI	Artificial Intelligence
API	Application Programming Interface
ARA	Activities–Resources–Actors
CMS	Charge Managements System
CO2	Carbon Dioxide
CPO	Charge Point Operator
CSRD	Corporate Sustainability Reporting Directive
DC	Direct Current
ERP	Enterprise Resource Planning
FMCG	Fast-moving consumer goods
FMS	Fleet Management System
GDPR	General Data Protection Regulation
GPS	Global Positioning System
HDT	Heavy-Duty Truck
HR	Human Resources
HVO	Hydrotreated Vegetable Oil
IT	Information Technology
I.E	In Essence
kWh	Kilowatt-hours
MLP	Multi-Level Perspective
MW	Mega-watt
OEM	Original Equipment Manufacturer
RQ	Research Question
SOC	State of Charge
TCO	Total Cost of Ownership
TMS	Transport Management System

1

Introduction

Heavy-duty trucks (HDTs) represent a marginal portion of the global vehicle population while contributing a substantial share of total carbon dioxide emissions within the transportation sector. Although the transition to electric HDTs is essential for decarbonization, it introduces a fundamental shift in operational logic. Previous research argue that traditional transport management techniques and systems, adapted for diesel fleet characteristics, are no longer sufficient to manage the complexities associated with electrification. This research investigates Swedish road freight actors' and transport management system (TMS) providers' perspective on emerging needs for additional system support and how needs can be met to enable large-scale electrification.

1.1 Background

This section establishes the context for the study by examining global and regional trends in road freight decarbonization. It explores how the shift toward electric HDTs impacts traditional transport planning and highlights the operational and structural complexities that arise.

1.1.1 The Unsustainable Road Freight Industry

The global transport sector is a primary contributor to climate change, accounting for approximately 23% of global energy-related CO2 emissions (ITF, 2023). Within this sector, HDTs are disproportionately impactful, contributing to approximately 5% of total global CO2 emissions (International Renewable Energy Agency, 2026). Without aggressive intervention, global freight demand is predicted to roughly double by 2050, potentially causing a 28% increase in total freight emissions compared to 2019 levels (ITF, 2023).

Beyond the CO2 emissions, the industry faces a structural inefficiency challenge in the form of low load factors. In 2024, one-fifth (21.6%) of all vehicle-kilometres traveled by road freight vehicles in the EU were performed by empty vehicles (Eurostat, 2024). This inefficiency is even more pronounced in national transport, where 25.8% of distances are driven without a load. These empty runs represent a significant waste of energy and capacity, often resulting from fragmented planning and the difficulty of securing return loads in a non-digitized ecosystem. However, it should be noted that the potential to reduce empty runs varies across segments which is discussed further by Tano and Pettersson (2026).

Momentum for sustainable transport is growing, but the transition for HDTs in Europe remains in an early stage. In 2025, electric vehicles accounted for 3.67% of newly registered HDTs in the European Union (European Alternative Fuels Observatory, 2026a). Sweden reached a significantly higher adoption rate during the same period, where electric models represented 16.56% of all new HDT registrations (European Alternative Fuels Observatory, 2026b). To meet the European Union's target of a 45% carbon dioxide (CO2) reduction by 2030, estimations suggest that more than 400,000 zero-emission trucks must be deployed within the decade. However, such transformation implies several challenges which will be described below in subsection 1.1.2.

1.1.2 Electrification Challenges

According to Ragon and Rodríguez (2022), the lack of adequate infrastructure remains the most significant barrier to the electrification of the European road freight industry as a whole. While the industry shows a strong preference for transitioning to zero-emission vehicles over other efficiency improvements, Ragon and Rodríguez (2022) argues that the current "infrastructure gap" prevents these ambitions from materializing into large-scale deployment. Other key barriers include operational constraints such as limited vehicle range and extended dwell times for charging, alongside TCO compared to conventional diesel alternatives. While Akther et al. (2025) highlights that the TCO for electric trucks is already lower than diesel counterparts in some regions, with global cost parity expected before 2033, Ragon and Rodríguez (2022) identifies initial capital investment as one of the most important key barrier, where smaller carriers often experience limited capital and restricted access to funding.

The challenges above also translate into increased transport planning complexity. Firstly, because of the significant upfront capital required for electric trucks there are increased requirements on capacity utilization to lower TCO (Al-dal'ain & Celebi, 2021). It implies keeping the trucks in motion while reaching a high load factor both in front-haul (on the way to the customer) and back-haul (on the way back). Secondly, optimizing routes while integrating charging stops into a transport schedule requires balancing battery range, charging station locations, and charging times with driver rest requirements and operational costs (PTV Logistics, 2025). Type of charging need to be selected where depot charging, overnight charging, destination charging, and public charging vary in cost and refueling time. Limited access to charge infrastructure further complicates charge and route planning. Thirdly, external conditions such as weather, traffic, topography and the influence of driving habits on energy consumption further adds complexity to the planning (Linköpings Universitet, 2026; Perger & Auer, 2020). An overview of the mentioned complexities can be found in Table 1.1.

Table 1.1: Electric Heavy Duty Freight Planning Complexities

Complexity	Description
Vehicle and Truck Load Utilization	High utilization rates needed to lower total cost of ownership and ensure long-term economic viability.[1]
Route and Charge Planning	Optimized routes with integrated charging stops requires balancing battery range, charging station locations, and charging times with driver rest requirements and operational costs. [2, 3]
Managing External Conditions	Energy usage and total range is influenced by environmental variables, including topography, weather, and traffic, alongside individual driving habits.[1, 4]

Note. Adapted from [1]Linköpings Universitet (2026), [2]Ragon and Rodríguez (2022), [3]PTV Logistics (2025) and [4]Perger and Auer (2020)

The complexities mentioned in Table 1.1 put additional pressure on the people, tools and systems used to manage transport. The core system used by many actors is called transport management systems (TMS), a digital platform to streamline the planning, execution, and optimization of freight movements. Basso (2017) however argues that these systems today fall short and are limited in effectively coordinating the complexities associated with electric trucks. The next section therefore covers research on re-optimization by Zackrisson et al. (2026) which demonstrates how new transport management techniques can enable large-scale electrification where new systems are likely to be needed.

1.1.3 How Re-Optimized Planning can Enable Electrification

Zackrisson et al. (2026) point out that the transition to electric HDTs in distribution logistics faces significant technical and economic hurdles when organizations attempt to fit these new vehicles into operational structures designed for conventional diesel fleets. The authors call this one-to-one vehicle replacement and suggest a holistic re-optimization approach instead. This approach moves beyond simple vehicle substitution by simultaneously solving for fleet composition to determine the ideal mix of electric and diesel trucks, shipment allocation to assign goods to the most appropriate vehicle type, and vehicle routing to map efficient paths that take battery range and delivery windows into account. Furthermore, it strategically incorporates charging into the schedule to ensure that it does not disrupt productive time. Zackrisson et al. (2026) argue that adapting and re-optimizing the entire logistics plan will maximize vehicle utilization and unlock significantly higher electrification potential compared to maintaining existing operational plans. Doing this in practice with all constraints and complexities involved leads the authors to argue that *"successful large-scale electrification likely requires the adoption of algorithmic* *planning tools..."* (Zackrisson et al., 2026).

Even though previous research by Zackrisson et al. (2026) point towards new planning tools and algorithms as enablers to large-scale electrification, little research exist on transport actors' perspective on what additional system support they need to manage and operate their electric vehicles. Moreover, it remains unclear how such needs could be met as existing TMS fall short in addressing these complexities while PTV Logistics (2025) recommends to have a single system for planning both electric and diesel trucks.

1.2 Research Aim and Problematization

The overall *aim* of this study is to explore the current and future demand of additional system support in the transport planning process of electric vehicles within the Swedish heavy duty road freight industry and how such demand can be met. Sweden was considered an appropriate market to study as the country has a relatively high adoption rate of electric HDTs and hence makes a mature environment for exploring the demand for additional system support.

The *issue* motivating the aim is the need for a practical perspective on additional software support needs in the transport management process and how those needs can be met. Despite the need for additional system support previous research point towards, it remains unclear how the transport actors themselves perceive their needs and how such needs can be effectively met when existing systems seem to fall short.

To achieve the *aim* and address the *issue* raised, the following research questions will be investigated:

RQ1: How do actors in the heavy duty road freight network plan their electric transport today?

This research question focuses on mapping road freight actors' additional planning *activities* of electric HDTs including *actors* and systems (*resources*) involved and how it impact the network and interdependencies with external actors. This mapping is a prerequisite for understanding and answering research questions two and three.

RQ2a: What are the challenges faced today and in the future in the transport planning of electric trucks?

This research question aims to identify, analyze, and categorize the challenges road freight actors face today in the planning of electric HDTs and the perceived challenges in the future.

RQ2b: What are perceived additional software support needs for planning electric trucks compared to diesel?

With the identified challenges in mind, this research question explores the underlying gaps between current software capabilities and the requirements of planning electric heavy duty road freight. This analysis serves to clarify the specific *demand* aspect of the study's overall aim, pinpointing where existing systems fall short.

RQ3: How can software support needs be satisfied?

The last research question aims to understand how the emerging demand for system support can be met. This involves investigating both the road freight actors' and TMS providers' perspectives on opportunities to manage these challenges, either on their own or through partnerships.

1.3 Scope and Delimitations

The scope of this study is delimited to the Swedish heavy-duty road freight industry. Sweden provides a unique and mature environment for this research due to its relatively high adoption rate of electric heavy-duty trucks (HDTs) compared to the European average. By focusing on this specific geographical market, the study explores the demand for additional system support within an advanced ecosystem where practical operational experience with electric vehicles is already present. This focus allows for a granular understanding of how mature networks respond to the emerging needs of electrification.

Regarding technological and systemic boundaries, the research is confined to the electrification of HDTs. The investigation is specifically limited to the transport management process and the digital resources used with a primary focus on the transport planning process. While the study acknowledges the broader sociotechnical transition and the need of many complementing resources such as enhanced infrastructure accessibility and improved battery range, the focus remains on software support needs and the organizational logic shifts in transport management required for large-scale deployment.

From a network perspective, the study focuses on primary data collection from a specific set of "key actors" within the heavy-duty electric freight ecosystem. These include road freight actors, specifically carriers and shippers who manage their own transport, and Swedish TMS providers. The study is delimited to mainly cover carrier TMS providers with one exception of a shipper TMS focusing on the high-intensity distribution segment. This delimitation is due to the difficulties in finding a contact person within the shipper TMSs, which were generally large global players. While other stakeholders such as Original Equipment Manufacturers (OEMs), Charge Point Operators (CPOs) and new start-ups developing supporting software for electric transport planning play critical roles in the transition, their influence is captured indirectly through the perspectives of the primary key actors. The sampling was further delimited to organizations that have already initiated electrification to ensure the findings are grounded in empirical operational experience.

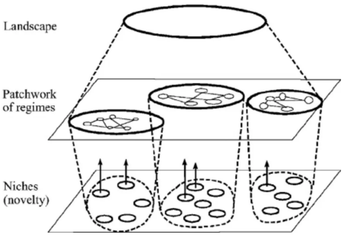
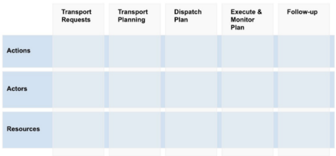
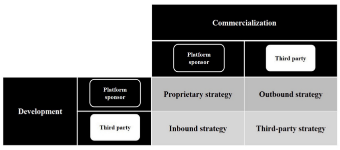
Finally, the study is designed as an exploratory, qualitative investigation. This methodological choice prioritizes the depth of insight into actors' perceptions and challenges over statistical generalization. The research utilizes pattern matching to systematically compare theoretical frameworks with empirical data. Consequently, the research does not aim to provide quantitative benchmarks for when additional system support is needed, but rather explore the general demand for it and investigate how these needs can be effectively satisfied within a transitioning network.

2

Frame of Reference

This chapter establishes the frame of reference, acting as both the guide of this study and lens for interpreting and analyzing the situation and research questions. The theoretical framework is structured into three main pillars. First, section 2.1 provides the systemic context by viewing road freight transport as an interconnected network and the electrification as a sociotechnical transition. The Actors, Resources and Activities (ARA) framework provides a network perspective while the Multi-Level Perspective (MLP) on sociotechnical transitions can describe the friction between legacy diesel operations and electric operations and why challenges arise in technical transitions. Secondly, section 2.2 defines transport management and planning including the role and functional scope of transport management systems. Based on the standard structure of transport management processes and the ARA framework, a matrix was obtained and used to guide interviews and the analysis of current planning process and where challenges arise. The established electric transport planning complexities (Table 1.1) are also part of section 2.2 and used to analyze challenges and how they translate into software needs. Finally, section 2.3 cover platform ecosystems as a strategic lens to analyze actors' openness and willingness to collaborate to understand their positioning in meeting emerging software needs. An overview of the theories and their purpose is visualized in Table 2.1.

Table 2.1: Overview of Theories and Their Purpose

<table>
<tr><th>Section</th><th>Selected Theory and Purpose</th><th>Figure</th></tr>
<tr><td>2.1
<i>Overarching Context</i></td><td>MLP and ARA provide lenses for the systemic context of networks and sociotechnical transitions</td><td>
</td></tr>
<tr><td>2.2
<i>RQ1: Planning Today</i>
<i>RQ2: Challenges & Needs</i></td><td>Transport Management Process x ARA matrix to map current process and where challenges arise which are mapped to established complexities in Table 1.1</td><td>
<table>
<tr><th></th><th>Transport Requests</th><th>Transport Planning</th><th>Dispatch Plan</th><th>Execute & Monitor Plan</th><th>Follow-up</th></tr>
<tr><td>Actions</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Actors</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Resources</td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>2.3
<i>RQ3: Actors' Positioning</i></td><td>Platform theory to analyze Actors' openness and willingness to collaborate to understand their positioning in meeting emerging software needs</td><td>
<table>
<tr><th></th><th></th><th colspan="2">Commercialization</th></tr>
<tr><th></th><th></th><th>Platform sponsor</th><th>Third party</th></tr>
<tr><td>Development</td><td>Platform sponsor</td><td>Proprietary strategy</td><td>Outbound strategy</td></tr>
<tr><td></td><td>Third party</td><td>Inbound strategy</td><td>Third-party strategy</td></tr>
</table></td></tr>
</table>

2.1 Road Freight Transport as a Network in a Sociotechnical Transition

Section 2.1 presents two complementary theoretical lenses to analyze the electrification of road freight at two different levels. The network lens and ARA model can facilitate a micro-level analysis to understand changes in actors, resources and activities due to the electrification. Conversely, the MLP framework provides a macro-level perspective, situating these developments within a broader sociotechnical transition where niche innovations challenge established industrial regimes.

2.1.1 Road Freight Transport as an Interconnected Network

Transport planning in road freight is rarely conducted by a single organization in isolation. Instead, Stål (2026) argue it takes place within a network of actors, including transport buyers, system providers, energy providers, and OEMs to name a few. A central framework to analyze such networks and interdependencies is the ARA framework (Hakansson & Snehota, 1997). The model describes networks as consisting of three dimensions: activities, resources, and actors. *Activities* refer to the processes carried out by actors. *Resources* include both physical and digital assets. *Actors* represent the organizations involved in a network (Hakansson & Snehota, 1997).

Stål (2026) investigates the road freight network in the context of the electrification using the ARA framework to understand how *actors* interact through coordinated *activities* and shared *resources.* His network perspective shows how electrification should not be understood as a simple replacement of diesel vehicles with electric ones, but rather as a broader transformation of the actors, resources and activities involved within the network. In terms of planning, this has resulted in a shift from "flexible allocation toward predefined transport missions" (Stål, 2026). The author explains that due to electric trucks being inflexible and costly, operations depend on repeatability, predictability, and stable planning horizons.

Stål (2026) also explains that as "routes, loads, charging opportunities, and time windows must be tightly aligned", the deployment of electric trucks depends on new and deeper relations with key partners such as OEMs and transport buyers where relations previously been more transactional. OEMs provide not only hardware today, but also software services among other things. The deployment also depends on the alignment of complementary resources such as charging infrastructure, grid capacity, *digital planning tools*, and organizational capabilities. With this in mind, Stål conclude that the challenges of electrification stem from “the need to align heterogeneous resources, such as vehicles, charging infrastructure, grid capacity, and *data systems* across organizational boundaries” and that it “calls for stronger activity links, re-source ties, and actor bonds”. From a transport planning perspective, he argues that optimization models must take these new conditions into account. As demonstrated, there are technical, relational, and organizational constraints on electric truck utilization where optimization risks resulting in plans that are technically feasible but in practice unrealistic.

2.1.2 Electrification as a Sociotechnical Transition

As established above, the transition from diesel-powered trucks to electric vehicles represents more than a technological substitution. To understand such large-scale transitions on a higher level, one can turn to the Multi-Level Perspective (MLP) developed by Geels (2002) where the road freight transport industry can be understood as a sociotechnical system. The Multi-Level Perspective conceptualizes technological transitions as interactions between three analytical levels: *landscape, regime, and niche* innovations (Figure 2.1) (Geels, 2002). The *landscape* level represents broader external pressures such as climate policy, environmental concerns, and regulatory initiatives promoting electrification. The sociotechnical *regime* level refers to the dominant structures, technologies, and practices that currently organize an industry. Finally, the level of technological *niches* represent emerging technologies and innovations that challenge the existing regime. Electric trucks, charging infrastructure, and new digital optimization tools can be understood as such niche innovations.

Sociotechnical regimes maintain stability through the continuous alignment of diverse actors and institutional structures (Geels, 2002). Within these established structures, innovation is predominantly incremental, serving to reinforce existing solutions rather than challenge them. Geels (2002) explains that while radical niche alternatives are developed, they often struggle to scale because they lack compatibility with the current regime's rigid configuration. Significant transformation occurs when the regime encounters external pressures or internal tensions that cause its structural linkages to "loosen," thereby creating an opportunity for niche innovations to emerge and reconfigure the dominant order. Geels (2002) wants to characterize these transitions as reconfiguration processes rather than a sudden disruption. During such reconfiguration process, mismatches often arise between existing systems and the requirements of new technologies. "Mismatch" refers to the structural misalignment between a radical innovation and the established socio-technical regime, where existing regulations, infrastructures, and social norms remain optimized for the incumbent technology rather than the newcomer. A full systemic transformation is realized only when developments across all levels, the *landscape*, the *regime*, and the *niche* innovations, align and mutually reinforce one another.

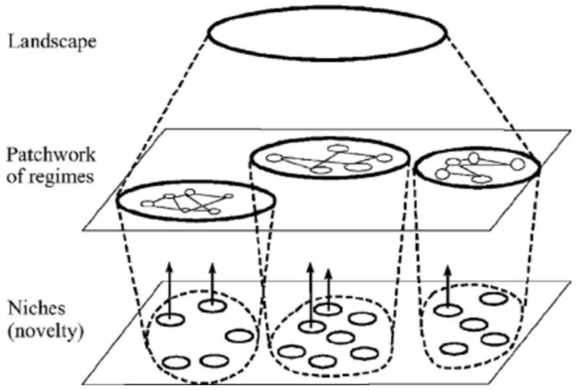


Figure 2.1: Multi-Level Perspective on Sociotechnical Transitions (Geels, 2002)

2.2 Transport Management and Systems

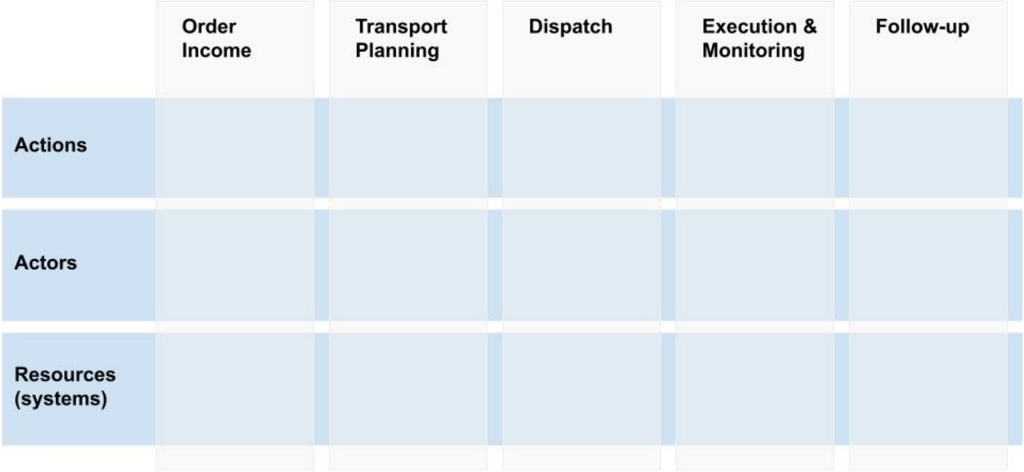
The following section presents the definition of transport management and critical steps in that process. Furthermore, supporting transport management systems are defined including future trends. The purpose of section 2.2 is to provide context to the subject matter.

2.2.1 Transport Management and Transport Planning

Transport management can be defined as the process of planning, executing, and optimizing the movement of goods (Zijm et al., 2019). This involves managing information and material flows across the supply chain. The process differs depending on the actor, but can in general be separated into the initial management of incoming orders from the customer that determines the demand which then has to be planned (SAP Learning, n.d.). The demand can be planned and agreed upon in advance between the shipper and carrier or be requested with short notice either by a contracted customer or without prior agreement. Once planned, the process moves via dispatch to execution which encompasses physical transportation of the goods and real-time monitoring for deviations. The final stage of follow-up includes reporting, analytics, and other administrative processes such as documentation and billing.

The transport planning performed before execution is crucial for the execution to succeed. It is either done on a strategic level or on a tactical and operational level (Mattsson & Jonsson, 2016). Strategic transport planning focuses on long-term network design and resource investment to meet future demand, such as determining the size and mix of the vehicle fleet (Goel, 2008). Operational transport planning handles day-to-day execution such as which vehicle drives what to where including load acceptance, routing, consolidation of goods, loading, monitoring and more. This is often supplemented by a real-time level that handles the monitoring of transportation processes and deviation management.

When the ARA model is combined with the general transport management process, a better overview and tool can be obtained for analyzing the current process for planning electric vehicles and where new activity links, re-source ties, and actor bonds emerge (Figure 2.2). The analysis will contribute to confirm parts of Stål's (2026) research and complement it with a narrower focus on systems as resources and activities related to the transport planning of electric vehicles specifically.



	Order Income	Transport Planning	Dispatch	Execution & Monitoring	Follow-up
Actions					
Actors					
Resources (systems)					

Figure 2.2: ARA x Transport Management Process Matrix

2.2.2 Transport Management Systems

Within the field of logistics, software systems serve as essential tools for the configuration and control of goods and information flows, encompassing Enterprise Resource

Planning (ERP), Warehouse Management Systems (WMS), Transport Management Systems (TMS), and Supply Chain Management (SCM) systems (Nettsträter et al., 2015). Within this broader framework of logistics software, the TMS acts as a critical functional link, facilitating the information flow between the broader resource planning of an ERP and the localized inventory control of a WMS. A TMS is defined as a specialized solution for the planning, control, monitoring, and optimization of transport networks and logistic chains (Nettsträter et al., 2015). Specific functionality differ between systems, but according to Nettsträter et al., a comprehensive TMS typically consists of several elementary functional fields such as order management, scheduling, load planning, strategic and operational transport planning and optimization, tracking and tracing, and fleet and resource management. Route planning and telematics links are mentioned as extended functions. Mattsson and Jonsson (2016) explain some of these features more in detail:

- *Transport Network Design (Strategic planning)*, a strategic process of determining the physical structure, location of nodes (like warehouses and terminals), and transport modes of a logistics system to balance long-term costs against required service levels
- *Transport Optimization*, plan optimal use of the transport network in terms of matching resources to expected demand
- *Route planning*, plan optimal routes for a vehicle fleet
- *Load planning*, what goods are suitable for consolidation to reach full truck load
- *Tracking and tracing*, support communication and monitoring during transport

A more updated source defines TMS as "a software solution that helps businesses to plan, execute and analyses transport operations" where the communication between shippers, carriers and customers can be streamlined (Viseo, 2026). There are two types of TMSs according to Viseo, carrier focused and shipper focused. Shipper focused systems can be used to manage carriers, costs and logistics flows across multiple locations. Carrier focused systems are designed to help carriers manage fleets and vehicle capacity, track drivers and improve customer service. IBM (n.d.) argue that a key component of any TMS is the ability to integrate with external software and systems through APIs where Viseo (2026) explain that there is a trend towards even more collaborative and API-enabled TMS platforms. Based on an interview, McCrea B (2026) quotes the VP of consumer products, retail and services at Capgemini who said “The API-fication of TMS has evolved far beyond where it was just a few years ago” where TMS vendors are including more prebuilt connections which previously required custom development. Bluegistics (n.d.) also comment on this trend, arguing that "by 2026, companies expect their TMS to receive direct and continuous data from vehicles and drivers, without relying on complex integrations or custom developments". IBM (n.d.) however argue that integrations can be a challenge where the complexity depends on several things such as the systems that needs to integrate and the costs of the integration.

As established in subsection 1.1.2, new planning complexities and needs emerge due to electrification where existing TMS often fall short. The specific complexities presented in Table 1.1 is thus also an important part of the frame of reference, facilitating the analysis of challenges and within what category they fall.

2.3 Transport Management System as a Platform

As described in subsection 2.2.2 there is a trend towards more integrative TMS platforms. To understand TMSs as platforms and how software needs can be met, the following section presents the definition of software platform ecosystems and different platform strategies.

2.3.1 Software Platform Ecosystems

A platform is a technological foundation with a modular architecture that enables complementary innovations (Gawer & Cusumano, 2014). The authors distinguishes between internal platforms for efficiency within firms and industry platforms for enabling innovation across ecosystems. An industry platform ecosystem hence comprises of interdependent firms innovating complementary applications and services around a core platform, coordinated by a platform leader or sponsor. If the core platform is software based it can be defined as a *software platform* (Tiwana, 2014). Modern industries have shifted from individual products to software platform ecosystems driven by increasing specialization, digitization of activities, the embedding of software into products and services, the growth of the Internet of Things, and better connectivity.

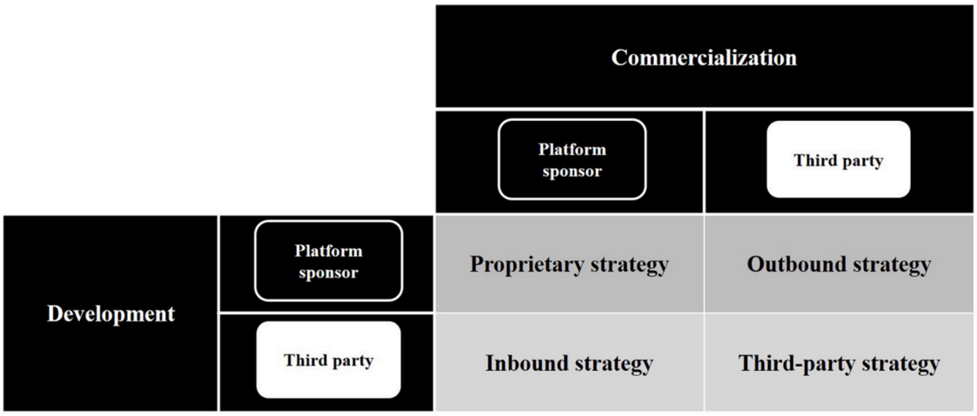
Tiwana (2014) explains that a software platform ecosystem is constituted of five core components:

- **The Platform:** The foundation and shared infrastructure that enables outside parties to build upon it.
- **Apps**: Software subsystems or services created by external actors that connect to the platform to extend its functionality. Can be called plug-in, module etc.
- **Interfaces**: How the platform and apps communicate, interact, and exchange information. For example through API (Application Programming Interface).
- **Architecture**: How the ecosystem is separated into a stable platform and a variable set of complementary apps, governed by specific design rules.
- **The Ecosystem**: The collective system composed of the platform and all the specific apps that interoperate with it.

2.3.2 Platform Ecosystem Openness and Strategies

Cenamor and Frishammar (2021) identifies a central dilemma for platform sponsors, those who own the core platform. While they need third party innovation to build a successful platform, they are also part of the complementary market, positioned as competitors to those same third parties. As the success of platform ecosystems are to a large extent determined by their complementary products, the author suggests that innovation openness is a key strategic decision platform sponsors must consider.

To understand possible platform strategies and their performance Cenamor and Frishammar (2021) move beyond the traditional "open versus closed" option by categorizing innovation strategies based on two dimensions, who develops the product and who commercializes it. This generates four different strategies (Figure 2.3).



		Commercialization	
		Platform sponsor	Third party
Development	Platform sponsor	Proprietary strategy	Outbound strategy
	Third party	Inbound strategy	Third-party strategy

Figure 2.3: Innovation strategies for complementary products (Cenamor & Frishammar, 2021)

- **Proprietary:** The platform sponsor handles both the development and the commercialization of the complementary product.
- **Outbound:** The platform sponsor develops the product but allows a third party to handle its commercialization.
- **Inbound:** A third party develops the product, but the platform sponsor takes over the commercialization and marketing.
- **Third-Party:** Third party handles both the development and the commercialization of the product (most open approach).

Cenamor's and Frishammar's (2021) study found that strategies involving the platform sponsor (proprietary, inbound, and outbound) generally have higher performance in terms of unit sales compared to the pure third-party strategy. The performance is also influenced by the platform's age. In the early stages, the proprietary and outbound strategies have a competitive advantage as the sponsor can differentiate with unique technological capabilities. As the platform matures, this differentiation and advantage tend to diminish due to knowledge transfer. In contrast, the commercialization advantage associated with the inbound strategy remains stable over time where platform sponsors can mitigate technological uncertainties and leverage third-party development to satisfy increasingly heterogeneous and specialized user needs.

The theoretical benefits of an inbound strategy, and an open approach in general, are however countered by significant transaction and coordination costs where transfer of necessary knowledge requires mutual effort (Cenamor & Frishammar, 2021). It furthermore implies a competitive risk for the platform sponsor where competitors or new actors may attempt to exploit the sponsor's competitive advantage. These costs and risks often compel sponsors to adopt defensive approaches that can hinder open innovation within the ecosystem. As benefits and costs exist for all strategies, the author recommends managers to implement multiple strategies simultaneously where platform sponsors may choose to compete with their own partners in certain segments while collaborating in others.

3

Methodology

Chapter 3 describes the research methodology employed in the study. This includes research approach, sampling and data collection, data analysis, research quality and ethical and sustainable considerations.

3.1 Research Approach

This study is designed as an exploratory study that focuses on current and future demand of additional system support in the transport planning process of electric vehicles within the Swedish heavy duty road freight industry and how such demand can be met. Bell et al. (2019) explain that this research design is suitable for studies that aim to map out new themes in areas where empirical data are currently limited. An abductive approach was used, which Bell et al. describe as an alternative way of reasoning that overcomes the limitations of deductive theory-testing and inductive theory-building. Rooted in a pragmatist perspective, abduction tries to explain a phenomena going back and forth between theory and empirical sources. This approach was found effective as existing theory was necessary to frame the issue initially, but where additional theory was needed as empirical data emerged.

The study iteratively followed six phases in accordance with Bell's (2019) description of the main steps of qualitative research. The study started with a literature review on previous research and suitable theory to frame the issue and formulate research questions. As a second step the study approach including sampling and interview guides was structured and prepared. This also included a road freight electrification expert interview to get a solid recommendation on actors to contact. The third phase consisted of data collection and refinements of our approach, starting with two initial interviews with road freight actors to test our assumptions and method. After a few minor changes in the research aim and interview guide we continued the interviews with road freight actors to investigate *RQ1, RQ2a, RQ2b* and part of *RQ3*. The fourth phase included interviews with the TMS actors that the road freight actors use to gather the last empirical data for *RQ3*. The data analysis and discussion, phase five, was guided by the mentioned theoretical frameworks of chapter 2. Lastly, phase six consisted of writing up the report.

3.2 Sampling and Data Collection

Section 3.2 covers how the sampling and data collection was done for the study.

3.2.1 Sampling

A combination of methods was used in the sampling. A purposive sampling strategy was initially employed which Bell et al. (2019) explains is when the selection is not on a random basis so that the selected participants are relevant for the study. This initial sampling was done based on experts' recommendations on who to interview. Furthermore, snowball sampling was used which is a type of convenience sampling where an initial contact is initiated with people who are relevant to the research topic and can in turn introduce other people to talk to. Complementing the initial target group with snowball sampling was found suitable to explore interviewees' recommendations on organizations to talk to while keeping the study within scope. This combined approach is effective for qualitative research, as it prioritizes depth of insight and access to specialized expertise.

The two different types of actors interviewed. Firstly, road freight actors, carriers and shippers managing their own transport. Secondly, TMS providers used by interviewed road freight actors. A set of road freight actors was sampled based on a list from industry experts. The selection criteria were actors operating in Sweden which are electrified to some extent with at least five electric vehicles. All actors had at least five electric heavy duty trucks except one who only had two. Within the companies we aimed to target a transport planner or someone with detailed knowledge about the planning process and pain points. We asked explicitly for such a person when first contacting the organizations. This generated interviews with different types of roles based on who was available and had the right knowledge. TMS providers were targeted based on the system the road freight actors interviewed was using. For those actors we explicitly asked for someone who had product and customer knowledge and can answer to questions about customer needs, external integrations and partnerships.

By targeting interconnected actors, the study could include different perspectives within a single network, providing a more granular understanding of the dependencies. Due to different types of road transport actors, two different types of ecosystems or networks were investigated; carrier focused and shipper focused. Carrier focused refers to single carriers or network of carriers that sell transport to shippers or third party logistics providers such as DHL, DSV or Postnord. Shipper focused refers to shippers who manage at least a part of their own transport instead of outsourcing it. Only one TMS actor within the shipper network was interviewed due to difficulties of reaching out as they tended to be large global actors. In these networks there are also other impacting actors such as OEMs (the truck manufacturers), charging operators (the ones owning charging stations) and politicians.

3.2.2 Data Collection

The primary data collection was conducted through semi-structured interviews. Bell et al. (2019) state that semi-structured interviews are suitable in cases where a genuine understanding of the situation is desirable while the focus and desired analysis method is fairly clear. In this study the focus is on the transport planning issue of electrification and the aim is to understand specific challenges within that topic. With that said, the interviews still needed to be open to some extent so that information about unknown issues could emerge.

An interview guide is typically used in semi-structured interviews which also was created for this study (Bell et al., 2019). Two different interview guides were created for road freight actors and TMS providers based on the frame of reference, research aim and questions. The guides were also iterated and adjusted based on the first interviews. The three main parts covered for road freight actors were; An introduction regarding transport activities and electrification status; Current transport planning process of their mixed fleet including actions, systems used and actors involved; Perceived challenges of planning electric vehicles, their view on what additional system support is needed, and how such needs can be met. The three main parts covered for TMS actors were; What solution they sell and how they currently meet specific electrification needs; How they currently work with partnerships and external integrations; Perceived challenges and opportunities to collaborate with external partners to meet specific electrification needs. The interviews covered follow-up questions that emerge as needed, but still covered these parts in a structured way.

The conversations were recorded and transcribed. In some cases contact was established after the interviews to clarify certain questions including emails and one additional interview with *Center*. All interviews conducted, including their date and duration, are presented below in Table 3.1.

Table 3.1: Interviews Conducted During the Study

Respondent	Type of Actor	Interview Date	Duration
Expert	Electric Freight Innovation Platform	19/02/2026	60 min
Center	Carrier	04/03/2026	60 min
Center	Carrier	23/03/2026	45 min
Charter	Carrier	01/04/2026	60 min
Circuit	Carrier	11/03/2026	45 min
Cluster	Carrier	18/03/2026	60 min
Colossus	Carrier	10/03/2026	60 min

Continued on next page...

Table 3.1 – continued from previous page

Respondent	Type of Actor	Interview Date	Duration
Cooler	Carrier	31/03/2026	60 min
Curb	Carrier	13/03/2026	60 min
Salt	Shipper	04/03/2026	45 min
Sheet	Shipper	12/03/2026	60 min
Skillet	Shipper	17/03/2026	60 min
Solvent	Shipper	18/03/2026	60 min
Store	Shipper	17/03/2026	60 min
Stream	Shipper	16/03/2026	60 min
Table	TMS provider	24/03/2026	60 min
Terminal	TMS provider	24/03/2026	45 min
Ticket	TMS provider	30/03/2026	60 min
Tile	TMS provider	18/03/2026	60 min
Token	TMS provider	08/04/2026	45 min
Transit	TMS provider	17/03/2026	60 min

3.3 Data Analysis

The analytical foundation of this study is built upon the logic of pattern matching, a technique used to compare observed data against predefined theoretical expectations. According to Yin and Campbell (2018), the core of this logic is the comparison between an empirically based pattern, the findings actually discovered during the study, and a predicted pattern (or several alternative predictions) established before the data collection phase. To align with the exploratory nature of this research, flexible pattern matching described by Vargas-Bianchi (2025) is used. This approach is tailored for studies where the primary goal is to explain and analyze complex situation and then improving that theory rather than testing a theory to see if it is "correct". The central criterion in this analysis is "meaning overlap", which evaluates the degree to which core concepts in the theoretical and empirical patterns share common elements found in the empirical data (Vargas-Bianchi, 2025).

The application of pattern matching in this study is structured into four phases. Following the recommendations of Vargas-Bianchi (2025), the analysis of the different phases has been iterative and is in the majority of cases based on visual matrices and tables to facilitate both the analysis and the creation of a comprehensive final report.

The first, foundational, phase of the analysis involves the application of the Multi-Level Perspective (MLP) framework to establish the macro-level context of the research. Following the logic of flexible pattern matching, the study utilizes Geels' (2002) sociotechnical transition theory as an overarching "predicted pattern" to explain the structural friction occurring within the industry. The purpose of this initial matching phase is to situate the study within a broader technical transition, providing the necessary context for why specific planning challenges and system needs emerge (or do not emerge).

In the second phase, pattern matching was used to map the current planning process and identify where operational deviations and challenges occur today, addressing RQ1, current process, and part of RQ2a, percieved challenges. The combined matrix of the Activities-Resources-Actors (ARA) framework and a standard transport management process (Figure 2.2) was used as a starting point in the interviews to capture actions, actors and resources (systems used). A collaborative mapping exercise was conducted with the interviewee to document each procedural step, with a specific focus on identifying operational variations unique to electric vehicles. Based on all responses, the matrix was refined before being used as the theoretical template where aggregated differences for electric transport planning could be mapped against this baseline (Figure 5.1). The primary purpose of this matching process is to confirm and complement the research of Stål (2026) regarding electric truck utilization to provide a strong basis for understanding challenges and software needs. While Stål provides a broad network perspective, this study applies the matching logic to narrow the focus specifically onto the planning activities and the digital resources (systems) involved.

As transport planning was perceived relatively pain free today, where operations are similar between diesel and electric trucks, the third phase explores future challenges more in depth. Pattern matching is in this step applied to compare, contrast and connect actors' view on future planning challenges and software needs with the predicted pattern of planning complexities found in Table 1.1. This addresses RQ2a: *"What are the challenges faced today and in the future in the transport planning of electric trucks?"*, and RQ2b: *"What are perceived additional software support needs for planning electric trucks compared to diesel?"*. Firstly, empirical insights regarding planning hurdles are matched and contrasted with these theoretical categories to determine their prevalence in the Swedish context. The analysis then further compares the road freight actors' perception of software needs against these challenges with a final analysis on possible reasons why previous research by Zackrisson et al. (2026) call for new transport management software whilst few actors are expressing a need for it.

Lastly, the analysis of how software needs can be satisfied, addressing RQ3: *"How can software support needs be satisfied?"*, utilizes the lens of platform ecosystem theory. This serves as a final application of pattern matching to understand how software needs can be met by placing the road freight actors' core system, TMSs, as the core platform of a platform ecosystem where innovations within the transport planning field are desired complementing actors. Using the theoretical "innovation strategies" (proprietary, inbound, outbound, and third-party), the actual positioning and collaborative behaviors of TMS providers, innovators and carriers can be understood including their willingness to meet emerging demands. Using this framework help determine the degree of overlap between theoretical strategic options and the actual competitive or collaborative actions observed in the industry.

3.4 Research Quality

Although there are different ways of judging the quality of qualitative research, Bell et al. (2019) explain that the most well-known criteria for trustworthiness in qualitative research are: *credibility, transferability, dependability* and *confirmability.* In this framework, *credibility* ensures confidence in the truth of the findings, *transferability* demonstrates applicability across different contexts, *dependability* indicates that findings are consistent and repeatable, and *confirmability* establishes a degree of neutrality, ensuring the study is shaped by respondents rather than researcher interest or bias (Lincoln & Guba, 1985).

3.4.1 Application of Research Quality Criterias

To ensure that the data collection resulted in source-critical and accurate findings, a systematic validation of all data was performed. The study evaluated information based on reliability, validity, and credibility by employing a triangulated approach. This involved cross-referencing insights across a diverse range of actors, including carriers, shippers, and TMS providers, to verify that different participants described the same concepts and challenges consistently. For non peer-reviewed sources, quality and validity was ensured through triangulation and rigorous source criticism. It should be noted that while the empirical data includes perspectives from both shippers and carriers, the TMS perspective is mainly based on carrier TMSs and not shipper TMSs. While this ensures high dependability within the carrier domain, the specific shipper TMSs needs represent an area where findings should be transferred with consideration.´

3.4.2 Use of Artificial Intelligence

In this thesis, artificial intelligence (AI) was utilized as a supportive tool to streamline administrative and linguistic tasks. Overleaf's AI feature provided language enhancements and grammar refinements to ensure academic rigor. Additionally, the study leveraged AI-driven transcription features within Google Meet and Microsoft Teams to convert audio recordings into text for analysis. These tools served exclusively for processing and refinement. All thematic interpretations, strategic discussions, and final conclusions are the original work of the authors.

3.5 Ethical and Sustainable Considerations

Throughout the study, ethical, societal and environmental aspects was considered and acknowledged. Ethical integrity was a core priority, specifically addressing the risks of participant harm, lack of informed consent, privacy invasion, and deception. The authors implemented strict measures to protect sensitive commercial data that could impact an organization's reputation or its relationships with business partners. Consequently, all actors were anonymized using pseudonyms and specific identifying details or terminology was removed to ensure confidentiality. Participation was entirely voluntary, and all interviews were recorded only after obtaining explicit consent. To ensure informed consent, respondents received clear information regarding the study's purpose and scope prior to their participation.

From a sustainability perspective, this research directly addresses the environmental imperative of the road freight industry. By identifying the system support needed to manage the complexities of planning electric freight, the study contributes to the sociotechnical transition toward zero-emission transport.

4

Empirical Findings

This chapter presents the empirical findings gathered through interviews with actors across the Swedish road freight network. The chapter begins with an overview of the interviewed participants in section 4.1. The subsequent sections provide a detailed deep dive into the insights from each organization, categorized into carriers, shippers, and TMS providers. The sections for carriers and shippers primarily address *RQ1*, *RQ2a*, and *RQ2b*. Specifically, the sections cover their electrification strategies, current planning workflows, and perceived challenges and system needs. The sections for TMS providers focus on evolving client needs related to electrification and their positioning in response to changing needs, addressing *RQ3*.

4.1 Overview of Conducted Interviews

Table 4.1 and Table 4.2 show the interviews conducted during the study. Table 4.1 contains interviwed carriers and shippers, and Table 4.2 contains interviewed TMS providers. Each interviewee is anonymized using pseudonyms, where carrier pseudonyms start with the letter *C*, shipper pseudonyms start with the letter *S*, and TMS provider pseudonyms start with the letter *T*. Each interview and its empirical findings are further discussed in subsection 4.2.1 through subsection 4.4.6.

In Table 4.1, fleet size is categorized as *Small*, *Medium*, or *Large* based on the total number of HDTs. *Small* represents a fleet of up to 100 HDTs, *Medium* indicates a range between 100 and 250 vehicles, and *Large* signifies a fleet exceeding 250 trucks. Furthermore, the degree of electrification is categorized as *Low*, *Mid*, or *High* and indicates what share of the total HDT fleet is electric. *Low* represents an electrification rate of 5% or below, *Mid* indicates a range between 5% and 20%, and *High* signifies a rate exceeding 20%.

In Table 4.2, the system tenure of each TMS provider is categorized as *Legacy*, *Modernized*, or *Emergent*. *Legacy* represents systems launched before 2000, *Modernized* indicates a launch date between 2000 and 2025, and *Emergent* signifies systems brought to market after 2025.

Table 4.1: Overview of Interviewed Carriers and Shippers

Actor	Cargo	Range	Size	Electrification	TMS used
Carriers					
Center	Broad focus	Distribution, regional, long-haul	Medium	Mid	Terminal
Charter	Broad focus	Distribution, regional, long-haul	Large	Low	Token
Circuit	Parcels	Distribution	Medium	High	Ticket
Cluster	Broad focus	Distribution, regional, long-haul	Large	Low	Tile, Table
Colossus	Broad focus	Distribution, regional, long-haul	Large	Mid	Table
Cooler	FMCG	Distribution, regional, long-haul	Small	Mid	Table
Curb	FMCG	Distribution	Small	Low	Table
Shippers					
Salt	FMCG	Distribution, regional, long-haul	Medium	High	Transit
Sheet	Textiles	Distribution, regional, long-haul	Small	Mid	None
Skillet	FMCG	Distribution, regional, long-haul	Small	High	Shipper TMS
Solvent	Bulk	Distribution	Small	Mid	Shipper TMS
Store	FMCG	Distribution, regional, long-haul	Medium	Mid	Shipper TMS
Stream	FMCG	Distribution, regional, long-haul	Medium	Mid	Shipper TMS

Table 4.2: Overview of Interviewed TMS Providers

Provider	TMS Type	System Tenure	Selected Users
Table	Carrier	Modernized	Cluster, Colossus, Curb

Continued on next page...

Table 4.2 – continued from previous page

Provider	TMS Type	System Tenure	Selected Users
Terminal	Carrier	Legacy	Center
Ticket	Carrier	Legacy	Circuit
Tile	Carrier	Legacy	Cluster
Token	Carrier	Emergent	Charter
Transit	Shipper	Modernized	Salt

4.2 Carriers

This section presents insights from the seven interviewed carriers. The findings detail how these actors manage electric HDTs within their current workflows and the specific planning hurdles they face.

4.2.1 Center

Center is a cooperative owned by multiple carriers, together managing over 200 HDTs. They offer a diverse array of transport services, resulting in diverse driving patterns, from distribution to dynamic long-haul routes. *Center* has with their 20 electric HDTs reached an electrification rate of approximately 10%, with a goal of reaching 50% by 2028. Their electric fleet covers various operations, including construction site vehicles and dedicated customer distribution, enabled by customers willing to pay a premium. While many peers focus on short-range distribution, *Center* has intentionally chosen other transport assignments as well, such as long-haul routes and heavy transports to prove the technology's viability. They have been engaged in unique high-capacity projects like a world-first 94-ton electric truck for wood chips.

> *"Pendulum flows is easy to electrify, distribution is easy, but we have chosen to go for what is not easy because we want to see if it works"*

In terms of charging strategy, they mainly rely on private infrastructure at home or customer sites and have also established their own charging company to address infrastructure gaps.

Planning Today

The current planning is highly manual and organized around dedicated transport managers responsible for specific geographic areas. After orders are placed via EDI, email or in other formats, transport planning is manually done in their TMS *Terminal.* Additional back-haul volumes are manually sourced through email and then manually planned. The daily planning process for electric trucks is usually not different as they mainly operate fixed routes. These routes are already pre-planned, including charging, and have been manually calculated using established research-models. If electric vehicles for some reason have to deviate from this plan, a lot of manual planning needs to be done in the form of a back and forth dialog between the transport planner and driver to make sure they can manage it.

> *"The heavy part of the electric specific planning is done when the electric truck is initiated, after that it is relatively pain free. The only issue is when the truck have to deviate from their fixed plan, then the transport planner and driver have to discuss back and forth to re-plan."*

Challenges and Emerging System Needs

The shift toward 50% electrification has exposed a critical "capability gap," as the TMS they use today lacks parameters for electric-specific planning. This is especially true for their free-running trucks, since these vehicles perform irregular, multi-day routes. Moreover, an important issue is also to plan back-haul volumes more effectively. *Center* expresses that they need a route planning optimization tool taking electric parameters into account such as finding and booking chargers. Such a tool can increase flexibility for more dynamic routes and to pick-up back-haul volumes at varying locations. To address these needs, *Center* is building a proprietary TMS using AI-tools and partnering with external actors for advanced optimization. Apart from electric route optimization, the aim is also to automate the puzzling of overflow volumes and provide proactive route suggestions to minimize empty miles. One barrier in building this internal TMS is fragmented data ownership. Each individual carrier in the cooperative needs to retrieve and provide their vehicle data which is both a cost and integrity issue.

4.2.2 Charter

Charter is a major Swedish transport company structured as a collaborative entity owned by multiple haulage companies, together managing a fleet of approximately 400 HDTs. Similar to *Center*, the organization oversees a diverse operational portfolio, also resulting in diverse driving patterns. *Charter's* current electric fleet consists of eight HDTs, deployed where a specific customer is willing to finance the higher cost. These eight vehicles primarily operate on local routes within the nearby region, handling tasks such as construction material transport and waste collection. Majority of the trucks charge at home overnight with a few requiring charging during lunch-break, either at home or at public spots. Management estimates that 75% of their total volume could easily be electrified. The rest 25 % is more difficult. Their long-term goal is to cease purchasing diesel vehicles within the next few years, moving toward full electrification as battery technology and charging infrastructure mature.

> *"We could easily electrify 75 % of our operations if we had customers willing to pay for it. Electrifying longer dynamic long-haul routes will*

> *require more planning and collaboration"*

Planning Today

The planning process at *Charter* is characterized by a high degree of manual oversight. Orders are received through various channels and then manually planned in their TMS. They do not use any route optimization tools and remain skeptic as they find existing tools too rudimentary to handle the hundreds of real-world variables processed better manually by transport planners. Planning for the current electric fleet is essentially identical to diesel planning, as their local routes mainly utilize overnight charging and hence do not require complex charge planning. Instead of using FMSs from different OEMs, *Charter* has equipped their vehicles with extra telematics technology connected to a third-party FMS. This enables unified usage of their vehicle data and limits dependence on OEMs. The third-party FMS can among several things provide real-time location data and accurate CO2 data. Other system changes include a new TMS where *Charter* is currently building its own as its old one will be discontinued and no system on the market could meet its needs.

Challenges and Emerging System Needs

The primary challenge for *Charter's* transition lies in the remaining 25% of transport, consisting of longer long-haul and dynamic assignments that require significantly more planning and collaboration with customers. Management identifies a lack of system support for finding and booking public charging stations as a major hurdle, noting that while there is currently overcapacity, they will soon need the ability to book charging spots to ensure operational reliability. Moreover, charging optimization is viewed as essential to assist drivers and planners by simulating routes to determine where and when it is most optimal to charge and how much.

> *"There is no good, general system support for finding and booking public charging. Today we rely on different maps and experience"*

While *Charter* is building its own TMS to be open for future AI integration, the most critical priority remains increasing the utilization and filling rate of the trucks. Furthermore, *Charter* anticipates the future will imply a need for “fleet optimization,” where differences between trucks, such as varying battery capacities and charging speeds, must be considered when assigning specific vehicles to various assignments. Finally, management identifies a lack of high-quality rest areas equipped with nighttime charging as a concern for long-haul routes.

4.2.3 Circuit

Circuit is a family-owned transport and logistics company. For over 65 years, the company has maintained a partnership with a global 3PL provider. Today, approximately 97% of *Circuit's* operations are dedicated to this customer. Today, roughly 70% of *Circuit's* fleet is electrified with 70 electric HDTs. The fleet's operational profile is suited for electrification, as 90% of their work consists of local distribution, with typical route lengths ranging from only 10 to 30 km. Their transport process involves emptying the 3PL's terminals by loading vehicles during the day and collecting pickups in the afternoon to be sorted and sent out at night. To support their electric operations, they own and manage their own charging infrastructure, treating energy management as a core component of their business model.

> *"In the past, we were a pure carrier. Now, we are just as much an energy company. We are trying to work with battery storage, solar energy, we regulate frequency and try to manage the fleet."*

Planning Today

Circuit use *Ticket* to manage their transport, where the planning is mostly manual. Because of the long-standing relationship with their main customer, the planning is however well integrated into their operations. Routes are generally static, covering the same areas daily with slight variations in the number of stops and volumes. Since their routes are inherently well-suited for electrification, *Circuit* manages its electric vehicles without any significant deviations from the diesel planning process. Due to the size of their electric fleet, managing charging power and peak shaving is become an increasingly important part of their planning process. They mitigate these operational risks by trying out third-party solutions that integrate charging hardware with software to steer and monitor the charging process.

Challenges and Emerging System Needs

Because the company has heavily electrified its fleet and operates its own charging infrastructure, it has transitioned into a role that is as much about energy management as logistics. This extensive electrification has created a need for "shift charging" to rotate vehicles through limited charging points, requiring precise coordination to ensure every truck is ready for its route. Currently, this process relies on manual monitoring to prevent charging failures, highlighting a need for a centralized digital overview to provide real-time status and automated alerts. Furthermore, to maximize the economic value of their energy assets, they require a system that can steer charging away from expensive power peaks toward cheaper overnight windows or periods of high solar production, ensuring that the fleet's energy consumption remains cost-effective and reliable.

> *"With electric vehicles, we will likely need a solution where we can monitor and control shift-charging and power output to ensure everything is 100%. Can we get an alarm if a truck hasn't charged more than 20%? Managing those scenarios is going to be essential"*

The third-party system used today to manage charging requires a a combination of manual oversight and software that provides basic scheduling and power control. *Circuit* describes that this process is currently requiring several hours of daily manual puzzling and monitoring. As their fleet scales, this process is becoming increasingly labor-intensive. Consequently, *Circuit* identifies a need for a more integrated TMS that can reliably orchestrate charging and provide real-time status alerts. However, they face a "lock-in" effect because they must use systems approved by their 3PL partner, making it hard to adopt more agile, third-party AI solutions. As a response to this, *Circuit* has begun building internal monitoring tools with partners, allowing them to track real-time battery status and charging failures outside of their primary administrative workflow.

4.2.4 Cluster

Cluster is a major Swedish transport provider, serving as an umbrella organization for approximately 120 associated haulage companies with similar offer as the other cooperatives, *Center* and *Charter*. *Cluster* operates a fleet of approximately 300 HDTs, including eight electric HDTs. Electric trucks have been deployed on long-haul routes where specific clients are willing to pay for emission-free transport. Even though distribution is "easy" to electrify, there have been no customers prepared to pay within that segment. To ensure reliability, they select highly predictable corridors with established charging infrastructure.

> *"We drive long-haul routes with our electric trucks. That is where we found long-term customers willing to bear the costs. Construction, where there are more local and regional flows, would in practice work great to electrify, but it is difficult to find long-term customers"*

Planning Today

The planning process at *Cluster* is split between two primary systems, *Table* and *Tile*. *Table* is used for distribution to manage high-volume zip-code routing, while *Tile* handles long-haul and construction logistics. For electric trucks, routes remain static and predictable where an initial plan have been set. On a daily basis, the electric trucks can therefore almost operate as the diesel trucks with the same planning process. Currently, charging coordination is handled manually by drivers using existing tools like *ChargeFinder*.

> *"The planning is not so complicated really, apart from the driver being aware of when to charge. We do not need additional software support to calculate that. ... Of course we cannot go anywhere. We have chosen to drive recurrent routes where we have checked charging opportunities in advance. You just have to do this once and after that the electric tucks can operate almost as diesel trucks."*

Challenges and Emerging System Needs

Cluster maintains a skeptical view toward over-complicating planning with advanced software, believing that as electric vehicle ranges increase, the complexity of electric transport will decline. They view their current operations relatively pain free where electric trucks should be able to operate as diesel trucks in the future, just swapping diesel with electricity refueling. The barriers for further electrification are in their view connected to economical and infrastructural issues rather than additional system support.

> *"Within two years, range will increase. There will be access to fast megawatt charging at end-location, meaning the truck will be fully charged within an hour and can then drive back. This development leads to a different discussion."*

4.2.5 Colossus

Colossus is a logistics group offering diverse transport services across Sweden. Their operations range from local deliveries to long-haul routes, utilizing partners' or their own fleet to meet tailored customer needs. *Colossus* currently has approximately 450 vehicles including 30 electric HDTs. The deployment of these electric vehicles have been initiated by customers willing to pay and are primarily used for local and shorter line-haul routes that operate predictably. For longer distances, *Colossus* currently uses gas trucks for the long-haul portion and swaps to electric trucks for the final local delivery to the customer. Because of their electric trucks' current battery range of about 210 kilometers, electric HDTs are mainly assigned on routes close to the home bases so that slow AC charging can be done at night. External DC fast charging is significantly more expensive, but is done in a few cases where top-up charging is needed.

Planning Today

> *"The pre-planned routes run like a clockwork. It is of course some work initially, but when the plan is set we do not have to work more with it"*

Colossus use *Table* to manage their transport where they currently have a relatively manual planning process. Day-to-day planning for electric trucks follows a similar manual process as diesel trucks, although it requires planners to select specific assignments where factors like payload weight and time requirements align with the vehicle's technical limitations. According to *Colossus*, an electric truck has to be in a "ready-to-run state" in the morning with preheated batteries and a warm cabin. This allows high energy drain from the battery that usually occurs during the startup phase when it is cold outside to be avoided. If everything is prepared that way, the interviewee means they do not need to charge until later in the day. Additionally, the company uses their OEM's FMS to monitor real-time data such as battery percentage, axle pressure, and driver behavior. *Colossus'* TMS and the OEM's FMS are not integrated and they do not see any major issue working in two systems. However, the interviewee mentioned that there are discussions on connecting the systems.

Colossus utilizes driver coaching led by a dedicated driver developer to analyze vehicle and driver data for rule compliance and efficiency. The company also coaches drivers of the electric fleet to optimize energy use, for example instructing them to return to the home base with an appropriate battery level. This strategy aims to ensure that the fleet can maximize inexpensive overnight AC charging.

Challenges and Emerging System Needs

One challenge for *Colossus* is that without the coaching previously mentioned, drivers over-charge out of caution and returns with more capacity than needed. This incurs higher costs for *Colossus* by missing out on cheap overnight AC charging.

> *"The issue arises when a driver stays at a DC charger longer than necessary, perhaps charging to 40% instead of the required 20% just to be on the safe side or to align with a break. This leads to a triple cost for the company of unnecessary overtime pay, the high price of fast-charging electricity compared to cheap overnight AC charging, and lost operational time. This quickly scales into a significant economic leak."*

Aspects such as suboptimal charging impact the company's already narrow, industry-standard margins. The interviewee did not mention any tools to assist in optimal charging, but recognizes a general need for automated route optimization to keep up with other industry actors. Such a tool would ideally be integrated with their TMS. Route optimization was however not framed by *Colossus* as an enabler for electrifying further. The primary challenge to electrify further is the time lost to charging compared to diesel refueling which complicates scheduling and can lead to expensive driver overtime where access to faster MW charging is needed.

4.2.6 Cooler

Cooler is a long-standing transport company. They operate a total fleet of almost 100 HDTs, with operations spanning across Sweden. The company specializes heavily on the food industry, with 99.9% of its cargo consisting of temperature-controlled fast-moving consumer goods (FMCG). *Cooler* operates seven electric HDTs, all from the same OEM. These vehicles are primarily deployed on regional routes for specific customer assignments. Trucks charge almost exclusively on-site or at specific locations where the company has established agreements to ensure cost-efficiency. Future electrification goals are currently cautious and entirely dependent on economic feasibility and customer demand, which has recently weakened due to a lack of political incentives and low willingness to pay the necessary premium.

Planning Today

Transport planning at *Cooler* is characterized by high stability, as the majority of their routes are static with fixed schedules. They utilize *Table* as their primary TMS where transport planners place orders onto routes. This is today done manually to not only ensure that delivery windows are met, but also specific customer "soft values" such as tailored service levels to ensure high customer satisfaction. Unlike planning of diesel trucks where the vehicles typically last the entire day without mid-route range concerns, planning of electric trucks necessitates initial route simulation and a strategic approach to charging based on where the company has existing charging agreements to ensure the *"price is right"*. For *Cooler*, this includes prioritizing a 20–80% battery range over a full 100% charge to maintain operational and time efficiency. For their electric fleet, planning is supplemented with an OEM FMS, which is used for such route simulation, battery level monitoring, and tracking eco-driving behavior.

> *"The electric routes are very static, except for one truck where more planning is needed. But really, it is not that complicated, you know how much a diesel truck consumes and you know how much an electric truck consumes, so it is not that difficult to convert"*

Challenges and Emerging System Needs

Cooler finds that while static route planning for electric vehicles is currently rather painless due to controlled conditions, dynamic routes remain a challenge due to limited range and charging uncertainty. Another complexity impacting operational efficiency is weather conditions. *Cooler* highlights that batteries require pre-heating in winter, and that high air-conditioning usage in summer can significantly impact energy consumption. In addition, driver behavior related to parameters such as speed speed also impacts energy consumption.

> *"It also depends on the driver. You can't go full throttle. Driving in 85 km/h instead of 80 might lead to 30 min extra charging per day. That is a lot of money... Eco-driving and driver education is important which we focus on a lot"*

A significant administrative burden is CO2 reporting, which currently requires manual data entry into *Table* since real values are not automatically aggregated across the mixed fleet. *Cooler* experience their customers' increasingly demanding full CO2 reports, highlighting a need for automated, accurate emission data collection. In addition to this, the company identifies a strong desire to see charging and vehicle data integrated directly into their TMS to avoid working in parallel systems. For future large-scale electrification, they emphasize the need for a functional booking system for charging that guarantees the specific power output at the booked time to avoid disruptions to driving and rest time rules. *Cooler* sees no immediate need for new route optimization tools, as their current manual process for static routes is considered effective.

4.2.7 Curb

Curb is a distribution specialist with a heavy focus on temperature-controlled transport. They have a total heavy fleet of approximately 50 trucks of which two are electric. One of the electric vehicles is used almost exclusively for temperature-controlled transport, driven by a specific customer agreement. The deployment of the second electric truck was driven by a combination of factors; Its urban distribution routes suit the vehicle's range, the schedule allows for efficient two-shift operations, and a separate customer pays to utilizes the truck as a marketing pillar for their brand. *Curb* also have several electric light-weight vehicles and aims to electrify further with investments in their own charging infrastructure as they prioritize charging at their depot. These investments include semi-public charging stations with battery storage and on-site solar panel installations. While electrification is a core goal, *Curb* believes a mix of technologies including electricity, gas, and HVO will be necessary for the foreseeable future due to the high investment costs of electric trucks and current infrastructure limitations.

> *"Looking ahead, it is clear that we want to replace even more of the fleet, but we don't believe in electrifying everything. It will require a combination of everything from HVO to electricity, and then there are new innovations emerging all the time."*

Planning Today

The planning process is dynamic, with routes finalized the evening before or early the morning of delivery. *Curb* utilizes *Table* as the primary TMS, though approximately 90% of the routing remains manual. This manual approach allows transport planners to account for "soft values," such as driver lunch locations or specific customer needs. A third-party FMS is used for vehicle positioning, battery level monitoring for electric vehicles, and for tracking temperature data for refrigerated loads. While *Table* has GPS capabilities, the company finds the third-party FMS's positioning more reliable.

According to *Curb*, planning electric vehicles for their urban distribution is manageable and mirrors traditional diesel planning. When requests for additional assignments arise outside of the planned routes, transport planners utilize open charge platforms to validate if and where top-up charging is required. For electric trucks running two-shift operations, they also evaluate whether the extra workload would still allow sufficient time to charge for the following shift.

Challenges and Emerging System Needs

For *Curb*, challenges emerge with complex routes or double-shift operations. A significant pain point remains charging speed, as current battery technology and infrastructure can be too slow to support full two-shift operations on longer routes. To address this, the company identifies a need for system support capable of extracting orders from the TMS, optimizing them based on electrification suitability, and automatically feeding the finalized plan back into the system. While they have tried an external route optimization tool available on the market, they found it better suited for long-haul transport with few stops. For *Curb's* core distribution business, which involves up to 20–50 stops per vehicle, the tool became too cluttered. Additionally, while having vehicle positioning from the third-party FMS inside their TMS *Table* is desirable, *Curb* believes that the lack of an industry-standard positioning system makes it difficult for TMS providers to build a universal integration. In terms of adding system support in general, *Curb* emphasizes that it must genuinely simplify the workflow rather than adding complexity.

4.3 Shippers

This section outlines findings from the six shippers. Similar to the previous section it covers details on how these shippers manage electric HDTs within their current workflows and the specific planning hurdles they face.

4.3.1 Salt

Salt is a specialized logistics provider focused on the distribution of temperature-controlled goods to restaurant and catering industries across Sweden. They operate a heavy-duty fleet of over 150 trucks, of which 35 are electric. Trucks are performing local distribution during the day and transitioning to hub-to-hub "inter-transport" routes during the night. Additionally, the company emphasizes maximizing ROI of electric trucks by operating these vehicles in two-shift rotations, partly through night-time distribution where diesel trucks are not allowed. *Salt's* charging strategy relies on utilizing internal infrastructure at their own terminals, where vehicles are fully charged at departure and charged again while unloading at the destination hub. Consequently, the routes selected for electrification are those with stable flows where the range is guaranteed and charging facilities are available at both endpoints. Additionally, *Salt* offers external freight services by utilizing spare capacity on existing routes, specifically targeting return loads to minimize empty mileage with minimal need of additional planning.

Planning Today

Transport planning is built upon a foundation of highly static and predictable routes, where drivers typically handle fixed customer visit cycles. This high degree of predictability is a core enabler of their electrification success to date. While the implementation of electric vehicles has introduced an additional layer of range verification in *Salt's* strategic planning, it has not altered the company's daily operational planning. The company utilizes the TMS *Transit*, which is integrated with their proprietary internal ERP system. While the general routes are fixed, *Transit* is used daily to optimize stops based on delivery windows and specific time slots. For strategic planning, the company relies on multiple OEM portals which allow them to simulate fixed routes based on vehicle specifications. These portals also allow *Salt* to run ad-hoc feasibility checks of planned routes, taking parameters such as payload weight and outdoor temperature into account, but this is not used on a daily basis.

Challenges and Emerging System Needs

The most significant operational headache identified is the fragmentation of the public charging landscape, which forces drivers to manage a large number of different payment cards and mobile apps for various charging operators. They perceive a need for a unified digital wallet or interface that works across all charging networks to simplify the driver's workflow. Furthermore, while current planning is static, the company sees a future requirement to integrate real-time battery status and charging station availability directly into their TMS.

> *"I think our TMS is fully sufficient today. But in the long term, it would be optimal to get the charging stops into the TMS."*

4.3.2 Sheet

Sheet is a textile service provider, offering comprehensive solutions including laundry, quality control, and repair. Despite being a service-oriented company, management views the organization primarily as a logistics firm due to the scale of its distribution operations. *Sheet* operates almost 100 HDTs, of which 14 are electric. The company has deployed those electric trucks on local distribution routes where vehicles remain stationary overnight at *Sheet's* own facilities. This allows the company to mainly utilize cost-effective AC charging rather than more expensive DC fast-charging. While the operational costs for electric trucks have proved lower and more stable than diesel, the high upfront investment poses a challenge.

Planning Today

The transport planning process at *Sheet* is characterized by highly static and predictable routes derived from long-term customer contracts. Drivers operate on fixed weekly or bi-weekly visit cycles, essentially visiting the same customers on the same days. This predictability simplifies electrification, as energy needs are consistent and well-understood. *Sheet* maintains a high level of confidence in the expertise of its drivers, believing they are knowledgeable enough to optimize their own charging schedules without necessitating changes to the core daily planning processes.

> *"Planning top-up charging isn't actually that complicated. Drivers learn where to charge on their own, it isn't something we feel the need to manage centrally. There is no need to make it more complicated than what it is"*

Information is managed through a proprietary ERP system developed in-house. While daily adjustments are handled locally by distribution managers, major strategic planning such as evaluating the battery requirements for new electric routes is supported by historical data provided by truck OEMs.

Challenges and Emerging System Needs

A primary technical challenge for *Sheet* is the complexity of integrating new digital tools into their legacy in-house ecosystem. For example, the company is currently struggling to effectively integrate a third-party startup's FMS due to data connectivity issues.

> *"Making them [new tools] work is the toughest part. Almost no matter which new system you bring in today, there are extremely many new connections and so much more data needing to be brought in to so many new places."*

For an almost full electric fleet, *Sheet* anticipates a need for automated grid management and peak-shaving functionality to avoid expensive electricity tariffs. There is also a perception of a future operational need for a centralized monitoring system that provides real-time alerts if a vehicle fails to initiate a charge overnight, as morning operational failures are a significant vulnerability. Additionally, environmental conditions remain a barrier. In northern regions winter temperatures can reduce battery range by up to 50%, making fixed plans unsustainable. In such cases a system which ad-hoc can identify where fast charging is available would be good. This is, however, nothing *Sheet* are exploring right now.

4.3.3 Skillet

Skillet is a major Swedish food wholesaler and distributor, providing products and logistics services to restaurants, industrial kitchens, and retail outlets. They primarily manage the final distribution of food products from their regional warehouses directly to thousands of individual customer sites. *Skillet* operates a distribution fleet of approximately 200 HDTs of which 16 are electric. The majority of their vehicles are managed through partnerships with external carriers where approximately 50 HDTs are owned internally. Their electrification strategy is focused on urban distribution, where routes are shorter and the environmental benefits such as noise reduction and zero tailpipe emissions are most valued. To support these vehicles, *Skillet* has invested in private charging infrastructure at their depots, allowing trucks to charge during downtime between shifts. They currently only electrify routes where internal charging is enough to power the trucks and where expensive public charging can be avoided.

> *"It is simpler to implement electric trucks within a last-mile structure than in long-haul or medium-haul structures. In a last-mile framework, you can rely almost entirely on your own charging infrastructure and only rarely need to depend on external charging"*

Planning Today

Skillet does not use a traditional TMS. Instead, they rely on their core business system and a specialized transport program that functions as an extension of their driver app. Planning is largely manual within the business system and is based on highly static and predictable routes. For electric trucks, *Skillet* planners must account for range variances caused by winter weather or seasonal route expansions. If a route length becomes too demanding due to these variances and no specific customer contract mandates an electrified delivery, the planner swaps the vehicle for an alternative and reassigns the electric truck to a shorter route. This is today manually planned. For finding and coordinating charging, they rely on external tools such as individual CPO systems and Google Maps.

Challenges and Emerging System Needs

While *Skillet* rather see a case for continuous dynamic route planning software in last-mile industry than in the long-haul segment, they do not feel a need for it due to their delivery cycles being fixed.

> *"When it comes to long-haul trucking, most of that is line-haul, meaning it's just fixed trips from point A to point B. You don't need a system to 'plan' that route every day. You just need to find the right charging spots once, and then you're done. I don't see much of a need for dynamic optimization there. It's really in the dynamic world of 'last mile' where that becomes essential. Maybe not in our specific case, but where customer behavior and online orders change daily and you have to adapt to a constantly shifting reality."*

One frustration for *Skillet* is the significant lack of physical data regarding public charging infrastructure. They express a critical need for information on whether a charging station can physically accommodate a HDT in terms of space and accessibility, noting that it is currently difficult to know if a station can handle the dimensions of their vehicles. Moreover, another issue with public charging is coordinating different CPOs to get a reliable charging network within the area of operations.

> *"The fact that you're forced to deal with so many different charging providers just to have a reliable network you can actually count on is a major challenge across the whole industry right now"*

4.3.4 Solvent

Solvent is a vertically integrated chemical distributor and logistics specialist that manages the entire value chain for liquid bulk products. They purchase chemicals globally and perform final distribution of up to 300 km to industrial clients. *Solvent* utilizes loggers in customer tanks to monitor levels and trigger replenishment. In addition to selling liquid products together with transport, they provide carrier services to manage return loads of other liquids directly from their clients' tanks.

Solvent operates approximately 50 HDTs, with six currently fully electric. Their initial electrification approach prioritized short, high-volume, and repetitive routes. *Solvent* is now aiming to double its electric fleet every year to reach 100% electrification by 2030. This implies that route electrification now evolve from simple vehicle replacement toward optimizing the entire logistics chain as advancing technology allows for greater flexibility and longer distances. *Solvent* aims to achieve energy balance by producing their own energy to power the fleet. Charging is planned manually, supported by private depots at their own sites and customer locations. By leveraging the high predictability of their static routes, *Solvent* can utilize smaller, cost-effective chargers during the 45–60 minute loading and unloading windows inherent to the liquid bulk industry.

Planning Today

The current planning process is characterized by predictable, static routes and replenishment triggered by client tank loggers. The transition from a logger alert to an actual transport order is currently handled manually by planners. To automate this, the company has initiated a project to build a custom internal connection between the client tank loggers and *Solvent's* TMS. While this applies for both diesel and electric trucks, this optimization is an important piece of *Solvent's* electrification strategy, as higher utilization is necessary to make the investment in electric trucks financially viable.

Challenges and Emerging System Needs

As *Solvent* sees a future need of optimized charging, they are participating in a project with a start-up, focused on automated charging orchestration.

> *"In the future we will need to optimize charging. This does not only include charging levels, but also the fact that we will pay different rates depending on if we charge at home, at other transport actors, or public charging stations."*

This is part of a larger digitalization project, where *Solvent* intend to move away from standard market TMS solutions. They believe those systems are primarily designed for larger transport actors where drivers are managed by subcontractors and are not treated as a central resource to be optimized. As *Solvent* employs its own drivers and owns its fleet, it requires a specialized approach to ensure driver hours are optimized as precisely as the vehicle assets themselves.

4.3.5 Store

Store is a logistics and purchasing company, managing the supply chain for major Swedish retail chains. They operate a large logistics network that includes several large distribution centers and a fleet of approximately 200 HDTs. Of those, 35 trucks are electric. *Store* operates their vehicles in two-shift rotations, performing local distribution by day and regional transport by night. Electric trucks are currently confined to "safe" static routes where range and charging requirements are predictable.

> *"Our routes are approximately 400-500 kilometers. We've specifically chosen to electrify the ones where we know the trucks have the range and we can handle the charging back at the home base."*

To enable electric trucks to operate within *Store's* standard two-shift rotations, they have invested in private charging infrastructure at their terminals. This is used for both high-speed DC charging during loading between shifts, as well as for slower AC charging over night. They are also exploring collaborations with third-parties for charging management solutions to support their aim of a 50% electrified fleet by 2030.

Planning Today

Transport planning at *Store* is highly centralized and digital. It is categorized by a combination of fixed master routes tied to long client relationships and dynamic daily adjustments based on fluctuating store volumes. They utilize a shipper TMS for route optimization and daily operational execution. While the current TMS is sufficient to optimize routes for diesel and HVO vehicles, it lacks specialized electric logic such as battery range and charging requirements. For real-time monitoring of vehicle battery status, *Store* currently rely on separate OEM portals which are not integrated with their TMS.

Challenges and Emerging System Needs

A primary challenge for *Store* is the lack of integration between transport planning and charging management. As fleets scale, they believe the manual coordination of vehicle availability and energy requirements will become a significant bottleneck.

> *"Our electric HDTs are spread out across several warehouses now. It's reaching the point where our transport planners need a CMS that talks to our TMS"*

In a similar fashion, a peer to *Store* with a fleet of roughly 200 electric HDTs provided insights based on their electrification progress. They noted that while smaller pilots are manageable, once a fleet reaches a threshold of approximately 30 HDTs, the transition from manual oversight to an automated Charge Management System (CMS) becomes a functional necessity. To solve this, *Store* is currently involved in a joint-project with their TMS and multiple third-parties to develop a CMS solution that can integrate real-time battery data and charging schedules directly into their shipper TMS. In addition to helping transport planners with dynamically optimized charging, this project also includes set-up of charging infrastructure.

> *"In the future we will need to charge outside our own depots where the system should tell us how much to charge to avoid unnecessary costs. When a truck returns to the home base, the system should also plan the charging so that the truck can be ready for the next shift. By 2030, 50% of our 200 HDTs should be electric. But honestly, we're not going to get there if we're still relying on people to manage the charging optimization by hand"*

They have also engaged in external projects on charge reservations, noting that while this is not a major issue today, there will come a time where the demand of chargers will enforce a need to secure charging availability.

> *"It has to happen. You can't have a situation where you show up and have to wait first 45 minutes for the guy ahead of you to finish, and then another 45 for your own charge. It just throws the whole route off schedule."*

4.3.6 Stream

Stream is a major dairy cooperative, handling both inbound milk collection from farms and outbound distribution of finished products to retailers and wholesalers. The company approximately 170 HDTs, about half of which are owned internally and half are contracted through external carriers. Currently, the fleet includes 23 electric HDTs. *Stream's* strategy focuses on maximizing the utilization rate of these more expensive vehicles within internal charging range, aiming to incorporating them in their standard two-shift rotations. While they have successfully electrified local and regional distribution, they are now testing electric vehicles for long-distance transport. *Stream* has established its own charging infrastructure at its depots, utilizing a mix of slow AC chargers for overnight stays and high-power fast DC chargers to support quick turnarounds between shifts.

Planning Today

Transport planning revolves around a "master plan" that is reviewed and optimized on a regional basis approximately once per year. Daily operations are largely static since the company serves a consistent base of milk farms, grocery stores, and industrial kitchens with predictable volumes. *Stream* uses a shipper TMS to manage daily transport planning. For its annual strategic master planning, the company utilizes a separate third-party optimization software. When plans are finalized and set, they are fed back into the TMS.

> *It's all about maximizing utilization on our current routes. It's essential that they [electric HDTs] cover as much distance as possible. If we assign a truck to a route and see that 20% of the battery remains, we'll try*

> *a slightly longer route next time. From a daily planning perspective, we don't make any distinction between electric trucks and non-electric ones."*

Challenges and Emerging System Needs

While *Stream* currently manages its electric fleet without separate planning processes from its other fleet, they anticipate that a 100% electric fleet will require more advanced system integration. A primary future need is the consolidation of fragmented tools into a single interface where range analysis and battery status are currently monitored through separate OEM portals. There is a desire for these electric-specific parameters to be integrated directly into the TMS environment to avoid the inefficiency of working across multiple systems. Additionally, as the fleet scales, they see a need for smarter charge management to prioritize which vehicles are charged first based on their next scheduled departure and energy requirements.

> *"Today, we only have 23 trucks spread out across four locations. We have four fast chargers and the rest are slow. As the electric fleet grows, it will be important to be able to prioritize charging and charge speed among the trucks, but today we don't have that need. So far, it can be handled manually."*

Operational discipline is also a challenge, as charging errors or a failure to initiate an overnight charge have much larger disruptive effects on the next day's schedule compared to forgetting to refuel a diesel truck.

4.4 TMS Providers

This section covers perspectives from the six interviewed TMS providers. The focus is on their perception of changing customer needs related to the electrification and their positioning in meeting those needs.

4.4.1 Table

Table is a Nordic TMS provider focusing on small to medium-sized transport companies (typically between 5 and 500 vehicles). *Table* offers a highly flexible cloud-based TMS that allows users to customize the system to fit their specific operational needs.

Changing Client Needs Related to Electrification

Table observes that due to their clients' differing electrification rate, needs also differ. This has, however, not translated in any requirements on changes in *Table's* system. They believe this is due to many clients currently treating electric trucks like diesel trucks. *Table* recognizes that integrating charging stops into route optimization could be interesting, but that this is not a request from customer, rather ideas communicated by entrepreneurs and start-ups. For *Table*, there must be a customer demand if they are going to find it interesting to invest time.

> *"There must be a customer demand for electric-specific features if we are going to find it interesting to invest time in new system integrations. We do not see such demand today."*

Furthermore, they also argue that such solutions will probably come through their already deeply integrated external route optimization partner. A barrier to meeting future advanced electrification needs is the requirement for 100% accurate order data (addresses, time windows, etc). Without high-quality input, automated electric-specific planning remains ineffective.

Positioning in Response to Changing Client Needs

Table is open to integrate with specialized third-party solutions. To motivate other deeper integrations similar to PTV, they explain that there has to be a broad customer demand. If only a few customers requested it, they would rather do a specific project for it which the customer would pay for. Currently, *Table* does not ingest real-time vehicle data such as battery levels, leaving vehicle-specific monitoring to FMSs.

4.4.2 Terminal

Terminal is a TMS provider with a customer base ranging from haulier cooperatives to more specialized carriers. *Terminal* provides an "on-premise" solution where customers host the software themselves.

Changing Client Needs Related to Electrification

Terminal notes a significant shift in how electrification is prioritized by their client base. Electrification was a high-priority topic three years ago, but has since dropped down the agenda in favor of immediate concerns like IT security and global geopolitical instability.

> *"Needs connected to the electrification was a more current discussion three years ago. Today there are other needs that have higher priority"*

Terminal's perception is that actors with existing electric vehicles view system-supported electric planning and route optimization as a "nice-to-have" rather than a "must-have". For easier transport assignment such as classic line-haul between two terminals, *Terminal* argue that there should not be any additional requirements on their system. A more current customer demand is CO2 reporting and compliance with regulations.

Positioning in Response to Changing Client Needs

Terminal positions its products to be technically prepared for future demand of electric features, but are not actively incorporating it today due to the low demand. To be prepared for future demand, *Terminal* has built its tools with the architectural flexibility to include charging depots and battery parameters as soon as clients request them. The company maintains an asset-agnostic approach, meaning their routing logic is designed to handle different fuel types simply as added parameters rather than as separate systems. However, translating this architectural readiness into real-time capability remains difficult. *Terminal* identifies the lack of standard data formats from vehicle OEMs as a major barrier to integrating real-time vehicle data into TMS platforms. Solving that would either require carriers to implement their own telematics or individual agreements with every OEM.

4.4.3 Ticket

Ticket is an established legacy TMS provider. The company is currently in a transitional phase, moving from several older, on-premise platforms to a new cloud-based platform. While they provide tools for transport planning, their primary specialization lies in the economic flow of transport operations. This specifically means managing how transporters are paid through automated invoicing, self-billing, and settlement processes. *Ticket's* primary customer segment is haulier cooperatives.

Changing Client Needs Related to Electrification

Ticket explains that while they do serve customers with electric fleets, they have not yet experienced a push for electric-specific features.

> *"As there are not too many electric trucks on the market yet, we have not noticed any additional electric-specific demands on our system"*

Instead, the most central shift in client needs is the increasing demand for environmental reporting. Currently, the industry largely relies on standard emission calculations based on hours worked or kilometers driven which satisfies approximately 95% of current client requirements. However, *Ticket* anticipates that these requirements will sharpen, necessitating the integration of actual vehicle data. With that, they argue that a significant challenge will be accessing and consolidating real-time emission data from various subcontracted hauliers.

Positioning in Response to Changing Client Needs

Ticket positions itself as a provider of a unified system that supports mixed fleets, emphasizing that clients prefer a single workflow regardless of whether they operate electric or diesel vehicles. Rather than building specialized planning or optimization tools for electric trucks in-house, *Ticket* intend to meet niche planning needs, if they emerge, by integrating with external providers. *"We can't be best at everything"*, they argue. Going forward, they prioritize system openness so that clients can "plug in" tools for specific needs as they emerge. *Ticket* identifies the maintenance and ownership of integrations as a major challenge in this open approach, and stress the necessity of detailed agreements. Furthermore, as they manage hundreds of unique integrations, they highlight the need for rigorous documentation so that support teams can resolve issues without relying on individual developers.

To address data security concerns, *Ticket* builds separate APIs for different information types, allowing them to control exactly what data is shared with partners and potential competitors. These integrations imply transaction and coordination costs. Hence, *Ticket* explains that it is easier to motivate an integration if it is initiated by a customer rather than by a third party, where *Ticket* would need to "sell" the solution to a customer.

4.4.4 Tile

Tile is a software provider, offering a broad suite of systems including a TMS and a FMS. Their core TMS manages everything from order registration and driver applications to customer contracts, pricing, and environmental data where haulier cooperatives is a large customer segment.

Changing Client Needs Related to Electrification

Tile recognize that if the electric transition increases, additional requirements will be placed on TMSs. Today, there are indications of changing client needs where customers have started to talk about planning tools taking electric-specific parameters into account, but there is no "real" demand yet.

> *"Our customers are still electrified to a small degree with electric trucks mainly deployed on fixed routes. On these routes customers do not have a need for complex planning"*

Positioning in Response to Changing Client Needs

Tile positions its products as integrable platforms capable of incorporating specialized electrification parameters as market demand matures. While *Tile* maintains its own routing engine and national road network data, they are open to integration with niche third-party specialists for advanced electric-specific route optimization if there is a broad customer demand and a clear business case.

4.4.5 Token

Token is a recently commercialized TMS that originated from the internal development efforts of a haulier cooperative. It was born out of a perceived absence of sufficient TMS solutions on the market.

Changing Client Needs Related to Electrification

Because *Token* has only recently been commercialized, the company has not yet established the same depth of client relationships as its competitors. As a result, they lack the same direct insight into changing client needs regarding electrification. However, being developed by haulier cooperatives, they are uniquely positioned to relate to emerging requirements where they have identified that traditional TMS providers are failing to keep up with the technical demands. Specifically, *Token* explains that integrations with necessary systems come with high costs where customers might have to pay for both the development of the integration and then the license to use it if there is no standard integration available. Token argue that such friction should not be part of modern digital solutions where they are building a TMS where cost effective integrations should be possible to do yourself. *Token* also perceives an unmet need among haulier cooperatives for fleet optimization compared to simple route planning. This involves managing hundreds of separate orders across hundreds of vehicles while balancing *"Robin Hood planning"*, where work is distributed fairly to ensure all cooperative members remain profitable. Furthermore, *Token* mentions that a significant barrier in the industry is the lack of standardized vehicle data. OEMs often treat data as proprietary or charge high fees for access, which hinders streamlined planning. *Token* actively lobbies at a political level to address these data access issues.

Positioning in Response to Changing Client Needs

> *"We do not only want to solve today's problems, but also future problems such as digitization, electrification and new fuel types. We have not seen any TMS provider on the market today with that mindset"*

Token aims to be a more proactive actor than existing TMS providers. In terms of planning electric vehicles compared to diesel, they believe that the main influential element is the need to feed more granular data points such as battery status and infrastructure locations, rather than a separate system. *Token's* system architecture is designed to break down input data into its smallest components, enabling modular aggregation suitable for both diesel and electric planning. Strategically, *Token* favors a partnership-first approach, where integrating specialized third-party tools should be easy and affordable for their customers.

4.4.6 Transit

Transit is a cloud-based TMS provider focused on last-mile distribution. The platform was born out of a desire to provide more precise delivery windows and focus on high-intensity distribution, characterized by high-volume stops within small geographical areas.

Changing Client Needs Related to Electrification

Transit identifies that for their core segment of high-intensity city distribution, the shift toward electrification has so far resulted in minimal changes to functional requirements. Most clients currently manage electric vehicles by maximizing battery usage during the day and returning to the terminal for overnight charging, avoiding the economic cost of mid-route charging. Consequently, *Transit* identifies added kilometer-based capacity constraints as the only significant emerging client need to ensure routes do not exceed a vehicle's specific range. Apart from this capacity adjustment, *Transit* has considered integrating charging data and OEM telematics data, but customers have not shown any interest.

> *"We thought we needed to connect charging infrastructure with our system, but there was no demand from our customers to do so as they aim to charge at home within the segment we serve"*

Positioning in Response to Changing Client Needs

Strategically, *Transit* positions itself as a central, open platform that prioritizes easy integration over building all features in-house. The platform integrates specialized third-party services for critical functions like route optimization. To provide detailed monitoring, they offer proprietary telematics hardware that track GPS and temperature data, bypassing the need for complex OEM integrations. A major partnership challenge identified by *Transit* is the protectionist behavior of large market actors who are often unwilling to share data or allow external communication with their end-customers. This lack of data transparency forces transporters to use multiple siloed apps, creating operational friction for drivers. *Transit* aims to overcome these industry silos by allowing two-way data flows between their platform and various systems to ensure a data-driven, digitized workflow.

5

Analysis & Discussion

In this chapter, the empirical findings from chapter 4 are analyzed and discussed in the context of the study's aim to understand the demand of additional software support in transport planning and how it can be met. The chapter will specifically cover *RQ1 and RQ2*, the current planning process of electric HDTs in relation to conventional diesel HDTs and where operational challenges and software needs arise. Lastly, the analysis evaluates the perspectives of both road freight actors and TMS providers to determine how these emerging needs can be satisfied, addressing *RQ4*. The chapter begins with a macro analysis based on the MLP of sociotechnical transitions by Geels (2002) to establish the broader context for why these challenges and software needs emerge.

5.1 Electrification as a Sociotechnical Transition

Geels (2002) explains that transitions occur when niche innovations gradually challenge and transform the established regime, often triggered by pressures at the landscape level. The Swedish road freight industry is currently a primary site for observing the friction between a dominant "diesel-oriented" regime, emerging "electric" niches of new trucks and software solutions, and external landscape pressures like the European Union's target for a 45% CO2 reduction by 2030. While the landscape and new innovations drive the deployment of new electric HDTs, existing transport management systems is still built on the assumption of how diesel HDTs operate. The disparity in transport management methods are from a sociotechnical lens natural where Geels (2002) explains that mismatches often arise in terms of misalignment between a radical innovation (niche) and the established socio-technical regime, where existing structures remain optimized for the incumbent technology rather than the newcomer. The empirical data showcased how several start-ups, OEMs and other actors are working to develop new software adapted for electric technology to address the transport management mismatch. Software and tools aiming to satisfy additional software needs can together with electric trucks be understood as what Geels (2002) describes as niches and the technology that challenge the current regime in sociotechnical transitions.

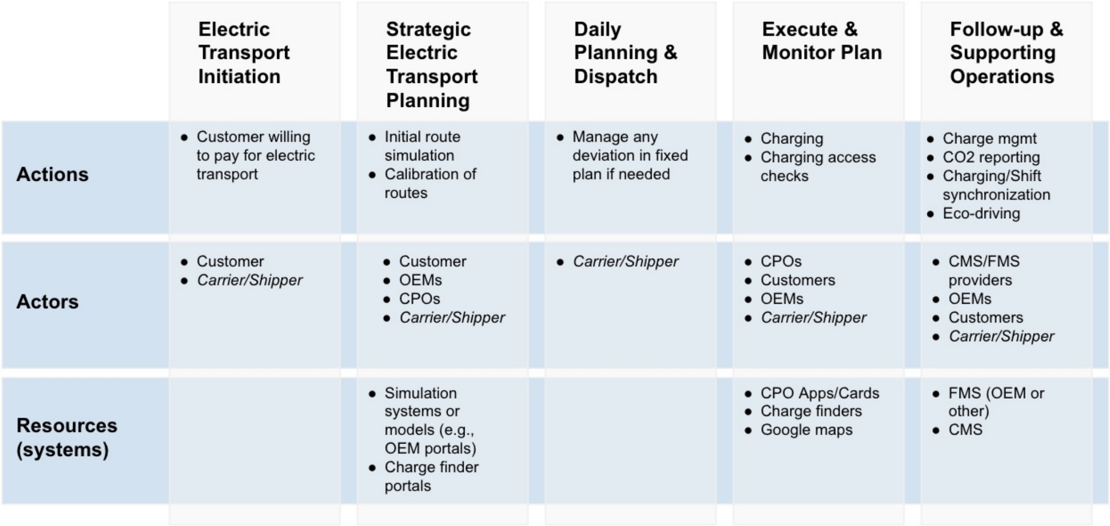
While this research point towards a mismatch in transport management methods, this has not yet led to major challenges in the daily planning for the interviewed road freight actor which is discussed further in section 5.2. Some however foresee that additional challenges and software needs will emerge as the transition proceeds and their electric fleets grow. Others downplay the importance of additional software needs and argue that additional landscape pressures in terms of political decisions and incentives are needed. Geels (2002) emphasize the need of all levels being aligned, reinforcing each other, for a full technological transition to be possible as existing structures in a regime tend to be rigid. From an sociotechnical transition perspective this points toward a regime in the early stages of its reconfiguration where structural linkages are beginning to feel pressure, misalignment have started to emerge in terms of challenges and software needs, but where further mismatches can be expected as the transition continues.

5.2 Electric Transport Planning Process and Where Challenges Arise

The following section will cover the analysis and discussion of current transport planning process of HDTs and where challenges arise, addressing *RQ1: How do actors in the heavy duty road freight network plan their electric transport today?* and *RQ2a: What are the challenges faced today and in the future in the transport planning of electric trucks?*. The ARA framework is used to identify how the transition to electric HDTs has modified existing planning process in terms of changed *activities*, *resources* (systems), and links to external *actors*. These findings are contrasted and compared to Stål (2026) research and ARA analysis on electric HDT utilization. The ARA framework facilitates an analysis from a network perspective which is highly relevant in the case of sociotechnical transitions where reconfiguration of links and structures is a critical process. The changes and challenges in current transport management are further brought into the discussion regarding where planning challenges will arise in the future. Lastly, challenges are synthesized in a table where they are compared, contrasted and connected to the established planning complexities mentioned in subsection 1.1.2.

5.2.1 Current Electric Transport Planning and Challenges

The following section will analyze and discuss how actors' planning process differ between their electric and diesel fleet and where challenges arise today. The focus will specifically be on the items where the traditional planning deviate due to electric needs. Findings suggest that the transition to electric transport has not yet forced a total overhaul of the *daily* transport planning as current operations are primarily characterized by a "one-to-one" vehicle replacement strategy, where actors have selectively electrifying predictable "safe" routes that maintain traditional daily planning logic. Differences rather occur in the initial strategic deployment of electric trucks and in the support operations before and after transport assignments. These insights led to a few adjustments in the *ARA x Process matrix* in Figure 2.2 with *Electric Transport Initiation*, *Strategic Electric Transport Planning* and *Follow-up & Supporting Operations* implemented as new columns resulting in the *ARA x Process matrix* in Figure 5.1. Figure 5.1 further presents the aggregated deviations from diesel planning due to electric needs in terms of additional activities performed to manage electric transport, and the actors and systems which are connected to those activities. The items presented in the matrix will be discussed further to understand the current planning process and where challenges arise.



	Electric Transport Initiation	**Strategic Electric Transport Planning**	**Daily Planning & Dispatch**	**Execute & Monitor Plan**	**Follow-up & Supporting Operations**
Actions	• Customer willing to pay for electric transport	• Initial route simulation • Calibration of routes	• Manage any deviation in fixed plan if needed	• Charging • Charging access checks	• Charge mgmt • CO2 reporting • Charging/Shift synchronization • Eco-driving
Actors	• Customer • *Carrier/Shipper*	• Customer • OEMs • CPOs • *Carrier/Shipper*	• *Carrier/Shipper*	• CPOs • Customers • OEMs • *Carrier/Shipper*	• CMS/FMS providers • OEMs • Customers • *Carrier/Shipper*
Resources (systems)		• Simulation systems or models (e.g., OEM portals) • Charge finder portals		• CPO Apps/Cards • Charge finders • Google maps	• FMS (OEM or other) • CMS

Figure 5.1: Aggregated Deviations from Diesel Planning due to Electric Needs

Electric Transport Initiation

Given the restricted range of electric HDTs, a primary challenge identified among various road freight actors is the inherent operational inflexibility. The ability to adapt to changing demands, spontaneous routing, or unforeseen deviations is restricted by uncertainty about the availability and timing of charging. Consequently, carriers characterized by varied transport assignments have prioritized the electrification of static, predictable routes. To date, carriers that manage dynamic long-distance operations, such as *Center*, *Charter*, and *Cluster*, have refrained from electrifying these specific flows due to the concerns mentioned.

The majority of shippers' routes are naturally fixed such as *Sheet*, *Salt*, and *Skillet*. Those companies have business models which rely on fixed delivery schedules to established clients. Fixed delivery schedules are also true for the carrier *Circuit* who primarily serves one customer. The fact that these actors are characterized by stable clients and simpler routes for electrification is an explanatory factor of why they have been able to electrify to a greater degree than other carriers. However, even within these structured schedules, infrastructure limitations persist. Actors like *Store* and *Skillet* explicitly state that they confine their electric HDTs to "safe" corridors, where both required range and charging availability are highly predictable and guaranteed. Ultimately, there is a general shift from flexible route allocation to predefined "safe" transport missions among all actors, which aligns with Stål's (2026) findings

The rationale for electrifying specific routes is also determined by the relationship with the customer. For carriers, electrification is almost exclusively tied to specific clients who are willing to pay a price premium. Depending on the customer's transport needs, different types of routes have been electrified. *Cluster* has, for example, only electrified static long-haul routes because that is where they have found paying customers. *Center*, on the other hand, have found customers willing to pay within different segments and have thus electrified a diverse array of routes, from distribution and "pendulum flows" to static long-haul. For shippers, the decision of which route to electrify depends mainly on operational and economic feasibility rather than a specific customer willing to pay for a specific transport assignment. An exception is *Skillet* who mentioned that they had a few customer specific agreements for electric transport.

Applying the ARA perspective to the initiation of electric transportation shows a significant strengthening of actor bonds between carriers and strategic customers. In diesel-based processes, relationships are often transactional, as described by Stål (2026), allowing carriers to move vehicles between contracted assignments and spot-market opportunities. However, the high initial investment and total cost of ownership (TCO) for electric HDTs necessitates closer coordination and shared financial risk. These requirements for deeper cooperation and shared commitment are further confirmed by the findings of Stål (2026).

Strategic Electric Transport Planning

A primary difference for deploying electric HDTs compared to diesel is the requirement of an initial feasibility check. Both shippers and carriers have introduced some type of activities to check required range, possible charging stops and other aspects to ensure operational feasibility of a new route assignment, either manually or using specific software. *Salt*, *Colossus* and *Cooler* mention that they are utilizing OEM portals to simulate routes based on parameters such as vehicle specifications, payload weight, and access to charging infrastructure. Less complex assignments may only require a manual range check in advance. *Stream* mention that they rather take a "learning by doing" approach, which means first testing and then refining fixed plans to increase utilization of truck load and battery capacity while managing range constraints.

In accordance with Stål (2026) ARA analysis, the empirical data indicate tighter bonds with OEMs. In the traditional diesel regime, the relationship between a shipper and an OEM is largely transactional, mainly focused on hardware procurement and maintenance. However, the reliance on OEM Portals where you can access vehicle data, charging spots and simulation tools for range calculation among other things marks a shift toward a new *resource-based* interdependency where the road freight actors' planning activity is now digitally coupled with the OEM's software. In addition, actors such as *Stream* are using several OEM portals depending on the brand of the vehicle in question. Other actors such as *Colossus* have instead purchased HDTs from a single brand for simplicity. The new fragmented resource dependence on OEMs seems to have increased the strategic importance of fleet composition in terms of brand.

Depending on what type of route is electrified, the need of charging during the transport assignment varies. Shorter distribution routes imply less planning as the vehicles can charge at home which is preferred as it is cheaper than public charging. Most interviewed actors explicitly state that they aim to mainly charge at home with *Skillet* even avoiding routes where public charging is needed. Longer distribution, regional and long-haul routes may require public charging or charging at customer site. Public charging introduce the Charging Point Operator (CPO) as a vital new external *Actor* in the transport network. However, these actors are fragmented resulting in several CPO apps, cards and negotiations as some actors such as *Cooler* aims to charge where the company has existing charging agreements. If public charging is needed as part of the strategic plan, the actors typically use OEM platforms or separate charge finder portals. Different systems cover different charging spots and there is a lack of a unified platform covering all charging opportunities for HDTs in Sweden.

Daily Transport Planning and Dispatch

By focusing on fixed routes which are pre-planned, most road freight actors can use the same logic in daily planning and dispatch as for diesel operations. Hence, they are using the same *resources* in terms of TMS systems and driver apps to plan and trace the transport. This showcases how road freight actors are primarily employing a "one-to-one" vehicle replacement where maintaining diesel operation logic is possible rather than holistically "re-optimizing" the whole logistics plan suggested by previous research explained in subsection 1.1.3. *Center* argue that such logic will not be possible in the case of electrifying more dynamic long-haul routes where additional system support in the daily transport planning will be needed.

Center points out that when the HDTs for some reason have to deviate from the fixed plan, more ad-hoc re-planning is needed for an electric vehicle than a diesel vehicle where range and charging possibilities might need to be considered. Such deviations could be weather and traffic conditions or picking up back-haul volumes to avoid empty transport which *Center*, *Salt*, *Solvent* and several other actors are actively working with. For *Center* the re-planning is today manually handled through conversations between the transport planner and the driver. Another important factor is to include range buffers in the fixed plan so that deviations can be managed without re-planning. Apart from *Center's* input on manual re-planning, no other actor has raised managing deviations as a burdening activity. This is probably because they currently operate small-scale fleets where manual occasional re-planning is no issue or where their fixed routes have enough range margins with no need of public charging. However, if more flexibility is desired, public charging required and deviations increase with a larger fleet, additional system support might be needed as *Center* implies.

Execute & Monitor

Charging is a new *activity* for the driver in the execution. *Salt* and *Skillet* highlight the burden for the drivers of managing several different CPO apps and cards for different CPO actors and emphasizes today's need of checking if a public charging station can physically accommodate a heavy-duty vehicle in terms of space and maneuverability through google maps satellite function. In some cases the drivers also plan where to charge, but the view on charging autonomy differ among actors. *Charter* believes charging should be centrally planned to make it easier for drivers. *Skillet* and *Cluster* rather view it as no different than diesel fueling and are hence giving the drivers more autonomy in deciding where to charge. On the one hand, charging might become more similar to diesel refueling as more infrastructure is built including faster chargers. On the other hand, *Colossus* work in coaching drivers to charge only as much as they need and various agreements with different CPOs indicate that there are more parameters in the charging process that can be optimized than in the diesel refueling suggesting that central planning tools could be useful.

Follow-up & Supporting Operations

Managing the trucks after an assignment to be ready for the next day or the next shift also implies new *activities*, *resources*, and *actors*. *Salt*, *Store*, and *Stream* all operate their electric fleets in two-shift rotations. This adds further complexity and requires planners to perform synchronization of the truck's downtime with its charging needs while managing stricter time constraints. *Stream* and *Sheet* furthermore emphasize that a failure to initiate an overnight charge results in an operational failure the following day. This is a much higher stakes deviation than forgetting to refuel a diesel truck. While a diesel vehicle can be refueled in minutes, an electric HDT typically requires approximately 60 minutes according to *Solvent*. In a tight schedule, even the availability of fast-charging may not suffice to recover the schedule, as a one-hour delay can lead to missed delivery windows and the subsequent loss of assigned customer time slots. Consequently, what was previously a minor hurdle in a diesel fleet becomes a critical point of failure that can jeopardize an entire day of operations for electric HDTs. Currently, the monitoring of charging relies on a fragmented set of *Resources*. Because real-time State of Charge (SOC) is rarely integrated into the primary TMS, actors must use separate FMSs, CMSs or manual physical audits to keep track of charging status.

Follow-up *activities* such as CO2 reporting has traditionally been done using standard values. According to some actor, such as *Charter*, it becomes more important to report actual values when driving electric as that is the very reason why customers pay a premium. They explain that customers expectations on CO2 reporting and more correct value are increasing which is confirmed by other actors as well. However, to retrieve data from the vehicles the actors often need to pay the OEMs. Furthermore, some actors have different OEM suppliers where the data do not have a standard format causing further work in compiling and formatting the data. *Charter* has implemented their own hardware and FMS to cut the dependency to OEMs. Other actors have strategically only deployed electric HDTs from a single OEM as mentioned earlier to avoid fragmented platforms and data.

The mentioned data fragmentation creates inefficiencies and additional costs. As a direct response to the limitations of fragmented systems, proactive actors have initiated discussions and projects, some with OEMs other without them to create more effective processes. Challenges such as system inefficiencies and actors' responses to this will be discussed further in subsection 5.2.2 and section 5.4.

5.2.2 Perceived Future Transport Planning Challenges

In this section, the focus shifts from current operational practices and challenges to the perceived emerging frictions and long-term transport planning challenges identified by the interviewed actors. While the current stabilized approach of mainly electrifying static routes has allowed for a relatively smooth initial deployment, the analysis reveals that this stability is somewhat temporary and contingent on the small scale of current electric operations. In a future where organizations aim to scale their electric fleet and become more flexible in their electric HDT utilization, predefined routes become obsolete and challenges connected to dynamic routing and mixed fleet operability will become more prominent. This section presents and connects those challenges to established planning complexities from previous research (Table 1.1).

Vehicle and Truck Load Utilization

As identified earlier, initial capital expenditure remains a primary electrification barrier, particularly for smaller carriers with limited access to funding. Additionally, the broader economic landscape presents challenges in the form of fluctuating electricity fees and a lack of political incentives, which leads some actors like *Cluster* to note that electric trucks can with higher electric rates currently be more expensive to operate than diesel despite the potential for lower long-term costs. On the other hand, *Sheet* highlight that operational costs for electric trucks have proved lower and more stable than for diesel. Hence, to offset the high initial investments and achieving lower operational costs, maintaining high utilization of the trucks and their load is important. In some cases, this can introduce new planning challenges for electric trucks. Shippers such as *Store*, *Salt*, and *Stream* utilize two-shift rotations to keep the expensive assets in near-constant motion. Such two-shift operations, however, create narrow charging windows that require more planning for fast turnarounds compared to diesel trucks. An example of this is *Stream's* investments in their own fast DC chargers planned to be used for trucks assigned on a second shift.

Furthermore, several actors such as *Center*, *Salt* and *Solvent* actively work to minimize empty miles through return pickups. These back-haul trips become more complex with electric trucks according to *Center* as deviations from the fixed plan and charging stops may need re-planning where they are developing proprietary AI tools to suggest routes that minimize empty miles. Stål (2026) is interestingly arguing in his research that an important secondary effect to the "increased planning intensity" required by electric trucks is that it may contribute to a reduction in unplanned, underutilized transport, where he refers to the benefits of tighter coordination and predefined transport missions. This might be true for outbound volumes, but in the case of back-haul volumes, the inflexibility of electric trucks might instead make it more difficult, as described by *Center*. Moreover, as the transition continues, the scope of electric truck transport may not remain within fixed missions, which makes his statement only true for the current situation.

While Karlsson and Grauers (2023) points out that high vehicle utilization is a key driver of cost-effectiveness of electric HDTs, *Charter* argue that high utilization is something they will always strive for no matter type of HDT. Karlsson and Grauers (2023) explains that by operating trucks in two-shift rotations and using mandatory driver breaks as the primary windows for high-power charging, companies can achieve a high battery and vehicle utilization which effectively lowers the cost of the vehicle over its service life. While charge management is an electric-specific action, one could argue that operating in two-shift rotations would be done for any vehicle if possible. In *Salt's* case, two-shift rotation has primarily been enabled through their electrification which allows them to operate in urban areas during night. This exemplifies a situation in which such two-shift operations would not be achievable with diesel vehicles.

Route and Charge Planning

Optimizing routes while integrating charging stops into a transport schedule requires balancing battery range, charging station locations, and charging times with driver rest requirements and operational costs. This has not been expressed as an issue for actors driving local routes within range limits where charging is possible at "home". For actors operating on routes where public charging is necessary charge planning is required. A large part of the charge planning today is manual and involves reliance on OEM simulation portals for feasibility checks and diverse charge finding platforms which are not integrated with actors' TMSs. Hence, transport planner's are forced to work across fragmented systems. Some find this doable whereas others such as *Center* and *Charter* express a need for integration of comprehensive charging optimization into their TMS and planning process so that charge plans can dynamically be updated taking range, charging locations, time, driver rest times, environmental factors and other parameters into account. Even though their current planning works, *Center* and *Charter* see optimized charge planning as a necessary step to continue scaling their electric fleet and becoming more flexible in their utilization of electric HDTs.

Behavioral friction also leads to operational and economical inefficiencies through driver-mandated over-charging. *Colossus* exemplifies an issue where drivers, acting out of caution or range anxiety, stay at DC fast-chargers until reaching 40% SOC instead of the optimized 20% required to reach the depot. This driver-mandated buffer leads to a double cost of unnecessary driver overtime pay and the high price of fast-charging electricity compared to cheaper overnight AC charging. *Colossus* do driver coaching "manually" to overcome this challenge, while *Charter*mention how comprehensive charging optimization would take such aspects into account so that drivers can be relieved of the need to plan where and how much to charge.

A future challenge mentioned is the risk of charging queues where several actors mention the need of charging reservations. *Store* emphasizes that as electric fleets grow, unpredictable queues at public chargers become a primary operational risk that can throw fixed delivery schedules into total failure. *Charter* also mention this as a future issue where there is a lack of comprehensive systems today where charging can be found and booked. Recent research by Eriksson and Pernestål (2025) quantifies this challenge, noting a trade-off between CPO profitability which requires high charger utilization and haulier reliability, which requires low queuing times. However, their simulations reveal a potential middle ground. By scheduling arrivals to even out the arrival of trucks, peak power demand on the grid can be reduced by up to two-thirds without significantly increasing waiting times. Solving this requires high digital coupling between the carrier's internal planning and the CPO's booking systems. This is a level of platform openness that does not yet exist as a standard.

External Conditions

Environmental variables such as weather and topography, and individual behavioral patterns introduce a level of uncertainty into electric transport planning that is more impactful than in the traditional diesel-oriented regime. Actors such as *Sheet* and *Colossus* highlight that winter conditions, particularly in northern regions, can reduce battery range by up to 50%. Similarly, *Cooler* notes that summer heat presents its own challenges, where high air conditioning usage significantly impacts energy consumption. This sensitivity elevates seasonality and driver behavior from a secondary operational detail to a critical parameter in managing range constraints. Proactive eco-driving can serve as a vital resource for extending range, yet it introduces a new dependency where the success of a plan is not only contingent on supporting software, but also on the individual driver's behavior. Consequently, planners often compensate for this variability by introducing larger energy buffers to ensure year-round feasibility, which increases operational costs and underscores the need for more dynamic planning tools.

Fleet Operability

As organizations mature in their electrification, they tend to transition from being simple transport providers to active energy managers. This shift forces actors to treat electricity not just as fuel, but as a resource that must be balanced against grid limits, variable spot prices, and the physical availability of charging points. This evolution result in moving from one-to-one vehicle replacement toward the holistic fleet re-optimization suggested by Zackrisson et al. (2026). In practice, this means shifting the focus from simply replacing diesel trucks with electric ones to redesigning entire processes around charging windows and grid capacity. Shippers like *Stream* and *Store* emphasize that manual charge prioritization is not scalable. They claim that a 100% electric fleet requires an automated link between the transport plan and a CMS to decide which vehicle gets power first based on parameters such as scheduled departures and energy prices.

Furthermore, pioneers like *Circuit* identify a future requirement for automated grid management and peak-shaving functionality to navigate volatile electricity tariffs and optimize self-produced solar power. The stakes of this energy management are far higher than in the diesel regime, as a failure to initiate an overnight charge leads to operational failure the following day. This creates a critical data dependency where planners currently must manually bridge the gap between fragmented OEM monitoring portals and their primary TMS to prevent morning operational collapses.

Integrating electric assets introduces vehicle-specific complexities that the legacy diesel regime could ignore. *Charter* identifies an emerging need for optimization on a fleet level. Unlike a fleet composed of only diesel assets, which are largely interchangeable, a mixed fleet with electric assets require precise resource matching, where planners must tailor specific trucks to specific routes based on battery capacity, charging speed, and payload constraints. Furthermore, electric truck characteristics change with age, as battery degradation gradually reduces range and alters charging behavior.

Vehicle Data Fragmentation and Accessibility

This complexity of *managing route and charge planning*, *external conditions* and *fleet operability* is further heightened by vehicle data fragmentation. Carriers and TMS providers like *Terminal* and *Token* express frustration that vehicle manufacturers often treat vehicle data as proprietary or charge high fees for access, creating data silos that prevent real-time battery status from being integrated into a unified TMS environment. This lack of standardization is particularly problematic for multi-brand fleets, where planners must juggle different OEM portals for range simulation and monitoring. Furthermore, the regulatory pressure of the Corporate Sustainability Reporting Directive (CSRD) presented in subsection 5.2.1 is shifting follow-up from simple bulk fuel tracking to granular reporting based on kilowatt-hours. As *Ticket* points out, consolidating this actual vehicle data across mixed fleets and subcontractors is a hurdle that current systems are ill-equipped to handle automatically.

5.2.3 Synthesis of Current and Future Planning Challenges

The perceived current and future planning challenges identified in subsection 5.2.1 and subsection 5.2.2 show how the complexities of electrification mentioned in previous research translate into concrete hurdles for the interviewed actors. Overall, the findings indicate that today's relatively smooth electrification is partly enabled by selective deployment on "safe" routes where planning is not too complicated. Future challenges emerge when actors seek to electrify less predictable transport flows, scale fleet size, and integrate electric operations into mainstream planning rather than isolated pilot structures. These empirical findings can be mapped against the core electric planning complexities originally identified in subsection 1.1.2. Specifically, these challenges align with the framework adapted from (Linköpings Universitet, 2026), (Ragon & Rodríguez, 2022), and (Perger & Auer, 2020) as presented in Table 1.1. An expanded mapping built on this is presented in Table 5.1, where a fourth category, *'Fleet Operability'*, has been added in addition to the three originally presented in Table 1.1. This fourth category was added to encompass the organizational hurdles regarding the operability of electric HDTs. Unlike the legacy diesel regime, where vehicle readiness is largely assumed, electric operations require a far tighter coupling between charging management and transport planning to ensure trucks are sufficiently charged and ready for their specific assignments.

Table 5.1: Electric Heavy Duty Freight Planning Complexities and Challenges

Complexity	Planning Challenges
Vehicle and Truck Load Utilization	• Managing two-shift rotations under tighter time constraints • Difficulty securing and planning return loads while balancing limited range and charging stops • Vehicle data fragmentation and accessibility
Route and Charge Planning	• Managing fragmented systems for charge planning not integrated with TMS • Lack of data on whether charging stations can physically accommodate HDTs • Driver "safe-side" over-charging leads to lost operational time and missed cheap overnight charging • Charging queues that disrupt fixed delivery schedules • Vehicle data fragmentation and accessibility
External Conditions	• Seasonal range reduction due to cold or air condition usage • Individual driver behavior • Vehicle data fragmentation and accessibility

Continued on next page

Table 5.1, continued

Complexity	Planning Challenges
Fleet Operability	• Matching mixed fleet specific truck characteristics to specific route assignments • High stakes of charging failure, forgetting to initiate an overnight charge leads to total operational failure • Vehicle data fragmentation and accessibility

5.3 How Challenges Translate Into Software Needs

The planning challenges identified in section 5.2 translate into new software needs among actors. With that being said, those identified challenges do not automatically create demand for the same software across all actors. Instead, software needs vary with electrification maturity, transport complexity, existing system architecture, and general perception of the ability of digital tools to address these challenges. The following analysis bridges these identified challenges with specific software solutions, categorized into subsection 5.3.1 *Dynamic Route and Charge Planning Software* and subsection 5.3.2 *Fleet and Charge Management Software*. This mapping, synthesized in Table 5.2, clarifies how the identified complexities and connected challenges translate into specific software needs. This analysis addresses the perceived software support needs central to *RQ2b*.

Table 5.2: Software Needs Derived from Mentioned Challenges

Complexity	Planning Challenge	Software
Vehicle and Truck Load Utilization	• Managing two-shift rotations • Return loads • Vehicle data	• Dynamic Route and Charge Planning Software

Continued on next page

Table 5.2, continued

Complexity	Planning Challenge	Software
Route and Charge Planning	• Fragmented charge planning systems • Lack of CPO data • Drivers over-charging • Charging queues • Vehicle data	• Dynamic Route and Charge Planning Software
External Conditions	• Seasonal range reduction • Individual driver behavior • Vehicle data	• Charge and Fleet Management Software • Dynamic Route and Charge Planning Software
Fleet Operability	• Mixed fleet truck characteristics • High stakes of charging failure • Vehicle data	• Charge and Fleet Management Software

5.3.1 Route and Charge Planning Software

The challenges identified above translate to operational inflexibility and infrastructure unpredictability. While most actors manage this friction by confining electric HDTs to static "safe" corridors where range and charging are predictable, actors such as *Center* argue that such logic will not be possible in the case of electrifying more dynamic long-haul routes where additional system support in the daily transport planning will be needed. Conversely, actors such as *Cluster* question the necessity of specialized software for route and charge optimization, asserting that charging should remain a driver-led task. They argue that as infrastructure matures and charging speeds increase, the process will mirror the simplicity of traditional diesel refueling.

Charging Infrastructure Visibility and Reservation

A common software need derived from the empirical findings is the consolidation of fragmented charger data into a unified digital interface. Currently, road freight actors typically use OEM platforms or separate public charge finder portals to plan charging. Different systems cover different charging spots and there is a lack of a unified platform covering all charging opportunities for HDTs. *Charter* emphasize the need of such a system where charge reservation should be possible. *Store* identifies unpredictable queues at public chargers as a primary challenge that can throw fixed delivery schedules into total failure. To mitigate this risk, they also express a demand for software that enables digital charge reservations. As *Cooler* highlights, such a system should guarantee specific power output at the booked time to prevent disruptions to driving and rest-time regulations. For a unified charge visibility and booking software to be effective, it also needs to include physical access parameters. Both *Skillet* and *Salt* emphasize that knowing a charger is functional is insufficient if the software lacks data on whether a station can physically accommodate the dimensions and maneuverability of a large trailer setup.

TMS Integration

Rather than working in parallel systems, both *Colossus* and *Cooler* express a desire to have vehicle and charging data integrated directly into their TMS to streamline the workflow. *Cooler* wants to avoid working in parallel systems to for example enable integrated customer bookings to act as the trigger for automated charge booking. *Salt* echoes this, arguing that getting charging stops into the TMS would be preferable. *Curb* identifies a slightly different type of TMS integration where a tool should be able to extract orders from the TMS, optimize them based on electrification suitability, and feed the finalized plan back into the system automatically. This preference for a not fully integrated tool working in parallel with the TMS may stem from the fact that *Curb* currently only operates two electric HDTs, representing a low degree of electrification compared to actors with larger fleets who perceive full system integration as a functional necessity.

Dynamic Charge and Route Optimization

Center, *Charter*, *Store* and *Solvent* take charge planning one step further by arguing that to scale electrification beyond fixed predictable routes, planning software must be able to dynamically plan routes based on new parameters and optimize charging. Charge Optimization is the process of determining the ideal timing, location, and duration of charging sessions during a route assignment to maximize operational efficiency while minimizing costs. For such functionality, the integration of vehicle and charging data into the TMS becomes essential rather than a "nice to have".

Charter argues that charge optimization is necessary to relieve drivers from the stress of planning where and how much to charge. Interestingly, *Colossus* do driver coaching "manually" to overcome the challenge of overcharging at DC fast-chargers, but do not mention the need of such tools. *Store* on the other hand believes charge optimization would take such aspects into account where they argue that the manual work of planning where and how much to charge on road and at home will be unsustainable for a larger fleet. *Solvent* also see the size of the fleet as an important factor where they see a need for more advanced planning software including charge optimization as they aim to scale their electric fleet.

In *Center's* case, their future system is intended to create a continuous digital dialogue between the vehicle and the planning. This allows for automated handling of deviations, such as charging delays or route changes, which currently represent the most significant operational bottleneck to become more flexible in their electric HDT utilization. Dynamic optimized planning that takes charging into account can both facilitate the electrification of dynamic long-haul routes and increased utilization efforts of back-haul volumes. *Center* is building a proprietary, AI-driven tool designed to automate the puzzling of these volumes and provide proactive route suggestions to minimize empty miles where dynamic planning is a necessary complement.

Charter also anticipates that the future will require software to strategically match vehicles to routes based on specific technical characteristics, such as battery capacity and charging speed. As an example, *Charter* foresees that older HDTs with smaller batteries and slower charging may be relegated to simpler, local assignments, while newer models with megawatt charging capabilities are reserved for more demanding long-haul missions. *Store* emphasize the planning systems' role in coordinating dynamic charge planning on routes with charge planning at home based on current SoC and planned departures. This implies a tighter connection between the fleet management, charge management and the daily transport planning. Even though *Charter* argues charge optimization and route planning based on fleet characteristics is necessary, they also emphasize that it is a small requirement in the context of their whole business. Their most critical priority remains increasing the utilization and filling rate of the trucks irrespective of being an electric or a diesel HDT.

Ultimately, although previous research by Zackrisson et al. (2026) points towards a need for new planning tools and algorithms as enablers to large-scale electrification, only a few of the interviewed road freight actors have expressed an urgent need for such tools. A few "nice to have" and "maybe in the future" needs have emerged, but *Center*, *Charter*, *Store* and *Solvent* stand out as proactive actors who are already trying to incorporate dynamic route and charge planning tools. The lack of perceived needs could be explained by some actors not operating routes where dynamic planning is required and/or where charging is mainly done at home, for example *Skillet's*, *Sheet's* and *Stream's* naturally highly static and predictable routes. It could also be unawareness of how software could improve actors' current flows enabling further cost savings or unawareness of what software needs will emerge as they continue scaling their fleet. Current operations are financially viable as customers pay more and the planning is feasible, but the question whether it is as efficient as it could be remains.

Other reasons could be the absence of plans to scale the fleet and scope of operations, or a belief that these tools would not bring any value in practice. *Cluster* and *Colossus* also operate more dynamic long-haul routes similar to *Center* and *Charter*, but argue that these will be difficult to electrify, not because of missing software, but because of a lack of infrastructure, faster mega-watt chargers, economic incentives and current battery ranges. *Center* and *Charter* certainly agree that those factors are important. However, they also view additional software as an additional piece that is needed to unlock the possibility to operate more dynamic long-haul routes. The differences in mindset could be due to different ambitions to electrify in the future where *Center* expresses a mindset to *"not go for what is easy"*. Lastly, the lack of perceived needs could also be due to the skepticism some actors have shown regarding the ability of digital tools to outperform real-world variables processed better by experienced transport planners and drivers. Even though *Charter* argues charge optimization is needed, they remain skeptical to route optimization and other start-up ideas such as automated return-load planning. They argue that while such solutions may seem good in theory, they rarely work in practice today.

5.3.2 Charge and Fleet Management Software

As actors' electrification mature, their roles shift from a pure logistics provider to an active energy manager. This means the firm no longer just manages the movement of goods, but also the timing and intensity of electricity draw. They must now balance delivery deadlines against grid constraints, peak-shaving needs, and fluctuating energy spot prices. This evolution of activities necessitates a new category of software support focused on depot-based energy orchestration, often referred to as a CMS.

Stream, currently operating 23 electric HDTs, manages its charging processes manually and does not yet perceive an immediate need for advanced utility management. By concentrating these vehicles on two-shift regional rotations and controlled long-distance trials, the company currently maintains high utilization through fixed depot-based charging. However, they anticipate that reaching a 100% electric fleet will require smarter prioritization to handle energy requirements. In contrast, *Store*, which operates 35 electric HDTs, has already reached a threshold where manual oversight has become a bottleneck. Their experience suggests that once a fleet exceeds approximately 30 vehicles, a CMS shifts from a nice-to-have to a necessity. This observation is supported by *Store's* peer, a large-scale electric operator, who noted that while small pilots are manageable, a fleet of approximately 30 HDTs marks the point where automated charging management becomes a necessity. The empirical data reveal a pattern regarding when these challenges translate into a software requirement, suggesting a tipping point based on the combination of fleet scale and operational intensity. This indicates that as the electric HDT fleet scale within organizations, manual processes become unsustainable. Consequently, a software need for larger fleets is a link between the TMS and the charging infrastructure to prioritize power delivery based on scheduled departures.

Charge Prioritization and Monitoring

The high stakes of charging failure introduce a need for real-time monitoring and alert systems. *Sheet* and *Circuit* both highlight that a failure to initiate an overnight charge leads to a high-impact operational failure the following day. Such failure could include breaches to contractual customer agreements and stranding of trucks for the duration of a charging cycle. The identified software need here is a centralized digital overview that provides automated alerts if a vehicle fails to charge. For actors like *Circuit*, who are mature in their electrification and operates its own charging infrastructure, this need extends to "shift charging" orchestration. The software must ensure that vehicles are rotated through limited charging points with precision, i.e. minimizing plug-in time through tight sequential scheduling while ensuring sufficient charge. This precision rotation is a task that currently relies on manual monitoring but requires digital integration to ensure 100% readiness.

Energy Optimization

As transport actors integrate more deeply with the energy grid, software needs evolve to include economic energy management. Actors like *Circuit*, *Solvent*, and *Sheet* identify a future requirement for automated grid management to steer charging away from expensive power peaks toward cheaper windows. For pioneers like *Circuit*, who produce their own solar power and use battery storage , there is a need for CMSs that can optimize the consumption of self-produced energy to maximize the economic value of these assets. However, *Circuit's* approach highlights the organizational hurdle of requirements to use a specific, approved TMS due to their deep client partnership. While they see a need for a sophisticated CMS, they did not perceive any value in integrating it to their current TMS that they find outdated. *Circuit* therefore seek this as a separate solution through projects with external partners focused on monitoring of real-time battery status and charging failures. This contrasts *Store's* approach who are instead actively participating in CMS projects that aim to integrate directly into their TMS.

5.3.3 TMS Providers' Perspective

The interviewed TMS providers indicate that while electrification introduces complex planning requirements, current demand from carriers for specialized electric features remains relatively low. The consensus among several TMS providers is that electric operations probably will necessitate advanced planning tools that account for battery capacity, charging, weather, and such. One plausible reason for these needs not being expressed despite the common understanding of additional complexity is the relatively low electrification rate and that this low rate is furthermore within easier application areas such as static distribution routes. This reason was mentioned by *Tile*, but also confirmed in the interviews with carriers and shippers. Currently, the only adjustments have been distance-limit settings in route planning tools to account for range and increased requirements for environmental reporting to track CO2 impact. Consequently, most providers focus on other parts of their product and more urgent customer requests instead of proactively developing future-ready electric capabilities.

5.4 How Software Needs can be Satisfied

The following section analyzes and discusses how certain software needs can be satisfied within road freight actors' current TMS from a *platform ecosystem perspective* including challenges in accomplishing that. Gawer and Cusumano (2014) define a platform as a technological foundation with a modular architecture that enables complementary innovations where the ecosystem constitutes of the interdependent firms involved. In this analysis, the TMSs are identified as the core platform for road freight actors and new niche innovations that Geels (2002) explains challenge the existing regime are identified as potential complements. From the platform strategy lens of Cenamor and Frishammar (2021) TMS actors and complementing actors openness to collaborate is discussed to understand the potential for needs to be satisfied within the same core platform. Furthermore, the discussion will cover alternative paths like building in-house solutions instead and how technological advances are changing the playing field.

5.4.1 TMS as the Core Platform

According to Tiwana (2014), the architecture of a software platform ecosystem consists of a stable core (the platform), a variable set of complementary applications and interfaces through which the core platform and applications are exchanging information (e.g., APIs). As established above, existing TMS solutions today can be categorized as core platforms, providing the foundational administrative infrastructure where integration to external systems is possible to extend the core functionality. As described in subsection 5.3.3, the established TMS providers do not express an ambition to build electric specific software functionality themselves. Instead, they point towards the possibility of integrating external systems using APIs when such need emerge.

Drawing upon the platform strategy framework established by Cenamor and Frishammar (2021), innovation strategies within platform ecosystems are categorized by the distinct roles platform sponsors and third parties play in the development and commercialization of complementary products. In the context of TMSs, an outbound strategy is exemplified when the platform sponsor (the TMS actor) performs the technical development of integrations on request, allowing external road freight actors to utilize this internal expertise to meet specific operational requirements without the sponsor necessarily marketing the integration as a core product feature. While the sponsor does not develop the external feature being connected, the creation of the integration bridge is recognized as the development of a complementary product that enables ecosystem participation. All TMS providers mentioned that they have multiple integrations of this sort, customized to specific road freight actors' needs. Conversely, an inbound strategy refers to a TMS actor commercializing external innovations by incorporating them into the official product description to enhance the platform's value proposition. A clear example of such a strategy is *Table's* and *Transit's* deeper integration of a third-party route optimization tool which work as a plug and play feature for customers. The proprietary strategy in this context implies both developing and commercializing electric features which, as previously said, no one is expressing an ambition to do apart from making smaller changes to range configurations and similar. Lastly, *Token's* strategy of letting customers and third-party actors manage both the development of new features and the integration to their platform could be identified as third-party strategy.

The adoption of strategies involving the platform sponsor (proprietary, inbound, and outbound) can according to Cenamor and Frishammar (2021) generally have higher performance than the third-party strategy where the actors in question outsource both development and commercialization. Therefore, it can be strategically motivated to through an inbound or outbound strategy allow for a broader customer offer without requiring a complete redesign of the core TMS. It can also minimize internal development risks and keep options open, which is necessary to navigate the high technological uncertainty currently surrounding heavy-duty electrification. However, the empirical data reveal that this openness is strictly conditional. *Table*, *Ticket*, and *Tile* explicitly state that standard integrations for electric specific features would be pursued under "broad customer demand". If only a few customers would be interested, *Table* would probably create a project around it which the customer in the end would have to pay for. This can be viewed as a rather reactive approach, probably explained by the fact that electrification has slipped down the agenda in favor of other more immediate concerns noted by *Terminal*.

Moreover, the actual integration openness of the TMS platforms further dissolves due to high transaction and coordination costs of individual integrations which is transitioned to the customer. *Token* explains that even though established TMS providers are open to integrations in theory, it comes with high costs where the customers have to pay for both the development of the integration and then the license to use it. *Token* argues that such friction should not be part of modern digital solutions and are hence building a TMS that apart from including standard integrations also include the possibility to cost effectively build individual integrations yourself. Even though Cenamor and Frishammar (2021) study showed that the third-party strategy generally had lower performance, they also acknowledge that different platform strategies should be used depending on the situation. In *Token's* case one could argue that it is motivated to let third-party actors manage both the development and commercialization of integrations as it is a critical value-adding feature for the customer while core functionality is still kept within the TMS provider's scope.

The mentioned integration costs and TMS providers' general reactivity create a "chicken-and-egg" dilemma where road freight actors need integrated system support to electrify more complex routes, but where TMS providers might not offer such tools in an affordable way until there is a broader demand on the market. Naturally, this demand will not emerge over a night indicating a need for more integrable TMS platforms. Increased integrability could either be reached through more commercially proactive TMS providers, proposing new standardized plug and play integrations in accordance with the inbound strategy or pursuing a third-party strategy like *Token*, letting customers and third-party actors manage both the development of new features and the integration to their platform. Being more proactive as a TMS provider might however be difficult if they cannot economically or strategically motivate cheaper individual integrations or deeper standard integrations where a customer demand has not yet emerged. The discussed dilemma calls for alternative solutions for early electric HDT adopters where *Center* and *Charter* are two examples of actors building in-house solutions instead to meet their current and future needs which is discussed further in subsection 5.4.3.

5.4.2 Complementing Niche Innovations and Vehicle Data

As established above, TMS providers are to some extent open to integrations with third-party solutions. One remaining question is if these external actors exist, in this discussion categorized as niche innovations in accordance with Geels (2002) transition theory. A second question is if these niche innovations can satisfy road freight actors' different software needs where Stål (2026) argue that optimization of different sorts risks resulting in plans that are technically feasible but in practice unrealistic as there are new technical, relational, and organizational constraints on electric truck utilization.

The interviews revealed how there are several innovative actors out there who are prepared to satisfy additional needs connected to the electrification. The name of these specific actors are anonymized in Chapter 4, but described here where connection to different road freight actors can be kept out. Firstly, for electric route planning and optimization, apart from the simulation capability the OEM platforms have, road freight actors and TMS providers have mentioned start-ups such as *BEV_R*, *Lots pathfinder* and more established route planning actors such as *PTV* who take electric parameters into account in their route optimization. Secondly, for finding public charging, road freight actors have used a diverse array of platforms such as different OEM platforms, *ChargeFinder*, *Lastbilsladdkartan*, developed within Project TREE (Danebergs, 2025), and *Google Maps*. While *Charter* argue that there is currently no comprehensive, functioning platform for finding booking public charging, BEV_R is actively working to bridge this gap. Their ongoing work focuses on a platform that allows for the sharing and booking of depot, public, and semi-public infrastructure (BEV_R, n.d.). Thirdly, for charge management systems, road freight actors have mentioned *Erinion* and *ChargeEye* where it is possible to monitor chargers remotely and balance power distribution to ensure vehicles are charged efficiently without overloading the electrical grid. Few actors have however reached the state where charge management is found necessary.

Another important complementing actor are OEMs or third-party FMSs where important vehicle data can be retrieved, but where most actors today work separately with their TMS and FMS. Most actors use OEM platforms as their FMS, but a few have adopted or are discussing external third-party solutions. Road freight actors such as *Cooler* and *Colossus* have had dialogs about integrating their vehicle data into their TMS from the OEMs. However, both road freight actors and TMS providers have commented the issue of getting OEMs to share data as they want to monetize on their platform and data retrievals. Operating a multi-brand fleet adds complexity by requiring communications with multiple actors and the reconciliation of diverse data formats. As a consequence, *Charter* bought and implemented their own telematics and a unified fleet management system which they now can easily integrate with their TMS to satisfy their needs.

Some road freight actors are already in active discussions with these companies, but it remains to be seen how the success of solutions and current fragmentation of the ecosystem will play out. One important issue for the route planning and optimization tools is the quality of input order data. The TMS provider *Table* find their bargaining power towards customers weak where it is difficult to force them to follow a standardized order format. This highlights the need for freight buyers to also adapt their processes so that new innovations can reach their full potential and facilitate the electrification. Another issue is making optimized plans realistic in practice which Stål (2026) emphasizes. Road freight actors such as *Curb* have tried new solutions for electric transport planning provided by emerging start-ups, but found it unsuitable in practice for their distribution-focused business. *Charter* gave the same platform and route optimization tools in general critique for not working in practice as they are too rudimentary to handle the hundreds of real-world variables processed better manually by transport planners, arguing that many of these tools do not bring any value at the moment.

The interview findings also demonstrate the central dilemma Cenamor and Frishammar (2021) discuss where actors complementing each others platforms collaborate in some contexts, but also compete in others. For software solutions such as electric route planning and optimization, vehicle data is an important aspect. The proprietary nature of data however make it a strategic asset for OEMs which they rather keep to themselves to monetize on data retrievals and their own platforms. Consequently, satisfying software needs for electrification requires not only a platform open to integrations, but also actors willing to share data and complement the core platform, preferably in a standardized format. *Tile* argue more standardized data should be legislated where *Charter* are actively pushing this question on a political level. This underscores the systemic scale of the challenge, as stakeholders across the entire transport hierarchy acknowledge that these data silos represent a bottleneck. It also suggests that Geels' (2002) concept of landscape pressures should not only be placed on the direct procurement of electric HDTs, but also on the surrounding ecosystem. This includes addressing operational concerns such as data availability to accelerate the transition.

5.4.3 In-House Solutions

Carriers and shippers have increasingly adopted build instead of buying strategies to address the perceived capability gap within the current transport management market. By internalizing the development of the core platform and partner up with actors for niche applications such as electric route planning and optimization, firms such as *Charter*, *Center*, and *Solvent* ensure that their system aligns precisely with their specific operational requirements. Furthermore, the lack of integration between transport planning and energy management has led some shippers to initiate their own partnerships where *Store* is currently engaged in a project to develop a CMS that can push real-time battery data directly into their shipper TMS. These efforts suggests that standard market solutions today fail to integrate the complex parameters necessary for these early adopters to continue scaling their electric fleet.

5.4.4 Future AI Capabilities and Technology

Even though *Charter* expressed skepticism towards existing optimization tools, they acknowledges that the ideas are valid and remain open to integrate them in the future as performance increase. *Charter* argues that AI is the "joker" in this where technological progress might improve these tools significantly in the future. Apart from *Charter's* input, the empirical data cannot yet confirm any success cases when it comes to these new software for planning electric transport as they are still in their infancy. One hypothesis is that some of the more advanced software needs will be difficult to satisfy today, but future AI capabilities will be able to address it.

Future technology might also lead to more actors satisfying software needs in-house. *Center* mentioned how transport planners have been able to leverage AI tools to automate processes. This possibility for non-coders to build solutions through "vibe coding" have been unlocked by AI and will most likely become even more accessible in the future as the technology advances.

It is not only AI technology that is getting better and unlock new opportunities. Several actors such as *Cluster* have mentioned the development of better hardware in terms of larger batteries and faster chargers so that range is increased and time for charging decreased. *Cluster* argues that as these batteries and chargers become more accessible, there will be a different discussion. Hardware advancements could for example transform the distribution segment by enabling even the longest routes to be managed solely with depot-based or 'home' charging. The software needs identified in this report will likely remain relevant, but technological change might alter the specific parameters that these software solutions must address.

6

Conclusion and Future Research

This chapter returns to the aim and purpose of the study to conclude what the demand for additional system support in transport planning of electric HDTs looks like and how such demand can be met. Furthermore, suggested future research is presented.

6.1 Conclusion

The overall aim of this study is to explore the demand for additional system support in the transport planning process of electric vehicles within the Swedish heavy-duty road freight industry and to investigate how such demand can be met. The research concludes that while actors' current planning processes remains sufficient for small-scale operations on static routes, two distinct categories of system support become critical as fleets scale and operational complexity increases. Firstly, route and charge planning software is required to become more flexible and cost- and time-effective in operations. Such planning software includes a unified interface for finding and reserving chargers, and dynamic charge optimization to plan optimal charging stops for a route based on parameters such as cost, battery range, and driver rest requirements. Secondly, charge management systems (CMS) serves as a specialized energy orchestration tool for depot-based prioritization, ensuring vehicles are charged efficiently based on scheduled departures and grid constraints.

The current or future need of CMSs was expressed among actors with fleets of over 20 electric HDTs. This indicates that such a need emerges as an electric fleet grows where planning becomes more complex and suboptimal charge management implies higher costs. The same distinct pattern could not be seen when it comes to route and charge planning software. Despite previous research indicating a need to optimize planning and charging to enable large-scale electrification, empirical findings reveal a fragmented landscape of perceived needs. Only a small group of proactive actors seeking to move beyond fixed corridors currently express a clear demand for dynamic route and charge planning tools. For many others, the perceived need remains low, either because they mainly operate highly static and predictable routes where existing manual processes works or because there is an absence of immediate scaling plans, both in terms of size and scope of operations. The research could also identify a general skepticism regarding the ability of digital tools to outperform the real-world variables processed by experienced transport planners and drivers. Whether this is true or if road freight actors are missing out an opportunity to cut costs due to unawareness about the potential to enhance current planning remains a question for future research.

Regarding how these needs can be satisfied, the study highlights a significant gap between actor preferences and current market offerings. Most road freight actors prefer to manage all operations within a single TMS to maintain a unified workflow. However, established TMS providers do not currently prioritize the in-house development of electric-specific features or establishment of any standard integrations to third-party tools as they do not perceive a demand from their customers. Consequently, the early adopters' system needs can primarily be met through individual integrations of third-party solutions which are costly. Due to these systemic frictions, several early adopters have begun to internalize development by building in-house solutions to ensure their systems align precisely with their complex operational requirements. Not all actors will however have the resources to build in-house solutions, indicating a need of more integrable TMS platforms.

Reflecting on the broader context of electrification, these findings indicate that the industry is in an early reconfiguration phase of a sociotechnical transition. While a fundamental mismatch exists between the dominant diesel-oriented regime and the requirements of emerging electric niche innovations, this has not yet led to major operational struggles because current deployment is largely confined to "safe", predictable routes. However, dynamic long-haul routes represent the primary case where electrification remains difficult, indicating that as the transition continues, more systems currently built for the diesel regime must be adapted. This transition is currently hindered by a "chicken-and-egg" dilemma: while advanced software is a prerequisite for making dynamic long-haul routes feel feasible according to some actors, such tools may not be broadly available within TMSs before a market demand exists, yet that demand will not materialize until those complex routes are electrified. This calls for proactive coordination and collaboration between actors in the road freight ecosystem so that steps in the right direction can be taken together.

6.2 Future Research

Based on the results, further research should be conducted to engage with other critical ecosystem actors, including original equipment manufacturers (OEMs), charge point operators (CPOs), and innovative software start-ups, to incorporate their perspectives on barriers to electrification and where additional software can support. Additionally, further inquiry is needed for transport actors who have invested in their own charging infrastructure, as the shifting role of these actors toward energy management necessitates a re-evaluation of their specific software support needs and the potential synergies between infrastructure ownership and logistics planning. The most immediate synergy discussed is the ability to align charging speeds at home depots, taking route assignments including departure urgency into account. Looking ahead, the research scope of this paper should be reassessed as the transition continues. With time, remaining questions will be answered such as reasons for some actors not perceiving a need of additional software and if innovative solutions will fully satisfy identified needs.

Finally, the scope of investigation should be expanded to other types of road freight actors and geographical areas beyond the Swedish market to assess the generalizability of these findings to other types of transport flow and international transport networks. This research covers actors already electrified and many of those within the fast moving consumer goods segment. Actors within other segments that have not been able to electrify are also of interest for future research as more difficult dynamic planning and lack of supporting software could be a reason for this. In terms of other geographical markets, Stål's (2026) research points out the significant difference in electric HDT utilization between Sweden and China, and argue that the ability to generalize across markets is limited. Therefore, more research is needed to understand how geography and infrastructure density impact perceived planning complexity. Additionally, studies should investigate how industry dynamics, such as carrier consolidation and available TMS solutions, differ across markets.

References

Akther, A., Polisetty, M., Lynch, C., Sharpe, S., Nijsse, F., Murphy, A., … Rodriguez, F. (2025). *Driving the Transition to Zero-Emissions Trucks* (Tech. Rep.). Economics of Energy Innovation and System Transition.

Al-dal'ain, R., & Celebi, D. (2021, 10). Planning a mixed fleet of electric and conventional vehicles for urban freight with routing and replacement considerations. *Sustainable Cities and Society*, *73*. doi: 10.1016/j.scs.2021.103105

Basso, R. (2017). *Route planning and energy consumption estimation for electric commercial vehicles* (Tech. Rep.).

Bell, E., Bryman, A., & Harley, B. (2019). *Business research methods.* Oxford University Press.

BEV_R. (n.d.). *Accelerating Heavy Vehicle Electrification.* Retrieved from `https://bevr.se/`

Bluegistics. (n.d.). *TMS Trends 2026: The Future of SaaS Software for Transportation Management.* Retrieved from `https://bluegistics.com/trends-tms/`

Cenamor, J., & Frishammar, J. (2021, 1). Openness in platform ecosystems: Innovation strategies for complementary products. *Research Policy*, *50*(1), 104148. doi: 10.1016/j.respol.2020.104148

Danebergs, J. (2025, 11). *Här laddar du lastbilen – ny karttjänst visar vägen.* Retrieved from `https://www.skogforsk.se/lastbilsladdkartan`

Eriksson, A., & Pernestål, A. (2025, 12). Power demand and queuing at heavy truck semi-public charging points: forestry transport as a case study. *European Transport Research Review*, *17*(1). doi: 10.1186/s12544-025-00744-7

European Alternative Fuels Observatory. (2026a, 5). *European Union (EU27).* Retrieved from `https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/vehicles-and-fleet`

European Alternative Fuels Observatory. (2026b, 4). *Sweden.* Retrieved from `https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/sweden/vehicles-and-fleet`

Eurostat. (2024, 8). *Road freight transport by journey characteristics* (Tech. Rep.). Eurostat. Retrieved from `https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_freight_transport_by_journey_characteristics#Data_sources`

Gawer, A., & Cusumano, M. A. (2014). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management*, *31*(3), 417–433. doi: 10.1111/jpim.12105

Geels, F. W. (2002). *Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study* (Vol. 31; Tech. Rep.).

Goel, A. (2008). *Fleet Telematics* (Tech. Rep.). Springer Science.

Hakansson, H., & Snehota, I. (1997). *Developing relationships in business networks.* International Thomson Business Press.

IBM. (n.d.). *What is a transportation management system (TMS)?* Retrieved from `https://www.ibm.com/think/topics/transportation-management-systems`

International Renewable Energy Agency. (2026, 3). *Heavy-duty trucks.* Retrieved from `https://www.irena.org/Decarbonising-hard-to-abate-sectors-with-renewables-Enablers-and-recommendations/Transport-sector/Heavy-duty-trucks`

ITF. (2023, 5). *ITF Transport Outlook 2023* (Tech. Rep.). Paris. Retrieved from `https://www.oecd.org/en/publications/itf-transport-outlook-2023_b6cc9ad5-en.html` doi: 10.1787/b6cc9ad5-en

Karlsson, J., & Grauers, A. (2023, 3). Case Study of Cost-Effective Electrification of Long-Distance Line-Haul Trucks. *Energies*, *16*(6). doi: 10.3390/en16062793

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry.* Newbury Park, CA: Sage Publications.

Linköpings Universitet. (2026, 3). *Ruttplanering av tunga elektriska fordon.* Retrieved from `https://liu.se/artikel/ruttplanering-av-tunga-elektriska-fordon`

Mattsson, S., & Jonsson, P. (2016). *Logistik - Läran om effektiva materialflöden* (3rd ed.). Studentlitteratur.

McCrea B. (2026, 1). *Nine Trends Shaping the Future of Transportation Technology.* Retrieved from `https://www.supplychain247.com/article/tms-2026-transportation-tech-trends`

Nettsträter, A., Geißen, T., Witthaut, M., Ebel, D., & Schoneboom, J. (2015). Logistics Software Systems and Functions: An Overview of ERP, WMS, TMS and SCM Systems. In *Cloud computing for logistics* (pp. 1–11). Springer International Publishing Switzerland. doi: 10.1007/978-3-319-13404-8{_}1

Perger, T., & Auer, H. (2020, 12). Energy efficient route planning for electric vehicles with special consideration of the topography and battery lifetime. *Energy Efficiency*, *13*(8), 1705–1726. doi: 10.1007/s12053-020-09900-5

PTV Logistics. (2025, 7). *Diesel fleet vs EV route planning: What's different and why it matters.* Retrieved from `https://blog.ptvlogistics.com/en/transport-logistics/diesel-fleet-vs-ev-route-planning-whats-different-and-why-it-matters/`

Ragon, P.-L., & Rodríguez, F. (2022, 9). *Road freight decarbonization in Europe: Readiness of the European fleets for zero-emission trucking* (Tech. Rep.). The International Council on Clean Transportation. Retrieved from `www.clean-trucking.eu`

SAP Learning. (n.d.). *Evaluating Transportation Management.* Retrieved from `https://learning.sap.com/courses/charges-and-settlement-in-sap-s-4hana-transportation-management-jp/evaluating-transportation-management`

Stål, J. (2026). *Exploring Electric Truck Utilisation in Business Networks* (Tech. Rep.).

Tano, B., & Pettersson, H. (2026, 3). *Lastbilstrafik.* Retrieved from `https://www.trafa.se/vagtrafik/lastbilstrafik/`

Tiwana, A. (2014). *Platform Ecosystems.* Elsevier. doi: 10.1016/C2012-0-06625-2

Vargas-Bianchi, L. (2025, 3). Pattern matching analysis: Overview of its rationale and application in qualitative research. *Methodological Innovations*, *18*(1), 66–75. doi: 10.1177/20597991251325451

Viseo. (2026, 2). *Transport Management System (TMS): a Comprehensive Guide on How to Optimise Transport Operations.* Retrieved from `https://www.viseo.com/insights/transport-management-system-tms-a-comprehensive-guide-on-how-to-optimise-transport-operations/`

Yin, R. K., & Campbell, D. T. (2018). *Case study research and applications : design and methods* (6th ed.). SAGE Publications, Inc.

Zackrisson, A., Engholm, A., Bengtsson, T., Link, S., & Plötz, P. (2026). Quantifying the impact of fleet planning re-optimization on truck electrification in distribution logistics. *npj Sustainable Mobility and Transport*, *3*, 23. doi: 10.1038/s44333-026-00091-7

Zijm, H., Klumpp, M., Regattieri, A., & Heragu, S. (2019). Operations, Logistics and Supply Chain Management. *Springer Nature.* doi: 10.1007/978-3-319-92447-2

A

Interview Guides

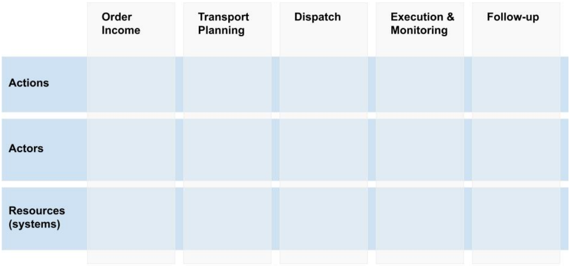
This appendix presents the interview guides utilized for the primary data collection phase of this study. The questions provided in the following sections were tailored to each specific actor category to capture their unique operational perspective, and are hence divided into section A.1 *Road Freight Actors* and section A.2 *TMS Providers*.

A.1 Road Freight Actors

1. **Introduction**
    - Who are you and what is your role?
    - What types of transport services do you sell/operate?
    - How large is your total HDT fleet?
    - What proportion and which of the transport activities are managed in-house versus outsourced?

2. **Degree of Electrification**
    - How many electric HDTs do you operate today?
    - Are there any outspoken future goals in terms of electrification?
    - What types of routes are today operated by your electric trucks?
        - Why were these specific routes chosen?
    - Do you charge at your own depots or terminals?

3. **Transport Planning Process**
    - Based on the presented matrix, please walk us through your current transport planning process for diesel vs electric HDTs.



	Order Income	Transport Planning	Dispatch	Execution & Monitoring	Follow-up
Actions					
Actors					
Resources (systems)					

4. **Challenges and Opportunities**
    - What do you see as the greatest challenges with transport planning for electric vehicles today and in the future?
    - What aspects of your current systems and planning processes work less effectively when handling electric vehicles?
    - How do you foresee your planning process needing to change if the majority of your fleet (and routes) becomes electric?
    - Do you see a need for new tools or new functionality to manage these challenges?
        - What type of tools/functionality?
        - How do you believe these should be integrated with the remaining systems you use?
    - What challenges do you foresee in implementing new tools and functionality?

A.2 TMS Providers

1. **Introduction**
    - Who are you and what is your role?
    - What types of transport management systems do you sell?
2. **Emerging Customer Needs**
    - Do you experience any emerging customer needs related to electrification?
        - What needs?
    - How do you meet or plan to meet these emerging needs?
3. **Partnerships and External Integrations**
    - How do you currently work with partnerships and external integrations?
    - What external systems are you integrated with?
    - How are these integrated?
4. **Challenges and Opportunities**
    - What are challenges and opportunities to collaborate with external partners to meet specific planning needs for electric fleets?

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SUPPLY AND OPERATIONS MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY