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Designing a framework of KPIs to measure and evaluate electric road freight

A qualitative study of the market perspectives

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Abstract

The electrification of the road freight sector has been visible in society during the last couple of years, where several companies have started to offer electric solutions. Further, this is due to an increased awareness of the negative impact of transport on the environment. However, Key Performance Indicators (KPIs) for evaluation and benchmarking have not kept up with the transition, creating a problem for new electric solutions to be communicated and understood.

The following study has been conducted with a Partner Company, which is a Swedish company that currently offers electric transport. The Partner Company experiences a knowledge gap regarding which KPIs transport buyers follow up, whereas they want to know which KPIs are demanded when going electric. Therefore, a framework of KPIs could facilitate communication between stakeholders on the market and, with some adjustments, also be tailored to fit the Partner Company's business. *The purpose of the study is thus to design a framework of KPIs to measure and evaluate electric road freight and further adjust the framework to Partner Company.* Developing a framework of KPIs requires structuring the constituent parameters to ease usability and practical applicability. The literature highlights that designing a framework can be done by determining KPIs, characteristics of the KPIs, and an appropriate categorization. Therefore, literature was studied regarding transport, KPIs, and processes of developing frameworks of KPIs. Together with the literature and the background, the process developed further acted as a basis for developing the study's three Research Questions, aiming to ease answering the study's overall purpose. The first Research Question is based on understanding traditional, fossil-driven road freight. The second Research Question aims to design a framework connected to electric road freight. When answering these questions, empirical data consisted of semi-structured interviews with transport buyers, transport providers, associated organizations, OEMs, and internal interviews at the Partner Company. The data collected was further analyzed to enable answering the Research Questions. Furthermore, the third Research Question intended to adjust the framework to fit the Partner Company, where a workshop with the Partner Company acted as empirical input and, together with an analysis of answers, further answered the last Research Question.

The framework developed was designed to facilitate communication between transport providers and transport buyers. Therefore, it was essential to capture transport buyers' concerns, level of knowledge, and maturity regarding electric road freight and match the needs with the transport provider's offers.

After analyzing empirical data validated by literature, a cross-functional categorization of the framework could be made. KPIs were selected and assigned in the constituent categories of Delivery service, Costs, Operational electric, Planning and optimization, and Environmental impact. Furthermore, several characteristics were applied to each of the included KPIs, where important characteristics are; based on data, traceable, transparent, and market-oriented. In order to meet the study's purpose, the framework was further adjusted to the Partner Company. The adjusted framework created a clear structure to facilitate when the Partner Company communicates KPIs with transport buyers. Several KPIs are recommended to be raised to solely build trust during the sales process. Other, more operational KPIs should be used by existing customers when following up the transport activity, and some KPIs should be written when the Partner Company contracts with new customers. In conclusion, the study's purpose was achieved, as the framework developed is considered to facilitate the measuring and evaluation of electric road freight. The generalizability of the framework enables stakeholders in the market to further apply it within their businesses. The framework reduces the knowledge gap and increases communicability for improved benchmarking. Further, as the framework can act as a standard, the understanding of electric road freight can increase, something the study's problematization was intended to facilitate.

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Chapter 1

Introduction

This chapter aims to give the reader an introduction to why this study is of common interest in the broader industry of electric road freight. The background focuses on the need to use the right KPIs in the proper context, which a broad audience in the market understands to evaluate electric road freight. The study formulates along with the study's purpose and contribution. The chapter concludes with a discussion on the study's delimitation, followed up with an outlining of the disposition of the study.

1.1 Background

Historically, road freight has been evaluated using Key Performance Indicators (KPIs), developed when fossil fuels primarily supplied the vehicles. When considering traditional, fossil-driven road freight, a prominent focus has been on reducing costs while maintaining a high delivery service, which explains why KPIs linked to cost and service have dominated when benchmarking (Lukinskiya and Pletneva, 2018; McKinnon and Ge, 2007). Furthermore, the purpose of KPIs is to ease the understanding of road freight performance on the market (Lukinskiya and Pletneva, 2018). In turn, KPIs should be based on a certain number of characteristics that determine how KPIs properly should be used and subsequently developed when a new solution requires measurement and, thus, evaluation. In addition, KPIs are usually categorized and structured in a framework to facilitate their use and communication as they are put in the proper context for stakeholders evaluating the transport activity (Prause and Schröder, 2015; Kurdve and Wiktorsson, 2013; McKinnon and Ge, 2007; Kaparias and Bell, 2011).

The rapid development of electrifying the road freight sector has been witnessed in recent years as a consequence of the technological shift, with a significant focus on reducing environmental impact (Brolin, 2020). As a result, many market players have started to convert to electric vehicles, and new entrants have emerged, being an early adopters focusing on optimized electric solutions. In 2019, 2.5 % of the world's total road freight market share was electric (Hertzke et al., 2020). However, the forecast predicts that the absolute number will increase to 56 % within the next 20 years, something that will require a significant shift for stakeholders in the road freight sector (Dahlsten and Thorsell, 2020). Even though the electrification of road freight is seen as crucial in reducing society's carbon footprint, it is also seen as one of the biggest challenges to achieving a sustainable future (Nagel et al., 2019). Therefore, the electrification of road freight is complex and requires a change in both the perception and evaluation of traditional fossil-driven road freight. Further, to monitor and adapt to electrification, new standards for KPIs need to be introduced, underlining the importance of a better understanding of measuring, optimizing, and implementing new solutions (Dahlsten and Thorsell, 2020). Furthermore, Monios and Bergqvist (2019) stress that these adaptations and changes are necessary to reflect in a framework of KPIs for a benchmark; otherwise, the KPIs will lose their relevance. Therefore, to use KPIs when benchmarking requires that KPIs are adapted and adjusted to correspond to the current environment and to be relevant to the purpose of the measurement (Monios and Bergqvist, 2019). Furthermore, McKinnon and Ge (2007) stress the importance of KPIs being developed and compiled at an industry-wide level to be adapted to all stakeholders and thus reflect the electric road freight sector.

The Swedish company, referred to as Partner Company, has advanced road freight during the last couple of years, focusing on fully electrified solutions (Chief executive officer, 2022). However, the company experiences a poor alignment of KPIs between what is documented and reality, as KPIs still mainly reflect how traditional, fossil-driven road freight powered by a combustion engine, is measured and evaluated. Furthermore, this is considered a consequence of relatively low market maturity and understanding of electrified road freight (Operation analyst, 2022). To disseminate knowledge related to the transition of the whole industry, suitable KPIs should be communicated and put in a framework where a proper categorization and characteristics application could facilitate transparency between stakeholders in the market. Furthermore, Partner Company's business model is based on offering transport as a service (TaaS), where Chief executive officer (2022) further manifests a challenge in adequately communicating the concept to the market. Thus, a framework of KPIs linked to electric road freight would need to be adapted to Partner Company's unique offering to best impact society to transition towards a greener future.

To conclude, better formulated and properly communicated KPIs adapted to electric road freight can improve market understanding and enable partnerships between transport buyers and providers. Furthermore, a framework can facilitate understanding of how the market can evaluate and benchmark with proper categorization. This study, therefore, aims to explore which KPIs and what characteristics such KPIs could have in a designed framework of categorization linked to electric road freight.

1.2 Purpose

Derived from the background, the aim of this study is as follows:

> *The purpose of this study is to design a framework of KPIs to measure and evaluate electric road freight and further adjust the framework to Partner Company.*

1.2.1 Contribution

This study provides a theoretical contribution by identifying traditional KPIs used within the fossil-driven road freight sector, to understand today's situation, and further demanded KPIs for electric road freight. Therefore, two frameworks will be presented, one for electric road freight and one adjusted to Partner Company's business. The focus will primarily be on designing a framework that a broader market can adapt, enabling a common understanding in the market, focusing on transport buyers' demands and requirements when evaluating electric road freight. However, to enable the framework's applicability, it needs to be adjusted to fit the environment within a specific company. Therefore, the framework designed will further be adjusted to fit Partner Company's business, where included KPIs, connected characteristics, and the categorization structure are adjusted, enabling a tailored and eased adaption of the framework that fits Partner Company's demands.

To sum up, with validation of the literature review, the study will contribute with an empirical point of view that captures both Partner Company's and the market's perspective on KPIs reflecting the electric road freight sector.

1.3 Delimitations

The electrification shift is currently progressing across industries worldwide (Brolin, 2020). However, this study will be delimited to investigate the Swedish road freight sector while collecting empirical data from stakeholders. The delimitation will ease the understanding as the investigation focuses on a targeted region, enabling it to deeply capture how the sector operates and draw conclusions related to Swedish regulators and infrastructure. This delimitation has been made because the Swedish market is far ahead in developing electrified road freight, where an exploratory study is well suited to be carried out (Monios and Bergqvist, 2019). Additionally, the delimitation has been made because Partner Company is based in Sweden and has its headquarters and largest market shares in Sweden. Thus, the result of the study could be applied to other markets as well.

The investigation of KPIs will focus on road freight on both regional and national levels, where the purpose of the transport is to move goods between cities and hubs. This type of transport, often called long-haul transport, is Partner Company's primary focus, which justifies the delimitation. Long-haul road freight is currently 10 % of traffic on public roads but stands for about 40 % of CO_2 emission caused by traffic (Transportföretagen, 2020). Reducing this number by the electrification will significantly affect the environmental impact. There are no specific route lengths specified in this study's concept of long-haul transportation, but will not include cities and urban areas.

Furthermore, this study will be delimitated to electric road freight. The study will focus on electrified transportation since the electrification shift is ongoing and the appropriate first step towards changing the way of transport, making it more sustainable (Dahlsten and Thorsell, 2020). Further, the study will only focus on full battery electric road freight, operating solely on the electricity stored in the battery, i.e., no hybrids or other power sources. The charging could rely on both public and private infrastructure for charging. This delimitation has been made because Partner Company only uses batteries as energy storage in their electric vehicles. In contrast, it would be challenging and too broad to collect enough empirical data to answer the study's purpose if focusing on other power sources than batteries.

1.4 Disposition

Chapter 1 - Introduction
This chapter aims to give the reader an introduction to why this study is of common interest in the broader industry of electric road freight. The background focuses on the need to use the right KPIs in the proper context, which a broad audience in the market understands to evaluate electric road freight. The study formulates along with the study's purpose and contribution. The chapter concludes with a discussion on the study's delimitation, followed up with an outlining of the disposition of the study.

Chapter 2 - Company description
This chapter describes Partner Company and its current situation. All information gathered throughout this chapter is based on unstructured, internal interviews unless otherwise stated. Initially, an overall description of Partner Company's business is presented, followed by a business model description, including Partner Company's digitalization and electrification. The chapter concludes by presenting currently used KPIs within Partner Company and a problem description.

Chapter 3 - Frame of reference
This chapter presents the structure of the frame of reference, followed by the relevant literature to answer the study's purpose. The literature is built up of two main areas: transportation and Key Performance Indicators (KPIs).

Chapter 4 - Task specification
This chapter first describes the studied system on which the study has focused. The purpose further breaks down into three main areas with support from relevant literature. These areas further include questions, comprehensive Research Questions, and Sub-questions, which form the basis for answering the study's purpose. The chapter concludes by presenting a summary of the Research Questions and Sub-questions.

Chapter 5 - Methodology
This chapter presents the study's methodology and the approaches taken in the study. The chapter describes the methods based on findings in the literature, where the research design builds up in three phases. Further, each phase will be presented separately, highlighting each phase's elements in detail. In each phase, a discussion regarding the study's credibility transpires to clearly describe the work to achieve credibility and the ethical guidelines followed. The chapter concludes by presenting a reflection on the methodology.

Chapter 6 - Findings and analysis
This chapter presents empirical data and further analysis of the study's finding. The chapter is structured on the three main areas where each area connects to the Research Questions developed. First, the identification of traditional road freight frameworks of KPIs will be described, then a description of how a framework could be developed, including KPIs connected to electric road freight, before concluding the chapter by presenting how the framework could be adjusted to Partner Company.

Chapter 7 - Conclusion
This chapter describes the study's conclusion and thereby fulfills the study's purpose, i.e., to design a framework of KPIs linked to electric road freight, and further adjust the framework to the Partner Company. Answering the purpose of the study can be done by answering the three Research Questions and the connected Sub-questions. Further, this is done by first describing which KPIs exist in traditional road freight, which characteristics these usually have, and how such KPIs are typically categorized in a framework. After that, it is clarified which KPIs are included in the developed framework, what characteristics they have, and how they are categorized to fit electric road freight. Lastly, the chapter presents the adjusted framework to the Partner Company.

Chapter 8 - Discussion
This chapter discusses the results from the study by presenting general discussions on the methodology, where the empirical collection, subjectivity aspects, and other aspects related to methodological choices are highlighted. The chapter concludes by discussing the work in a broader context, thus future studies.

Chapter 2

Company description

This chapter describes Partner Company and its current situation. All information gathered throughout this chapter is based on unstructured, internal interviews unless otherwise stated. Initially, an overall description of Partner Company's business is presented, followed by a business model description, including Partner Company's digitalization and electrification. The chapter concludes by presenting currently used KPIs within Partner Company and a problem description.

2.1 The Partner Company

The Partner Company is a Swedish company, operating with electric vehicles (Partner Company, 2021). Being an early adopter, Partner Company is considered to be at the forefront, driving the electrification transition in the transport sector, where its goal is to offer an improved solution with less environmental impact that favors the whole transport sector (Operation analyst, 2022).

Electric vehicles and the Partner Company's software platform is currently in live operation, but the company strives to grow and further expand their operation in the upcoming years (Chief executive officer, 2022). Partner Company's Chief executive officer (2022) argues that when comparing Partner Company's business model with traditional, fossil-driven road freight, going full scale, CO_2 emission can be reduced by almost 90 % at the source. Further, in comparison to fossil-driven road freight, Partner Company's solution strives to be beneficial both when comparing CO_2 emission from fuel consumption and lowering costs related to labor, taxes, and maintenance over time (Senior logistics strategist, 2022).

2.2 Business model

Road freight has traditionally been seen as a movement of goods from place A to B, being reliant on parameters such as distance, volume, weight, fuel, and utilization (Senior logistics strategist, 2022). Further, Partner Company's offer, Transport as a Service (TaaS) is currently dependent on physical factors such as electric vehicles, an established network of charging, infrastructure, and non-physical factors such as intelligent technology through their software platform .

Partner Company is offering their service monthly, whereas customers usually sign long-term contracts (Chief executive officer, 2022). Partner Company and the customer formulate a Service Level Agreement (SLA) during the sales process, where both parties negotiate regarding service promises. The SLA between customers, i.e., transport buyers and Partner Company, involves moving a volume from sites A, B, and C to D, collecting and arriving on time hh: mm - hh: mm, on the conditions of 1, 2, and 3 (Operation analyst, 2022). When it comes to SLAs, Partner Company is working a lot with tailor-made solutions in a close relationship with their customers to reach a high level of customization (Operation analyst, 2022). However, TaaS has a few general parameters always included in the SLA, which however change over time as Partner Company develops. Today, the basic parameters included in the TaaS are (Operation analyst, 2022):

> *A fixed, minimum volume is shipped with electric vehicles at a monthly cost with a predetermined frequency on available infrastructure.*

Customers
Partner Company's customers are transport buyers. Customers are indirectly cooperating with Partner Company for marketing Partner Company as well as themselves for being pioneers of the electrification of road freight (Head of customer deployment and operations, 2022). Today, the customers are included within Partner Company's transport system to the fullest extent possible, starting with electrified road freight on the most optimal routes. As the Service Level Agreements (SLAs) between Partner Company and the customers is a partnership contract, a long-term relationship is preferable, with the shared aim to scale the customer's solutions together as society's coverage of the electric network expands (Head of customer deployment and operations, 2022).

Partners
Partner Company, besides customer cooperation with transport buyers, also has partnerships with other stakeholders, called *Partners* (Operation analyst, 2022). Today, Partner Company's partners exist in *Carriers*, *Charging*, *Manufacturing*, *Service*, *Engineering*, and *Finance*. These partners deliver and perform daily operations to Partner Company's customers, following the agreed SLA between Partner Company and each of Partner Company's customers. There are agreements between Partner Company and each partner describing what the partner will contribute to Partner Company's TaaS offering to customers (Head of customer deployment and operations, 2022).

External stakeholders
It is also important to cooperate with other companies outside Partner Company's business model. The companies of most relevance to cooperate with are other *transport providers*, *associated organizations* working with electrifying the road freight sector, *original equipment manufacturers (OEMs)* and *transport buyers* (Operation analyst, 2022). These collaborations could enable the expansion of the whole network for electric road freight (Head of customer deployment and operations, 2022). According to Chief executive officer (2022), partnerships are crucial for continuous scale-up due to the need for a joint effort to make electrification possible. See an overview of Partner Company's business model in Figure 2.1.

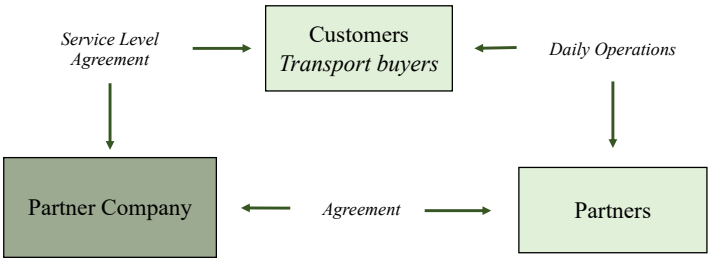

Figure 2.1: The Partner Company's business model.

2.2.1 Digitalization

Digitalization is a part of Partner Company's offer and facilitates optimization of electric road freight, as electric operation is complex and dependent on a number of external factors with a high implication on daily performance (Operation analyst, 2022). Digitalization enables data to be collected, maneuvered, and controlled, and therefore helps optimize routes and an improving business (Chief product officer, 2022). The idea is a seamless transport system, supported by real-time transport data (Head of customer deployment and operations, 2022).

Partner Company considers transport data parameters as essential input parameters to optimize customer routes. These input parameters will play an essential role in the efficiency and output of Partner Company's road freight solution (Head of customer deployment and operations, 2022). Further, Senior logistics strategist (2022) highlights the importance of knowing the differences in input parameters when going electric. Such parameters are, for example, the characteristics of roads, weather, traffic, and a changing market structure that will have a more significant impact than what the parameters had on fossil-driven vehicles, as well as such parameters, can not be affected nor changed (Senior logistics strategist, 2022).

The Partner Company has developed a software platform, which is a digital planning tool connecting all relevant partners and customers within Partner Company's business model (Senior logistics strategist, 2022). The software platform, therefore, enables to reach a transparent and standard network view of both how the electric vehicle will perform, is performing, and has performed (Chief product officer, 2022). Decisions made centralized upon real-time data with the software will, in turn, optimize the TaaS regarding both costs and performance, and the aim with the software platform is that all included stakeholders should have full transparency to encourage improvement and cooperation (Chief product officer, 2022).

2.2.2 Electrification

The Partner Company is operating fully electric, e.g., no hybrid models, and is operating all their vehicles with integration to software platform, where they have complete control and capability to monitor the shipments (Operation analyst, 2022). Electrification is a far more complex way of transport than traditional, fossil-driven transport, which makes the software platform significantly elaborating all transport parameters and continuously measure the efficiency and how the transport corresponds to plan (Chief product officer, 2022).

2.3 KPIs in the Partner Company's perspective

The Partner Company uses KPIs to differentiate itself from transport providers offering fossil-driven road freight and to monitor how the company is doing (Business controller, 2022). For the Partner Company, the software platform enables collecting data from an operating vehicle, and the digital software platform is therefore acting as the connecting bridge, transforming real-time data from the hardware to understandable and visual KPIs in the software (Chief product officer, 2022). Today, the Partner Company uses the collected data and communicates several KPIs to their customers and partners through the software platform (Head of customer deployment and operations, 2022). Therefore, the KPIs can, for example, be used both for internal monitoring and be directly visualized and evaluated by the customer on a dashboard within the software platform (Chief product officer, 2022). The software also enable each customer to have a customized visualization of measurements, enabling the customer to have complete control of the TaaS (Chief product officer, 2022).

Characteristics of KPIs
When the Partner Company develops KPIs, Senior logistics strategist (2022) mentions that different types of characteristics are used to clarify the meaning of the KPI. Senior logistics strategist (2022) further mentions that KPIs can look very different but aim to evaluate the performance based on collected data, where the KPI, therefore, should be put into the proper context and adapted to the environment it intends to measure and evaluate. Further, this means that the characteristics set the rules for how KPIs should be developed and used. Following requirements are used within the Partner Company when developing KPIs (Senior logistics strategist, 2022):

- Understandable - the KPI should be logical and make sense,
- Transparent - all stakeholders should see how performance is increasing or decreasing,
- Aggregated - KPIs should be scalable and applicable on, for example, one or several vehicles,
- Relevant - the KPI should be chosen for the right purpose of use and must link to a performance in a process or activity,
- Useful - KPIs should only link to internally collected data owned by the company or accessible via its software platform.

Used KPIs
KPIs that the Partner Company today uses internally within the scope of this study can be seen in the list below (Business controller, 2022):

- Number of transports performed electric,
- Number of electric vehicles operating,
- Ratio of used fuel/energy type,
- Driving time,
- Delivery cost, which is expressed in average pallet/kilometer,
- CO_2 savings, both what is contracted with customers and actual savings.

2.4 Problem description

The Partner Company is considered a pioneer in the electrification of road freight, and its focus is on communicating the right Unique Selling Point (USP) (Chief executive officer, 2022). Further, the Partner Company themselves has a clear picture of their USP but experiences difficulties in communicating their solution due to non-adjusted KPIs to electric road freight, further a knowledge gap of TaaS on the market.

Today, there is a challenge to spread knowledge regarding electric road freight, as a lack of knowledge among transport buyers regarding electric vehicles and a lack of proper communication in the market between providers and buyers exist. Such deficiency can result in low demand for more sustainable transport solutions. Furthermore, low demand for electric road freight from transport buyers results in a gap between the development of electric vehicles and their contribution to a more sustainable society. The consequence of KPIs not reflecting electric road freight and the absence of how to benchmark these KPIs in the market means that the development pace will slow down, and old habits will further remain in the transport sector, relying on fossil-driven transport.

To increase the understanding of both TaaS and the general electrification of the vehicle fleet, it becomes relevant to investigate the broader market outside the Partner Company. Therefore, it is interesting to understand better the market demands and maturity of electric road freight. To identify which KPIs are relevant to describe electric road freight, the market perspective is best represented in this case by *original equipment manufacturers (OEMs)*, *transport buyers*, *transport providers*, and *associated organizations* that either is at the forefront of following and participating in the development of an electrified transport fleet, or in the transition phase trying to understand the electrification, see Figure 2.2. The perspective of transport buyers on the market, other than just the Partner Company's current customers, is essential to capture since they create a demand on the market. OEMs' perspective is relevant as they are the ones who develop the hardware. This stakeholder has, therefore, an overview of the parameters, services, challenges, and opportunities electric vehicles have compared to fossil-driven ones. It is also interesting to see how transport providers work with the electrification of road freight. Their perspective of communicating KPIs with their customers can understand how to be best understood as a transport provider. Associated organizations are working to spread knowledge about the electrification of transport and are thus involved in many initiatives to prepare infrastructure during the transition towards electrified road freight. By capturing the associated organization perspective, understanding how electrification works on an aggregate level can thus be captured.

Given the purpose of this study and the previous section, it is interesting to analyze both the Partner Company and the market demands. First, it will be interesting to understand what KPIs are usually used, their characteristics, and how they are categorized while benchmarking traditional road freight. Secondly, it will be interesting to see how these KPIs, characteristics, and categories will change when road freight electrifies further and how this will affect the Partner Company. KPIs derived from the market demands could enable a framework of KPIs that both the sector and the Partner Company could use for improved communication, understanding, and follow-up of operational performance.

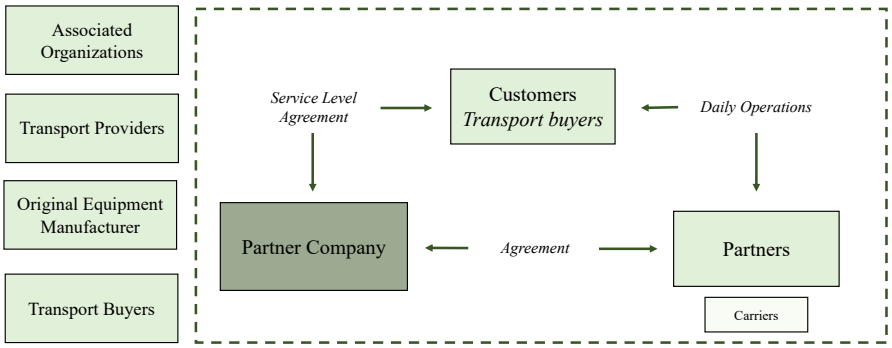

Figure 2.2: The Partner Company's business model and external stakeholders on the market.

Chapter 3

Frame of reference

This chapter presents the structure of the frame of reference, followed by the relevant literature to answer the study's purpose. The literature is built up of two main areas: transportation and Key Performance Indicators (KPIs).

3.1 Structure of the frame of reference

A structure over the frame of reference enables an eased understanding of why specific topics exist in the following chapter. The purpose of the study is as follows:

> *The purpose of this study is to design a framework of KPIs to measure and evaluate electric road freight and further adjust the framework to Partner Company.*

The literature presented in the frame of reference builds up by two main areas, *transportation* and *Key Performance Indicators (KPIs)*. The first main area enables an understanding of what electric transport is. Before presenting electric transportation, a brief description shows how structures in the transport system look historically. Further, the literature will explain how the transport sector has changed as society electrifies, followed by literature on electric transportation, its benefits, obstacles, and further opportunities. The first main literature area concludes by presenting a new way of transport with a new business model arising with the electrification.

The frame of reference further highlights relevant literature that addresses methods for developing and designing frameworks of KPIs. The literature highlights the purpose of KPIs, followed by a description of individual KPIs' characteristics, what common KPIs exist in the transport sector, what KPIs exist in electric road freight, and how these KPIs occur in a framework where categories create a structure in a framework design. The frame of reference concludes by presenting the developed process this study will follow when designing a framework of KPIs related to electric road freight. All areas investigated can be seen in Figure 3.1.

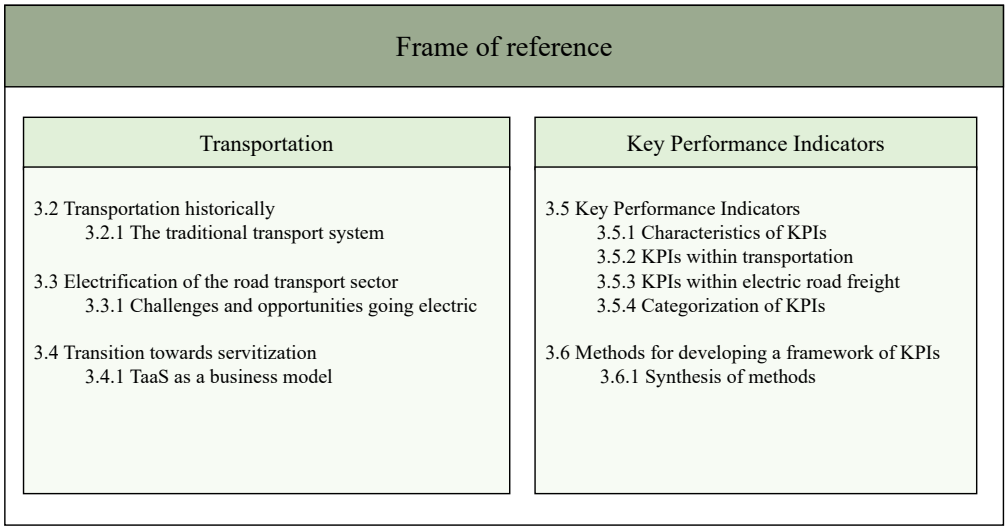

Figure 3.1: The structure of the frame of reference.

3.2 Transportation historically

In the middle of the 1990s, most of the world's vehicles were petrol-driven. Since then, the world has witnessed a dieselization process, which has resulted in significant emissions (Morganti and Browne, 2017). Diesel is still the most common fuel used, especially by the road freight sector (Monois and Bergqvist, 2019). The trend is, however, changing, where new policies encourage alternative and emission-free fuels (Morganti and Browne, 2017). As World Business Council for Sustainable Development (2016) predicts, there is a triple demand for road freight measured in transport work between 2015 and 2050, infusing incentives to continue to develop alternative fuels to meet governmental sustainability demands.

3.2.1 The traditional transport system

Transportation aims to fulfill a demand of transporting products from an origin to a destination within a predetermined time frame (Oskarsson et al., 2013). Several elements are included within a transport system, requiring relationships to function between stakeholders, assets, and infrastructure (Monois and Bergqvist, 2019). During the 1990s, OECD (1992) developed the traditional model of the transport system, visualizing the system by identifying different layers where the layers interact with each other. Within the traditional model of the transport system, the efficiency and effectiveness of the whole system are determined by the efficiency and effectiveness of each layer (OECD, 1992). The independent layers indicate that communication and coordination traditionally have had a supportive role in the transport system (Monois and Bergqvist, 2019). Further, the traditional business model puts particular emphasis on the exchange between manufacturers and transport providers, where manufacturers sell vehicles to transport providers (Sandberg et al., 2011). Transport providers can both be local carrier companies but also large third-party logistics companies who can either provide simple transport services or complete logistics solutions to transport buyers (Monois and Bergqvist, 2020).

3.3 Electrification of the road transport sector

Electric cars have had fast-paced progress, while the penetration of electric road freight vehicles is progressing slowly (Schmidt et al., 2021). In the late 2000s, electric road freight vehicles made their first appearance on the market but have increased in sales during the last couple of years (Morganti and Browne, 2017). In a survey with fleet managers within road freight, Zero Emission Transportation Association (2022) presented that more than 80 % of the participants mentioned that meeting sustainability goals was the most significant motive to electrify their vehicle fleet. Further, World Economic Forum (2021) predicts that in 2030, 37 % of the world's road freight vehicles sold will be electric. Additionally, the Swedish Government believes that by 2030, more than two million vehicles in Sweden must be able to be supplied with electricity (Regeringskansliet, 2021).

Nagel et al. (2019); Transportföretagen and HUI Research (2020); Ministry of the Environment and Energy (2017) discuss the importance of electrifying the road freight sector to decrease the carbon footprint. Therefore, restrictions exist connected to emissions to resolve the climate crisis but also to reach a sustainable value chain (Regeringskansliet, 2021). The World Economic Forum (2022) describes that electrification is a paradigm shift that needs industry leaders across the transport landscape to collaborate. The collaboration will help to overcome the challenge that electrification brings. Further, the World Business Council for Sustainable Development (2016) highlights that collaboration is the key to success, indicating that joint ventures, partnerships, and a multi-stakeholder approach will foster the market revolution, something World Economic Forum (2021) agree on.

3.3.1 Challenges and opportunities going electric

The technological development, together with new customer demands and the focus on sustainability, have made the road freight shift increasingly visible in society, visualizing several challenges and opportunities that electrification brings (Transportföretagen and HUI Research, 2020). One main difference when comparing electric road freight with fossil-driven one is the way how the road freight system is scaling (Monois and Bergqvist, 2020). Traditional road freight increases in competitiveness when volumes are high and distances are long (World Economic Forum, 2021). According to Li et al. (2021), electric vehicles do not predict to compete with the volume of each transport service, and the vehicle will not be bought as a unit. Instead, Li et al. (2021) highlight the function of delivering a dynamic service that moves individual load units, like, for example, containers, hence independent of the number of routes driven or vehicles used.

Further, Monois and Bergqvist (2020) describe that economies of scale will derive from the performance level of offering a comprehensive network, including a software's ability to gather large volumes of data, the physical assets, and the interface connecting the network and reality, something that Li et al. (2021) agree on. Therefore, electric vehicles add a new dimension while using digital flow management and agile and flexible deployment of capacity in a dynamic network system, including, for example, software, charging network, vehicle insurance, batteries, and after-sales services (Li et al., 2021). Additional opportunities that come with the network perspective, according to Kley et al. (2019), is the possibility of better utilization of the vehicle's capacity due to a shared vehicle fleet. Further, Kley et al. (2019) mention the opportunity to reach a better secondary usage value of several components like batteries leading to an increased residual value.

One benefit of electric vehicles, highlighted by Melander et al. (2019), is savings in fuel costs when compared with fossil-driven ones. Further, according to Transportföretagen and HUI Research (2020), not only fuel costs will decrease when turning electric, but also the total operating costs for electric vehicles, something that Monois and Bergqvist (2019) also mention when arguing that cost savings derive from the easier maintenance of the electric vehicles. The production costs will also decrease when manufacturing electric vehicles compared with traditional ones since electric engines are both lighter and less complex, therefore also cheaper to buy and maintain (Zero Emission Transportation Association, 2022). On the other hand, World Business Council for Sustainable Development (2016) mentions the importance of building a sustainable life cycle perspective when turning electric. World Economic Forum (2021) emphasizes the fact that different countries have different supplies of renewable energy, something that will affect the environmental perspective of the electric vehicle. Further, this means that an identical electric vehicle can be more environmentally friendly in one country than in another (Melander et al., 2019). According to Melander et al. (2019), Sweden has good prerequisites for supplying batteries in electric vehicles with renewable energy, while, for example, Germany uses more coal-powered energy-supplying vehicles. Therefore, the type of energy should also be taken into account when evaluating the carbon footprint of an electric vehicle (World Economic Forum, 2021).

To fully electrify the road vehicle sector, several challenges require a solution (Morganti and Browne, 2017). Challenges connected to the electrification of vehicles are, for example, integrating completely new stakeholders, such as battery makers and software providers within the value chain (Kley et al., 2019). Something that also is challenging is the significant up-front investments that Melander et al. (2019) mention, which further comes when charging infrastructure must be built up (Morganti and Browne, 2017).

Additional challenges mentioned by Monois and Bergqvist (2019) are unreliable energy grid and the capacity of today's batteries, which closely connect with driving range, payload, and charging time. However, World Economic Forum (2021) describes that the development of batteries is fast, whereby cheaper, lighter, and more powerful batteries will appear on the market shortly. The increased demand for electric vehicles also creates an increased demand for charging infrastructure and available power, where the KPI charging capacity becomes relevant (Zero Emission Transportation Association, 2022). When developing the charging infrastructure, it is, therefore, essential to place charging stations within reasonable distances (Monois and Bergqvist, 2019). Additionally, Monois and Bergqvist (2019) mention that electric vehicles, preferable, should be used 24/7 to maximize efficiency, which indicates that it is not attractive to stop and charge on a route if charging does not coordinate with drivers' rest.

According to Morganti and Browne (2017), electric vehicles must be cost-competitive to reach their full potential. In order to break through, electrification requires both expensive upfront investments to extend the charging infrastructure but also initiatives and support from the government through regulations (Zero Emission Transportation Association, 2022). Additionally, electrification brings a new dimension of complexity due to technological software development and the requirement of sharing data and cooperation between new stakeholders; this complex system perspective is, therefore, also seen as a challenge (Nagel et al., 2019).

3.4 Transition towards servitization

Servitization of several industries could be seen in society in general, where one transformation within the transport sector is the concept Transport as a Service (TaaS) (Tongur and Engwall, 2014). TaaS can be seen as a new service model based on an exchange between a manufacturer, through a service provider to a transport buyer, and therefore bypasses the traditional transport provider (Monois and Bergqvist, 2019). As Tongur and Engwall (2014) argue, the outcome of TaaS is an increased non-ownership business model promoting leasing offerings, taking a step away from seeing road freight as the number of vehicles towards seeing the transport acitvity as a service. Tongur and Engwall (2014) highlight the joint agreement in TaaS, which is that goods move from spot A to B, indicating that the transport buyer should be reliant on optimized routes. Additionally, since the transport buyers buy a service, the capacity, range, payload, and other operational factors like vehicle maintenance and and battery management should not be bothered since they agreed on delivery at the right time and place (Zero Emission Transportation Association, 2022). Further, mentioned by Zero Emission Transportation Association (2022), is that TaaS makes it possible to tailor-made service solutions demanded by different customers and their specific needs.

Skeete (2018) explains the fact that TaaS is turning fixed costs of owning a vehicle into variable costs that will lower the operational costs. Tongur and Engwall (2014) describe this as a cost based on the number of kilometers driven, and Zero Emission Transportation Association (2022) argues the cost should be a monthly fee. Tongur and Engwall (2014); Skeete (2018); Zero Emission Transportation Association (2022) agree that even though the cost is based on various units or time frames, focusing on TaaS move away from dividing costs into investments and operational. Skeete (2018) further argue that TaaS has emerged due to the need for closer involvement of the manufacturer of the hardware and the developer of the software. Zero Emission Transportation Association (2022) highlights this as the main benefit of TaaS, namely that the customer does not have to take the risk of investments connected to electric vehicles.

Further, Kent and Dowling (2016) highlight the ease of a shared road freight transportation service, but also the flexibility and reliability that shared vehicle fleets enable. Discussed by Skeete (2018), the pros with TaaS, is for example, that it reduces travel time, is more fuel-efficient, reduces air pollution, and lowers traffic congestion. Hopkins and Stephenson (2016) believe this servitization is an excellent paradigm leap, resulting in a reduced rate of vehicles used and acting as a catalyst while enabling a transformation away from the long-standing culture of road transport.

3.4.1 TaaS as a business model

That TaaS can succeed as a business model depends on the minor threshold of using digitalization and subscription services as the common knowledge is ever increasing regarding connected items and digital assets (Transportföretagen and HUI Research, 2020). As the value chain within road freight is changing, with a reduced focus on vehicle technology and an increased focus on the software component, several new market positions open up, for example, software developers (Melander et al., 2019). All new stakeholders that the new business model will include are mentioned as critical by several authors (Tongur and Engwall, 2014; Monois and Bergqvist, 2020; Le Pira et al., 2021). They all say that the software will be the core source of future value creation within electric road freight, where the big focus on the software will, in turn, require the repositioning of both traditional and new critical actors in the value chain (Kley et al., 2019).

According to Monois and Bergqvist (2020), the source of demand will, in the new business model, still be the transport buyers. According to World Economic Forum (2021), transport buyers must demand a sustainable solution for TaaS to be beneficial for society. Therefore, decarbonizing the road freight sector need customers to request more sustainable shipping and clarify their commitments toward a zero-emission future. Further, Monois and Bergqvist (2020) describes the transport provider to play an important part, consisting of either a third-party logistics company or a freight forwarder who manages the transport flows, providing transportation or subcontracting it to, for example, local haulers. These transport providers should work jointly with other stakeholders to make the most of the business model (Kley et al., 2019).

The World Economic Forum (2021) mentions that transport manufacturers must invest in solutions that make way for technological development. Monois and Bergqvist (2020), further mention that the technical development together with TaaS has changed the traditional business model, where manufacturers sell vehicles to transport providers. Vehicle manufacturers will instead sell their vehicles to a new network operator, i.e., a service provider in the system, which can be seen as a competitor to traditional transport providers (Kley et al., 2019). This new key stakeholder predicts to emerge, providing a service of transport solutions across the network with a base in a software system (Monois and Bergqvist, 2020; Kley et al., 2019). Predicted by Regeringskansliet (2021), the new stakeholder will have new responsibilities, enabling service before, during, and after the transport activity, like swapping batteries or offering a comprehensive charging network during operation. According to Monois and Bergqvist (2020), the new actor will most likely have superiority concerning the technology of software and design, but also financial, data, and information assets to plan flows and optimize the network. The critical change is that the new service provider moves closer to the transport buyer and, therefore will be able to react dynamically to real-time data (Le Pira et al., 2021).

Other important stakeholders within the new business model, mentioned by World Economic Forum (2021), are financial institutions supporting the development of innovative leasing models and the broad public that must make responsible decisions. The policymakers are, according to Le Pira et al. (2021), also significant players while deciding at what pace the acceleration towards a zero-emission road vehicle fleet can take place. Energy and infrastructure companies will additionally play a vital part as they are the ones that will forge partnerships with manufacturers, logistics operators, and local governments (World Economic Forum, 2021). According to Melander et al. (2019); Le Pira et al. (2021), the communication, interaction, and collaboration between all stakeholders, and the infrastructure, legal requirements, and industry investments will be necessary to succeed with the electrification.

3.5 Key Performance Indicators

To measure, follow up, and evaluate whether a business is successful or not is of great importance for all cost-driven companies (Prause and Schröder, 2015). According to Kaparias and Bell (2011), measurements enable companies to obtain data and to compare the internal or external performance of activities within different time frames. Further, this comparison of performance helps evaluate the overall performance of how a business is continuously progressing. Prause and Schröder (2015) argue that performance measurements, called Key Performance Indicators (KPIs), act as an appropriate measurement tool for system control and decision making. Already in the 1990s, KPIs and measurements were commonly used, where Caplice and Sheffi (1994) define measurements as follows:

> *A measurement is an assignment process where numbers are assigned to represent some attribute of an object or event of interest.*

Further, Caplice and Sheffi (1994) mention KPIs to evaluate activities to reach a predetermined goal, which indicates that business objectives are linked to various KPIs to assess how a business is improving. KPIs are used, not only internally to follow up on business goals, but also act as the most common measurement tool to benchmark across an industry (Lukinskiya and Pletneva, 2018). Therefore, Lukinskiya and Pletneva (2018) argue that benchmarking needs a shared measurement system, i.e., a framework of KPIs, for companies to compare differences. A shared measurement standard across the industry must therefore be known, enabling a company to collect, evaluate, and compare data to the set standard for each KPI in the framework (McKinnon and Ge, 2007). Conducting different kinds of KPIs to enable broader use of measurements external in benchmarking processes towards other companies is something Kaparias and Bell (2011) agree on as essential. Additionally, McKinnon and Ge (2007) argue that a comprehensive framework of KPIs is a robust tool to reach a common understanding within a whole sector and a specific company.

3.5.1 Characteristics of KPIs

In order to use KPIs, requirements must be set regarding the aim and the characteristics of KPIs (Kaparias and Bell, 2011). The authors discuss these requirements to either be set by external pressure or internal management, where they further argue that characteristics are one of the first things to define when developing KPIs.

Even though KPIs need to be *measurable*, *transparent*, *valuable*, and *controllable*, only to mention a few characteristics, one of the most important characteristics, according to Kaparias and Bell (2011), is *customer-orientation*. Kaparias and Bell (2011) highlight this characteristic as the most critical, depending on that a KPI must be *understandable* by a broad audience on the market; else, it is useless.

The customer perspective was already highlighted by Caplice and Sheffi (1994) in the 1990s as a significant characteristic. Caplice and Sheffi (1994) meant that selecting KPIs from the customer perspective is essential to reach satisfaction from the customer's point of view. The current business environment is also something that Caplice and Sheffi (1994); McKinnon and Ge (2007) mention as necessary when selecting which KPIs should be used in a framework. McKinnon and Ge (2007) therefore argue that all KPIs used within a company must win acceptance from stakeholders across an industry sector, indicating that KPIs should have the characteristics to be accepted and thus *stakeholder-oriented* as well as *related to an industry-standard*. The characteristic of being stakeholder-oriented is similar to what Kaparias and Bell (2011) highlight, namely that KPIs should be *scalable* both internal and external, which means to be able to be *aggregated* into different levels. The stakeholder perspective will additionally ad an even more broad dimension than the customer one, where the whole value chain must accept the same standard on a macro level, taking into account the entire market and therefore be evaluated against an industry-standard (McKinnon and Ge, 2007). KPIs must be *robust*, i.e., commonly understandable by all stakeholders and thereby reach full utilization (Giannopoulos, 2021). Adding a macro-perspective when developing KPIs is a new characteristic when compared to traditional characteristics as KPIs mostly solely have been concerned with internal economic efficiency (McKinnon and Ge, 2007).

Defining the right and suitable KPIs for a specific business or sector requires a good understanding of the studied system (Prause and Schröder, 2015). Before tailor-made the characteristics of KPIs for a particular use, it is important to add several generic characteristics that KPIs within all sectors should have, even though all characteristics do not apply to all KPIs. A summary of what characteristics KPIs should have, according to Kaparias and Bell (2011); Giannopoulos (2021); McKinnon and Ge (2007); Prause and Schröder (2015); Caplice and Sheffi (1994), is presented:

- Measurable,
- Predictable,
- Traceable and clarified - enabling an easy application,
- Aggregated - the KPI should be able to capture and report data at the right level of aggregation or granularity for the decision-maker to make a decision,
- Controllable - the KPI should be able to control in order to reach a goal that limits the KPIs dark side, discouraging counter-productive actions from taking place,
- Validable and based on data - the KPI should reflect the actual activity in real-time,
- Relevant and understandable - enable decision-makers to take a course of action and that the KPI is compatible with existing data collection and business processes,
- Customer-oriented and stakeholder-oriented, the KPI should be integrated and communicated to relevant stakeholders and customers, incorporating all major components and aspects of the activity measured, thereby promoting coordination across firms. Moreover, the KPI should be able to be both tailor-made but also have a one-fits-all approach,
- Robust - the KPI should be widely accepted, be interpreted similarly by all users, and be used for comparison across time, location, and organizations,
- Time-based - the KPI must be able to be measured frequently both in short- and long-term,
- Useful and have a significant impact - the KPI should affect vital success factors.

3.5.2 KPIs within transportation

Transportation is significant activity within the concept of logistics (Lukinskiy et al., 2013). To measure logistics performance, KPIs have been used to evaluate a company's ability to deliver services and goods at an acceptable cost (Lee et al., 2015). The traditional focus when evaluate logistics has therefore been connected to *delivery service* and *transport costs* (Oskarsson et al., 2013). According to Oskarsson et al. (2013), transport usually stands for about 40 - 60 % of a company's total logistics cost. Further, this means that companies often choose the least costly transport option, which explains why transport costs traditionally have been an important KPI as evaluations have been done from a cost perspective (Prause and Schröder, 2015). Additionally, Lukinskiya and Pletneva (2018); McKinnon and Ge (2007) agree that the most commonly used KPIs within transportation connect to transport and *delivery cost*.

In addition to costs, it is essential to fulfilling customers' expectations, something that still is very important (Caplice and Sheffi, 1994). According to Oskarsson et al. (2013), the customer will not pay for the delivery unless it is not fulfilling a high level of customer and delivery service. Oskarsson et al. (2013) differentiate between the concepts where customer service takes place from the placement of the order until after delivery. In contrast, delivery service takes place only during the delivery.

Further, Lee et al. (2015) argue that overall service is dependent on how customers perceive the interacting activities before, during, and after delivery. *Information and transparency* are essential during all activities connected to the delivery to success with fulfilling customer satisfaction (Wang et al., 2013). Measuring service enables companies to compare against competitors and benchmark to distinguish superior performance (Oskarsson et al., 2013). The delivery service usually applies by the activity transportation and can be measured with delivery service KPIs where Oskarsson et al. (2013); Lee et al. (2015); Wang et al. (2013); Caplice and Sheffi (1994); Lukinskiy et al. (2013) highlight the following KPIs:

- Lead time - the delivery time, and thus the time it takes from order placement to received delivery,
- Delivery reliability - the reliability in lead time,
- Delivery quality - the right product with the right quality in the right quantity,
- Delivery precision - the sum of reliability and quality,
- Stock availability - describes the proportion of orders or order lines that can be delivered directly at the customer's request,
- Information and transparency - KPIs that measure the quality of communication from the customer's perspective,
- Flexibility - measures the ability to adapt to customers' new wishes, business environment conditions, and trends in a particular sector.

More transportation-specific KPIs than costs and delivery service, mentioned by (McKinnon and Ge, 2007; McKinnon, 2009), are *vehicle fill*, *empty running vehicles*, *vehicle utilization*, and *deviations from schedule*. What McKinnon and Ge (2007); McKinnon (2009) further highlight as important is that the same KPIs should be used within the whole sector to benchmark equitably.

3.5.3 KPIs within electric road freight

Already in the 1990s, KPIs were said to not keep up with the pace of a changing business environment (Caplice and Sheffi, 1994). The authors meant that many businesses use KPIs that do not correspond with their current goals and, therefore no longer adequate to fit the specific sector. Even though many KPIs do not correspond with existing activities, Prause and Schröder (2015) argue that there is no need to develop new KPIs. Instead, Caplice and Sheffi (1994) suggest using existing KPIs, but instead in proper context. Companies should therefore reevaluate their existing frameworks of KPIs, both the individual KPIs and the system as a whole (Caplice and Sheffi, 1994; Prause and Schröder, 2015).

KPIs within road transportation has, as mentioned, traditionally focused on costs and service. However, with electrification, a shifted focus toward emphasizing the environmental perspective has been made visible (Oskarsson et al., 2013; Prause and Schröder, 2015). Why companies measure environmental performance from a micro company perspective depends, according to Oskarsson et al. (2013); Prause and Schröder (2015), on the controlling aspect to see whether the company is striving in the right direction and improving internal effectiveness.

Kurdve and Wiktorsson (2013) stress that a joint evaluation of the three parts of sustainability has been trending within the road freight sector in the last decade, whereas all three dimensions should be measured. Denant-Boemont and Hammiche (2019) agree and highlight the necessity to use KPIs that measure non-economic parameters. However, according to Denant-Boemont and Hammiche (2019), it is challenging to attribute economic values to non-market effects of transportation activity and internalize adverse external effects like CO_2 emissions. Tyrinopoulos and Antoniou (2020) analyzed what KPIs could be used when road freight is turning electric but found it hard to specify concrete KPIs. Instead, they highlighted that KPIs should focus on *time savings* and *accessibility* regarding electric road freight to find which parameters electric road freight performs better on compared to fossil-fuel one.

As mentioned by Oskarsson et al. (2013), the total cost of transportation is a crucial component when making decisions involving great economic investments, indicating that KPIs connected to costs will be necessary even when the road freight sector becomes electric. Further, this means *investment, transport*, and *delivery costs*. Tor (2020) argues that electric vehicles will decrease operational costs, which indicates a lower focus on transport costs during operation. Therefore, Tor (2020) mentions that the customer's attitude and understanding of the electric system, its infrastructure, and charging are more obstacles than the price itself. KPIs that enable a common understanding of how to measure and evaluate electric road transport will ease the penetration of electric vehicles on the market (Tor, 2020).

Schücking et al. (2017) concertize several new KPIs that could be used when evaluating electric road freight, for example, *distance traveled electric* and *driving range*. Transportföretagen and HUI Research (2020) have also investigated what kind of KPIs can measure and evaluate electric road freight, where KPIs that highlight *emissions throughout the value chain*, taking into account the sustainability perspective, are important. Further, Dahlsten and Thorsell (2020) argue that the electric road freight network demands a more efficient consolidation of goods when compared to a fossil-driven one. However, increasing the payload and minimizing the cost per unit shipped still make traditional KPIs like *payload* important.

Below is a summary of what KPIs, according to the authors Transportföretagen and HUI Research (2020); Schücking et al. (2017); Tor (2020); Tyrinopoulos and Antoniou (2020); Denant-Boemont and Hammiche (2019); Kurdve and Wiktorsson (2013); Prause and Schröder (2015), should be used when evaluating electric road freight where some of them already have been highlighted in italic text in the previous section:

Traditional KPIs considered to be relevant for electric road freight

- Transport work,
- Distance traveled,
- Emissions throughout the whole value chain,
- Payload,
- Costs.

KPIs considered relevant for electric road freight

- Distance traveled electric,
- Energy consumption,
- Average speed,
- Charging time for a full recharge,
- Charging locations,
- Ratio of driving time to charge time,
- Ratio of used fuel type,
- Frequency of charging,
- Driving range,
- Battery capacity,
- Environmental perspective on batteries, where the KPI must take into account energy use during production and a perspective taking into account the re-usability of batteries,
- Batteries lifetime.

3.5.4 Categorization of KPIs

Kaparias and Bell (2011); Prause and Schröder (2015) highlight that only one KPI of a process or activity is not enough to reflect the performance of a whole system. The authors, therefore, mention that the categorization of individual KPIs in a framework is essential and can ease the understanding of what is measured to reach a realistic view of the entire system's performance. McKinnon and Ge (2007); Kurdve and Wiktorsson (2013) also discuss that categorization of KPIs enables a more accessible understanding of the significance of each KPI. Caplice and Sheffi (1994) stress that, regardless of how the categorization is done, the categories act as a bridge when designing a framework of KPIs, connecting individual KPIs into a whole system, thus putting them in the right context.

Categorization can be made in many different ways where Kaparias and Bell (2011) propose categorizing KPIs according to various *stakeholders*. To categorize according to stakeholders will, according to Kaparias and Bell (2011), reflect reality better than the use of more narrowly and internal focus, using categories to group KPIs according to *business units*. However, categorizing KPIs internally according to different business units is very common (McKinnon and Ge, 2007). What Kurdve and Wiktorsson (2013) highlight is that, regardless of how categorization is done, it is essential to consider macro perspectives when developing a framework of KPIs where the KPIs are arranged in categories understood by all users. Further, Kurdve and Wiktorsson (2013) argue that if individual KPIs only are used within a sub-division of a whole system, sub-optimization may occur, which can hurt the company, as different business units work in different directions. Therefore Kurdve and Wiktorsson (2013) propose that KPIs, at least, should be divided into *internal* and *external* categories, where the external KPIs should be understood by all external stakeholders and the internal understood by all business units.

Prause and Schröder (2015) further discuss that categorization of KPIs can be seen as a categorization of different *areas within the transport system*, where each area represents a thematic set of KPIs. Prause and Schröder (2015) mention that categorization can be done in categories like economic, social, and ecological sustainability, or within different processes or activities, for example, the transportation process or the delivery service activity. As an example, Prause and Schröder (2015) mean fuel consumption and CO_2 emissions are KPIs within the ecological sustainability category, the number of transports performed, i.e., frequency of deliveries are placed within the transportation process, and additional lead time can be included in the category delivery service, but also within the whole sustainability category. All KPIs included within each category can be adopted and applied by each stakeholder group on the market, enabling this categorization to be dynamic and adjustable to specific business environments (Prause and Schröder, 2015).

Further, McKinnon and Ge (2007); McKinnon (2009); Caplice and Sheffi (1994) highlight *performance dimensions* as good categories for KPIs within a framework. The first performance dimension is utilization KPIs, expressing the ratio of actual input of resources out of a normative value. The second category is productivity KPIs, highlighting the system or activities' transformation efficiency. The third category is effectiveness which includes KPIs that measure the quality of the process output. The goal in each business is to maximize output and minimize the consumed input, whereby the three performance dimensions describe a process performed in a comprehensible way (McKinnon and Ge, 2007). When it comes to the category utilization, Caplice and Sheffi (1994) highlight KPIs like operational cost and vehicle utilization. KPIs in the productivity category often express a ratio between two measures, like for example, distance traveled per volume fuel consumed. In addition, common effectiveness KPIs track availability and timeliness where vehicle fill, service quality, lead time, and flexibility are KPIs that could be included (Caplice and Sheffi, 1994).

Below, the different categorization of KPIs mentioned by McKinnon and Ge (2007); Caplice and Sheffi (1994); McKinnon (2009); Prause and Schröder (2015); Kurdve and Wiktorsson (2013) is presented:

- Stakeholders,
- Business units,
- Internal and external,
- Areas of the transport system,
- Performance dimensions; utilization, efficiency, and performance.

3.6 Methods for developing a framework of KPIs

Several studies exist on identifying relevant KPIs for a given purpose, categorizing them into suitable categories, and further conducting a framework of the chosen KPIs. Some of these studies have been selected and will act as a foundation of references for how this study will identify and formulate suitable KPIs for electric road freight. Further, the studies are a foundation with literature on categorizing, adapting, and adjusting the KPIs for different users or stakeholders, applying different characteristics. The selected studies have examined similar situations, meaning that they use a design method for conducting a framework of KPIs within, fore and foremost, the transport sector. However, since the transport sector is continuously developing, the selected methods will be compiled to give an equitable process that suits this study and its design of a framework of KPIs within electric road freight.

Study 1
In order to develop a framework of KPIs, Kaparias and Bell (2011) mean that companies must define goals, identify specific KPIs that will measure relevant outcomes, and have knowledge regarding required input resources in order to achieve the set goals. Further, the authors highlight the importance of KPIs in the framework of common knowledge for the relevant sector. Kaparias and Bell (2011), therefore, suggest a process describing how to establish a framework of KPIs within the sector of road transport, see Figure 3.2. The first process step when creating a framework is to *define goals* that the company or the studied system has. The next step is to *define and select KPIs* that will match the proper aim of the framework. The chosen KPIs should be selected according to what kind of data is available and what kind of need the user of the KPIs has; therefore, the third step is to *adapt KPIs to situation* (Kaparias and Bell, 2011).

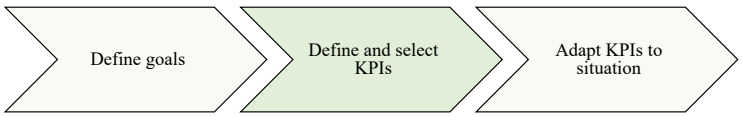

Figure 3.2: Method by Kaparias and Bell (2011) in their study conducting a framework.

Study 2
In Prause and Schröder (2015) study, a framework was developed to evaluate cross-company systems within transportation; see Figure 3.3 for the included process steps. The first process step is to *identify KPIs* used within the specific transport system and further do a complementing literature study for potential KPIs within the same system. After that, the aim of the following process step is to *find gaps between used KPIs and literature* and, by that, conclude an all covering picture. The third step is to *relate all found KPIs to stakeholders* within the transport system and then *find relationships* on how these KPIs will affect different stakeholders and parts of the system. The last step is to *evaluate and categorize the found KPIs* which in turn will help how to continuously work and improve KPIs for a seamless network through these building blocks. Prause and Schröder (2015) highlight that it is essential to evaluate both operational and strategic aspects from a process perspective, on both a company level but also on a cross-industry macro level. Including critical stakeholders will improve the use of the identified KPIs (Prause and Schröder, 2015).

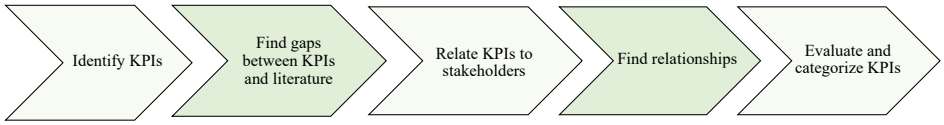

Figure 3.3: Method by Prause and Schröder (2015) in their study conducting a framework.

Study 3
Multi-Criteria Decision Analysis (MCDA) emphasizes the possibility of including KPIs that might be hard to quantify but could be qualified (Al Haddad et al., 2020). According to Al Haddad et al. (2020), the method focuses on the feasibility of each KPI, making the output more reliable. The study addresses the measurement of future transport systems, whereas technology and operating business might still be unknown to the character. Al Haddad et al. (2020) argue that few existing frameworks are focusing on the selection of KPIs suitable for disruptive transport systems and further empathize the gap to represent disruptive and future transport systems based on factors not just limited to sustainability plans. Al Haddad et al. (2020) identify the gap by working with the MCDA method on potential KPIs collected through expert interviews. Using this method will ease the way of highlighting KPIs that otherwise is unseen when investigating and developing a framework for a disruptive system with high uncertainty. The first process step is to *identify the purpose of usage* followed by identifying the *studied system*. After that, the study highlights the step, which is to *find characteristics* of both the KPIs and the studied system, followed by the step that will *validate* the characteristics relative to their importance. Lastly, the method conducts a summarized *evaluation of the results* which will indicate how to improve the framework further. See Figure 3.4 for all the process steps. The advantage of using MCDA is the possibility to use indicators that include qualitative KPIs when having conflicting objectives which could be hard to express in monetary value (Al Haddad et al., 2020).

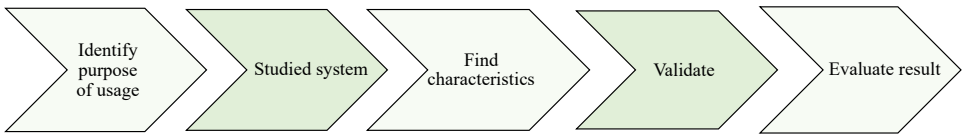

Figure 3.4: Method by Al Haddad et al. (2020) in their study conducting a framework.

Study 4
Caplice and Sheffi (1994) study the assessment process of KPIs when integrating both internal and external KPIs and how each measurement must cover both perspectives. The process begins with the step of *finding characteristics* of all KPIs that should be used both internally and externally. The second step is to *identify trade-offs and relationships*, which means to evaluate the found KPIs and how these KPIs are dependent on each other, and when there occur trade-offs between them. The last step is about *categorizing and evaluating* the KPIs, putting them in suitable sub-groups that will ease an evaluation of them. See the framework's process steps in Figure 3.5. This study helps build a framework with both an internal and an external perspective as the categorization could be seen as all covering characteristics, with specific KPIs adapted depending on internal or external use (Caplice and Sheffi, 1994).

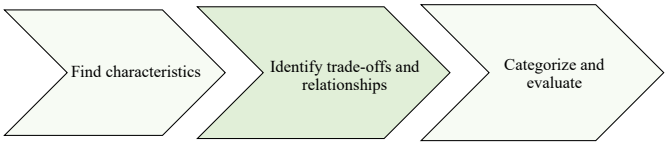

Figure 3.5: Method by Caplice and Sheffi (1994) in their study conducting a framework.

Study 5
Harvey et al. (2016) investigated how to formulate KPIs for a process within companies; see Figure 3.6. In contrast, the study could be relevant for several other use areas, adapting the found process steps to a specific studied system. The first step in their method is to define the *studied system* that is of interest to investigate, and within this studied system, *identify relevant stakeholders*. The next step is to *organize the assessment group*, followed by the *creation of a process map* that visualizes the supply chain process or the flow of goods. The next step is to identify, and *correlate KPIs to each process step*, and further to *measure and set goals* of the found KPIs in the process. Measuring current activities within a process enables setting goals and using identified KPIs for continuous improvement.

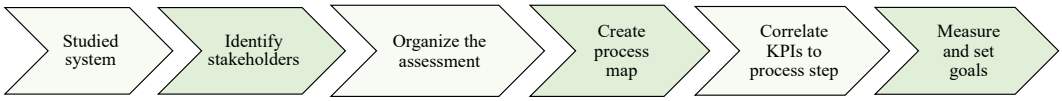

Figure 3.6: Method by Harvey et al. (2016) in their study conducting a framework.

Study 6
In the study by Gonçalves et al. (2015), the authors investigate how to measure performance in a particular department of a company by using a method for identifying and measuring suitable KPIs. The method contains six steps and should have an output in a framework of KPIs suitable for a specific company. The first step is to *define the company goals,* followed by *finding characteristics* of KPIs and then *identifying all possible KPIs* that exist within the studied system. Further, a *selection of best suitable KPIs* to the system should be done. After that, it is time to evaluate the found KPIs regarding demands of characteristics and do this *evaluation in an iterative manner*. See Figure 3.7 for the whole process.

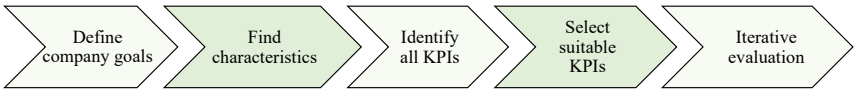

Figure 3.7: Method by Gonçalves et al. (2015) in their study conducting a framework.

Study 7
McKinnon (2009) has written several articles on the subject of how to work with logistics efficiently and comprehensively. In contrast, a study from 2009 is specifically looking at the choice of KPIs for improved transport efficiency in a supply chain. The study gathers input from various researchers, where McKinnon (2009) conducts a method specified for the studied situation. First, it is crucial to choose the *studied system*, which is, in the case of McKinnon (2009), the transport sector. Secondly, in the process, it is vital to decide what *characteristics of the demanded KPIs* are of most importance, where McKinnon (2009) solely focuses on operational KPIs within road transport. Therefore, this method oversees the total logistics costs. The third step is to *identify cross-industry accepted KPIs* when a broader context is evaluated. McKinnon (2009) highlights the importance that the selected KPIs should be accepted cross-industry, with the motivation that if all stakeholders accept the KPIs and the framework, the better output will come and also a common understanding that will ease benchmarking. Last but not least, the KPIs should be *adapted and validated* by the industry for improved results. In this case, McKinnon (2009) highlights the importance of including environmental aspects. See Figure 3.8 for this process.

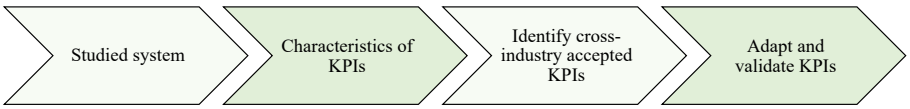

Figure 3.8: Method by McKinnon (2009) in his study conducting a framework.

Study 8
Bouchery et al. (2010) have in their study investigated how to build KPIs adapted to sustainability since the authors experience a lack of methods for evaluating processes such as. The proposed framework aims to be used as a tool specifically for sustainable supply chains but could further adapt to general logistic operations. See all process steps in Figure 3.9. Bouchery et al. (2010) further mention the importance of complementing operational KPIs with strategically orientated ones for best output. The methods consist of seven steps; where the first step is to *define goals* where the company should define what they mean by sustainability. Secondly, the company should define *characteristics of KPIs*, and thirdly set the *strategic orientation* for the company as a whole. After that, the company should *measure current sustainability and set goals* against which the KPIs could be evaluated, followed by *identifying the impact* of each KPI in the system. Further, *indicators for impact* should be set for each KPI to see which KPI shows the most impact on sustainability, followed by an *evaluation* of the individual KPIs as well as the whole framework. Once then, it is possible to take action to lower the impact (Bouchery et al., 2010).

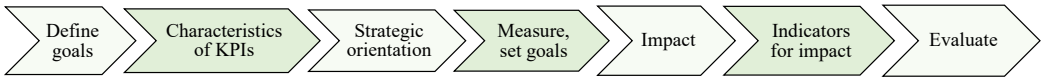

Figure 3.9: Method by Bouchery et al. (2010) in their study conducting a framework.

Study 9
Haponava and Al-Jibouri (2016) have conducted a method and set-up of KPIs through a pilot study to adapt the KPIs, especially to the studied company. See the author's process in Figure 3.10. The first step is to *identify currently used KPIs by conducting a literature review* and set up a frame of KPIs suitable for the studied company. Secondly, a *complementing empirical KPI collection through internal interviews* should be done to broaden the understanding of the daily operations, goals, and KPIs. The information collected from interviews, and the literature review, can together be compiled into a new set-up of KPIs. Finally, the defined KPIs can be *validated by users* like, for example, several interviews with experts in the company.

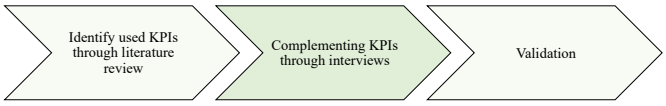

Figure 3.10: Method by Haponava and Al-Jibouri (2016) in their study conducting a framework.

3.6.1 Synthesis of methods

In Table 3.1, all presented methods have been compiled to show the similarities and differences clearly.

Table 3.1: Summary of all methods.

	Kaparias & Bell (2011)	Prause & Schröder (2015)	Harvey m. fl. (2016)	Caplice & Sheffi (1994)	McKinnon (2007)	Concalves (2015)	Al Haddad et. al. (2020)	Bouchery et. al (2010)	Haponava & Al-Jibouri (2009)
Studied system			x		x		x		
Define goals	x					x		x	
Investigate relationships to stakeholders		x	x					x	
Identify purpose of demanded KPIs							x	x	
Identify used KPIs		x							x
Identify gaps in literature and used KPIs		x							
Formulate characteristics for demanded KPIs				x	x	x	x	x	
Define and select KPIs	x		x			x			
Categorize KPIs		x	x	x					
Validate KPIs by users				x		x	x		x
Adapt KPIs to studied system	x		x		x	x		x	x
Evaluate KPIs		x	x	x	x	x	x	x	

After going through all the studies, it can be concluded that they are similar. Although different formulations of the steps are used, the meaning of the process steps are similar. For this reason, the studies have been selected and further grouped to fit the purpose of this study. Furthermore, great importance has been attached to the fact that many studies should validate each other and, in turn, create a process that this study will follow. Given Table 3.1 and relevance for this study, a process adapted for this study has therefore been conducted, presented in Figure 3.11.

This study investigates what KPIs best can evaluate and measure electric road freight. It is crucial to understand how the traditional road freight sector uses and has designed KPIs frameworks, for an improved understanding. The first step is, therefore, to *identify the goal and purpose of the demanded KPIs* for the studied system. Al Haddad et al. (2020); Bouchery et al. (2010); Kaparias and Bell (2011); Gonçalves et al. (2015), are all emphasizing the importance of defining goals for the studied system and what demand is the reason behind an accurate conducted study. The next step in this study's process is to *identify currently used KPIs and their characteristics*. Knowledge of previous or current used ways further helps to understand customer's behavior and thereby how to adapt and formulate KPIs that both customers easily understand, but also other stakeholders on the market (Prause and Schröder, 2015; Haponava and Al-Jibouri, 2016). Although the literature does not validate the importance of examining the categorization of previously used KPIs, in this case, KPIs connected to traditional fossil-fueled road freight, categorization is considered essential to include within this step. However, the literature validates the categorization of new KPIs, explaining why categorization is deemed to be relevant also when investigating traditional road freight (Caplice and Sheffi, 1994; Gonçalves et al., 2015; Al Haddad et al., 2020).

The third step will be to *find demanded characteristics of KPIs*. With the knowledge of current usage and the new demand, concludes what characteristics of KPIs are suitable (McKinnon, 2009; Caplice and Sheffi, 1994; Gonçalves et al., 2015; Al Haddad et al., 2020; Bouchery et al., 2010). After that, the fourth step naturally becomes to *define and select suitable and demanded KPIs*, as the road freight sector becomes electric (Kaparias and Bell, 2011; Harvey et al., 2016; Gonçalves et al., 2015). After choosing suitable and required KPIs with the right characteristics according to purpose within the studied system, Prause and Schröder (2015); Harvey et al. (2016); Caplice and Sheffi (1994) all argue that putting KPIs in proper context by being categorized in a framework to ease the understanding of each KPI as well as the framework as a whole. The fifth step is naturally to *categorize the KPIs in a framework*, which in turn will enable a better understanding of how to use the KPIs, the variation of usage, and the different importance of the included KPIs. The sixth step will after that be to *validate the framework* for an eventual re-categorization, which can take place in several different formats like workshops or inputs from experts to secure a correct evaluation (Caplice and Sheffi, 1994; Gonçalves et al., 2015; Al Haddad et al., 2020).

The last and seventh step will be to *integrate and evaluate the usage of framework*. Kaparias and Bell (2011); Harvey et al. (2016); McKinnon (2009); Gonçalves et al. (2015); Bouchery et al. (2010); Haponava and Al-Jibouri (2016) all argue that the conducted framework must be adapted to the situation or suitable usage, further be cross-industry accepted for the best outcome of usage. In addition, Prause and Schröder (2015); Caplice and Sheffi (1994); Al Haddad et al. (2020) mention the importance of tailoring the framework to a specific company to continuously adapt to the current situation and not get stuck in old routines.

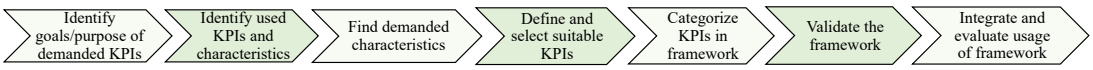

Figure 3.11: The process this study will use when designing the a framework of KPIs for electric road freight.

Chapter 4

Task specification

This chapter first describes the studied system on which the study has focused. The purpose further breaks down into three main areas with support from relevant literature. These areas further include questions, comprehensive Research Questions, and Sub-questions, which form the basis for answering the study's purpose. The chapter concludes by presenting a summary of the Research Questions and Sub-questions.

4.1 Studied system

To design the studied system, inputs from the Partner Company and the supervisor from Linköping University have been essential. The studied system limits the scope of the study. It also enables an eased understanding by determining specific system boundaries, which means that the study only focuses on the system within these boundaries.

Based on the purpose of the study, the studied system includes the *Partner Company*, *current customers*, *carrier partners*, *transport buyers*, *associated organizations* working with electrifying road freight, *transport providers* offering either an electric transport solution or a fossil-driven one, and *original equipment manufacturers (OEMs)*. Internal at Partner Company, the focus will be on operational activities. Even though the Partner Company is in focus, the result of the study aims to apply to the whole electric road freight sector, meaning that only part of the work will focus on tailoring the framework to the Partner Company and connecting the developed framework to fit Partner Company's specific business model. Moreover, the framework aims to apply to a broad audience as included KPIs aim to be sufficiently generalizable within electric road freight. The studied system has thus been chosen due to the market focus of the study. Since KPIs today mainly represent traditional, fossil-driven road freight, it will be essential to reach transport buyers to see their demand and capture their knowledge level and objectives regarding measuring and evaluating electric road freight.The inclusion of only carriers as Partner Company's partners is due to their essential function in transport activity. OEMs and associated organizations will be vital as they possess a high knowledge level that facilitates understanding the market. Furthermore, it will also be essential to capture transport providers' perspectives as they are working with offering road freight solutions and thus working close to KPIs and the development of electrification. See Figure 4.1 for an overall picture of the studied system.

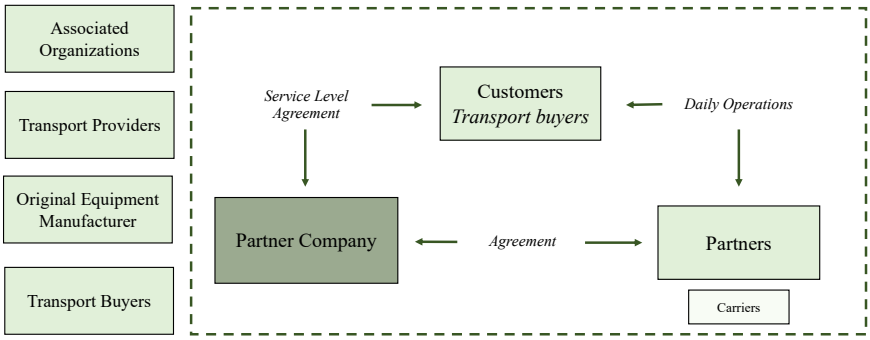

Figure 4.1: An overview of the studied system.

4.2 Breakdown of purpose

The following section breaks down the purpose into three specific Research Questions. For the convenience of the reader, the purpose of the study is:

> *The purpose of this study is to design a framework of KPIs to measure and evaluate electric road freight and further adjust the framework to Partner Company.*

The study aims to develop a framework of KPIs for electric road freight, where demanded KPIs by the market will be included. The KPIs included will further be categorized according to required and appropriate categories within the framework. All individual KPIs will be build-up by requested characteristics to simplify and facilitate measurement, evaluation, and communication. The idea is that the framework will first be conducted in a general manner, enabling applicability for a broad market, and secondly, be adjusted, allowing the Partner Company to adapt and integrate the framework to suit their business. In the frame of reference, a process for creating a framework of KPIs was presented based on the literature, see *Section 3.6.1 Synthesis of methods*. This study aims to use that process to create the framework of KPIs suitable for electric road freight.

For the convenience of the reader, the process is shown in Figure 4.2. The process has been designed with inspiration from Kaparias and Bell (2011); Prause and Schröder (2015); Al Haddad et al. (2020); Caplice and Sheffi (1994); Harvey et al. (2016); Gonçalves et al. (2015); McKinnon (2009); Bouchery et al. (2010); Haponava and Al-Jibouri (2016).

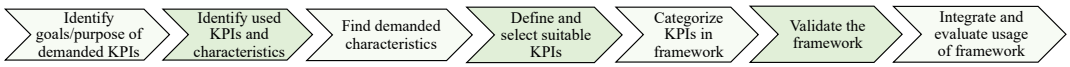

Figure 4.2: The process this study will use when designing a framework of KPIs for electric road freight.

As the Partner Company already has *identified internal goals and has an idea regarding the purpose of demanded KPIs*, the first step in the process is outside the scope of this study. For simplicity, the authors of this study have chosen to divide the remaining six steps of the process, visualized in Figure 4.2, into three main areas, which will form the basis of the study's Research Questions and further Sub-questions, see Figure 4.3. Below is a brief presentation of how the different process steps are divided into the three main areas.

The second step in the process in Figure 4.2 is to *identify current KPIs and characteristics* of commonly used KPIs. This step investigates KPIs and characteristics within the traditional road freight sector, meaning to find what the environment outside the context of the Partner Company is measuring today connected to fossil-driven road freight. Further, this is a critical process step according to Harvey et al. (2016) who mention the importance of having an overview of the market and knowing which key stakeholders exist. By this, the study has chosen to formulate the first main area that involves ***identification of traditional road freight frameworks of KPIs*** when road freight is fossil-driven. Further, this means examining the studied system externally, providing a picture of the KPIs traditionally used in road freight, the characteristics of such KPIs, and how they could be categorized to understand the KPIs better. Categorization is, however, not mentioned by the literature supporting this second step in the process. Although, as categorization will play a vital part in step five in the process, it will be essential to look at the categorization regarding traditional road freight as well.

To *find demanded characteristics of KPIs* that fit electric road freight, *find and select what KPIs that are suitable* for the new specific system, as well as *categorize selected KPIs* constitute process steps 3 - 5 in Figure 4.2. These steps form a central part of the framework design for electric road freight. They, therefore, constitute the second main area of the study, which will be to create the framework, i.e., ***design a framework of KPIs for electric road freight***.

Integrating the framework internally at Partner Company means adjusting and tailoring the framework to the needs of the company, which is crucial in successfully developing a comprehensive framework of KPIs. The two final steps in the process in Figure 4.2 are the *validation of the framework* and the *integration and evaluation of the framework*, which in turn means that users should confirm the framework, further to give inputs to tailor the framework to the specific business. Once the designed framework is validated, with its KPIs, characteristics, and categories, it is natural to enable it to be adapted to a user company. Further, this means reviewing and modifying the framework together with the company, thus to fulfill demands, which is why the third main area of this study is ***integration of the framework***.

Based on the discussion above, the overall purpose divides into three main areas that describe what is to be studied and investigated, see Figure 4.3. Each area further leads to a Research Question with corresponding Sub-questions.

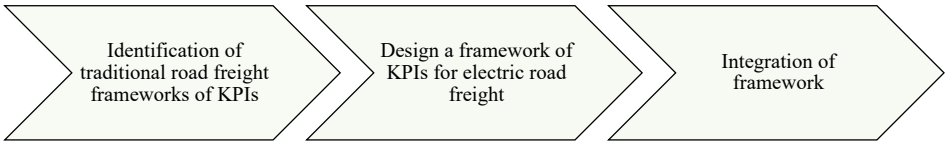

Figure 4.3: The three main areas which the Research Questions will be based on.

4.2.1 Identification of traditional road freight frameworks of KPIs

The first main area can be seen in Figure 4.4 and involves identifying the current situation in terms of KPIs and their characteristics, as well as the categorization used for KPIs in traditional, fossil-driven road freight.

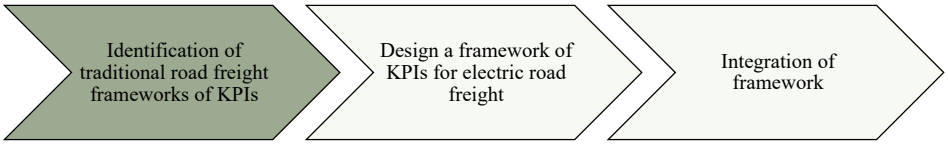

Figure 4.4: The first main area which Research Question 1 will be based on.

According to Haponava and Al-Jibouri (2016), it is essential to identify the current situation regarding KPIs to facilitate continuous monitoring. Continuous monitoring, in turn, is crucial for improving and developing a business, often with the help of KPIs (Prause and Schröder, 2015). Choosing the right KPIs for a specific system is, according to Prause and Schröder (2015), essential to evaluate actual performance. McKinnon (2009) believes that the whole industry must accept the KPIs in order to compare and benchmark against the market. Based on this, the conclusion is that understanding the current situation on the market outside the context of the Partner Company is of great importance to know what a framework of KPIs in traditional road freight includes. The construction of a framework, what characteristics and KPIs exist, and the categorization of KPIs are essential to investigate. Further, this enables a broader understanding of how transport providers of road freight work with KPIs internally and how transport buyers and other stakeholders externally can understand and adapt to those KPIs. Based on the justifications above, the first Research Question of the study is as follows:

Research Question 1: How is a general framework of KPIs designed for traditional road freight?

Every measurement framework consists of a set of individual KPIs, which are a tool enabling to monitor and evaluate customers' satisfaction with a service (Caplice and Sheffi, 1994). From the literature, commonly used KPIs in traditional road freight can be read, where for example, Oskarsson et al. (2013) highlight the importance of KPIs related to the delivery service. Further, McKinnon (2009); Prause and Schröder (2015); Lukinskiya and Pletneva (2018) mention that transport costs have always played a significant role when it comes to logistics activities. However, what is considered significant in the process of developing a framework of KPIs, is to identify the KPIs that actually are used within the system and not just draw conclusions from the literature (Prause and Schröder, 2015). Therefore, it is of high relevance to look at which KPIs are used today across the industry to create a comprehensive and as realistic picture of the reality as possible (Kaparias and Bell, 2011; McKinnon, 2009). Hence, it becomes significant to use empirical evidence through data collection to create a broad set of KPIs that important key stakeholders use (Kaparias and Bell, 2011). The above discussion leads to the first Sub-question within the first Research Question and is as follows:

Sub-question 1.1: Which individual KPIs are used?

In order to create a robust framework of KPIs, it is essential to follow a structure where the individual constituent elements of the framework are defined and built up by several characteristics (Prause and Schröder, 2015). Further, Kaparias and Bell (2011) argue that in order for an individual KPI to be accurately measured and evaluated, it should have different characteristics or requirements. Furthermore, Prause and Schröder (2015) also argue that the characteristics of the constituent KPIs in a framework are essential. Establishing the criterion for KPIs is also an essential step within Caplice and Sheffi (1994); Gonçalves et al. (2015); Bouchery et al. (2010); McKinnon (2009) approach when creating a framework of KPIs.

Therefore, the basis for creating a framework of KPIs suitable for electric road freight is to look beyond the context of the Partner Company and investigate the traditional road freight market, which means taking a cross-industry and market-wide perspective. Further, this will help find key characteristics that used KPIs connected to fossil-driven road freight have. As the first Sub-question investigates what KPIs are used, it is natural to analyze further what such KPIs usually have as characteristics. With the reasoning above, the first Research Question leads to the second Sub-question:

Sub-question 1.2: Which characteristics exist for individual KPIs?

Once identifying the specific KPIs and their characteristics, Caplice and Sheffi (1994) argue that KPIs should be categorized to facilitate the interpretation of the whole framework, as categories create a clear structure, but also as categories simplify understanding of each KPI, positioning it into a context. Categorizing KPIs to facilitate understanding and use is also something that Kaparias and Bell (2011) highlight as essential. Companies categorize KPIs differently, but the macro-perspective is critical when identifying and classifying them, wherefore it is crucial to know how the market-wide sector works with categorization today. In conclusion, it is therefore essential to analyze categories. It is essential to look sector-wide when identifying commonly used categories when structuring a framework of traditional KPIs connected to road freight. Further, this leads to the third Sub-question:

Sub-question 1.3: How are these KPIs categorized?

See the summary of the first Research Question and its three Sub-questions in Figure 4.5.

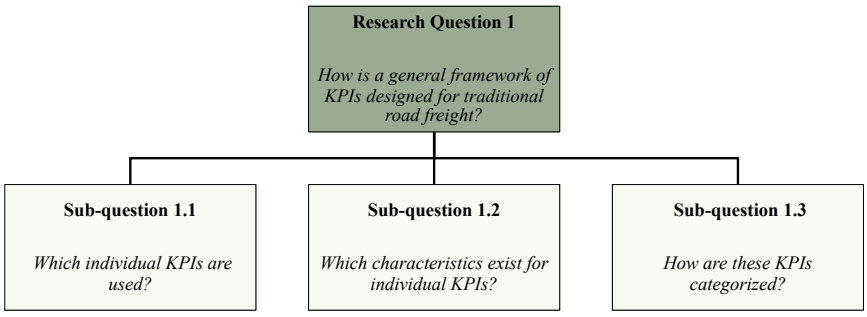

Figure 4.5: Summary of Research Question 1 with the three corresponding Sub-questions.

4.2.2 Design a framework of KPIs for electric road freight

The second main area is to design a framework of KPIs suitable for the electric road freight sector. Additionally, this will be done based on the current situation regarding traditional road freight. Once answering the first Research Question and its corresponding Sub-questions motivated in *Section 4.2.1 Identification of traditional road freight frameworks of KPIs*, the investigation within the second main area can start, see Figure 4.6.

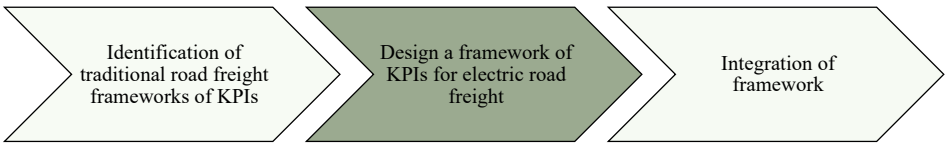

Figure 4.6: The second main area which Research Question 2 will be based on.

When designing a framework of KPIs for electric road freight, it is relevant to analyze the market outside the Partner Company and the internal environment within the Partner Company since they possess general knowledge regarding electric road freight. Caplice and Sheffi (1994) mention the importance of, when developing KPIs for a new or changed system, starting with finding characteristics for KPIs before choosing which KPIs to include in the new framework. Thus, it will be imperative to find out what demanded characteristics KPIs should have (Prause and Schröder, 2015; Caplice and Sheffi, 1994). Additionally, Prause and Schröder (2015) mention the importance of finding the gaps between existing characteristics of used KPIs and demanded characteristics of relevant KPIs. Further, finding what characteristics are suited for KPIs connected to electric road freight will be essential. In order to create a structure within a framework, it is essential to identify how the constituent KPIs in a framework could be categorized (Caplice and Sheffi, 1994). Therefore, analyzing how involved stakeholders in the electric road freight sector want to categorize KPIs within a framework is essential to benefit internally and externally. Utilizing an industry-wide perspective is something that McKinnon (2009) highlights as essential before the framework is tailored and integrated into a specific company context. Thus, the idea of the second Research Question is that the framework developed should apply to a broader audience than just the Partner Company specifically, which explains why the second Research Question is as follows:

> *Research Question 2: How could a framework of KPIs be designed for electric road freight?*

To specify characteristics of demanded KPIs in a specific studied system is something that Kaparias and Bell (2011); Prause and Schröder (2015); McKinnon (2009); Gonçalves et al. (2015); Al Haddad et al. (2020); Bouchery et al. (2010); Haponava and Al-Jibouri (2016) constitute a critical first part in the process of designing a framework. Therefore, this becomes particularly important as electric road freight is under development, and investigating the characteristics that suit the changed transport network is central. Further, the transition might imply characteristics to vary significantly from characteristics of KPIs suited for traditional road freight since new demands occur with new technology.

Examining the demanded characteristics that KPIs connected to electric road freight could have, both internal at Partner Company and also on the external market, will, in turn, contribute to a broad understanding of how to determine the most relevant characteristics for KPIs. Therefore, the second Research Question's first Sub-question is as follows:

Sub-question 2.1: Which characteristics are demanded for electric road freight?

Once finding the characteristics, it becomes relevant to select and screen KPIs for the framework's purpose. The process of collecting and finding KPIs that the studied system can adapt is central (Kaparias and Bell, 2011; Harvey et al., 2016; Caplice and Sheffi, 1994; Bouchery et al., 2010). Thus, capturing the macro perspective on the market and the micro perspective of the Partner Company regarding which KPIs will be relevant is central when designing the framework. Indeed, it is the individual KPIs that visualize how the business is doing and tell the degree of goal achievement or performance (Caplice and Sheffi, 1994). Some KPIs used in traditional road freight will be relevant even post-electrification. However, including new KPIs can be relevant as exploring the need to evaluate electric road freight. Identifying the need and finding out how companies are working with electric road freight and the significant activities included will explain what KPIs could be included in the framework. Further, this results in the next Sub-question regarding which KPIs the framework could include.

Sub-question 2.2: Which individual KPIs could be included?

After choosing KPIs with the true purpose and appropriate and demanded characteristics, a categorization of the chosen KPIs should take place to ease the understanding and the structure of the framework (Caplice and Sheffi, 1994). Maintaining the broad system perspective and capturing knowledge from the internal Partner Company perspective when finding appropriate categories will help the framework be accepted cross-industry. Once well-matched categories are chosen to fit the KPIs, the framework can take shape and be used by a broad audience. The third Sub-question is, therefore, as follows:

Sub-question 2.3: How can these KPIs be categorized?

See the breakdown of Research Question 2 into Sub-questions in Figure 4.7.

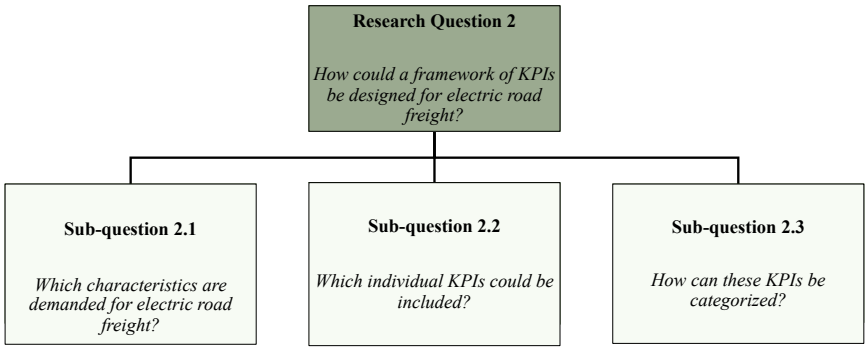

Figure 4.7: Summary of Research Question 2 with the three corresponding Sub-questions.

4.2.3 Integration of framework

After designing the framework, integrating the framework into the focused company's business is essential. This third main area is illustrated in Figure 4.8 and acts as the cornerstone of the study's third Research Question.

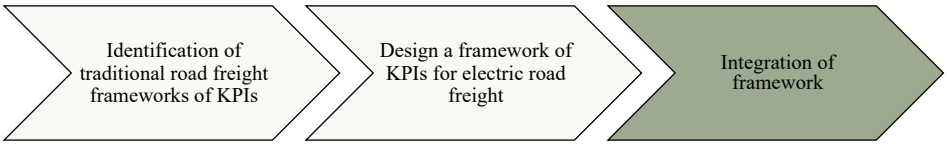

Figure 4.8: The third main area which Research Question 3 will be based on.

Successful integration of a framework, with its constituent categories and individual KPIs, requires linking the framework to the activities and purpose of the framework for the specific company (Gonçalves et al., 2015). Therefore, the purpose of the study is further to integrate the designed framework of KPIs within Partner Company. According to McKinnon (2009); Harvey et al. (2016); Al Haddad et al. (2020); Gonçalves et al. (2015); Bouchery et al. (2010); Haponava and Al-Jibouri (2016), it is central to evaluate the framework of KPIs in the proper context. Harvey et al. (2016); McKinnon (2009); Haponava and Al-Jibouri (2016); Bouchery et al. (2010); Al Haddad et al. (2020); Gonçalves et al. (2015) claim that integration of KPIs in the proper context is at least as necessary as the design of the framework itself. McKinnon (2009) argues that tailoring the framework of KPIs in a company must be done in a company-broad manner and include all critical persons in order for the framework to be applicable in daily operations. However, it is an excellent start to first validate the framework by a small group of experts within the company before applying it to a company-wide extent (Gonçalves et al., 2015; Al Haddad et al., 2020). Further, this will verify its relevance and credibility. Additionally, McKinnon (2009) mentions the significance of first tailoring the framework of KPIs in a specific business unit before spreading it to the whole company; else, the integration will become challenging.

Furthermore, the designed framework must be made understandable by the Partner Company and, primarily, its current customers and potential future customers. Some KPIs might only be relevant for internal measurement. In contrast, others need to be communicated to customers, indicating that KPIs must be categorized to fit Partner Company's business. Further, the KPIs might also be transformed to ease the dialogue and communication with customers. If the KPIs are presented in an unclear way, the communication with customers can lead to misunderstandings and further destroy the relationship (Kurdve and Wiktorsson, 2013). A transparent bridge between the Partner Company and customers, with the help of KPIs, enables to capture indications of what internal changes are needed to improve customer satisfaction.

Using KPIs that the Partner Company finds essential can enable them to reach a better customer perspective and improve communication and acceptance, further crucial aspects of succeeding with the usage of KPIs (McKinnon, 2009; Caplice and Sheffi, 1994). With this reasoning, the conclusion is that it is crucial for the success of the result to tailor-made the framework in the Partner Company context, which leads to the third Research Question:

> *Research Question 3: How could the framework be adjusted to suit Partner Company?*

As described above, Research Question 3 aims to, by modifying the designed framework, enable a solid integration that suit Partner Company's business. See the Research Question 3 in Figure 4.9.

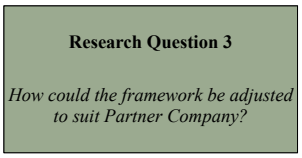

Figure 4.9: Summary of Research Question 3.

4.2.4 Summary of task specification

Presented in Figure 4.10, an overview of the three Research Questions together with their Sub-questions can be seen.

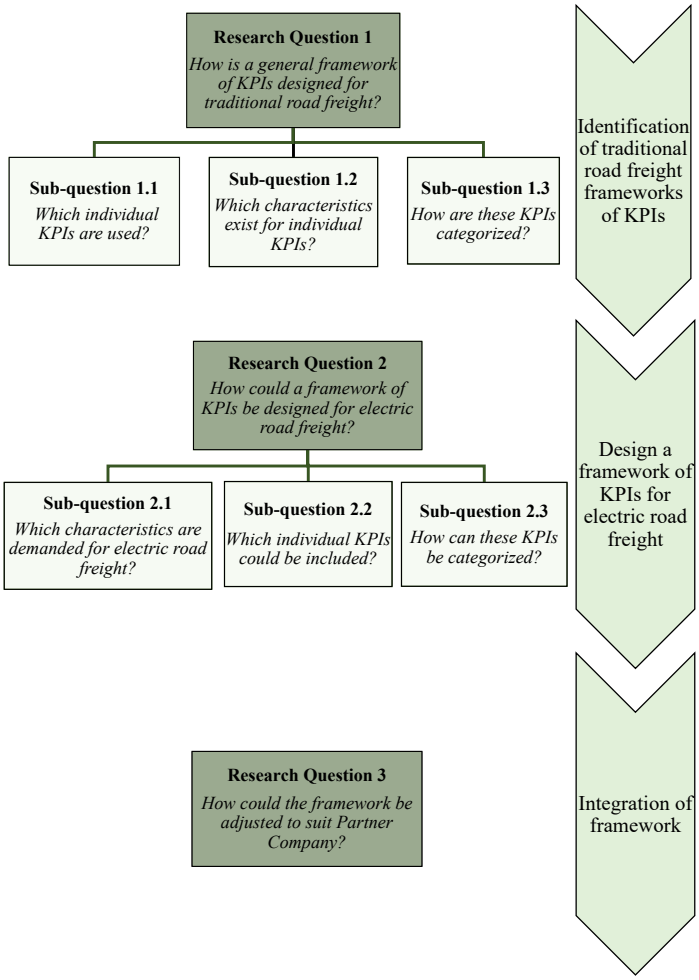

Figure 4.10: All Research Questions together with Sub-questions and the main areas.

Chapter 5

Methodology

This chapter presents the study's methodology and the approaches taken in the study. The chapter describes the methods based on findings in the literature, where the research design builds up in three phases. Further, each phase will be presented separately, highlighting each phase's elements in detail. In each phase, a discussion regarding the study's credibility transpires to clearly describe the work to achieve credibility and the ethical guidelines followed. The chapter concludes by presenting a reflection on the methodology.

5.1 Choice of methodological approach

According to Höst et al. (2006), the methodology is the primary approach chosen for a specific study. Therefore, the methodology provides a structure with correlated principles for a study's typical approach. Furthermore, the choice of the methodological approach depends on specific research objectives and their characteristics. As this study aimed to answer a purpose not previously explored thoroughly, the study could be seen as exploratory (Blomkvist and Hallin, 2014; Höst et al., 2006). When linked to this study, the three Research Questions that build up the purpose are exploratory. A study with an exploratory focus means, according to Blomkvist and Hallin (2014), that the authors of the study ask questions to find new insights about how reality looks or develops. Often, it is about understanding recent trends, phenomena, or events in research fields that have not previously been studied.

Research Question 1 identified what KPIs are used in traditional, fossil-fueled road freight. It aimed to understand how current KPIs are described in terms of characteristics and how the road freight sector categorizes them. Research Question 2 can be seen as more exploratory due to its nature of answering which KPIs exist in the electric road freight sector and identifying demanded future KPIs and their characteristics and how to categorize them. Additionally, Research Question 3 was about integrating and tailoring the designed framework of KPIs within the Partner Company to enable efficient communication with their customers, i.e., transport buyers. Thus, the overall aim was to profoundly understand the reality of how to measure and evaluate electric road freight and reflect the electrification in KPIs, which sums up why the study is exploratory (Höst et al., 2006).

5.2 Research design

This study was built up of three phases; an *initial phase*, a *main phase*, and a *final phase*. The authors of this study have taken inspiration from Blomkvist and Hallin (2014); Björklund and Paulsson (2019), regarding the research design, where key elements from both research designs have been included in this study's three phases to achieve the result in answering the purpose. Blomkvist and Hallin (2014) propose a design that consists of four phases dealing with *formulation*, *construction*, *production*, and *delivery*. In contrast, Björklund and Paulsson (2019) highlight three phases in the conception of research design, namely, an *idea phase*, a *knowledge phase*, and an *immersion phase*.

The initial phase was about framing the problem and generating ideas, where the primary outcome was to formulate the purpose of the study. The initial phase further included a background description of the problem and a summarizing company description of Partner Company. The main phase in the research design was about acquiring lots of knowledge, where great inspiration was taken from Björklund and Paulsson (2019) knowledge phase. The main phase included a literature review and collection of data in terms of interviews and a workshop. Regarding the study's chapter creation, the main phase contributed to the design of the frame of reference, the task specification, the method, and the findings with corresponding analysis.

The final phase consisted of creating the study's conclusion and subsequent discussion. The main aim of the final phase was to answer all three Research Questions and their connected Sub-questions. The finalization of the study acted as the sum of Björklund and Paulsson (2019) immersion phase and Blomkvist and Hallin (2014) delivery phase. Figure 5.1 visualize this study's research design. What can be seen in the figure is that this study's developed process for designing a framework of KPIs connected to electric road freight is included within the main phase. However, as the first process step already have been executed by the Partner Company, it is included in the initial phase because the authors gathered information regarding that process step in the initial phase.

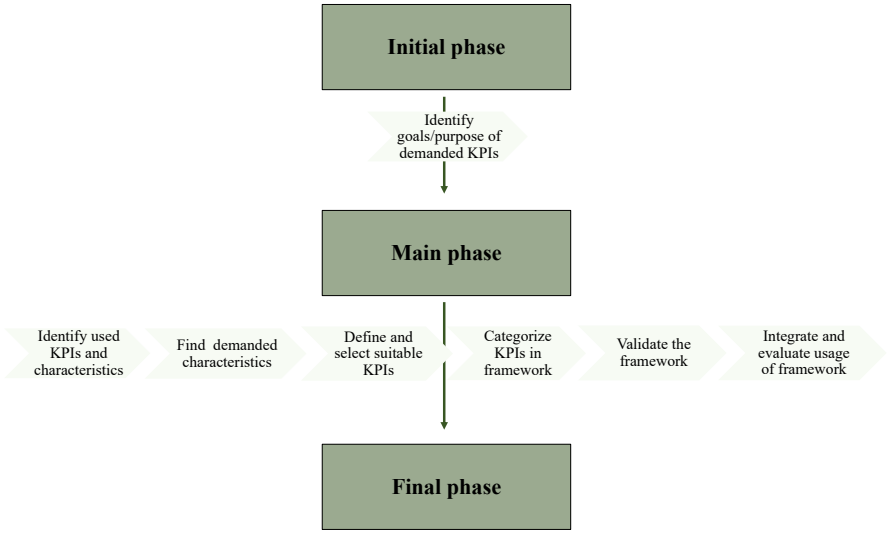

Figure 5.1: Phases of this study's research design.

The following sections will, in detail, specify the three phases in chronological order. Further, this will help the reader to get a comprehensive and detailed picture of how the study was constructed and how the authors of this study were proceeding when answering the Research Questions, Sub-questions, and the study's overall purpose. Each phase has undergone several iterations and has continuously been discussed with the supervisors at the University and Partner Company. During all phases, literature has been collected and updated to follow research news, the dynamic changes of the purpose, and new requests or delimitations from the University and the Partner Company. See the method in Figure 5.2. On the left side of the figure, it can be vertically read in which phase each part of the study was performed. The first column of the figure visualizes which steps and thus which headings the next sections within this chapter highlight. The middle column of the figure visualizes which chapters have been constructed when conducted each step. The column on the right only clarifies which process steps in the developed process of creating a framework of KPIs have been carried out in what phase.

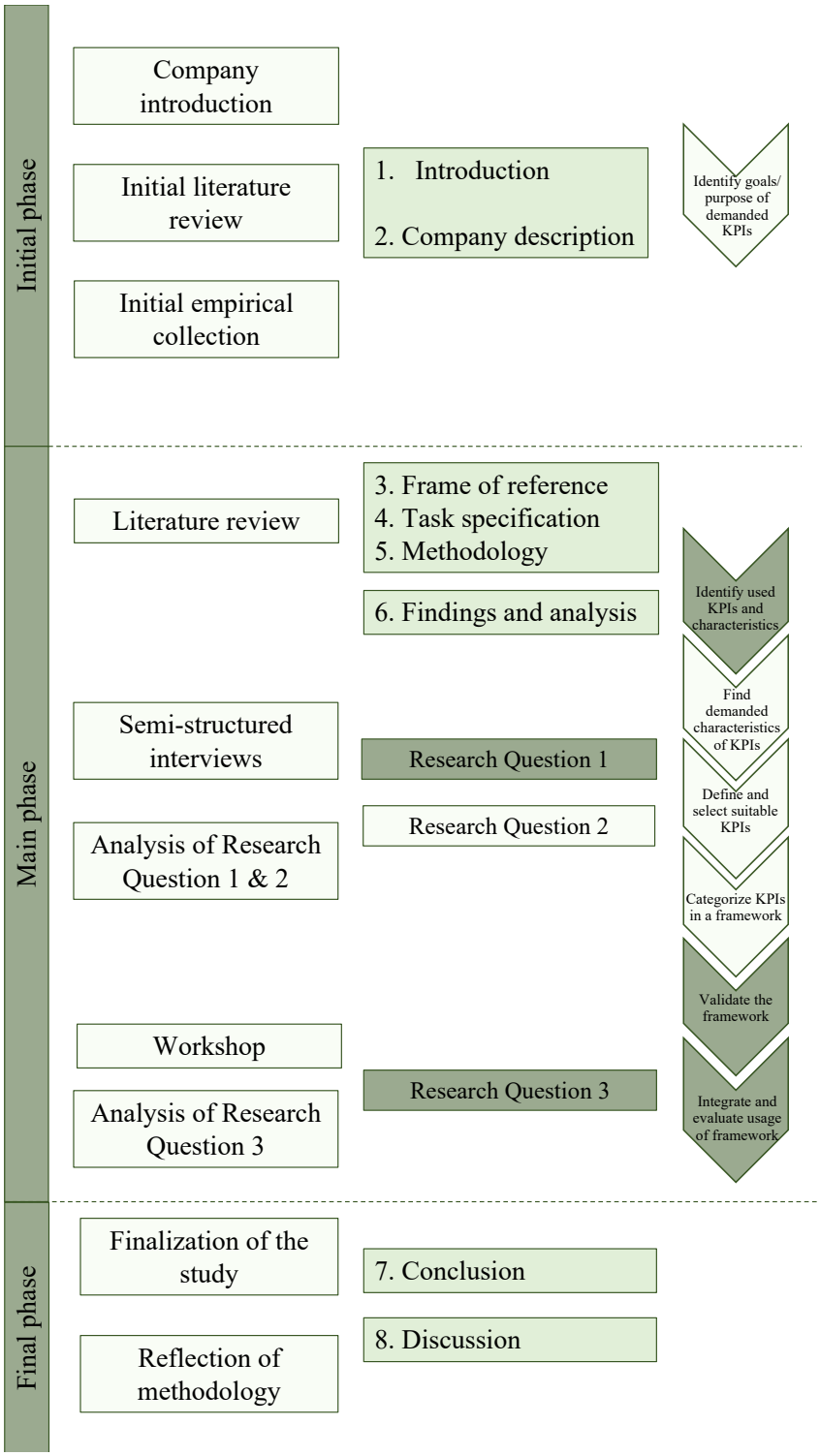

Figure 5.2: The over-all method and research design of the study.

5.3 Initial phase

The initial phase's main aim was to develop the study's purpose, which laid the foundation for all the following work. The initial phase included creating the introduction and composition of the company description, which was carried out iterative to best complement each other and build up the study's two first chapters. The Partner Company themselves had already carried out the first step of the developed process. However, the first step is essential when creating a framework of KPIs, which describes why it still is mentioned, but not investigated by this study's authors. While the purpose and goal of demanded KPIs were already identified, gathering this information during the initial phase was essential, resulting in a base for further work. The first step in the developed method, *identify goals and purpose of demanded KPIs*, is visualized in Figure 5.3. The purpose and goal of demanded KPIs, according to the Partner Company, is to enable a common understanding of the market regarding electric road freight.

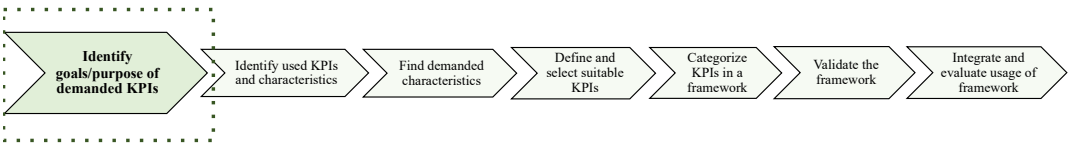

Figure 5.3: The first step of the developed method.

5.3.1 Company introduction

The authors of this study participated in an introduction week at the Partner Company, where various introductory lectures were held to create an overall understanding of the company. The presentations and seminars ranged from what Partner Company's business model looks like and core competencies to future challenges within their business. As the study was performed in close collaboration with the Partner Company, where the company was involved in shaping the study, it might have affected the objectivity. Objectivity is, however, crucial to be kept as high as possible to maintain a high level of credibility (Björklund, 2018). Therefore, this study's authors have been aware of the subjective perspectives collected from the Partner Company, whereas triangulation has been used to strengthen the information collected internally. Subjectivity has been kept low, and as the literature has been built up from several sources outside the company's context, objectivity is considered to be high.

5.3.2 Initial literature review

In parallel with the introduction week, the start of a brief initial literature review was carried out. The initial literature review aimed to create a basic knowledge of the studied topics outside the context of the Partner Company. To gather extensive knowledge quickly, the authors prioritized reading only abstracts, focusing on capturing the essential information from the articles and reports considered to be of most relevance and appropriate to the study's problem statement. Further, this initial literature review used only a random search on the Scopus database. Using the snowball effect, e.g., reading related articles or cited articles, the authors could move forward by reading correlated articles or articles conducted by authors that resembled or mentioned in the article. The initial literature review was further used as a base for creating the chapter's introduction and company description. The initial literature review also provided a solid base for the main phase.

5.3.3 Initial empirical collection

In addition to the initial literature review, several unstructured interviews were conducted during the initial phase. Unstructured interviews are often used when researchers have enough understanding of the topic of interest, hence having a clear plan but without any pre-determined questions (Sajjad Kabir, 2018). During the initial phase, multiple unstructured interviews were held, where the authors of this study could capture new insights from respondents. These unstructured, internal interviews held at the Partner Company aimed to understand the study's basic requirements, expectations, and requests. The interviews also complemented the initial literature review and contributed to a better understanding of the Partner Company. As Patel and Davidson (2019) argue, four important ethical rules must be taken into account when conducting interviews, something that this study's authors have considered when conducting the unstructured interviews. Before all interview sessions, the interviewees were informed about the purpose of the interview, and their participation was voluntary. Personal data was handled confidentially, and participants were anonymized, only highlighting their role. What Patel and Davidson (2019) also mention to be important is that all information collected from interviews must have the intention to be used within a study, something that this study has sought to achieve. In Table 5.1, the conducted unstructured interviewee roles are presented, together with the purpose of the interview and the date of execution. In *Appendix A Interview Questions - Unstructured internal at Partner Company*, the interview questionnaire used during the unstructured interviews can be found.

Table 5.1: Unstructured interviews in the initial phase.

Interviewee at Partner Company	Purpose	Date
Solution Development team	Customer journey, obstacles with electric freight transport	18/1 2011
Operations Analyst and Global Solution Architecture	Service Level Agreement and sales process	9/2 2022
Operation Analyst	Service Level Agreement, macro perspective of electrification	11/2 2011
Business Controller	Used KPIs internal and development of more corresponding KPIs to electric road freight	17/2 2022
Deployment Project Manager	Implementation of projects and operational KPIs	28/2 2022
Customer Operations and Freight Mobility Platform (FMP) implementations	KPIs and software platform	28/2 2022
Sales Executive	Customers point of view and process during sales	1/3 2022

The initial literature review and initial empirical collection contributed to finalizing the initial phase, i.e., conduction of the introduction and the company description. In addition, the study could formulate the purpose, delimitations, and disposition.

5.4 Main phase

Followed by the initial phase, the main phase took place. Within the main phase, most literature has been gathered through a literature review, and data have been collected through empirical collection. The literature review has aimed to build up the frame of reference and further conclude the task specification and method to create a solid foundation for the empirical collection and analysis.

The empirical collection has aimed to collect data for the build-up of findings, and by that being able to answer the Research Questions and corresponding Sub-questions defined in *Chapter 4 Task Specification*. The majority of the process steps from the developed process were included in the main phase and can be displayed in Figure 5.4.

The main phase first aimed to determine how traditional, fossil-driven road freight uses KPIs frameworks. Secondly, the aim was to create the framework of KPIs for electric road freight and further adjust the framework to fit the Partner Company's business. The step *identify used KPIs and characteristics* aimed to help answer Research Question 1 with findings and analysis from semi-structured interviews regarding traditional road freight. This process step was also to find out how to categorize the found KPIs in a framework. The steps *find demanded characteristics*, *define and select suitable KPIs*, and *categorize KPIs in a framework* have also been executed with the help of semi-structured interviews and analysis of the data to help answer Research Question 2. Further, the two steps *validate the framework* and *integrate and evaluate the framework* have been done with the help of a workshop where interaction and discussion internal at the Partner Company have enabled to adjust the framework of KPIs to fit the Partner Company's business. Even though the developed process is visualized linearly, iterations have been required to update findings and enable a successful analysis and outcome of the process steps.

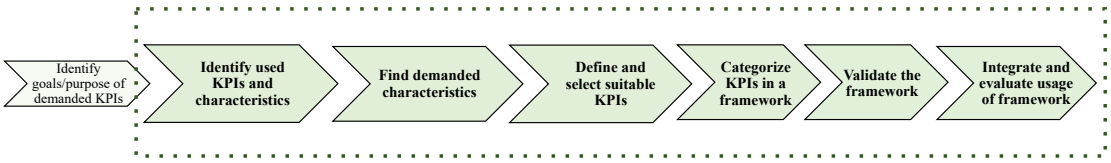

Figure 5.4: The process steps in the main phase.

5.4.1 Literature review

Two main topics have been identified as necessary to analyze when conducting the literature review within the scope of this study; *transportation* and *Key Performance Indicators (KPIs)*. According to Björklund (2018), it is of high importance that correct information is gathered and further correlated to the purpose of a study to strengthen the validity. As Patel and Davidson (2019) argue, specifying the studied system before collecting literature enables to ensure that correct information is collected for answering the purpose, a statement that this study has followed.

Before the literature review started, a plan was created, specifying where, how, and which keywords to use. Scopus was the most used database during the review, mainly because the authors felt comfortable using its features and assurance of all articles being peer-reviewed. Google Scholar and Unisearch have also been used to complement Scopus. The search set-up was always advanced to enable filters and relevance of searched topics. The authors of this study used search keywords related to the two main topics; transportation and KPIs.

First, the authors registered the number of results for each search. If the result generated too many hits or was considered too broad, an eventual change of the amount of, or transformed, keywords could be done. For example, searching solely on the keyword *Key Performance Indicators* generated 10 551 articles, where the authors complemented the search with a second and a third keyword such as *road freight* and *electrification*. When narrowing down the number of results to under 100 articles, the authors read headlines to determine whether the articles were of relevance or not. If the headline had any of the keywords searched on, in this example; *Key Performance Indicators*, *road freight* or *electrification*, the abstract was read. If the headline did not include any keywords, the article was considered too low relevance. Therefore, the abstract was not read, and further, the article was considered out of scope.

After reading the abstract of articles being of relevance, further screening was done. The whole article was read if the abstract were relevant or if the article seemed to have conducted a similar study like this one. If the headline contained the right keywords, but the abstract gave a non-relevant description, for example, if the article was about financial KPIs, e.g., a non-comparable situation, the article was rejected. After reading the relevant articles, the authors further investigated whether any related or cited articles also were relevant, thereby using the snowball effect for further findings of relevant articles. Figure 5.5 presents the steps used and *Appendix D Literature search* additionally displays which keywords were searched on, the number of hits, and relevant articles.

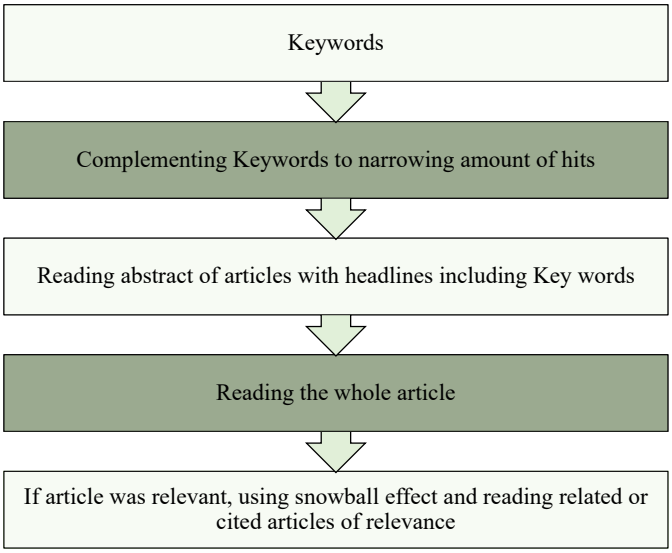

Figure 5.5: The search process of the literature review.

As a part of the literature review, a more random search was conducted to conclude and gather the latest research. For example, e-journals, reports by research institutions, consulting studies, trade press articles, and recently published e-books were also used when conducting the frame of reference. This literature has been very significant because the study is highly up-to-date within the research fields. However, random literature research may be considered less valid, mainly if not always, peer-review articles are gathered. Still, as the literature gathered from the databases has been peer-reviewed, and the authors have used triangulation as a method, this random literature search can be said to ensure the study's validity. According to Patel and Davidson (2019), the use of several sources in a study's frame of reference will strengthen information, and therefore, triangulation clarifies its validity. The detailed documentation of the literature review and the detailed description of the methodology has further contributed to reducing the risk of missing important information. The documentation has further strengthened the study's reliability which is a credibility factor, described by Björklund (2018) as an essential factor.

During the collection of literature, the authors of this study could create a process for how to design a framework of KPIs, i.e., answering the study's purpose. In *Section 3.6.1 Synthesis of methods*, nine different studies have been presented that deal with processes when designing a framework of KPIs. These studies were analyzed and compared to find similarities and differences between the study's different processes. Most studies were similar, where process steps only differed in levels of aggregation and types of formulations. Further, this enabled to easily aggregate the different process steps of the studies into process steps that fit this study's purpose. Therefore, the authors of this study based the selection of what process steps to include within this study on how many studies could validate the process step and the study's relevance to the purpose, resulting in seven process steps, visualized once again for the convenience of the reader in Figure 5.6.

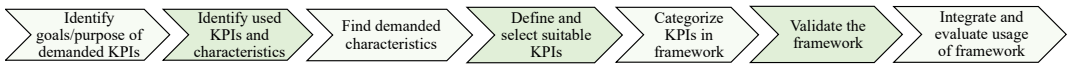

Figure 5.6: The process this study will use when designing a framework of KPIs for electric road freight

The selected process steps suited this study very well, primarily since the first process step prior had been performed by the Partner Company and thus had already been included within this study's initial phase. The second process step is further linked to Research Question 1; see *Section 4.2.1 Identification of traditional road freight frameworks of KPIs.* However, what is worth mentioning once again is that the literature could not validate the relevance of investigating a categorization in the framework linked to traditional road freight. As literature instead could validate the relevance of categorizing a framework with new KPIs linked to electric road freight, the authors of this study considered it also relevant to include an examination of a framework categorization linked to Research Question 1. The remaining process steps could be validated by literature and reflect the majority of the studies examined in *Chapter 3 Frame of reference*, but only with different formulations on the process steps, as the aim was to fit this study.

5.4.2 Semi-structured interviews

Empirical collection of data can, according to Björklund (2018), consist of various methods, whereas the most common ways to collect data are through interviews, observations, and surveys. Since a qualitative study focuses on perceptions and descriptions, interviews were considered to fit the purpose of creating a framework of KPIs. According to Sajjad Kabir (2018), interviews are a beneficial method of primary data collection, where the focus is on asking questions to collect answers from specifically selected and essential participants. The use of semi-structured interviews as empirical data collection was considered to suit this study's exploratory focus, whereby open-ended questions could provide an opportunity to identify new perspectives on the topics at hand but also enable a discussion to diverge (Sajjad Kabir, 2018). Therefore, digital, semi-structured interviews have been conducted.

During the interview sessions, it was essential to ask all respondents the same questions, or at least similar ones, enabling different perspectives from different stakeholders, but all with the same starting point. Therefore, a paper-based interview guide prepared ahead of each conducted interview was used during all sessions. The prepared questions were sent to the interviewees beforehand. As Patel and Davidson (2019) mention, two critical aspects exist when collecting information with the help of an interview guide, namely standardization and structuring. These aspects treat the perspective of the interviewer. The degree of knowledge level regarding designing questions and how the questions are asked plays an essential role in whether correct information can be collected. The semi-structured interviews were recorded to enable later transcriptions, thus easing the following analysis. The recording also enabled uncertainties to be corrected by asking clarifying questions to the respondent after the interview session. In *Appendix B Interview Questions - Semi-structured internal at Partner Company* and in *Appendix C Interview Questions - Semi-structured external with stakeholders*, the interview guides can be found.

Ethical considerations are of importance when conducting interviews. According to Sajjad Kabir (2018), adhering to moral norms will help to promote the purpose of a study by avoiding errors, collecting proper knowledge, and preserving truth. Regulations should therefore be followed when collecting empirical data (Swedish Research Council, 2022). Similar to the conduction of unstructured interviews, the collection of first-hand data from semi-structured interviews has also followed these restrictions. Interviewees have been informed beforehand and the aim of the interview session and further how the data was handled. All interviewees participated voluntarily, and the interview sessions started with an agreement between the interviewee and the authors regarding permission of collected data and audio recording. In order to follow up on interviews, the compilation of the data was reviewed by the interviewees before publication. Therefore, the presentation of empirical data in *Chapter 6 Findings and analysis* was sent to all internal and external participants and the responsible supervisor at the Partner Company for inaccuracies to be corrected. All confidential information has further been delimited from the study to protect the privacy and confidentiality of involved companies and persons (Sajjad Kabir, 2018).

Further, the interview participants have been anonymized by private and company names; only roles, stakeholder positions, and each interview date have been mentioned. Based on the concept of reliability, the main drawback of the study is how the selection of the semi-structured interviewees was carried out. Although there has been a systematic approach in which many perspectives have been represented, personal contacts and sometimes coincidence have generated interview opportunities. However, the authors themselves cannot observe an unnatural selection in the empirical data, and this should be partly compensated for by the large number of interviews conducted.

Research Question 1
Research Question 1, and its connected Sub-questions could be answered with the help of semi-structured interviews and further analysis. Interviews with Partner Company (PC), transport providers (TP), transport buyers (TB), associated organizations (AO), and original equipment manufacturers (OEM) have acted as input before analyzing and further answering Research Question 1.

Figure 5.7 gives an overview of what stakeholders have been interviewed to help analyze and further answer each Sub-question to Research Question 1. In Table 5.2, a description of each interview's purpose can be found, further also what role and stakeholder position each interviewee posses. The semi-structured interview questions that have been used are highlighted in *Appendix B Interview Questions - Semi-structured internal at Partner Company* and in *Appendix C Interview Questions - Semi-structured external with stakeholders*.

Even though the Partner Company (PC) is fore and foremost working with electric road freight, the internal interviewees considered having experience measuring and evaluating traditional road freight. Therefore, internal interviewees have contributed with input on Research Question 1 and its connected Sub-questions. Internal interviews aimed to determine how the company recognizes traditional KPIs of fossil-driven road freight and what KPIs the Partner Company perceives the industry to use. Further, potential categorizations of KPIs could be answered by several interviewees. KPIs characteristics could also be discussed during interviews, where interviewees internal at Partner Company enabled input regarding what they consider essential characteristics of general KPIs within transportation. For example, a regional director could help with inputs regarding KPIs, characteristics, and categorization of traditional road freight, due to prior knowledge working closely with fossil-driven transportation.

Original equipment manufacturers (OEMs) were interviewed due to their knowledge regarding traditional, fossil-driven road freight. The answers collected from these interviews could primarily help answer what KPIs are used in traditional road freight and give some input on what characteristics those KPIs have.

Transport providers (TP) were interviewed to answer all Sub-questions and included one current carrier partner to the Partner Company, haulage contractors, and providers of road freight solutions. The providers could either be a small company on the market that only offers the transport solution or a larger company that offers a comprehensive transport solution. The aim of interviewing transport providers was to find out how they measure traditional, fossil-driven road freight. As the first Research Question regards traditional transport, it was essential to determine what KPIs exist when evaluating and measuring fossil-driven road freight, what characteristics those KPIs have, and how they are conducted within a framework and further communicated internally and externally. Different perspectives, as well as a broad understanding of how KPIs are used, could be captured. At the same time, the interviews enabled finding differences in measurements and evaluation between a small haulage company and a large company offering a comprehensive transport solution to customers. It was interesting to see whether they communicate with the same KPIs and if the KPIs used are understandable external by transport buyers. Therefore, what KPIs do different stakeholders use when follow-up internal performance and benchmarking external to the market, could be captured.

Associated organizations (AO) have competence regarding how the transport sector has developed and what KPIs are understood in the market. Therefore, researchers' perspectives have been essential to capture when analyzing what KPIs are used, i.e., Sub-question 1.1 and Sub-question 1.2, i.e., what characteristics the commonly used KPIs have.

Furthermore, transport buyers (TB) have been interviewed. The transport buyers included were both existing customers of Partner Company and transport buyers on the market. Interviewing transport buyers provided helpful information on how traditional KPIs are communicated in the broader market and how well transport providers communicate KPIs, further how transport buyers adopt these KPIs connected to traditional road freight. The transport buyers could answer which KPIs they consider significant when evaluating road freight and what they consider essential factors when considering an agreement with transport providers. The answers from the transport buyers aimed to analyze Sub-questions 1.1 and 1.2 as KPIs, and existing characteristics are more easily to grasp from a buyer perspective than how KPIs are categorized. However, several interviewed transport buyers could also input Sub-question 1.3, i.e., how categorization within a framework of KPIs connected to traditional road freight could be done.

The interviewees' professionalism was further considered to fit the purpose of each interview. For example, it was essential to find out how KPIs regarding traditional road freight are communicated on the market and the market's maturity, which explains why a key account manager was interviewed. A key account manager is responsible for customer relations and thus aware of the maturity, demands, and obstacles that the market has regarding traditional road freight and the adaptation to electrification. Also, people responsible for transport solutions and sustainability work were considered essential to interview. These roles have insight into daily operations within their companies, which explains why they could provide insights into how traditional KPIs are used.

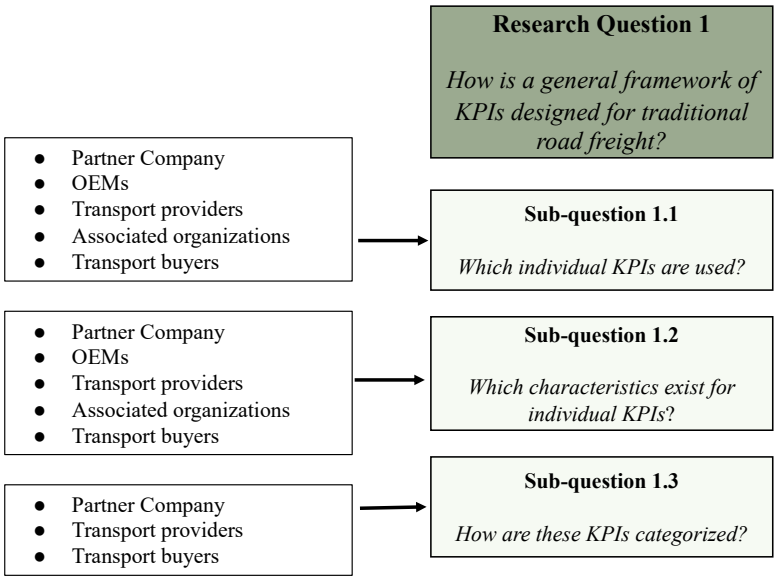

Figure 5.7: Interviewed stakeholders to answer Research Question 1 and its Sub-questions.

Research Question 2
Research Question 2 and its connected Sub-questions have been answered with the help of analyzes of both external and internal semi-structured interviews. Internal interviews have been conducted with the Partner Company (PC). The external interviews have been conducted together with transport providers (TP), transport buyers (TB), associated organizations (AO), and original equipment manufacturers (OEM). Summarized in Figure 5.8 are the Sub-questions to Research Question 2 and what different stakeholders have helped out in further analyzing and answering them. In Table 5.2 a more detailed description of each interview's purpose can be found, and the semi-structured interview questions that have been used are highlighted in *Appendix B Interview Questions - Semi-structured internal at Partner Company* and in *Appendix C Interview Questions - Semi-structured external with stakeholders*.

Interviewing transport providers (TP) have enabled to collect information that could help analyze all three Sub-questions connected to electric road freight. The roles that have been interviewed are considered to have a natural connection to the purpose of all three Sub-questions; due to that, they, for example, work closely with KPIs and are responsible for sustainable transport solutions within their companies. Interviewing such roles has eased to capture answers on what characteristics are required for KPIs to fit electric road freight. Additionally, what KPIs are demanded within electric road freight, and how these KPIs could be categorized to best fit their businesses, further adapted by the market using a stakeholder perspective.

Associated organizations (AO) have been interviewed due to their knowledge of electrification on the broad market. As the interviewees were experts in electric transport, Transport as a Service (TaaS) business model, and challenges and opportunities on the market, inputs to the further analysis of all Sub-questions could be captured with the help of associated organizations. If only capturing, for example, the perspective from a transport provider, one single company's micro-perspective is captured, which will miss the market's view of electrification and linked KPIs. Researchers, therefore, enabled to capture a broader perspective.

Transport buyers (TB), both current customers of the Partner Company and transport buyers on the market, were interviewed. These interviews mainly helped to give input on Sub-questions 2.1 and 2.2. The primary purpose of the interviews was to find out what needs and requirements exist on the market, which is essential, while the customers are those who create demand. Thus, interviewing, for example, freight managers and the head of logistics and transport became important. However, different professionals were interviewed, which reflected customers' degree of maturity regarding electrification, something that varied greatly. Even though finding the proper role to fit the purpose of the topics was challenging, the chosen interviewees were considered to possess the company's most appropriate level of knowledge to answer questions regarding the electrification of road freight. Several interviewees with a high level of knowledge could also help input how to categorize KPIs in a framework connected to electric road freight.

Original equipment manufacturers (OEMs) could contribute with input that further helped analyze Sub-questions 2.1 and 2.2, i.e., what characteristics are demanded when evaluating KPIs connected to electric road freight and what KPIs could be used when the road freight sector turns electric. As one interviewee within OEMs was responsible for electric mobility and sustainability, a spot-on perspective could be captured when holding the interview. The aim of capturing a mature interviewee could be fulfilled, thus also significant input on the questions discussed.

Furthermore, it also became essential to capture the micro perspective internally at the Partner Company (PC), which explains why relevant key persons were interviewed internally. Inputs on all three Sub-questions could be captured when holding interviews internally. Internal interviews enabled an understanding of which KPIs are used by the Partner Company and further which KPIs could be developed or used to fit better or complement the evaluation of electric road freight. The characteristics that the Partner Company works with today and wants to work with in the future could be captured, and how a framework of KPIs related to electric road freight could be categorized.

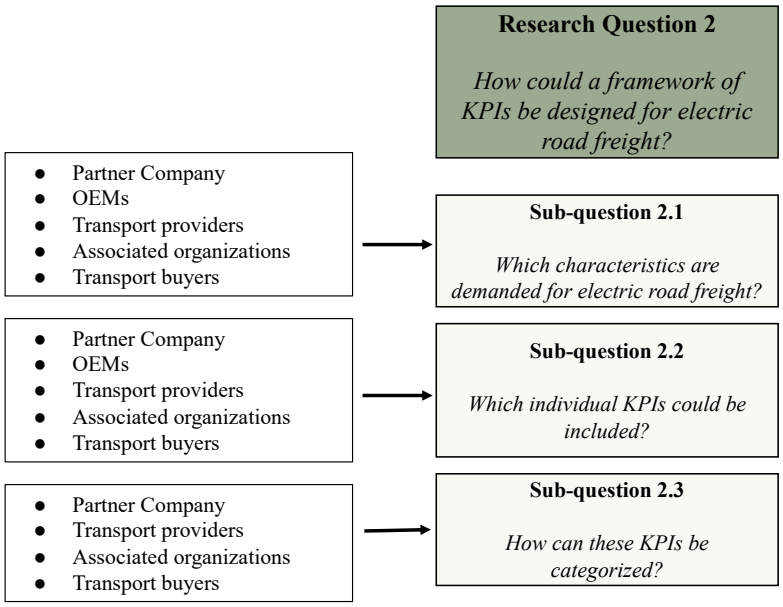

Figure 5.8: Interviewed stakeholders to answer Research Question 2 and its Sub-questions.

In Table 5.2, the different stakeholders that gave input to the connected Sub-questions to Research Questions 1 and 2 are visualized. The abbreviations pictured in the right column will be further used in *Chapter 6 Findings and analysis* when presenting the empirical data collected.

Table 5.2: Conducted semi-structured interviews during the main phase.

Interviewee	Stakeholder position	Purpose	Sub-question to answer	Date	Referred as
Responsible E-mobility and sustainability	Original Equipment Manufacturer	Traditional KPIs and characteristics and Electric characteristics and KPIs	1.1, 1.2 2.1, 2.2	11/4 2022	OEM
Key Account Manager	Transport Provider, haulage contractor	Traditional KPIs and characteristics	1.1, 1.2	31/3 2022	TP1
Managing director	Transport Provider	Traditional KPIs, characteristics, and categories and Electric characteristics, KPIs, and categories	1.1, 1.2, 1.3, 2.1, 2.2, 2.3	30/3 2022	TP3
Responsible for transport solutions	Transport Provider, 3PL	Traditional KPIs and Electric KPIs	1.1, 2.2	29/3 2022	TP4
Researcher in transport infrastructure	Associated Organization	Electric characteristics and KPIs	2.1, 2.2	31/3 2022	AO1
Researcher in servitization and digital transformation of transports	Associated Organization	Traditional KPIs and characteristics, and Electric characteristics, KPIs and categories	1.1, 1.2 2.1, 2.2, 2.3	4/4 2022	AO2
Project manager for electrification of road freight	Associated Organization	Traditional KPIs and Electric KPIs	1.1 2.2	22/4 2022	AO3
CEO trainee	Transport Buyer	Traditional KPIs and characteristics and Electric characteristics and KPIs	1.1, 1.2 2.1, 2.2	26/4 2022	TB1
Freight manager	Transport Buyer	Traditional KPIs and characteristics and Electric characteristics and KPIs	1.1, 1.2 2.1, 2.2	4/4 2022	TB2
Head of transportation and logistics	Transport Buyer	Traditional KPIs and characteristics and Electric characteristics and KPIs	1.1, 1.2 2.1, 2.2	7/4 2022	TB3
Head of transportation, procurement and logistics	Transport Buyer	Traditional KPIs, characteristics, and categories and Electric characteristics, KPIs, and categories	1.1, 1.2, 1.3 2.1, 2.2, 2.3	30/3 2022	TB4
Sustainability manager	Transport Buyer	Traditional KPIs and characteristics and Electric characteristics and KPIs	1.1, 1.2 2.1, 2.2	31/3 2022	TB5
Supply chain director	Transport Buyer	Traditional KPIs and characteristics and Electric characteristics and KPIs	1.1, 1.2 2.1, 2.2	6/4 2022	TB6
Head of transport development and logistics & Head of electrified development solutions	Transport Buyer	Traditional KPIs and characteristics, and Electric characteristics, KPIs and categories	1.1, 1.2 2.1, 2.2, 2.3	13/4 2022	TB7
Senior logistics strategist	Partner Company	Traditional KPIs and characteristics, and Electric characteristics, KPIs and categories	1.1, 1.2 2.1, 2.2, 2.3	3/2 2022	PC1
Regional director	Partner Company	Traditional KPIs, characteristics, and categories and Electric characteristics, KPIs, and categories	1.1, 1.2, 1.3 2.1, 2.2, 2.3	23/2 2022	PC2
Data scientist, CEM team electric	Partner Company	Traditional KPIs, characteristics, and categories and Electric characteristics, KPIs, and categories	1.1, 1.2, 1.3, 2.1, 2.2, 2.3	4/3 2022	PC3
Sales, sales team	Partner Company	Traditional KPIs and Electric characteristics and KPIs	1.1 2.1, 2.2	8/3 2022	PC4
Director regulatory affairs	Partner Company	Traditional KPIs and Electric characteristics, KPIs and categories	1.1, 2.1, 2.2, 2.3	8/3 2022	PC5

5.4.3 Analysis of Research Question 1 and 2

According to Patel and Davidson (2019); Björklund (2018), there are no specific rules for how qualitative data should be analyzed, wherefore the authors of this study have chosen to tailor the continuous analysis of data to suit this study. The benefit of qualitative data collection with semi-structured interviews is that collected data, during the time it is collected, also can be analyzed. Further, this enables empirical data from the interviews to be linked to the Research Questions and Sub-questions continuously (Patel and Davidson, 2019). For exploratory studies, it is a strength that iterative data collection can be done in parallel with the analysis of data, as it reduces the risk of being influenced by pre-existing research, which in turn will strengthen the objectivity (Blomkvist and Hallin, 2014).

Therefore, analysis of collected data has continuously been conducted during the empirical collection. As mentioned, semi-structured interviews were used as a basis for the analysis regarding Research Questions 1 and 2. However, literature has also enabled the analysis to be conducted but is seen as a secondary help during the analysis. Further, this depends on this study's deductive approach, where the analysis primarily has been based on interview responses. Literature has, in turn, acted as a backup to validate the empirical collection's semi-structured interviews, which means that the study has based its conclusions first and foremost on the analysis of empirical data.

Once a semi-structured interview had been conducted, the authors could sort the collected data based on which of the Research Questions 1 or 2 it could help answer and which Sub-question it intended to act as input when further doing the analysis. The sorting and structuring were done with great care, as some interviewees were able to answer questions related to both traditional and electric road freight. Found KPIs, characteristics, and categories could further be put into tables, one table for each Sub-question connected to Research Questions 1 and 2. See Figure 5.9 for the structuring according to Research Question and Sub-question.

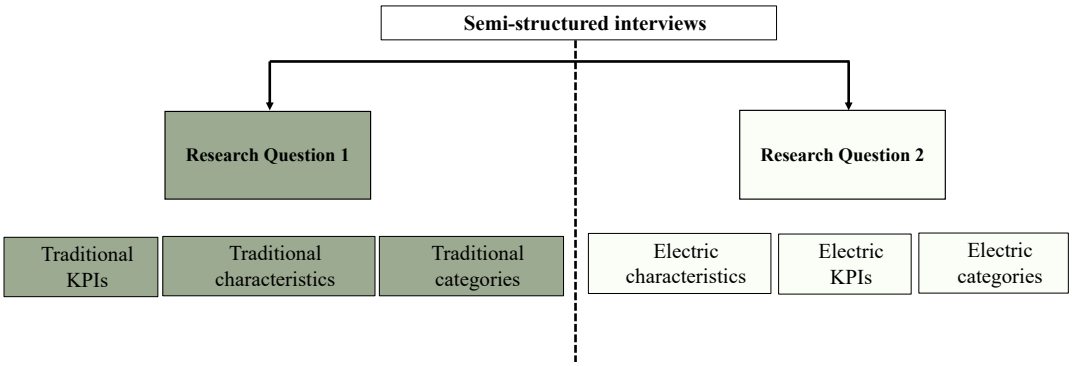

Figure 5.9: Structuring of collected data.

Furthermore, six different tables were created with KPIs, characteristics, and categories linked to traditional or electric road freight. The conducted tables include one column with KPI, characteristic, or category and one column with a corresponding description. Additionally, the tables include five columns that highlight which of the interviewed stakeholders mentioned the KPI, characteristic, or category; internal (PC), original equipment manufacturers (OEMs), transport buyers (TB), transport providers (TP), and associated organizations (AO).

For the convenience of the reader, the text that presents the empirical findings in *Chapter 6 Findings and analysis* has used the abbreviated names for the different stakeholders. Lastly, the tables have one column with literature, which help indicate if literature from the frame of reference could validate the collected data found during interviews. One tick in the table meant that at least one of the interviewees within the specific stakeholder group or literature mentioned the KPI, characteristic, or category. Since each KPI can be measured in several ways, units were chosen not to be presented in the tables regarding KPIs. See Table 5.3 for how the tables were structured. The figure only shows an example where at least one transport buyer (TB) and at least one associated organization (AO) mention the KPI, characteristic, or category, and literature confirms it.

Table 5.3: Structuring of collected data within the tables.

KPI/characteristic/category used in traditional/electric road freight	**Description/comment**	**Internal**	**OEM**	**TB**	**TP**	**AO**	**Literature**
KPI/characteristic/category				x		x	x

After sorting out the data in tables, a description of the tables was written. In order to ease the text presentation of the empirical collection in *Chapter 6 Findings and analysis*, the following words have been used when presenting the interview responses:

- Several - means that more than two of the interviewees within the specific stakeholder group mentioned the KPI, characteristic, or category,
- Majority - means that more than half of the interviewees within the stakeholder group mentioned the KPI, characteristic, or category,
- All - means that all interviewees within the specific stakeholder group mentioned the KPI, characteristic, or category.

If none of the above were mentioned, the exact stakeholder who highlighted the KPI, characteristic, or category was specified

Research Question 1 had a slightly narrower analysis than Research Question 2, due to its relatively explanatory nature, where empirical data from semi-structured interviews have acted as the basis for answering the Sub-questions. Further, this means that Research Question 1 involves only presenting what KPIs, characteristics, and categorization traditional road freight frameworks have. Therefore, analysis linked to Research Question 1 became more of a discussion regarding what was considered essential from the stakeholder perspective and whether the literature could validate it. KPIs, characteristics, and categories could be highlighted during the analysis and discussed regarding what stakeholders mentioned the KPIs, characteristics, or categories, and what similarities or differences between stakeholders existed.

When the analysis of Research Question 1 had been carried out, the second step in the process in Figure 5.6, *identify current KPIs and characteristics* could be concluded. See Figure 5.10 for the connection between the first process step and the first main area, which at this stage could be finalized.

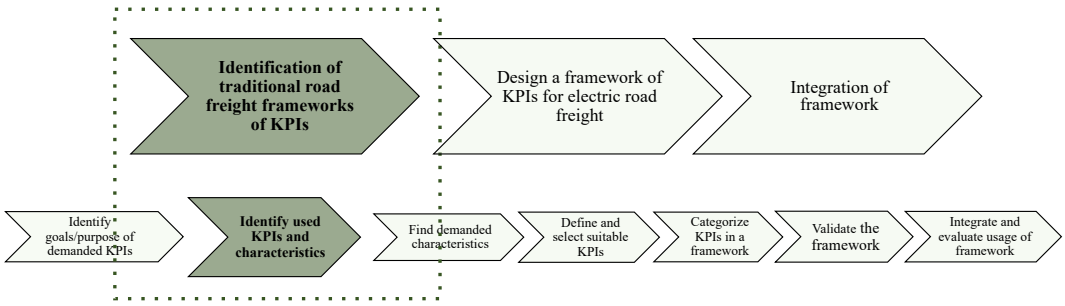

Figure 5.10: A visualization of the first step in the process and its connected first main area.

Regarding Research Question 2, the analysis was more comprehensive than the analysis of Research Question 1. Three lists could be created with characteristics, KPIs, and categorization linked to electric road freight, where the order of the Sub-questions shifts from the order of the Sub-questions linked to Research Question 1. Further, this is because KPIs related to electric road freight are not as straightforward as KPIs related to traditional road freight. Therefore, it became relevant to determine the demanded characteristics related to the KPIs before determining what KPIs could be used. Since many interviewees answered both Research Questions 1 and 2, the tables looked quite similar. Therefore, the tables connected to Research Question 2 constituted with other colors to differentiate what interviewees answered regarding characteristics, KPIs, and categories connected to electric road freight from what they mentioned regarding traditional road freight. The more green color facilitated the comparison of traditional and electric road freight, highlighting if a new stakeholder mentioned a characteristic, KPI, or category or if a new characteristic, KPI, or category was mentioned that previously was not mentioned regarding traditional road freight.

The analysis regarding Research Question 2 handled the selection of what to include in the framework connected to electric road freight. The selection and analysis have been based on three grounds. Firstly the relevance of the characteristic, KPI, and category was evaluated in terms of the frequency of responses where answers from transport buyers were most significant. Thus, if many transport buyers, for example, mentioned a specific KPI, this KPI was considered more significant than a KPI that many OEMs or transport providers mentioned. However, if the majority of all stakeholder groups mentioned the characteristic, KPI, or category, it was considered relevant to include it in the framework.

Secondly, the interviewee's expertise was considered. For example, the answers from an interviewee working in the forefront of the development, e.g., project manager for electrification of road freight, were considered to possess more knowledge and thus be more relevant to include than the answers collected from an interviewee with the role of key account manager or CEO trainee.

Furthermore, the third parameter considered relevant during the analysis was that literature could back up the characteristic, KPI, or category. If literature additionally could back up empirical data, substance and robustness could be built in when the selection was made. However, a characteristic, KPI, or category that only could be validated by literature was never selected. Further, this depends on this study's market focus, namely to look at the knowledge levels on the market and not base decisions on research articles. The fact that the literature has supported the empirical data has been considered to add weight as validation of peer-reviewed articles strengthens the confidence and robustness of the framework's components.

The selection of what KPIs, characteristics, and categories to include in the framework was based on the parameters highlighted. In addition, there was a fourth parameter when it came to the selection of KPIs. The selection of KPIs was also based upon the KPI's maturity in terms of transport buyers' awareness of how electric road freight could be evaluated with that KPI, i.e., how understandable the KPI is assessed to be according to transport buyers. For example, if a transport buyer is aware of a KPI connected to traditional road freight, and if a similar KPI was highlighted to be used when road freight becomes electric, this was considered suitable to include within the framework and thus reach the right knowledge level of the transport buyers. See Figure 5.11 for how the analysis regarding Research Question 2 was done.

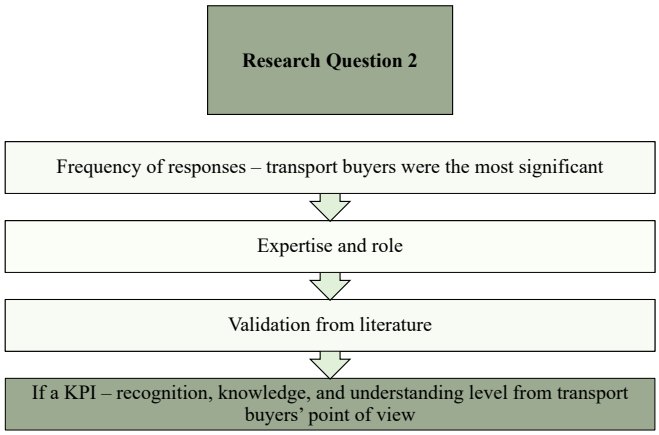

Figure 5.11: The analysis and selection strategy when conducting the framework.

After going through the four parameters carefully to find what elements to include within the framework, the framework's design could be carried out. Furthermore, this was first done by creating a structure for how the framework could be categorized. Secondly, the selected KPIs could be included in the framework and placed under each category. Thirdly, the naming of the categories could be done to align with the selected KPIs in the framework, and finally, each KPI could be described with several characteristics.

When the design of the framework connected to electric road freight had been conducted, the steps in the developed process that this study follows; *find demanded characteristics of KPIs*, *find and select what KPIs that are suitable*, and *categorize selected KPIs* was finished. See Figure 5.12 for what has been executed within the process steps connected to the second main area when answering Research Question 2.

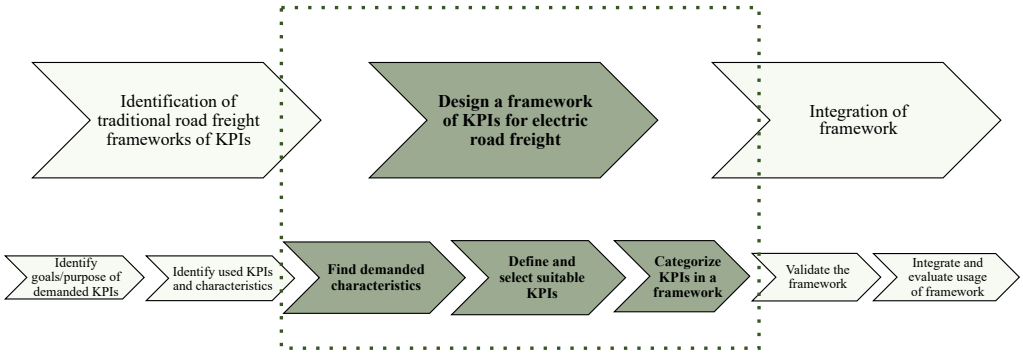

Figure 5.12: A visualization of the three process steps and the main area that have been executed when answering Research Question 2.

5.4.4 Workshop

To further conduct the two last steps in the developed process, *validation of the framework* and *integration and evaluation of the framework*, see Figure 5.6, a workshop was held to help analyze further and thus answering Research Question 3. The aim with the workshop was namely to give input in tailoring the framework to the Partner Company. As the process is iterative, and, therefore, to carry out these last process steps, the framework designed in Research Question 2 needed to be in place to act as a base when holding the workshop. However, before conducting the workshop, the list with collected KPIs and the list with characteristics connected to electric road freight that transport buyers, transport providers, associated organizations, and OEMs had highlighted during interviews was sent out to all workshop participants. The out-handed lists aimed to get the participants' individual opinions before the discussion took place within the workshop. The participants aimed to identify which characteristics and KPIs they considered best fit electric road freight. Further, to enable the participants to understand what external interviewees had highlighted and expressed as important KPIs and characteristics, an appendix was sent out summarizing the external stakeholder's responses from the interviews. In addition, an accompanying appendix was sent describing the meaning of the characteristics and the meaning of the KPIs so that the responses to the out-handed document would be genuinely valid. The list with ways of how to categorize KPIs in a framework connected to electric road freight was not sent out to the participants, as it was considered essential to use a specific categorization when adjusting the framework to the Partner Company. If the list with categories had been sent out, the workshop participants would have been influenced too much by the categories, which was not the intention as only the Partner Company and its categorization of the framework should be focused.

The workshop acted as a further empirical collection to discuss, validate and further tailor the framework to better suit Partner Company's business. The aim was further to collect a complete set of data and inputs in a short time from a predetermined sample group of 8 people who have the same type of knowledge (Sajjad Kabir, 2018).

The workshop enabled capturing ascertain perspectives and experiences from people within the Partner Company that further intended to work with the framework of KPIs. Only people at the Partner Company were chosen to participate in the workshop, depending on that they are the focused company and are considered to have a high knowledge level, working closely with KPIs connected to electric road freight. The participants of the workshop, mentioned only by role, can be seen in Figure 5.13

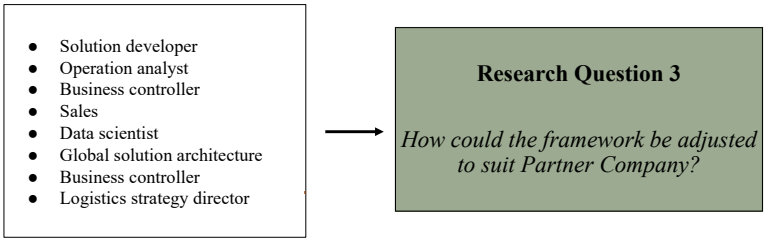

Figure 5.13: Roles that helped answering Research Question 3.

With the help of the workshop, opinions could emerge, which otherwise might not have emerged when only a single one-to-one interview was held. A risk with a group discussion is the lack of anonymity, wherefore the authors of this study have considered ethical aspects when holding the workshop. These ethical aspects have been mentioned earlier and are essential to capture to avoid private data being used in the wrong way (Patel and Davidson, 2019). In addition, peer pressure can occur when using a workshop as a data collection method, which means that everyone's opinions are not taken into account (Sajjad Kabir, 2018). However, this was avoided by sending out individual out-handed lists where individual opinions could also be captured, avoiding peer pressure.

The following process has been used before the workshop and when conducting the workshop. A more detailed plan on what discuss questions that were highlighted during the workshop can be found in *Appendix E Workshop.*

1. Planning workshop and deciding whom to lead the workshop and whom to take notes and observe the discussion,
2. Structuring the format of the workshop, what topics to be discussed, the order in which they should be discussed, and whether areas should be distributed among the participants in order to capture all possible perspectives,
3. Sending out invitations with the purpose of the workshop and the topics that were to be discussed, the time and place at which the workshop was to take place,
4. The out-handed individual list with corresponding appendices was sent out, where all participants were to fill in the document before the workshop,
5. Holding the workshop, where the authors of this study both participated, taking notes and making sure that the workshop followed the right discussion topics,
6. Conducting a summary of the workshop.

5.4.5 Analysis of Research Question 3

After finishing the workshop, the authors summarized the workshop. All answers from participants in the workshop were chosen to be presented together. This decision was taken because an overall perspective of the Partner Company was sought and not individual opinions. Further, this depends on the individual thoughts that already had been captured by the individual responses from the out-handed document. As a result of including various professionals in the workshop, such as operation analysts and solutions architectures, the discussion was considered comprehensive and acted as a solid base for adjusting the framework to the Partner Company.

The summary of the workshop, together with the answers from the individual out-handed document, and the designed framework from Research Question 2, was input when tailoring the framework to better suit the Partner Company. Since the out-handed document and the workshop were based on the framework designed, it can be concluded that the starting point of the analysis was the framework designed in Research Question 2. Further, this meant that the analysis of the inputs to Research Question 3 was based on a solid and robust foundation, taking into account the macro perspective as the focus in the designed framework had been on the market perspective and, more specifically, transport buyers' perspective.

Furthermore, the out-handed documents were compiled, and all responses received were equally valued. Since the out-handed document was based only on KPIs and characteristics received from transport buyers, transport providers, associated organizations, and OEMs, the KPIs and characteristics validated by most of the responses could be filtered out.

Further, as the out-handed document contained some KPIs and characteristics that the designed framework in Research Question 2 did not contain, several KPIs and characteristics were new to add within the adjusted framework. The authors of this study chose to only include new KPIs and characteristics within the adjusted framework that the majority of the respondents highlighted as most valuable. The KPIs and characteristics that none of the respondents thought should be included were excluded and were therefore not considered relevant to be included in the adjusted framework.

The next step in the analysis was based on the discussion during the workshop. During the workshop, KPIs, characteristics, and categories were discussed, mainly focusing on KPIs and the categorization of the framework. Therefore, when a characteristic was mentioned, it was considered relevant to capture and thus it was further included in the framework, even though only one person could validate it. It can be discussed whether or not such a characteristic should be included, as only one person supported it. However, as only a slight focus was spent on characteristics, it was considered essential to capture all mentioned characteristics.

When it came to KPIs, the analysis was based on including only those KPIs that at least three people considered necessary to include. If several participants highlighted similar KPIs but used different names, meanings, or ways of communicating such KPIs to the customer, it became indirectly essential to include even such KPIs in the framework, as they had the same definition.

There was a relatively comprehensive focus on how the framework should be categorized. In order to follow a structure, the analysis was based on the categorization the framework from Research Question 2 had. Further, a discussion was held regarding how to adjust this categorization. If more than three participants had similar arguments or thoughts on how the categorization could take form, this was considered a reasoned and well-supported response. In contrast, that categorization was chosen to be included in the adjusted framework.

See Figure 5.14 for how the analysis regarding Research Question 3 was done. The selection of what KPIs, characteristics, and categories to include in the framework was based on the steps highlighted in the figure. What should be highlighted is that the literature only acted as validation for the empirical collection of data. Further, this means that a deductive approach was used during the analysis of Research Question 3, where the literature was used only for secondary purpose.

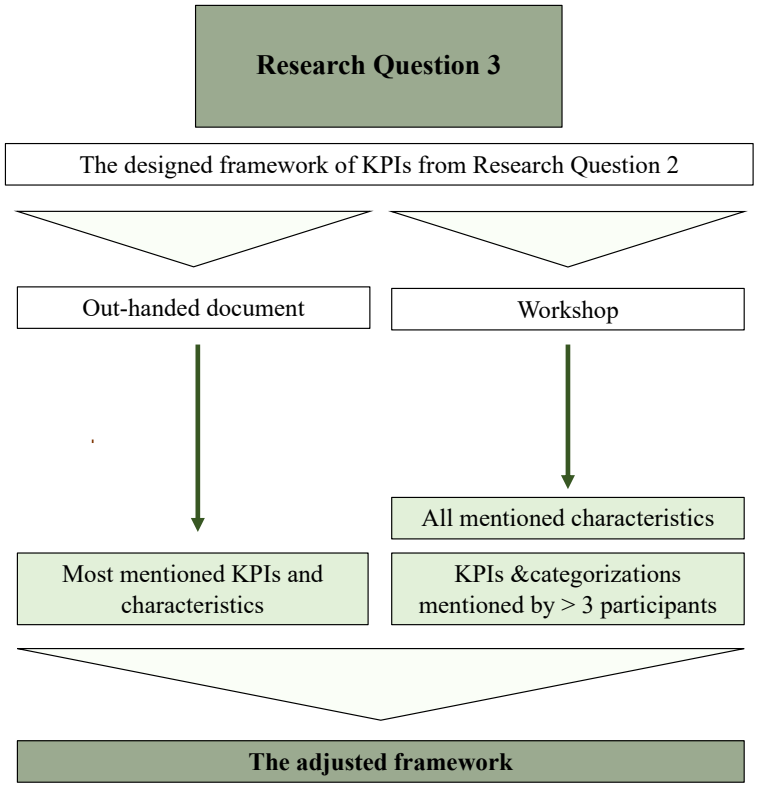

Figure 5.14: The analysis and selection strategy when conducting the adjusted framework.

When the analysis of Research Question 3 was done, the two steps *validation of the framework* and *integration and evaluation of the framework* were done, enabling to answer Research Question 3. See Figure 5.15 for the connection between the last main area and the process steps connected to Research Question 3.

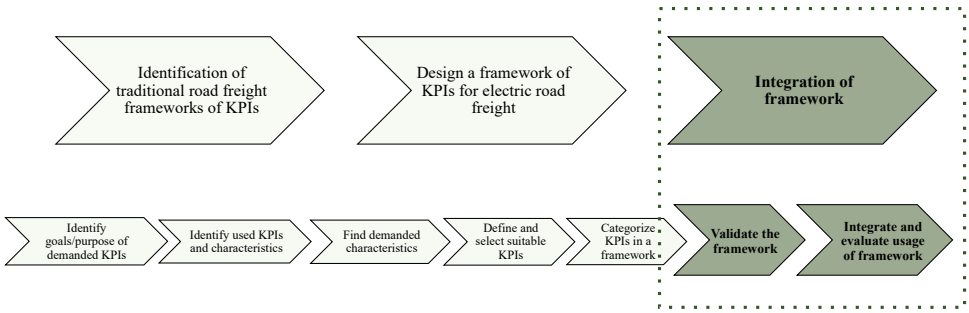

Figure 5.15: A visualization of the two last process steps and the last main area.

5.5 Final phase

The final phase included the study's conclusion, which aimed to answer all the Research Questions, and the connected Sub-questions and further the study's overall purpose. Furthermore, a discussion could be drawn that highlight future research areas that may be interesting to continue studying and the general validity of the study.

5.5.1 Finalization of the study

As a final part of the final phase, the study was finalized by conducting the conclusion and discussion. Findings from the analysis and answers to the Research Questions have been presented, whereby the study's overall purpose has been answered. The conclusion first presented how traditional road freight is measured and evaluated, i.e., what KPIs, characteristics, and categories are commonly used. Further, presenting a framework of KPIs that could be used when measuring and evaluating electric road freight. In addition, the conclusion highlight, with help from internal inputs, how the framework could be tailored to fit the Partner Company better, enabling them to reach a better understanding of how to work and what to communicate to customers when benchmarking with KPIs. A discussion of the results has followed the conclusion. The discussion has included comments on the results obtained, what developments could be done regarding the methodological approach, and further possibilities to investigate, i.e., future work.

5.5.2 Reflection of methodology

What should be considered when reflecting on this study's methodology is whether the methodology has enabled the study to be conducted with high credibility (Björklund, 2018). According to the authors, credibility is divided into validity, reliability, and objectivity, which during this chapter have been justified. Validity is about how relevant the content of the study is, i.e., whether the study deals with and processes what is intended. Reliability is about how reliable the study is, i.e., how likely it is to obtain the same results if someone else had carried out the study. Objectivity is about how personal values have influenced the study.

For the reader to assess this study's reliability and validity, the methodology presented has been clearly described and structured. This study has chosen to divide the method into three phases. After that, each phase has continuously been described, highlighting what has been done in chronological order.

In terms of overall objectivity, literature in the frame of reference has been presented accurately without distortions. Further, triangulation was used during the study. Due to convenience constraints, the majority of all interviews were conducted digitally. Conducting interviews digitally affects the outcome, but it is unclear how much the results are different from if the interviews were conducted face-to-face. It is, therefore, essential to highlight this discussion. The advantages of using a digital medium are cost and time savings, which probably made it easier for the study's authors to schedule meetings with the relevant stakeholders, capturing a comprehensive data set of empirical data. A disadvantage, however, is that the respondent may have multi-tasked and not been as focused on the interview as the respondent would probably have been if the interview had been held on-site. Conducting interviews only with one person reduced the risk that the respondent would be allowed to focus on other things.

When the interviews were formulated, they were critically reviewed not to allow the respondent to be influenced by how they were structured or delivered; value-related words and leading questions were avoided. However, there is an inherent bias in respondents' answers, which justifies why responses from all interviews were critically analyzed and triangulated with literature.

Furthermore, objectivity should also be commented on as an overarching point regarding the interviews. The authors of this study have critically ensured that external interviewees always backed internal interviewees to capture as objective results as possible regarding Research Questions 1 and 2. In addition, the interviews with the Partner Company's customers were triangulated with external transport buyers and other stakeholders in the market to capture the overall perspective and avoid subjective responses of existing customers. However, the authors chose to conduct the workshop internally within the company to answer Research Question 3, which was deliberately decided as the framework was tailored to the Partner Company. Therefore a subjective angle was accepted during this part of the study.

In addition, it should be mentioned that the general framework with KPIs developed is only one of many frameworks that can measure and evaluate electric road freight. As the study is exploratory, with a deductive approach, and deals with a highly topical research topic, the framework may need to be updated and extended as technological development evolves, whereby more interviews need to be executed to suit the technological developments brought by electrification.

Chapter 6

Findings and analysis

This chapter presents empirical data and further analysis of the study's finding. The chapter is structured on the three main areas where each area connects to the Research Questions developed. First, the identification of traditional road freight frameworks of KPIs will be described, then a description of how a framework could be developed, including KPIs connected to electric road freight, before concluding the chapter by presenting how the framework could be adjusted to the Partner Company.

6.1 Identification of traditional road freight frameworks of KPIs

The following section aims to present and analyze data from semi-structured interviews with Partner Company (PC), transport providers (TP), transport buyers (TB), associated organizations (AO), and original equipment manufacturers (OEM), connected to Research Question 1. For the convenience of the reader, the Research Question and its Sub-questions are visualized in Figure 6.1. When presenting the empirical collection, *several* means that more than two of the interviewees within the stakeholder group mentioned the KPI, characteristic, or category; *majority* implies that more than half of the interviewees said the KPI, characteristic, or category, and *all* means all interviewees within the stakeholder group mentioned the KPI, characteristic, or category.

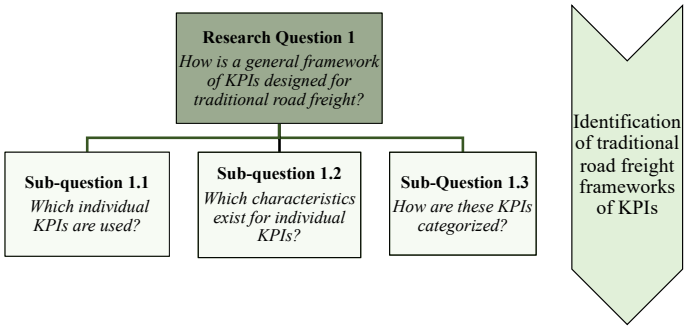

Figure 6.1: Research Question 1, its Sub-questions and the corresponding main area.

For each Sub-question, empirical data will first be presented, together with a summarized list of the findings and complemented literature. Each mark in the list of findings represents that at least one of the interviewees or literature mentions the data. To conclude each Sub-question, a sub-analysis will be presented. The section concludes with a summarized analysis of Research Question 1. To ease the understanding of the structure of this section, see Figure 6.2.

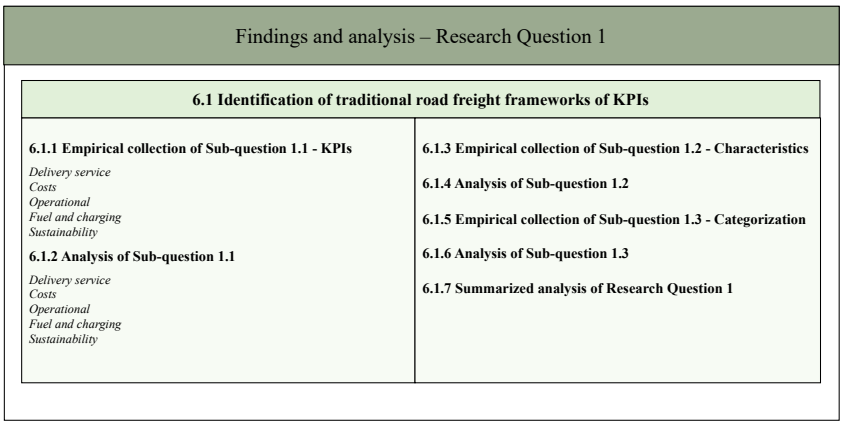

Figure 6.2: The structure of the findings and analysis connected to Research Question 1.

6.1.1 Empirical collection of Sub-question 1.1

Delivery service

The majority of all interviewees, both internal at the Partner Company and external with all stakeholder groups, highlight *delivery service* as essential to measure when evaluating road freight. According to TP4 (2022), the basis of transportation and thereby how to operate and build KPIs derive from the four cornerstones right product, delivered on decided time to the right place to the agreed cost. Further, described by the majority of the transport providers as *delivery precision*, such as correct orders both collected and delivered on the set time, agreed on the delivery quality of products without damage, and amount of correctly delivered orders as necessary. PC3 (2022) agrees on the importance of measuring *lead time* and delivery precision. Further, TP1 (2022), and several transport buyers add that *deviations from schedule* and *time for packing and lashing* are also of importance when looking at the lead time and thereby indirectly delivery precision. PC2 (2022) highlights the KPI *delivery quality*, whereas PC5 (2022) agrees on both time and right quality, mentioned as measuring *delivery reliability*.

Further mentioned by the majority of the transport buyers is the aim for high delivery service with high *flexibility*, i.e., striving to achieve the four cornerstones mentioned by TP4 (2022), but with space for changes as well. AO2 (2022) argues that most customers value flexibility and reliability, especially if the transport buyer demands fast deliveries, but where it could be hard to quantify flexibility. TB4 (2022) additionally highlights the importance of measuring delivery service when evaluating customer satisfaction, and TB2 (2022) considers it essential to be able to convert delivery service into a cost if deviations from the predetermined contract occur. Table 6.1 present KPIs connected to delivery service.

Table 6.1: Identified KPIs connected to delivery service in traditional road freight.

KPIs used in traditional road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Delivery service							
Lead time	Also mentioned as delivery time, thus the time it takes from order placement to received delivery.	x		x	x	x	x
Delivery reliability	Reliability in lead time or delivery time.	x	x	x	x	x	x
Delivery quality	The right product with the right quality in the right quantity. Also delivery accuracy and delivery security.	x	x	x	x	x	x
Delivery precision	A total index/sum of delivery reliability and delivery quality.	x	x	x	x	x	x
Flexibility	A soft service element that measures the ability to adapt to new wishes from customers.		x	x	x	x	x
Information and transparancy	Measures the quality of communication from the customer's perspective.						x
Stock avaliability	Amount of orders that can be delivered upon request from the customers.						x

Costs

Focus has always been on cost, with *investment costs* and *operational costs* being the main focus (PC4, 2022). Further, TP4 (2022); OEM (2022) agree that *transport costs*, including investment and operational costs, act as an essential KPI in traditional road freight and will remain crucial as long as the transport sector continues to be a low-margin industry. Highlighted by PC1 (2022); PC2 (2022) is the operational driver cost, i.e., wages for drivers as the most expensive operational cost. AO2 (2022); TB4 (2022) agree with driver costs being expensive but believe that other associated operational costs and investment costs are important KPIs as well. TP3 (2022); TP4 (2022); TB3 (2022) believe that all costs related to the transport will be essential inputs in decision making and should thereby be economically justifiable. PC1 (2022); PC3 (2022); TB5 (2022); TB6 (2022) further say costs being measured in many different ways, ranging from the total cost to the broken-

down cost of delivering a pallet, i.e., *delivery costs*, where the latter KPI usually is considered essential for customers when procuring road freight services. Since delivery costs can be measured in different ways, for example, per volume or weight, making it customer-specific, it is challenging to reach a standard in the industry (PC2, 2022). For example, TB3 (2022) discusses the importance of relating the investment costs to the lifetime of the vehicle to see the full picture. For TB3 (2022), this means utilizing the current fleet is more beneficial than investing in new vehicles. Table 6.2 present KPIs connected to costs in traditional road freight.

Table 6.2: Identified KPIs connected to costs in traditional road freight.

KPIs used in traditional road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Costs							
Transport costs	Total transport costs.			x	x	x	x
Investment costs	Costs for purchasing a vehicle, but can also be an investment cost for customers to sign up for a new partnership.	x	x	x	x	x	x
Operational costs	Total cost related to the actual transport. The operational costs consist of driver, service, and fuel/energy costs. Can be measured per pallet, volume, or weight depending on customer demands.	x	x	x	x	x	x
Delivery cost	Based on the total costs a delivery cost is calculated that is communicated to each specific customer. Can be calculated based on SEK/delivery, SEK/km, or SEK/month, i.e., leasing costs.	x		x	x		x

Operational

Driving time, the number of transports performed, distance traveled, transport weight, transport capacity, transport work and *the number of vehicles used* are all KPIs that are considered commonly used within traditional road freight according to the majority of both internal and external interviewees. Further, PC1 (2022) and the majority of the transport providers argue that the *vehicle fill* is a traditionally used KPI and is of great importance when evaluating transport alternatives. However, PC1 (2022) argues that vehicle fill can be confusing as stakeholders use different vehicle fill measures, ranging from capacity depending on maximum weight, volume, and floor area, to ceiling height or the number of pallets. PC2 (2022); PC5 (2022) also consider that vehicle fill is an important KPI for calculating *vehicle utilization*. Additionally, *the number of empty running vehicles* becomes a cost driver and thus a KPI traditionally measured in the road freight sector (PC2, 2022). Further, TP4 (2022) highlights the importance of only paying for what is transported, whereas TP3 (2022) believes the KPI driving time is essential to measure as driving is the most expensive operational activity. Table 6.3 present collected KPIs within operations in traditional road freight.

Table 6.3: Identified KPIs connected to operations in traditional road freight.

KPIs used in traditional road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Operational							
Driving time	How long time a particular transport, route, vehicle, pallet, etc. is traveled.	x			x		
Number of transports performed	Can also be the number of routes driven or the number of delivered pallets. Can be measured per week or day.	x		x	x		
Vehicle fill	Customers want to know how much vehicle fill rate is on delivered transports. Ex. maximum fill rate is 100% and minimum, i.e., empty running vehicle, is 0%. Customers measure vehicle fill differently based on volume, weight, floor area, ceiling height, or the number of pallets.	x		x	x	x	x
Empty running vehicles	A KPI connected to vehicle fill, measuring the number of empty running vehicles, pallets, and km depending on what the customer use for the unit. Can be measured per day, week, or month.	x		x	x	x	x
Distance traveled	Kilometers driven. Can be based on per vehicle, per delivered unit, and per delivered pallet.	x		x	x	x	x
Transport weight	Measures how much weight is transported, where customers measure differently based on per vehicle, per week, per end customer.	x		x	x		
Time for packing and lashing	Measures the time of packing and lashing. Can be measured per day, route, or shift depending on customer demand. Either the whole vehicle fleet or specific vehicles. Will be dependent on optimizing routes while packing and lashing should be scheduled at the same time the electric vehicle is charging.				x		
Maximum payload	Total weight capacity of the vehicle's trailer, i.e. how much goods a vehicle can transport.						x
Transport capacity	Available tkm during a predetermined time span, i.e. transport work/h. Can also be expressed as a utilization rate of available transport work.	x					
Number of vehicles	Measures how many vehicles are used and operating in real time. Can be based on the total number in the vehicle fleet, the number demanded by a delivery. Can also be based on how many vehicles are used for a specific end customer.	x		x	x		
Vehicle utilization	Measure the utilization of vehicles compared to capacity. Ex 5 of 10 vehicles are operating menas vehicle utilization 50%.	x					x
Deviations from schedule	Measures how often or how much time is lost when deviating from the schedule.			x	x		x
Transport work	How much work is carried out by a vehicle when multiplying the weight of the vehicle by the distance traveled.			x	x	x	x

Fuel and charging

Fuel consumption, type of fuel used, fuel price, the energy content of the fuel, and thus also, the *frequency of fueling* are mentioned by several transport providers, several transport buyers, OEM (2022) and PC3 (2022) as vital KPIs. Further, the frequency of fueling will influence the driving time required, and according to TP1 (2022) also depending on to what extent the driver is *driving eco-friendly* and if unpredictable events in traffic occur that also will influence the delivery quality. TB4 (2022); TP3 (2022) mean that eco-driving is an important KPI to track and the *ratio of used fuel type*. See Table 6.4 for KPIs collected from interviews connected to fuel and charging.

Table 6.4: Identified KPIs connected to fuel and charging in traditional road freight.

KPIs used in traditional road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Fuel and charging							
Fuel price	Continuously follow-up of fuel prices.		x	x	x		x
Type of fuel used and type of vehicle	Example petrol, diesel or electric vehicle. Will influence fuel consumption, price etc.		x	x	x		x
Energy content	How much energy is stored within the fuel. This further will influence other KPIs, such as how much the operational costs are, environmental impact, and frequency of refueling.		x	x	x		
Frequecy of fueling	How often refueling takes place is important as customers want to know operating time vs. charging time, that delivery service is kept high, security for drivers, etc. Can be measured per day, week, or month for either a specific vehicle or the whole vehicle fleet.		x	x	x		
Fuel consumption	How much fuel consumption is per driven km and what is the fuel demand.	x	x	x	x		x
Eco-driving	Eco-driving can measure how much fuel can be saved in percentage when driving with another speed or behavior compared to a reference value. Further, connects to how to drive fuel-efficient.			x	x		
Ratio of used fuel type	Measures how much of the vehicle fleet use a particular type of fuel/energy. Ex. 20% of the fleet is powered by diesel, 70% by petrol, 10% by electricity.			x	x		

Sustainability

The importance of measuring *CO_2 emissions* is highlighted by all interviewed transport buyers, all transport providers as well as all internal interviewees at the Partner Company, where all except one transport buyer are measuring emissions in daily operations. Even though vehicles are running on different types of fuel, CO_2 emissions are the most measured KPI today for evaluating environmental impact, according to the majority of the transport providers and the majority of the transport buyers. For TB2 (2022), one critical KPI measured is how much CO_2 emissions can be saved per volume transported if a larger vehicle can replace two smaller ones. Furthermore, TP3 (2022) considers that a ratio indicating the percentage of the fleet using a particular type of fuel is an important KPI. However, what is mentioned by TB4 (2022), is that benchmarking with CO_2 emissions or fuel consumption is problematic since every parameter varies between time and between companies. Further, TB4 (2022) mentions *particle emission* as a KPI to keep in mind when evaluating the environmental impact of road freight. Table 6.5 present identified KPIs connected to sustainability.

Table 6.5: Identified KPIs connected to sustainability in traditional road freight.

KPIs used in traditional road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Sustainability							
CO_2 emissions	Measures how much CO_2 emissions are emitted from the vehicle per distance driven. Can also be measured as CO_2 savings when comparing different transport alternatives. Can be based on one route, CO_2 emissions per pallet, CO_2 emissions throughout the value chain, or total emissions during a specific time.	x		x	x		x
Particle emissions	Measures how many particles are emitted from the transport. Can for example be measured on one vehicle within a certain time frame, or the whole vehicle fleet.			x			

6.1.2 Analysis of Sub-question 1.1

Delivery service
Delivery service is of great importance according to the majority of the interviewees and confirmed by literature. As mentioned by Oskarsson et al. (2013); Lee et al. (2015); Caplice and Sheffi (1994); Wang et al. (2013); Prause and Schröder (2015); Lukinskiy et al. (2013), delivery service is fundamental in all related transport operations and thereby of relevance when measuring and evaluating traditional road freight. The majority of the interviewed transport buyers mention the importance of maintaining a high level of service delivery; however, at an acceptable price, which Oskarsson et al. (2013) further mention is critical in being successful and for businesses to survive. Lee et al. (2015) highlight the importance of evaluating service both before, during, and after the delivery, corresponding to the majority of the transport providers' and transport buyers' arguments of preserving high *flexibility* throughout the whole transport activity. Other KPIs such as *stock availability*, could be seen as not relevant since none of the interviewees highlight the KPI. To conclude, crucial delivery service elements to measure in road freight is *delivery precision, reliability, quality* and flexibility.

Costs
According to interviewees and literature, cost-related KPIs are as essential as delivery service when benchmarking. As described by Oskarsson et al. (2013), *transport costs* usually stand for 40-60 % of logistic costs, whereas *investment and operational costs* for road freight thereby become crucial (Prause and Schröder, 2015). When benchmarking, several transport buyers and several transport providers agree on including both investment and operational costs. Further, they mention investment costs for the vehicle frequently, which goes naturally with the relevant cost. As mentioned by OEM (2022); TP4 (2022), the transport industry is a low-margin industry, where measuring and benchmarking costs always will remain crucial as long as the industry remains the same when scaling. The traditional KPIs of various cost elements could be seen as a core in what road freight measures, evaluates, and improves.

Operational
KPIs most frequently mentioned by interviewees working closely with daily operations are *transport costs, vehicle fill, distance traveled, vehicle utilization, deviations from schedule* and *transport work*. All these KPIs are confirmed by literature, further relevant for follow-up on daily operations since the majority of transport buyers in particular value high delivery precision and thereby, for example, deviations from schedule become essential. Many operational KPIs depend on each other and are used differently depending on the user and the user's business. Even though McKinnon (2009) emphasizes the importance of using the same KPIs and having an understanding of them cross-industry-wise, adaption to one's business may result in different units used or various ways of combining operational KPIs. As long as good communication is in place, it should not be a problem measuring, e.g., vehicle fill by pallet, weight, or volume. Operational KPIs are always important to measure to improve operating performance; however, adjusting which measurements are used according to one's business is critical for understanding and communication between buyers and providers.

Fuel and charging
There is a clear pattern in the KPIs used for measuring fuel-related parameters. The transport buyers and transport providers who work closely with daily operations have inherent knowledge regarding more technical KPIs. They measure several parameters such as *frequency of fueling, fuel consumption, energy content,* and *eco-driving*. Transport buyers who are not working closely towards daily operations tend to have less knowledge of fuel consumption or, in some cases, not measuring it. Internal interviewees at the Partner Company do not mention any KPIs related to the fuel consumption of fossil-driven vehicles. Instead, their answers are connected to energy consumption. However, KPIs related to fuel and charging are still relevant since they are used by transport buyers and transport providers, thus crucial to follow-up in daily operations.

Sustainability
The majority of all the interviewed transport buyers and the majority of the transport providers measure CO_2 *emissions* from their road freight, however, in different ways. Lowering emissions is mentioned by World Economic Forum (2021); Morganti and Browne (2017); Brolin (2020) as crucial reducing the environmental impact of road freight which corresponds to the interviewee's answers. However, the majority of the interviewees mentioned the challenges of measuring emissions in terms of standards, further confirmed by Denant-Boemont and Hammiche (2019); Kurdve and Wiktorsson (2013) as one great challenge when benchmarking. Therefore, it is clear that the industry is moving toward a fossil-free future, but there is a crucial need to have a shared understanding and standard for measuring and calculating CO_2 emissions.

6.1.3 Empirical collection of Sub-question 1.2

Having *traceable* KPIs is something that the majority of the transport buyers, transport providers, and associated organizations highlight as essential, and PC1 (2022) argues that this characteristic eases follow-up and enables tracking data. Further, TB2 (2022) discusses that for a KPI to be traceable, it must be *measurable* and *time-based*, meaning that the KPI must be capable of being measured in specific terms. Further, this is agreed by the majority of transport buyers, and PC1 (2022); OEM (2022).

PC2 (2022) highlights that KPIs usually have the characteristic of being *aggregated*, meaning the KPI can be broken down or compiled into different levels to ease the differences between customers, periods, vehicles, or regions. Aggregation is also highlighted by TB7 (2022) as an essential characteristic. According to PC1 (2022); PC2 (2022); TP3 (2022); OEM (2022) and the majority of the transport buyers, it has always been important to *base KPIs on data*. Data facilitates monitoring and adds a substance to what is being measured, enabling KPIs to be traceable. Further, KPIs based on *real-time data* ease operational improvements (TB7, 2022). However, PC3 (2022) argues that a lot of KPIs are made up of parameters based on assumptions, indicating that KPIs can be difficult to explain due to their complexity of not being based on data. KPIs should further be *relevant* and *useful*, two essential characteristics mentioned by the majority of the internal interviewees at the Partner Company and several transport buyers.

TP3 (2022) believes it is essential to align KPIs with an *industry-standard* that enables benchmarking against competitors, which connects to the relevance and usefulness of KPIs. The majority of the internal interviewees agree that KPIs are based on either an industry standard or an internal one, which will ease the evaluation. The majority of the Partner Company interviewees mention that internal comparison and evaluation of KPIs have been common in the traditional road freight sector, which explains why KPIs sometimes have been difficult to compare with other companies as companies use their definition of, e.g., vehicle fill.

Customer orientation and *stakeholder orientation* are two other characteristics of KPIs connected to traditional road freight (TB5, 2022). However, KPIs that are market-oriented will be easier to understand for transport buyers, resulting in *transparency* of what is measured. Also, the majority of the transport providers and associated organizations, together with several transport buyers and OEM (2022), highlight transparency as a vital characteristic that will ease communication with stakeholders for improved cooperation. Several external interviewees stress that KPIs will be more *understandable* if they also are *communicable*. Once understood, KPIs will be more accessible to internal and external follow-ups on how the business progresses. However, AO2 (2022) mentions transparency to be difficult as many stakeholders in the market are reluctant to share their data and how and what they measure. In addition, TB2 (2022); OEM (2022) highlight that the KPIs should be *cost-based* and thus measurable in purely economic terms. The characteristic of being cost-based is agreed by the majority of the internal Partner Company interviewees to be of importance. Table 6.6 presents the characteristics identified from the empirical collection and the literature connected to traditional road freight, with a description connected to each characteristic.

Table 6.6: Identified characteristics of KPIs connected to traditional road freight.

Characteristics of KPIs used in traditional road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Traceable	Be able to continious find and follow up data behind the KPI. Also clarified while it must be explained.	x	x	x	x	x	x
Measurable	Capable of being measured i.e. in specific terms both in short- and long term.	x		x			x
Time-based	The KPI should be able to be measured in a temporal manner both on long- and short term.	x		x			x
Aggregated	Be able to broke down or compute the KPI into different levels ex. by geographical areas, by customer or vehicles. Also scalable.	x		x			x
Based on data	No assumptions but only collected data. Also reliant as the KPI is dependent on data.	x	x	x	x		x
Based on real-time data	Ability to continiously collect data.			x			x
Relevant	Approriate to what is to be measured and compatible to the purpose.	x		x			x
Useful	Be useful for the practical purpose within the studied system. Also functional.	x		x			x
Related to a standard	The KPI should be able to be evaluated against an industry standard that is of common understading for relevant stakeholders. Or an internal standard that is of common understandning for relevant employees. Also be able to evaluate.	x			x		x
Stakeholder-oriented	Common agreement how to measure the KPI between relevant stakeholders. Also integratable to stakeholders.			x			x
Customer-oriented	The KPI should be customized to what is demanded. Also integratable to customers.			x			x
Transparent	The KPI should be able to share data between stakeholders of relevance.		x	x	x	x	x
Understandable	For stakeholsers that use the KPI.			x	x	x	x
Communicable	A common understanding to relevant stakeholders demand the KPI to be communicatable.			x	x	x	x
Robust	The KPI should be uncompromised.						x
Cost-based	The KPI should connect to a measure that influence costs.	x	x	x			x
Valuable	The KPI should add value for the activity and thus vital for its purpose.						x
Controllable	The KPI should be able to be controlled as the goal is to limit the KPIs dark side.						x
Predictable	One should be able to predict the measurement.						x
Validable	Able to collect real-time data on the real activity.						x

6.1.4 Analysis of Sub-question 1.2

What can be concluded from Table 6.6 is that all literature supports all characteristics mentioned during interviews. However, *traceability* is the only characteristic mentioned by both transport providers, transport buyers, associated organizations, and OEMs, as well as by Kaparias and Bell (2011); Giannopoulos (2021); McKinnon and Ge (2007); Prause and Schröder (2015); Caplice and Sheffi (1994), and the Partner Company. Further, traceability seems to be an essential characteristic that can create trust and clarity in KPIs, as data can be traced. Therefore, the conclusion is that several characteristics are interrelated and thus build on each other.

If a KPI is traceable, it must also be *measurable, based on data*, and *time-based*. Additionally, *useful* is a synonym for *valuable*, thus further validating the interrelation between the mentioned characteristics. Furthermore, transport buyers are those who express the most characteristics, which could be seen as a natural cause of them being the ones evaluating transport from procurement. Transport buyers highlight the importance of KPIs being based on data, being traceable and measurable to facilitate past, present, and future evaluation. It is of further importance that the KPIs are formulated in a *communicable* way to be easily *understood* and thereby being *customer-oriented*. Characteristics of KPIs being communicable are essential to strengthening the relationship between buyer and provider. According to Monois and Bergqvist (2020), the demand will always come from transport buyers, which goes hand in hand with the empirical collection, explaining the importance of tailoring KPIs to relevant customers. Kaparias and Bell (2011); McKinnon and Ge (2007) stress that KPIs become useless if they are not put in the proper context. They describe the importance of KPIs to win acceptance from stakeholders across an industry sector and thereby being *stakeholder-oriented*. Further, *transparency* enables or discourages strong relationships between provider and buyer and is therefore also a crucial characteristic. This characteristic relies on the continuous sharing of data, which can be very sensitive. However, all transport providers and buyers consider this essential; therefore, increased transparency is necessary to strengthen the relationship but demands careful security. To conclude, most of the mentioned characteristics are connected, whereas all mentioned characteristics will be required to be further evaluated when adjusting the chosen KPIs characteristics to a specific business situation.

6.1.5 Empirical collection of Sub-question 1.3

PC3 (2022) mentions that categorization, internal at the Partner Company, is done by dividing KPIs into *business units*. Further, this means that different parts of the company track, measure, and evaluate different KPIs according to team-specific purposes. Some KPIs are for internal follow-up, while others are for external use, thus communicated to customers. Also, TB4 (2022) mentions a categorization of KPIs according to specific areas of the business. Such categorization could divide KPIs into environmental, quality, cost, or operational. For example, CO_2 emissions can be considered an environmental KPI that is communicated to customers, and vehicle fill could be an operational, thus internal KPI (TB4, 2022). Further, this also means a categorization according to *internal and external* KPIs.

PC2 (2022) suggests a categorization according to different parts of the *transport delivery*. For example, some KPIs could measure the preparation of the delivery, such as planned driver hours, and some could measure the delivery itself, such as vehicle fill or operational costs. In contrast, other KPIs could measure the delivery finalization, such as delivery quality.

Another potential categorization according to TP3 (2022), is *areas of the transport system*. TP3 (2022) mentions, for example, that some KPIs could be divided into the category vehicle, and other KPIs could be divided into other areas of the transport system, like costs or transport activity. Further, this will ease the evaluation of, for example, different vehicle fleets as the same KPIs are measured on vehicles regardless of the fuel used, enabling seeing how different fleets perform on a given set of KPIs. A categorization that divides the transportation system into different building blocks can enable the comparison of fossil-driven vehicles with electric vehicles (TP3, 2022). Table 6.7 presents the categories identified from the empirical collection and the literature, with a description connected to each category.

Table 6.7: Identified categories connected to traditional road freight KPIs.

Categorization of traditional road freight KPIs	Description/comment	Internal	OEM	TB	TP	AO	Literature
Business units	Categorization due to business units internal ex. logistics, production, sales, marketing etc. Can also be based on environmental, operational, financial.	x		x			x
Activities within the transport delivery	Categorization due to where the KPI are measured or used within the delivery ex. before, during, after delivery.	x					
Areas of the transport system	Categorization that divid the transportation system in different building blocks where each block represents a thematic set of KPIs ex. hardware, software, fuel.				x		x
Stakeholder	Categorization regarding what stakeholders the KPIs are relevant for. Some KPIs are important for transport buyers and some for original equipment manufacturers.						x
Internal and External	KPIs are divided into internal evaluation and external communication.	x		x			x
Utilization, productivity, effectiveness	Categorization is due to the three pillars of sustainability; environmental, economic, and social.						x

6.1.6 Analysis of Sub-question 1.3

Overall, the literature highlights all categories except one, namely the breakdown of KPIs by *transport delivery*. However, this categorization could be considered relevant since one internal interviewee at the Partner Company mentions that the breakdown eases the process and understanding of how different activities operate.

Categorizing according to *business units* is mentioned by McKinnon and Ge (2007), the Partner Company, and by one transport buyer. Such categorization clarifies internal tasks and thus links KPIs to objectives within a company's respective business unit. On the contrary, Kurdve and Wiktorsson (2013) highlight that the market perspective is missed when KPIs are divided to fit internal teams. However, this can be counteracted if internal and external KPIs are further divided within each business unit, allowing for accessible communication to stakeholders. To use these two types of categorizations, first business units and then internal and external, are mentioned by Kaparias and Bell (2011); McKinnon and Ge (2007); Kurdve and Wiktorsson (2013); Caplice and Sheffi (1994) as an effective way to create a framework.

Categorization by areas of the *transport system* is highlighted by Prause and Schröder (2015); Caplice and Sheffi (1994), who discuss that KPIs naturally can be connected to different building blocks within the studied system. The empirical collection also supports this assertion and enables separate KPIs tailored to fit a specific system. For a transport provider under development with a relatively undefined business model, this kind of categorization can be helpful as it allows a dynamic update of which KPIs to include and which building blocks KPIs should be contained within. However, it can be considered challenging with such a categorization because different elements are integrated, making it difficult to distinguish where the KPI belongs. For example, lead time can belong to the vehicle categorization or the service categorization. As parameters are interrelated, a shared understanding of dividing the KPIs needs to be accepted before applying such categories into a framework.

Kaparias and Bell (2011) propose categorizing KPIs according to dimensions in the market segments, i.e., dividing KPIs into relevant *stakeholder* groups. Further, this might reflect reality better than using an internal focus, like categorizing KPIs according to business units. A conclusion can be drawn where this categorization is similar to the internal and external division, but where the external, in turn, further is divided to fit different stakeholders. The categorization is evident as it distinguishes, for example, technical parameters measured by manufacturers from operational parameters measured by transport providers.

The last category is mentioned by Caplice and Sheffi (1994), where a categorization of KPIs is done within the three performance dimensions *utilization, productivity, and effectiveness*. Such categories are easy to understand, and the author's aim with the way of the categorization is to understand the underlying structure and the significance of KPIs connected to specific activities. However, the empirical collection did not mention the three performance dimensions to fit traditional road freight, but the categorization dealing with areas within the delivery can be considered quite similar. Transport delivery is the operational service measured by transport providers and transport buyers, thus making the utilization, productivity, and effectiveness categories almost self-evident to use before, during, and after the delivery.

To summarize, a categorization of KPIs depends on how a company is operating and, thereby, which kind of categorization is relevant to be best adapted to the business. All mentioned categorizations will be of interest when looking at Research Questions 2 and 3.

6.1.7 Summarized analysis of Research Question 1

The following section aims to summarize the analysis of the three Sub-questions to further answer Research Question 1, which is as follows:

> *Research Question 1: How is a general framework of KPIs designed for traditional road freight?*

From the first sub-analysis, it can be concluded that the majority of the KPIs used for traditional road freight are consistent among all interviewees, mainly between transport buyers and transport providers. In addition, the literature shows good agreement on KPIs related to *delivery service* but less validation on KPIs about fuel and charging. The most mentioned and important KPIs, according to interviewees, are related to maintaining a high delivery service to a justified *cost*. Delivery service is related to and built up by several operational KPIs; where these KPIs are of great importance but vary depending on the business. Further, there is an increased interest and awareness of measuring CO_2 *emissions*. However, even though many interviewees claim to work with sustainability and consider themselves to have a greater understanding, there are few KPIs related to environmental impact. All KPIs mentioned by interviewees and collected through literature are visualized in Table 6.8.

Table 6.8: Summary of found KPIs connected to traditional road freight.

Delivery service	**Costs**	**Operational**	**Fuel and charging**	**Sustainability**
Lead time	Transport costs	Driving time	Fuel price	CO2 emissions
Delivery reliability	Investment costs	Number of transports performed	Type of fuel used and type of vehicle	Particle emissions
Delivery quality	Operational costs	Vehicle fill	Energy content	
Delivery precision	Delivery cost	Empty running vehicles	Frequecy of fueling	
Flexibility		Distance traveled	Fuel consumption	
Information and transparancy		Transport weight	Eco-driving	
Stock avaliability		Time for packing and lashing	Ratio of used fuel type	
		Maximum payload		
		Transport capacity		
		Number of vehicles		
		Vehicle utilization		
		Deviations from schedule		
		Transport work		

Looking at the various mentioned characteristics, transport buyers are the ones most frequently mentioning the importance of being *transparent* to enable tracking the measurement from *real-time data*. It comes as no surprise that the customer requires transparency since they are paying for transport and, thereby, would like to see that the transport provider fulfills the promised quality. Further noticed is the fact that many of the most mentioned characteristics are connected and reliant on each other; for example, if a KPI should be *measurable*, it also needs to be *based on data*. Therefore both characteristics become essential for KPIs evaluating an operational business. This could further be applied for example *traceable* and based on real-time data, as well as *stakeholder-oriented* and related to an *industry-standard.* Many of the collected characteristics are often market-related compared to literature focusing on more internal evaluation characteristics, which could be seen as a trend towards more *communicable*, market-oriented KPIs, facilitating a dialog between transport providers and buyers. All characteristics mentioned by interviewees and found in the literature are visualized in Table 6.9.

Table 6.9: Summary of found characteristics connected to KPIs within traditional road freight.

Characteristics of KPIs used in traditional road freight
Traceable
Measurable
Time-based
Aggregated
Based on data
Based on real-time data
Relevant
Useful
Related to a standard
Stakeholder-oriented
Customer-oriented
Transparent
Understandable
Communicable
Robust
Cost-based
Valuable
Controllable
Predictable
Validable

Regarding the categorization of KPIs linked to traditional road freight, it can be concluded that the Partner Company internally divides KPIs into *business units*, which is also supported by the literature. Furthermore, several transport buyers highlight that it is easy to understand KPIs when they are put in a context where a good categorization is *internal and external* or using business units, which is validated by the literature. Further, one transport providers highlight a categorization that divides the *transport system into different areas*, something that can facilitate a broader classification of KPIs for electrified road freight. All categories found in literature or mentioned by interviewees are visualized in Table 6.10.

Table 6.10: Summary of found categories connected to traditional road freight.

Categorization of traditional road freight KPIs
Business units
Activities within the transport delivery
Areas of the transport system
Stakeholder
Internal vs. External
Utilization, productivity, effectiveness

6.2 Design a framework of KPIs for electric road freight

The following section aims to present and analyze data gathered from semi-structured interviews with Partner Company (PC), transport providers (TP), transport buyers (TB), associated organizations (AO), and original equipment manufacturers (OEMs), connected to Research Question 2. For the convenience of the reader, Research Question 2 and its Sub-questions can be visualized in Figure 6.3. When presenting the answers from the empirical collection, *several* means that more than two of the interviewees within the stakeholder group mentioned the KPI, characteristic, or category; *majority* implies that more than half of the interviewees said the KPI, characteristic, or category, and *all* means all interviewees within the stakeholder group mentioned the KPI, characteristic, or category.

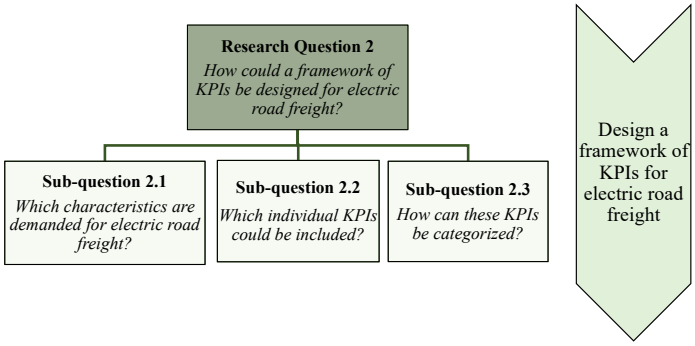

Figure 6.3: Research Question 2 and the corresponding main area.

To ease the understanding of this section's structure, see Figure 6.4, where each Sub-question is divided into separate sections. Firstly, empirical findings are presented, together with a summarized list of the findings. Each mark in the list of findings represents that at least one of the interviewees or the literature mentions the data. The green color in the tables means that at least one interviewee within the specific stakeholder group expressed the characteristic, KPI, or category previously not mentioned during traditional road freight. Additionally, the green color highlight if a new characteristic, KPI, or category was mentioned that previously was not mentioned regarding traditional road freight. Following the empirical presentation, a sub-analysis will be presented connected to each Sub-question. The section concludes with a summarized analysis of Research Question 2, which explains the framework's design.

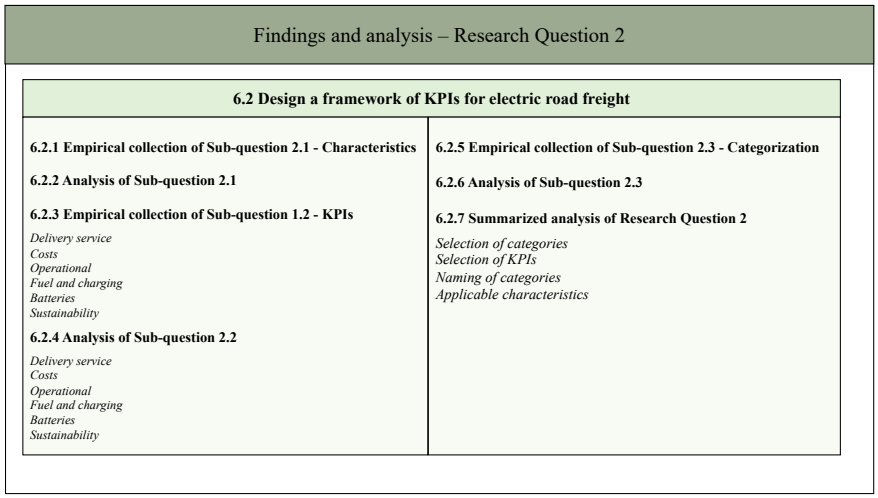

Figure 6.4: Structure of the findings and analysis connected to Research Question 2.

6.2.1 Empirical collection of Sub-question 2.1

The majority of the external and internal interviewees believe that KPIs related to electric road freight should be *traceable* and thus be *based on data*. Specifically, TB4 (2022); TP3 (2022) mention that regardless of which fuel is used, KPIs should always be data-driven, which enables comparison with other stakeholders in the market. Further, the majority of the transport providers and several transport buyers mention that KPIs should be based on *real-time data*. PC1 (2022); PC4 (2022) agree upon the importance of using real-time data, especially as vehicle fleets become electric and optimization becomes more complex, indicating that KPIs must be *measurable* and *time-based*.

The characteristic of being *aggregated* is mentioned by TB7 (2022); PC1 (2022) as necessary. Once moving to more electric transportation, it will be essential to be able to aggregate KPIs when the electric infrastructure network scales. Additionally, the characteristics *relevant* and *useful* are essential according to the majority of the transport providers, transport buyers, and internal Partner Company interviewees. Further, they all mean that measurements should have a purpose, be compatible with the business, and be functional within the scope of the system's performance.

According to TP3 (2022), the *data-driven* characteristic further enables a KPI to be *related to a standard*, thus aligning to an industry value against which they can be evaluated. Additionally, this, in turn, facilitates companies at the forefront of electrical development by increasing knowledge about electrification, as they can learn from each other if the same type of KPIs is used. TP3 (2022) additionally mentioned that an industry-standard should be acceptable by stakeholders, meaning that the KPI should be *stakeholder-oriented*, agreed by AO2 (2022); TB2 (2022). The majority of the internal Partner Company interviewees mention that target values are essential when evaluating KPIs. Therefore, the Partner Company works with target values, where the majority of the internal interviewees stress that setting a suitable standard for the target value is essential to enable a benchmark, making stakeholders understand what the KPI is measuring.

PC2 (2022) argues that customization is an essential characteristic of KPIs related to electric transport. *Customer-orientation* further means that the characteristic *transparency* becomes highly important (OEM, 2022). The majority of the interviewees, external and at the Partner Company, mention that KPIs should never hide anything from the customer, which requires all KPIs to have built-in visibility. In order to reach visibility within the supply chain, data must be shared, and once a common understanding between provider and buyer is reached, collaboration can develop (PC3, 2022).

PC2 (2022); PC4 (2022) describe that electric road freight is more complex than traditional one, and therefore partnership between transport buyers and transport providers is needed rather than a traditional customer-provider relationship. A mutual *understanding* is, according to them, therefore, the most critical characteristic of KPIs, where the measurements and characteristics must inherit a suitable level of knowledge that the customer understands. A joint dialogue of customer-oriented KPIs increases the partnership because the customer's level of expertise sets the limit for which KPIs can be communicated, indicating KPIs to be *communicable* and presented in a way that is easy for customers to assimilate (AO2, 2022; TB2, 2022).

As sustainability plays a more central part in all organizations' businesses, several transport buyers and AO2 (2022); OEM (2022) mention that KPIs should have the characteristic of communicating how sustainable a transport is, i.e., KPIs should be *sustainability related*. If KPIs can show whether transport is more or less sustainable compared to a reference value, pressure will derive on transport providers to always have the environmental aspects in mind.

According to PC2 (2022); TB2 (2022), good KPIs are also good *cost drivers* and an instrument to keep costs down and increase revenues. It is further relevant to translate soft KPIs into monetary values, facilitating businesses to take environmental responsibilities, where for example, a price could be put on CO_2 emissions. Pricing soft parameters like emissions that negatively affect society could thus create an incentive for companies to work more proactively with ecological sustainability (TB3, 2022). Table 6.11 presents the identified characteristics from the empirical collection and the literature, with a description connected to each category.

Table 6.11: Identified characteristics of KPIs connected to electric road freight.

Demanded characteristics of KPI in electric road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Traceable	Be able to continious find and follow up data behind the KPI. Also clarified while it must be explained.	x	x	x	x	x	x
Measurable	Capable of being measured i.e. in specific terms.	x		x			x
Time-based	The KPI should be able to be measured in a temporal manner both on long- and short term.	x		x			x
Aggregated	Be able to broke down or compute the KPI into different levels ex. by geographical areas, by customer or vehicles. Also: scalable. and therefore applicable on both micro- and macro level.	x		x			x
Based on data	No assumptions but only collected data. Also: reliant as the KPI is dependent on data.	x	x	x	x	x	x
Based on real-time data	Ability to continiously collect data.	x		x	x		x
Relevant	Approriate to what is to be measured and compatible to the purpose.	x		x	x		x
Useful	Be useful for the practical purpose within the studied system. Also: functional	x		x	x		x
Related to a standard	The KPI should be able to be evaluated against an industry standard that is of common understading for relevant stakeholders. Or an internal standard that is of common understandning for relevant employees. Also be able to evaluate.	x		x	x	x	x
Stakeholder-oriented	Common agreement how to measure the KPI between relevant stakeholders. Also integratable to stakeholders.			x	x	x	x
Customer-oriented	The KPI should be customized to what is demanded. Also integratable to customers.	x		x	x	x	x
Transparent	The KPI should be able to share data between stakeholders of relevance.	x	x	x	x	x	x
Understandable	Fot stakeholsers that use the KPI.	x	x	x	x	x	x
Communicable	A common understanding to relavnt stakeholders demand the KPI to be communicatable.	x	x	x	x	x	x
Robust	The KPI should be uncompromised.						x
Cost-based	The KPI should connect to a measure that influence costs.	x	x	x			x
Valuable	The KPI should add value for the activity and thus vital for its purpose.						x
Controllable	The KPI should be able to be controlled as the goal is to limit the KPIs dark side.						x
Predictable	One should be able to predict the measurement.						x
Validable	Able to collect real-time data on the real activity.						x
Real-time visibility of data	Meaning that real-time data continiously can be shown for relevant stakeholders and customers at a digital platform.	x					x
Sustianability related	The KPI should be able to reflect wheter an alternative is sustainable or not and there should be an ability to relate how the KPI could be imporved for less environmental impact. Including environmental- social and cost perspectives.		x	x		x	

6.2.2 Analysis of Sub-question 2.1

The data and analysis presented in *Section 6.1.3 Characteristics of traditional road freight KPIs* can also be applied to Sub-question 2.1 as the empirical collection confirm the majority of the characteristics to fit KPIs connected to electric road freight as well. Further, the following analysis highlights the difference in characteristics when road freight becomes electric.

Giannopoulos (2021) implies that data should be monitored in real-time. As the interviews confirm this, it can be concluded that the road freight sector requires more *real-time data* as it electrifies and moves toward the new way of a more digital and optimized mode of transport. Electrified road freight is more complex than traditional and requires the sector to increase communication, interaction, and collaboration between new stakeholders. Electrification also requires more interaction with the infrastructure since charging, and batteries are not fully developed, making it difficult for transport providers to keep delivering the same high quality as when driving fossil (Melander et al., 2019; Le Pira et al., 2021; Monois and Bergqvist, 2020). However, the characteristic of continuous monitoring of real-time data is not considered sufficient for KPIs connected to electric road freight. Data also needs to be shared to achieve *transparency* and a shared *understanding*, highlighted by the Partner Company, transport providers, and transport buyers.

Given that road freight is moving from the traditional transport model of OECD (1992) with different layers constituting the transport system to electrified and digital transport that requires more intensive collaboration, a conclusion can be drawn that characteristics with an external focus, such as *stakeholder and customer-orientation*, are becoming increasingly important to apply to KPIs. If a common understanding of KPIs is created, it could accelerate the penetration of electric road freight vehicles. Interviews show that the market is still at an early knowledge phase, as road freight transport's electrification is still very unsettled in society. KPIs should further be relatable to an *industry-standard* that can ease increased knowledge of how to measure electric road freight. Therefore, the characteristic *communicable* becomes essential when electrifying, both for the eased understanding of the market and also for building relations between transport providers and buyers.

What further can be seen as an essential step in embracing electrification is making KPIs *traceable*, a characteristic related to transparency and based on data. In addition, the Partner Company responds that electric road freight is complex and more challenging to understand than the traditional one. Therefore, it becomes essential to build KPIs that customers can quickly assimilate, thus having traceability built-in. Zero Emission Transportation Association (2022) points out that the primary motivation for transport buyers to electrify a vehicle fleet is to meet sustainability goals, which, in turn, means that KPIs should reflect and measure *sustainability*. Therefore, a conclusion is that benchmark KPIs that facilitate the evaluation of a transport provider's offering in sustainable terms are essential.

To conclude, some characteristics increase in importance when road freight isturning electric, and two new characteristics, real-time visibility of data and sustainability, are mentioned as being specific for electric road freight. The characteristics of significance have increased and are related to the critical need for better transparency and communication between transport buyers and transport providers.

6.2.3 Empirical collection of Sub-question 2.2

Delivery service

As the road freight sector strives toward fossil-free fuels and, in particular, going electric, the majority of the internal and external interviewees emphasize the importance of delivering the same quality. However, quality must be met at the same time as retaining the same *lead time, delivery precision, reliability, quality* and *flexibility.* PC5 (2022) believes delivery reliability is considered to be the most crucial KPI, since having customers trust while going electric is key to expand. TP3 (2022) have experienced that although the customer has ordered an electric transport, the most important is that the transport activity is carried out and meets the agreed delivery precision, e.g., delivery precision still unconquered transportation of a particular fuel. For customers to rely on delivery precision, flexibility must be maintained despite weather conditions or other unpredictable factors (TP3, 2022). On the other hand, TB3 (2022) believes the most challenging parameter with the transition to electricity is the behavior of the customers. For example, driving electric enables driving night shifts which broaden the delivery time frame. However, the customer wants to maintain the old routines causing inflexibility, which counteracts a potentially improved utilization of transport (TB3, 2022). See Table 6.12 for collected KPIs connected to delivery service within electric road freight.

Table 6.12: Identified KPIs connected to delivery service in electric road freight.

Demanded KPIs in electric road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Delivery service							
Lead time	Also mentioned as delivery time, thus the time it takes from order placement to received delivery.	x		x	x	x	x
Delivery reliability	Reliability in lead time or delivery time.	x	x	x	x	x	x
Delivery quality	The right product with the right quality in the right quantity. Also delivery accuracy and delivery security.	x	x	x	x	x	x
Delivery precision	A total index/sum of delivery reliability and delivery quality.	x	x	x	x	x	x
Flexibility	A soft service element that measures the ability to adapt to new wishes.		x	x	x	x	x
Information and transparancy	Measures the quality of communication from the customer's perspective.						x
Stock avaliability	Amount of orders that can be delivered upon request from the customers.						x

Costs

The costs will shift when going electric, where *investment costs* will increase and *operational costs* will decrease (TP1, 2022). The majority of the internal interviewees believe it is important to measure the investment costs; however, internal only. Further, PC2 (2022) emphasizes the operational costs to be of importance as well since it is during the use of electric vehicles that significant gains can be made, which also lies within many of the external interviewee's interests. Highlighted by the majority of the transport buyers is that the solution should be economically justifiable, which means that the benefits of going electric must outweigh the costs, something also AO3 (2022); World Economic Forum (2022) agree on while mentioning the fact that transportation is a low-margin sector. PC2 (2022); OEM (2022) explain that electric vehicles are less expensive in terms of operational costs when looking at service, maintenance, driving, and energy consumption than traditional ones. However, this argument often falls out of the discussion when looking at electric alternatives since many transport buyers focus wrongly on the investment costs (PC4, 2022). A more accurate display or discussion showing lowered operational costs when going electric would be beneficial as the delivery precision is kept the same. Further, this means that the focus can be shifted away from the high investment cost (PC5, 2022; OEM, 2022).

A new KPI, *leasing costs*, is something that PC1 (2022) mentions to be necessary. Corresponding to leasing costs is *delivery costs*, a word more recognized by transport providers and transport buyers. Delivery costs equal the cost per delivery of a pre-determent unit and could thereby be seen as a more broadly accepted name of the cost since it has recognition among transport buyers and transport providers.

Other KPIs emerging with the electrification is *costs related to the aftermarket* (AO2, 2022; AO3, 2022). They believe it is essential to highlight the KPIs value of electric road freight vehicles while it significantly impacts the first market. AO3 (2022) further adds a new KPI, the *software cost*, as the software platform will play a vital role when electrifying the transport sector.

In order to distinguish electric road freight from traditional one, further to relate the transport to environmental impact, the KPI *cost savings/ton CO_2 emission reduction* is highlighted as a significant KPI (PC1, 2022; PC3, 2022). See Table 6.13 for collected KPIs connected to costs within electric road freight.

Table 6.13: Identified KPIs connected to costs in electric road freight.

Demanded KPIs in electric road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Costs							
Transport costs	Total transport costs.	x		x	x	x	x
Investment costs	Costs for purchasing a vehicle, but can also be an investment cost for customers to sign up for a new partnership.	x	x	x	x	x	x
Operational costs	Total cost related to the actual transport. The operational costs consist of driver, service, and fuel/energy costs. Can be measured per pallet, volume, or weight depending on customer demands.	x	x	x	x	x	x
Delivery cost	Based on the total costs a delivery cost is calculated that is communicated to each specific customer. Can be calculated based on SEK/delivery, SEK/km, or SEK/month, i.e., leasing costs.	x	x	x	x		x
Leasing cost	Delivery costs are presented in a different manner. Costs that customers pay for the transport solution.	x					x
Costs after market	Costs connected to the aftermarket regarding electric vehicles and its components but also costs when obsolate.					x	x
Cost savings/ton CO_2 emission reduction	How much could be saved in a monetary value, when turning electric compared to driving with, for example, diesel when lowering the emissions.	x					x
Costs for software	How much the software costs.					x	

Operational
The majority of the external interviewees believe that operational KPIs connected to traditional road freight are also used when going electric. According to several transport buyers and transport providers, what is added as critical KPIs are the number of *electric vehicles used*, either as a ratio of the entire vehicle fleet or as a number. PC1 (2022); PC3 (2022) agree on many KPIs still being relevant but highlight *driving time* as an essential parameter within electrification. Driving time will be a more complex KPI than evaluating traditional road freight, primarily due to the dependence on charging. Driving time is further mentioned by AO3 (2022) as of importance together with the amount of *electric transports performed* and *time for packing and lashing*. The latter will be important when optimizing different distribution flows and when building charging stations at hubs, warehouses, or depots where it is a natural downtime for off and on-loading. However, it is considered extra important with idle time when it comes to the public charging infrastructure as public charging is more uncertain and often more waste of time as no activity can be done during the charging time.

In order to use a delivery cost per month, the majority of the internal interviewees mention the following KPIs to be measured: *number of transports performed*, *distance traveled*, *transport weight*, *vehicle fill*, and *number of vehicles used*. Furthermore, PC1 (2022); OEM (2022) believe that *transport capacity* is a KPI that will be important, which is the potential utilization rate of available *transport work*, i.e., a certain amount of goods to be transported a certain distance. PC5 (2022) agrees on the importance of measuring transport work and its utilization rate, which sums up well in a KPI linked to *hardware utilization*. Hardware utilization is also mentioned by several transport providers, OEMs, and transport buyers, believing that such KPI could be a measurement of interest that is not yet measured today. With hardware utilization, one can measure the use of hardware compared to capacity, where hardware includes, for example, vehicle, charging, and battery, something several transport providers mention as essential.

Vehicle fill, within traditional road freight, has been a critical KPI, something PC2 (2022) mentions no longer to act as a primary KPI, but rather a secondary KPI, as electric transport scales differently than traditional one, and therefore vehicle fill is not as important. Instead, PC2 (2022) believes that capturing the whole system, i.e., vehicle and charging infrastructure, is more critical as these are the most expensive and, thus, the most significant cost drivers. Therefore, PC2 (2022) believes in KPIs linked to *system utilization*, a broader concept than not just measuring the hardware utilization but also including the network of the software and charging.

Additionally, several transport buyers mentioned weather conditions as an essential parameter when evaluating electric road freight. They further argue that there is a concern regarding how electric vehicles can fulfill demanded delivery service if the weather conditions are bad, meaning it is significant to highlight this parameter to ease the understanding. See all operational KPIs collected from interviews and literature connected to electric road freight in Table 6.14.

Table 6.14: Identified KPIs connected to operations in electric road freight.

Demanded KPIs in electric road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Operational							
Driving time	How long time a particular transport, route, vehicle, pallet, etc. is traveled.	x			x	x	x
Number of transports performed	The number of routes driven or the number of delivered pallets. Also, measure the percentage or number of transports performed electrically. Can be measured per week or day.	x		x	x	x	
Vehicle fill	Customers want to know how much vehicle fill rate is on delivered transports. Ex. maximum fill rate is 100% and minimum, i.e., empty running vehicle, is 0%. Customers measure vehicle fill differently based on volume, weight, floor area, ceiling height, or the number of pallets.	x		x	x	x	x
Empty running vehicles	A KPI connected to vehicle fill, measuring the number of empty running vehicles, pallets, and km depending on what the customer use for the unit. Can be measured per day, week, or month.	x		x	x	x	x
Distance traveled	Kilometers driven. Can be based on per vehicle, per delivered unit, and per delivered pallet. Also, distance traveled electrically as a ratio to the total distance traveled.	x		x	x	x	x
Transport weight	Measures how much weight is transported, where customers measure differently based on per vehicle, per week, per end customer.	x		x	x		
Time for packing and lashing	Measures the time of packing and lashing. Can be measured per day, route, or shift depending on customer demand. Either the whole vehicle fleet or specific vehicles. Will be dependent on optimizing routes while packing and lashing should be scheduled at the same time the electric vehicle is charging.				x	x	
Maximum payload	Total weight capacity of the vehicle's trailer, i.e. how much goods a vehicle can transport.						x
Transport capacity	Available tkm during a predetermined time span, i.e. transport work/h. Can also be expressed as a utilization rate of available transport work.	x	x				
Number of vehicles	Measures how many vehicles are used and operating in real time. Can be based on the total number in the vehicle fleet, the number demanded by a delivery. Can also be based on how many vehicles are used for a specific end customer.	x		x	x		
Hardware utlization	A broader concept than vehicle utilization. Measures the use of hardware compared to capacity, where hardware is the vehicle, charging, battery, etc. Can also measure the ratio of driving time to charge time. For example, the vehicle operates 18h a day, if charging for 6h then the hardware utilization when it comes to the vehicle perspective is 66%.	x	x		x		x
Deviations from schedule	Measures how often or how much time is lost when deviating from the schedule.			x	x		x
Transport work	How much work is carried out by a vehicle when multiplying the weight of the vehicle by the distance traveled.	x	x	x	x	x	x
Number of electric vehicles	KPI measures how many electric vehicles are used during a specific period of time for a specific customer or specific delivery. Can also be the number of electric vehicles in the fleet.			x	x		
Life time of vehilce	For how many years can the vehicle operate. This KPI is dependent on driving behavior, i.e., eco-driving, technical quality and service possibilities on the vehicle, distance traveled etc.			x	x		x
System utilization	Utilization of the whole system, i.e., both hardware and software. Broader concept than hardware utilization, thus measures how much the whole network is utilized.	x					
Time savings	Based on how optimized the system is. Time savings can arise from maximizing system use and hardware utilization.						x
Accessibility	Measures how accessible it is using an electric vehicle. Not a pre-defined KPI, for example, the KPI can have a range from 1 to 10 where 10 is 100% accessible. Includes the accessibility of findning charging stations, charging time, costs, driving range, battery, services etc.						x

Fuel and charging
As electric vehicles are powered by electricity, the *charging capacity* is of great importance, according to all interviewees. Flexibility is already mentioned as an essential KPI within delivery service, where TP4 (2022) further argues that flexibility is dependent on how the charging infrastructure is built up. The majority of the transport providers, OEMs, and internal interviewees agree that *charging infrastructure coverage and density* are essential to measuring. According to TP3 (2022); AO2 (2022); AO3 (2022), there should be requirements for charging infrastructure to cover different geographical areas. They further stress that sufficient power should be available in the right place with adequate quantity. Mentioned by all interviewees, *charging efficiency* will be an important KPI. AO2 (2022); OEM (2022) argue that limitations in the energy system are also limitations in the ability to supply road freight with demanded quantity, where more capacity is needed to reach economies of scale in the system. Further, this KPI connects to the *frequency of fueling*, which becomes significant when electric vehicles need to charge more often than fossil-driven vehicles (AO3, 2022; TB4, 2022; TP3, 2022; OEM, 2022; PC3, 2022). In addition, TP3 (2022) argues that charging hubs should have a cross-industry standard for assessing handles, increasing the flexibility and the same capacity of power, regardless of the number of vehicles charging on the hour of the day.

All interviewees further mention KPIs like, for example, *charging time* to be of importance to communicate since customers want to understand the solution and how to scale the business. However, PC2 (2022); PC4 (2022) stress that this KPI is only necessary if the customer is mature enough to evaluate the importance of technical KPIs.

Additionally, PC2 (2022) believes the *energy efficiency* as a KPI, will be necessary to communicate to customers. Correspondingly, TP3 (2022); TB6 (2022); OEM (2022) highlight that *fuel efficiency* should be used as a KPI when going electric. The energy efficiency of electric road freight can then be compared to fossil-driven fuel efficiency, enabling an understanding from the customer's point of view, where differences and similarities between energy consumption in an electric vehicle and, for example, diesel consumption in a conventional vehicle can be compared. A KPI mentioned by the majority of the internal interviewees is the *energy mix* supplying electric vehicles. This KPI could be measured by how much CO_2 emissions are caused during electricity production, whereas the Swedish energy mix differs a lot from, for example, the German energy mix. Further, AO3 (2022); OEM (2022) and internal interviewees highlight the energy mix as essential and the *fuel price* as it suddenly becomes necessary to consider when charging the electric vehicle.

TB4 (2022) highlights the fact that there has not yet been an electric vehicle in operating business throughout a whole life span, and thereby predicting *lifetime and aftermarket for vehicles* is still a matter to observe and gain knowledge from. In addition, electric vehicles demand a new type of security through insurance, maintenance, and service, which TB4 (2022); AO3 (2022) also believe will be a complexity to add on how to work with measurements and benchmark between different alternatives on the market. By this, TB4 (2022) stresses that there is essential to reach a broadly shared understanding of electric road freight. According to the majority of the interviewed transport providers and OEMs, not only batteries, charging, and the grid will affect the sector, but also non-controllable parameters like different weather conditions that will impact energy consumption and the lifetime of vehicles. See all collected KPIs connected to fuel and charging within electric road freight in Table 6.15

Table 6.15: Identified KPIs connected to fuel and charging in electric road freight

Demanded KPIs in electric road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Fuel and charging							
Fuel price	Continuously follow-up of fuel prices, i.e. peak hours in the day, when to charge due to price, thus also energy mix. Customers want to know how green the energy is and want to gain knowledge of how and when to charge depending on price.	x	x	x	x	x	x
Type of fuel/energy used i.e. type of vehicle	Example petrol, diesel or electric vehicle. Will influence fuel consumption, price etc.		x	x	x		x
Energy content	How much energy is stored within the fuel ease comparison between different fuel types. This further will influence other KPIs, such as how much the operational costs are, environmental impact, frequency of charging.		x	x	x		
Frequency of fueling/charging	How often does charging take place is important as customers want to know operating time vs. charging time, that delivery service is kept high, security for drivers, etc. Can be measured per day, week, or month for either a specific vehicle or the whole vehicle fleet.	x	x	x	x	x	
Fuel/energy consumption	Also, the energy mix as customers want to know energy consumption/driven km and energy demand. The KPI is transformed into Joule to ease comparison with diesel consumption. Several customers say fuel consumption explains the transport efficiency.	x	x	x	x		x
Eco-driving	According to customers, the KPI eco-driving is demanded to measure. They highlight eco-driving to measure how much energy/fuel can be saved in percentage when driving with another speed or behavior compared to a reference value. Further, connects to a KPI regarding how to drive fuel-efficient.		x	x	x		
Ratio of used fuel/energy type	Measures how much of the vehicle fleet use a particular type of fuel/energy. Ex. 20% of the fleet is powered by diesel, 70% by petrol, 10% by electricity.			x	x		x
Energy mix	Based on what different primary energy sources are used when producing the electricity that powers the vehicle. A measure on "how green" the transport is. The energy mix is dependent on when the vehicle is powered during the day.	x	x			x	
Average speed	The speed of the vehicle has an impact/is dependent on fuel efficiency, fuel consumption, eco-driving, weather, etc.						x
Energy efficiency	The KPI highlight how much energy can be saved to perform the same transport service when, for example, comparing energy use when driving with diesel vs. electric. Thus, diesel consumption must be transformed into corresponding kWh for later measuring the KPI in percentage.	x					
Charging time	Measures how long time it takes to recharge the electric vehicle to a proper battery percentage. KPI is dependent on battery type, transport weight, charging capacity, distance traveled, etc. Also measuring charging time when still operating during the time for lashing/packing vs. charging time that is needed when adding an extra stop. Also waiting time when charging, i.e., non-used time.	x	x	x	x	x	x
Charging capacity	Measures how much a charging station can deliver. Demanded is that correct amount of power on the grid must be present to supply the vehicle. The KPI is dependent on peak-hours on the grid. Can also be connected to scheduling of slot-times when charging, which means that a high capacity indicates no queing (either many stations or fast-charging).	x	x	x	x	x	x
Charge efficency	Measures the energy added to the battery divided by the energy required to charge the battery. Is highlighted by customers to be important as it will affect the charging time. KPI is dependent on charging station, battery type etc.	x	x	x	x	x	x
Density of charging	Measures the coverage of the charging infrastructure in the transport network. This measure decides when and where vehicles can charge and have an impact on the optimization of routes regarding location and time.	x	x		x	x	x

Batteries
TP3 (2022); TP4 (2022) emphasize several challenges related to the complexity that comes with electrified road freight, where the most crucial parameter, according to TP4 (2022), is flexibility. In turn, flexibility is dependent on batteries, where all external interviewees highlight *battery capacity* to be crucial when measuring and evaluating electric road freight. AO2 (2022); AO3 (2022); TB7 (2022) raise that the bottleneck is battery capacity in terms of energy generation and further the challenge that batteries are currently cumbersome and large, i.e., battery weight and volume. Further, several transport buyers, several transport providers, and the majority of the internal interviewees highlight the concept of *battery management*, which is connected to KPIs regarding the *lifetime of batteries* and efficient usage of batteries, i.e., *battery utilization*, also highlighted by the majority of the associated organizations and OEMs. Further, several transport buyers and PC3 (2022) mention the sustainability perspective on batteries while highlighting the aftermarket on batteries as a crucial parameter they want to understand.

Additionally, several transport buyers and TP3 (2022); OEM (2022) believe that a more extended lifetime strongly correlates with good usage of batteries and knowledge of how to operate and *drive eco-friendly*, which means driving fuel-efficient, the ratio of slow and fast charging and gently driving to reduce wear and tear. AO3 (2022); OEM (2022) mention driving education, i.e., driver knowledge, might be required in the future regarding how to best handle electric vehicles. The majority of the associated organizations and OEMs additionally mention the *maximum range of the battery* to be a vital measurement when driving electric. See Table 6.16 for all found KPIs connected to batteries in electric road freight.

Table 6.16: Identified KPIs connected to batteries in electric road freight.

Demanded KPIs in electric road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Batteries							
Battery type	KPI decides" how green" the hardware is and how much kg CO2 emissions it emits. Interviewees highlight the environmental perspective on batteries where the KPI must take into account energy use during production and a perspective taking into account the re-usability of batteries, i.e. after-market.					x	x
Battery management	A broad KPI or more of a concept, customers highlight to be of importance. However, no one mentions how to measure it, but an index of several input KPIs is an example highlighted. Input KPIs could be how much to charge/utilize the battery, when recharge, eco-driving, range of the transport, etc. This KPI is not defined yet, i.e. needs to be concretized.	x		x	x		
Battery utilization	How much the battery is utilized out of 100% utilization. The KPI connects to eco-driving, thus measuring in some way how to charge in a smart way.	x	x	x	x		
Battery capacity	How much energy a battery can generate. Closely connected to battery type.		x	x	x	x	x
Maximum range of the battery, i.e. driving rage	The KPI connects to the range of the vehicle. The range refers to how long the electric vehicle maximum can drive after one charging. Depending on the type of battery, eco-driving, weight of the transport, etc.		x			x	x
After market on batteries	Specifies, in a monetary value, the life after the battery can not operate anymore. Connects to the environmental perspective on batteries.	x		x			x
Life-time on batteries	How long the battery can operate. Connects to the KPI regarding after-market of batteries. Depend on battery management, battery type, utilization, capacity, etc.	x	x	x	x	x	x

Sustainability

CO_2 emissions or savings will be a fundamental KPI linked to electric road freight according to the majority of the interviewees, both internal at Partner Company and external. However, according to PC2 (2022); PC3 (2022), the maturity and market demand for KPIs connected to sustainability are low apart from measuring CO_2 emissions. Due to a knowledge gap on the market, PC3 (2022) suggests that a KPI, previously mentioned within costs, could be *cost savings/ton CO_2 emission reduction* compared to fossil-driven vehicles, which in turn will ease the understanding of the customer. PC2 (2022) believes sustainability KPIs linked to CO_2 emissions will be of more importance in the coming years. However, PC2 (2022); OEM (2022) believe that zero CO_2 emissions will soon become a hygiene factor, and therefore other sustainability KPIs will be required to benchmark in the long run. Furthermore, PC2 (2022); TB7 (2022) believe that sustainability KPIs will be necessary to communicate because it is primarily the incentive to become more sustainable that makes customers buy electric transport. PC3 (2022); PC4 (2022) believe that total NO_X emissions and other *particle emissions* are significant KPIs that should be included when measuring and evaluating electric road freight. Even though particle emissions are strongly related to fossil-driven road freight, it remains relevant since the wear of tiers creates emissions.

PC3 (2022); PC2 (2022); OEM (2022), and the majority of the transport buyers believe that an aggregate KPI should exist that shows how environmentally friendly road freight is from a life cycle perspective, measuring life cycle efficiency throughout the value chain. Such KPI will thus relate to *emissions from life cycle perspectives*. A KPI of 100 % means fossil-free at all stages, from extraction of materials to recycling. For example, if battery production is only 70 % carbon-free, this will decrease the overall KPI. Further, this means that KPIs can differentiate between embodied and operational CO_2 emissions and create a standard evaluation of the whole lifecycle (PC3, 2022; TB5, 2022; AO3, 2022). In addition, OEM (2022) mentions the importance of what kind of energy mix is used in each process step since the electricity itself could have various levels of emission behind the production. Also, TB2 (2022); TB6 (2022); OEM (2022) mention the importance of transparency throughout the value chain, enabling to meet customer's demand to know how much CO_2 emissions individual items have caused from origin until consumption or use. TB3 (2022) believes traceable emissions for one product or emissions from one specific delivery will be more accurate and demanded from customers than before. Furthermore, TB6 (2022) believes there needs to be a better way to translate emissions from the whole life cycle to a comparable and comprehensive measurement, including all environmental-related parameters. See Table 6.17 for all KPIs found that can be connected to sustainability within electric road freight.

Table 6.17: Identified KPIs connected to sustainability in electric road freight.

Demanded KPIs in electric road freight	Description/comment	Internal	OEM	TB	TP	AO	Literature
Sustainability							
Emissions during activity i.e. CO_2 emissions and Particle emissions can also be CO_2 savings	Measures how much CO_2 emissions are emitted from the vehicle per distance driven. Can also be measured as CO_2 savings when comparing different transport alternatives. Can be based on one route, CO_2 emissions per pallet, CO_2 emissions throughout the value chain, or total emissions during a specific time.	x	x	x	x	x	x
Particle emissions	Measures how many particles are emitted from the transport. Can for example be measured on one vehicle within a certain time frame, or the whole vehicle fleet.	x		x			
KPI index related to emissions from life cycle perspectives	KPI is not pre-defined but can for example, be CO_2 emissions during the value chain, waste of materials, pollutants from the extraction of raw materials, handling of waste after use, etc. The purpose of the KPI is to enable to tracking of what is meant by ex. "climate neutral". The index should take into account not just the price but also social and environmental sustainability.	x	x	x	x		x

6.2.4 Analysis of Sub-question 2.2

Most of the KPIs mentioned in *Section 6.1.1 KPIs used in traditional road freight* are further also applicable within electric road freight. The analysis will further highlight the differences between KPIs connected traditional road freight and what new KPIs can be relevant when going electric.

Delivery service
Delivery service as a concept is mentioned by Oskarsson et al. (2013) where the authors highlight several delivery service elements. For the Partner Company and all external interviewees, *reliability, quality, and precision* are the most crucial KPIs to measure since delivery service will remain the basis of the transport activity. According to transport buyers, it is essential to keep up with the *flexibility* and further highlight the KPI to ease the understanding of what flexibility can be requested when procuring electric road freight. Whether how flexibility should be measured is challenging as it is a soft measure. However, Caplice and Sheffi (1994) mention that in order to reach a customer orientation, flexibility must be communicated to achieve satisfaction from the customer's point of view. Flexibility is thus crucial, where Lee et al. (2015) argue that overall service is dependent on how customers perceive the interacting activities before, during, and after delivery.

Transport buyers are concerned that delivery service KPIs become more challenging to maintain when going electric because electric vehicles need to be charged more frequently than traditional ones. Monois and Bergqvist (2019); Morganti and Browne (2017) highlight the challenge of developing the infrastructure required for electric road freight to enable the same flexibility in route planning and thereby being able to transport goods unhindered easily. To conclude, delivery service elements become crucial when transitioning to electric, where all empirical data confirm maintenance of high delivery service, but with an extra focus on flexibility, further something the framework should highlight.

Costs
Costs are substantial to highlight when the road freight sector goes electric. There is a clear trend that the majority of transport buyers mention the high *investment cost* as a barrier to switching to electric options. However, this is something that the Partner Company argues will be compensated with lower *operational costs* and not of relevance when paying a *leasing cost*. However, customers seem not ready to understand the type of business model that relies on a leasing cost, so it may be more important to continue talking about the monthly cost as a *delivery cost*, which stakeholders seem to be familiar with and thus understand better. Once an understanding is in place of what electric transport means, stakeholders will understand the underlying factors that enable operational costs to decrease compared to fossil-driven road freight (Transportföretagen, 2020; Melander et al., 2019; Monois and Bergqvist, 2019). Further, the KPI linked to *cost savings/ton CO_2 emission reduction* can be communicated, which is an acknowledgment of the incentive for why most companies are switching to electric transport; namely to meet sustainability goals (Zero Emission Transportation Association, 2022). Therefore, the most crucial cost-related KPI to communicate when conducting the framework will be to see the delivery cost, which is based on internal measurement of operational and investment costs.

Operational
In terms of operational KPIs, it becomes crucial to monitor whether electrical road freight is running according to a predetermined plan, something that Schücking et al. (2017) describe vitally. KPIs related to the *number of transports performed electric* and the *distance transported electrically* therefore become important KPIs. This conclusion can be drawn after the majority of the interviews conducted confirmed this. However, such operational KPIs are important when it comes to evaluating an already established transport system, where operational KPIs, therefore, should be tailored to what each transport buyer wants to monitor, indicating a stakeholder-orientation (McKinnon and Ge, 2007; Kaparias and Bell, 2011).

During the empirical collection, many operational KPIs were collected with similar characteristics. The previous mentioned KPIs, together with *transport weight*, and *empty running vehicles* could together create a base of various KPIs demanded by transport buyers; for example, several transport buyers would like to have *transport work* communicated while others are just interested in distance traveled electrically. By this, KPIs could be stakeholder-orientated and adapted to various transport buyers.

One significant KPI that transport buyers demanded during the empirical collection is measuring *eco-driving*. This KPI will show how well transport providers perform on several operational parameters related to sustainable parameters such as *battery utilization* and *vehicle fill*. More detailed KPIs that become irrelevant to communicate but essential to monitor by transport providers are, for example, *hardware utilization*, *transport capacity*, and *time for packing and lashing*.

To summarize, operational KPIs are often adapted after suitable measurements for one's business, where many of the KPIs are connected or built on each other. The most significant difference found in this study is the increased demand for KPIs measuring eco-driving and other sustainable related parameters such as battery utilization and vehicle fill. Further traditional KPIs are now adjusted to operate electric, such as the number of electric vehicles, transport work, the lifetime of vehicles, and degree of utilization.

Fuel and charging
KPIs linked to fuel and charging differ significantly from traditional road freight. All KPIs related to charging are new to include in the evaluation of electric road freight. Due to the complexity of electric road freight, it becomes essential for transport providers to communicate their solutions in a way that overcomes transport buyers' concerns. From interviews internally, it is crucial to explain how optimizing KPIs connected to electric road freight has been done to make customers understand that the solution offered is full-coverage. As mentioned above, for operational KPIs, many parameters are essential to measuring for transport providers, but only a few to communicate and for transport buyers to follow up. For example, *driving range* and *charging time* are indirectly related to *density of charging*, and *charging capacity*, where the transport provider could measure them all but only communicate driving range and charging time to transport buyers since these are the actual transport activity that affects the operational business. The authors Monois and Bergqvist (2019); World Economic Forum (2021) highlight these KPIs to be easily understood as they further incorporate technical parameters that should be measured by transport providers such as *battery capacity,* and *energy efficiency*. Additionally, Monois and Bergqvist (2019) highlight that *frequency of charging* and *fuel consumption*, therefore, becomes unnecessary to communicate as the solution will be more robust when scaling the network, indicating transport buyers do not have to be concerned about such KPIs.

To conclude, many new KPIs related to fuel and charging emerge when going electric, where a significant focus during interviews has been on the importance of understanding and trusting this new way of transport. All new KPIs mentioned in Table 6.15 could therefore be considered to be of great importance when conducting the framework.

Batteries
Battery capacity is a KPI mentioned as necessary during the majority of interviews. Since the technology of batteries is constantly evolving, while the maturity level of the market in terms of knowledge about batteries is low, many different variants of battery KPIs are raised, which subsequently have a similar meaning. *Battery management* is a KPI that several transport providers and transport buyers highlight, a KPI that encompasses several different parameters related to *battery lifetime*, *battery utilization*, and how best to charge the battery to maximize *driving range*. Most KPIs mentioned are interdependent and highly technical, explaining why transport buyers are confused by the different meanings. Furthermore, it can therefore be concluded that technical KPIs related to batteries are irrelevant to communicating to transport buyers. According to Monois and Bergqvist (2019); Zero Emission Transportation Association (2022), the electric way of transport is different from the fossil-driven one and should not be evaluated on very many detailed KPIs. Instead, Monois and Bergqvist (2019); Zero Emission Transportation Association (2022) argue that since the transport buyers buy a service, the battery management should not be bothered since they agreed on delivery at the right time and place. Instead, it can be concluded that transport providers should internally measure and follow up on this to further communicate, for example, *eco-driving* to transport buyers, a KPI that is easier to evaluate and understand.

To summarize, many of the KPIs related to batteries are, foremost, connected to the understanding of the range, utilization, and power, rather than actual daily performances in the transport activity. Therefore, it is essential for transport providers to measure and communicate these technical KPIs, but for transport buyers, instead, evaluate the transport provider on range and eco-driving.

Sustainability
The continuously increased development of electric road freight contributes to more initiatives to change from fossil-driven vehicles to electric-driven vehicles. As the development continues, KPIs that include environmental aspects, become more relevant and demanded by transport buyers. The main initiative, according to interviewees and Zero Emission Transportation Association (2022), is to reduce emissions to meet climate targets. However, sustainable and environmental solutions are often linked to economic parameters, where the price plays a vital role, something that Kurdve and Wiktorsson (2013) highlight when mentioning the importance of evaluating the triple bottom line of sustainability, i.e., ecologic, economic and social. The majority of the transport buyers demand the *life cycle perspective* on road freight to be evaluated, not just CO_2 emissions during the activity itself. Such life cycle index depends on KPIs linked to *fuel consumption*, *eco-driving*, and the *energy-mix* which is why it is essential for transport providers to measure emissions from various particles, CO_2 emissions in particular. However, it is still interesting to distinguish *emission from activity*, and from the whole life cycle. To conclude, KPIs related to sustainability should include various ways of measuring emissions from both activities, life cycle, and eco-driving due to how sustainable the vehicle and the transport activity are.

6.2.5 Empirical collection of Sub-question 2.3

The Partner Company is categorizing their KPIs according to *business units* and uses the categorization of separating *external and internal* KPIs (PC3, 2022). Such categorization is also mentioned by TB4 (2022) to be suitable for electric road freight.

In *Section 6.1.5 Categorization of traditional road freight KPIs*, TP3 (2022) mentioned a categorization according to *areas within the transport system*. Further, this categorization is similar to the *transport delivery* classification, that PC2 (2022) mentioned.

Categorization after different *stakeholders* is mentioned by PC2 (2022); AO2 (2022). The stakeholder categorization will ease the communication and collaboration between stakeholders when transitioning to electric and becoming more digital (PC2, 2022; AO2, 2022). Further, TB7 (2022) mentions a categorization of stakeholders as well but argues that the categorization should be done after specific roles and areas of responsibility, not just specifically after the stakeholder perspective. Such categorization could help transport buyers only focus on KPIs relevant for them to measure. TB7 (2022) gives an example where two groups are considered to create an overall structure of a framework to suit electric road freight. First, fleet management is highlighted as a group to which KPIs can be linked. TB7 (2022) argues that these KPIs are technical and relatively knowledge-heavy, thus intended to be used by transport providers or those working with vehicles or services. The second group, TB7 (2022), calls operational, where more communicable KPIs are included. This categorization makes it easy to see which KPIs should be communicated to customers from a transport provider perspective.

Utilization, productivity, and effectiveness are categories that PC1 (2022) highlights as relevant when dividing electric road freight KPIs into sub-groups. However, PC1 (2022) believes that these operational categories should be complemented with a category that highlights social aspects related to electric road freight. In contrast, a combination of the sustainability categorization could be possible when designing a framework.

PC2 (2022); PC5 (2022), on the other hand, argue that a possible way to categorize is to divide KPIs depending on whether they are linked to costs, social, or the environment, i.e., the *three pillars of sustainability*. A similar categorization of KPIs for electric road freight is to divide KPIs according to where in the *life cycle* the KPI is used (PC3, 2022). This categorization links, for example, KPIs to the production of raw materials or the production of the electric vehicle, whereas other KPIs could be linked to the use of the vehicle. For example, a KPI that measures CO_2 emissions during electricity generation can be distinguished from a KPI that measures CO_2 emissions during transport.

Table 6.18 presents the identified categories connected to electric road freight, both from the empirical collection, and the literature, with a description connected to each category.

Table 6.18: Identified categories connected to electric road freight.

Demanded categorization of electric road freight KPs	Description/comment	Internal	OEM	TB	TP	AO	Literature
Business units	Categorization due to business units internal ex. logistics, production, sales, marketing etc. Can also be based on environmental, operational, financial.	x		x			x
Activities within the transport delivery	Categorization due to where the KPI are measured or used within the delivery ex. before, during, after delivery.	x					
Areas of the transport system	Categorization that divid the transportation system in different building blocks where each block represents a thematic set of KPIs ex. hardware, software, fuel.				x		x
Stakeholder	Categorization regarding what stakeholder the KPIs are relevant for. Some KPIs are important for transport buyers and some for truck manufacturers. Can also be responsible areas in the transport system.	x		x		x	x
Internal and external	KPIs are divided into internal evaluation and external communication.	x		x			x
Utilization, productivity, effectiveness	Categorization due to the three pillars.	x					x
Lifecycle and sustainability	Categorzation regarding production, use, and after-market, i.e. taking into acount the whole life cycle of the transportation. Can also be connected to the three pillars within sustainability i.e., economic, ecological and social.	x					x

6.2.6 Analysis of Sub-question 2.3

The analysis presented in *Section 6.1.5 Categorization of traditional road freight KPIs* can also be applied to Sub-question 2.3 as the empirical collection confirm the majority of the categories to fit KPIs connected to electric road freight as well. Further, the following analysis regards categories demanded or suggested when road freight is electric.

Compared to the empirical collection regarding traditional road freight, associated organizations and the Partner Company highlight the *stakeholder categorization* as essential when road freight becomes electric. Further, this may be due to the increasing importance of capturing a macro-perspective and thus considering which stakeholders are present in the market. According to the chosen stakeholder's position, categorizing KPIs based on responsibility and applicability becomes significant. Challenges connected to the electrification are, namely, closely related to the market where completely new stakeholders, such as battery makers and software providers, are starting to be visualized (Kley et al., 2019). Thus, to understand the market and pinpoint what and where benefits in the new business model can be found, this categorization can facilitate where to position. On an aggregated level, the stakeholder categorization could also be seen as an *internal and external* categorization of where the KPIs are measured and used. Using an external focus is highlighted by Kaparias and Bell (2011); Caplice and Sheffi (1994); McKinnon and Ge (2007), which subsequently goes in line with how data shows that more and more characteristics of KPIs are also becoming more market-based.

Furthermore, an internal validation of the category related to *utilization, productivity, and effectiveness* has been confirmed. The Partner Company highlights, in the context of electrification, that it may be relevant to divide KPIs into these three categories. However, what is mentioned is that an additional category dealing with social sustainability aspects should also be included in the framework to create a comprehensive framework of KPIs, internal and external. This categorization can further link to what the Partner Company highlights regarding *life cycle and sustainability*. The majority of the internal interviews highlight the importance of categorizing KPIs, either according to where they are measured and evaluated in the life cycle or based on the three pillars of sustainability: economic, environmental, and social sustainability. Such type of categorization can be linked to how Prause and Schröder (2015) categorize KPIs. Both literature and empirical data confirm that the life cycle perspective and sustainability aspects should reflect road freight. Preferably such categorization should also enable comparison between electric and traditional to facilitate an understanding of the environmental gains made if a transport buyer considers electric over fossil-powered road freight. Furthermore, Kaparias and Bell (2011) also consider that a category in a framework of KPIs related to electric road freight should address environmental impact. It thus becomes clear that electrification is initiated by environmental challenges and a response to a rapidly evolving technology. It is therefore evident that the framework of KPIs with its categorization needs to be adapted to this type of technology shift, as the main reason for transport buyers to switch to electric transport is precisely the sustainability incentive (Zero Emission Transportation Association, 2022).

To categorize by areas of the *transport system* is highlighted by Prause and Schröder (2015); Caplice and Sheffi (1994) and interviewees, discussing KPIs being divided into different building blocks. In this study, a categorization could enable a suitable division of areas within the electric road freight system. As the industry is developing quickly, the categories could change over time, enabling flexibility always to be adapted after the relevant areas, further being suitable for this study. This categorization is also challenging due to its flexible and changing nature, where several KPIs could belong to different areas. However, as long as KPIs are communicated appropriately and still relevant, the categorization is more an enabler than an obstacle. To conclude, various categorizations could be used when working with electric road freight, but where the majority of data collected and literature points towards a greater focus on distinguishing sustainability and categorization on a stakeholder level together with a focus on dividing KPIs in areas of the transport system.

6.2.7 Summarized analysis of Research Question 2

Based on the empirical collection of internal and external interviews, the framework of KPIs connected to electric road freight will be designed to answer Research Question 2:

> *Research Question 2: How could a framework of KPIs be designed for electric road freight?*

Selection of categories
From empirical collection and literature, categorization according to *stakeholders* is consistently standard and considered to fit electric road freight. A clear trend can be seen towards becoming more aware of the market, where a prerequisite, according to Regeringskansliet (2021); Monois and Bergqvist (2019), for electrification to take off is cooperation between stakeholders. Further, different KPIs must adapt to different stakeholders and their market needs, wherefore the framework will focus on transport buyers and transport providers. Additionally, this could also be seen as an *internal and external* focus where the transport provider will be seen as the internal part and the transport buyer the external part. Furthermore, this breakdown can enable an understanding of how internal KPIs build up each external KPI. Indeed, communicated external KPIs have mainly been seen as an aggregation of several internal KPIs that are not communicated to the transport buyer but rather act as the underlying data for communicable, external KPIs. For example, investment and operational costs might be essential KPIs to measure by transport providers but might be communicated to transport buyers through a delivery cost.

Further, the framework will be divided into cross-functional categories, where the horizontal categorization consists of the stakeholder perspective, i.e., internal and external, and the vertical categorization will consist of *areas of the transportation system*. Prause and Schröder (2015) highlight that this categorization facilitates frameworks connected to systems under development, i.e., well applicable to the electrification of road freight. The authors and empirical data from transport providers mention that the areas can be anything in the system, which additionally creates opportunities for the development of the framework as it might need to be adjusted to either other stakeholders or as transport providers are developing.

See Table 6.19 for how the framework will be structured with included categories. In designing the framework, the different areas of the transport system need to be selected, which will be done after presenting what KPIs should be included.

Table 6.19: Categories included in the framework.

Categorization	**Transport provider (internal)**		**Transport buyer (external)**	
Areas of the transport system	**KPI**	***Characterisics***	**KPI**	***Characteristics***
Area 1 .... Area n				

Selection of KPIs
Flexibility should be at the core when selling a new type of solution to a customer, according to empirical data. Further, *delivery precision*, built up by *reliability*, and *quality* should also be communicated KPIs towards transport buyers. On the other hand, *lead time* becomes only relevant for transport providers to measure.

As road freight is a low-margin industry, price will always be an essential parameter. However, what will be necessary is how cost KPIs are communicated. Since transport buyers only procure transports, costs should only be seen as a *delivery costs*, meaning that *investment and operational costs*, as well as *costs after market* only will be measured by transport providers. To benchmark a delivery cost enables comparison to something the market is aware of, increasing understanding of what transport providers offer. Additionally, the KPI *cost savings/ton CO_2 emission reduction* allows for shifting focus towards savings in emissions and thus a cost that takes the focus away from the expensive electric road freight, stakeholders in the market perceive. Furthermore, this KPI is an excellent way to compare electric road freight with traditional one.

Transport buyers want to know how well electric road freight is performing, where the KPIs *number of transports performed electric*, *transport weight*, and *distance traveled* electrically become essential. Further, this means that transport buyers can evaluate *transport work*, a traditional KPI considered vital to include in the framework. Operational KPIs aim to visualize how well the transport activity performs according to the predetermined plan. Further, transport providers must measure primary and detailed data-driven KPIs and then translate them into more aggregated and simple KPIs communicated to transport buyers. *Eco-driving* is a KPI mentioned as essential by transport buyers to evaluate, as it puts a value on the environmental perspective of transports as it includes *vehicle fill, empty running vehicles* and *battery capacity*. However, the KPI needs to be defined so that transport buyers can track what transport providers measures within the eco-driving KPI.

Frequency of charging, *capacity of charging* and the *density of the charging infrastructure*, are considered essential KPIs to measure for transport providers. As mentioned above in the analysis, it becomes essential to communicate *driving range* and *charging time* as KPIs to transport buyers. For transport providers to plan operations, it is also considered essential that they clearly explain the *efficiency of the energy content* and current *transport capacity*, something that transport buyers want to track.

Concerns regarding time losses related to electric charging of road freight exist, whereas transport providers need to spread the knowledge of the optimized network further to measure *hardware utilization*. Once a common understanding is created and transparency exists on how charging is optimized to achieve the required quality of service and zero emissions during transport, transport buyers can evaluate more detailed and technical KPIs, which can only be seen as crucial for providers to be aware of.

KPIs describing batteries are complex and often hard to understand for transport buyers. However, there is no standard in what is meant by battery management, and as technology is developing fast, the market considers the KPI hard to understand KPIs like *battery utilization* and the environmental footprint of today's batteries. These battery parameters will, therefore, only be measured by transport providers, which in turn are KPIs that form the basis for, e.g., *eco-driving*, which is of relevance to evaluate for transport buyers. Beyond KPIs such as eco-driving, it is not relevant to communicate complex and technical KPIs related to batteries. It is, however, still essential to maintain transparency in how transport providers measure eco-driving.

Transport buyers highlight the importance to track performance in *fuel consumption*, i.e., CO_2 *emissions* that can be saved with electric compared to fossil. Furthermore, as discussed by interviews and literature, transport buyers should be able to measure the carbon footprint of their transport, both throughout the life cycle of the vehicle but also during active transport. CO_2 *and particle emissions during operations*, *life-time of batteries*, *energy-mix* used and *emissions that can be tracked throughout the life cycle* therefore becomes vital to measure for transport providers. Additionally, the soft measure of driver's knowledge is important to keep track of, while it directly will impact how environmentally friendly the transport becomes. For transport providers, it will be essential to create a simple way to communicate the benefits of electric road freight compared to conventional to attract customers. See Table 6.20 for all KPIs that are included in the framework.

Table 6.20: Included KPIs in the framework.

KPIs in the framework	
Lead time	Transport work
Delivery reliability	Frequency of fueling/charging
Delivery quality	Fuel/energy consumption
Delivery precision	Eco-driving
Flexibility	Energy mix
Investment costs	Energy efficiency
Operational costs	Charging time
Delivery cost	Charging capacity
Cost savings/ton CO_2 emission reduction	Density of charging
Number of transports performed	Battery utilization
Vehicle fill	Battery capacity
Empty running vehicles	Life-time on batteries
Distance traveled	Maximum range of the battery, i.e. driving range
Transport weight	Emissions during activity i.e. CO_2 emissions and Particle emissions can also be savings
Transport capacity	
Hardware utlization	KPI index related to emissions from life cycle perspectives

Naming of categories

Once the above KPIs have been selected for the framework, they can be grouped into areas within the transport system, forming the vertical categorization that the framework will have. The first category will address the service KPIs that transport providers and transport buyers should measure: *delivery service* creates the first category. Furthermore, *costs* will act as the second category of KPIs in the framework. This category is relatively self-explanatory since costs, as mentioned, will always be critical KPIs to evaluate in transportation systems.

The subsequent categorization, *operational electric*, compiles all measurements performed daily when transport providers are operating. Most of these are not communicated nor measured by transport buyers; however, there is a great interest in having these KPIs transparent. Instead, eco-driving, for example, is an essential operational electric KPI that transport buyers want to use when evaluating providers. This category will be significant from an operational perspective, as customers will determine how well transport providers perform once the system is up and running.

Planning operational is the next category, containing communicable KPIs that transport buyers need to understand when providers plan their transport. With their optimization of electric road freight, transport providers can explain driving range, charging time, and optimized charging times to customers when, for example, an expansion of the network is made or when a new route planning of the already existing system is created. Last is the *environmental impact* category, which is intended to reflect the KPIs previously linked to the sustainability KPIs, as the category includes KPIs such as emissions, fuel consumption, and eco-driving.

Applicable characteristics
As KPIs' characteristics are often interrelated, where one characteristic contains many underlying characteristics, only several will be added in the framework. For example, *traceability* is dependent on the KPI, also being *measurable*, *communicable*, and *based on data*, where traceable will be the only characteristic included. The choice of which characteristics to include is based on what transport buyers mainly highlighted as necessary. In addition, the selected characteristics are considered to be in line with how each KPI can be described, as it is the KPI that determines the characteristic and not the other way around.

After the selected characteristics have been chosen, they can be applied to the KPIs that exist in the framework. As an example, the KPI cost savings/ton CO_2 emission reduction can be described with the following characteristics; *traceable*, *based on real-time data*, *stakeholder- and customer-oriented*, *transparent*, *understandable*, *communicable*, and *sustainability-related.* These are characteristics demanded by interviewees rather than characteristics that the KPI has today. It is desirable to have transparency, but as this characteristic depends on the relationship between provider and buyer and differs between relationships, it cannot be ensured that the KPI is transparent if the relationship somehow counteracts this. Furthermore, understandable and communicable are characteristics that depend on the knowledge level of a transport buyer. An understandable KPI for one transport buyer may be complex and intangible for another. Additionally, the characteristic *related to a standard* can be applied to all KPIs as it is desirable to constantly follow up on KPIs and compare them on a macro level to simplify the evaluation and procurement of transports for transport buyers. However, this is not the case, whereas the designed framework only suggests which KPIs might be possible to apply a standard. Furthermore, other KPIs can also be evaluated against a standard, which is up to each company to use when integrating the framework. See Table 6.21 for all characteristics that will describe the included KPIs in the framework.

Table 6.21: Characteristics chosen to be included in the framework.

Characteristics in the framework
Traceable
Based on real-time data
Related to a standard
Stakeholder-oriented
Customer-oriented
Transparent
Understandable
Communicable
Sustianability related

The conducted framework with chosen KPIs with characteristics, divided into selected categories, will be presented in *Chapter 7 Conclusion.*

6.3 Integration of framework

The following section aims to present and analyze collected data to answer Research Question 3, which can be visualized in Figure 6.5.

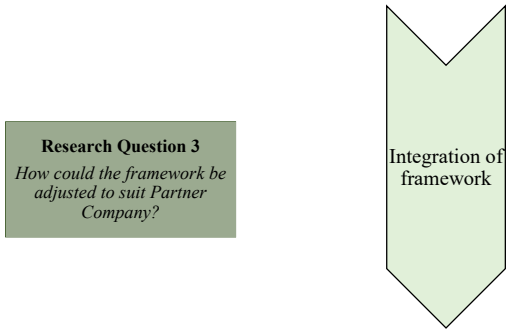

Figure 6.5: Research Question 3 and the corresponding main area.

To ease the structure of the following section, See Figure 6.6. First, collected data from out-handed documents and workshop will be presented, followed by an analysis of Research Question 3, where the adjusted design of the framework will be presented.

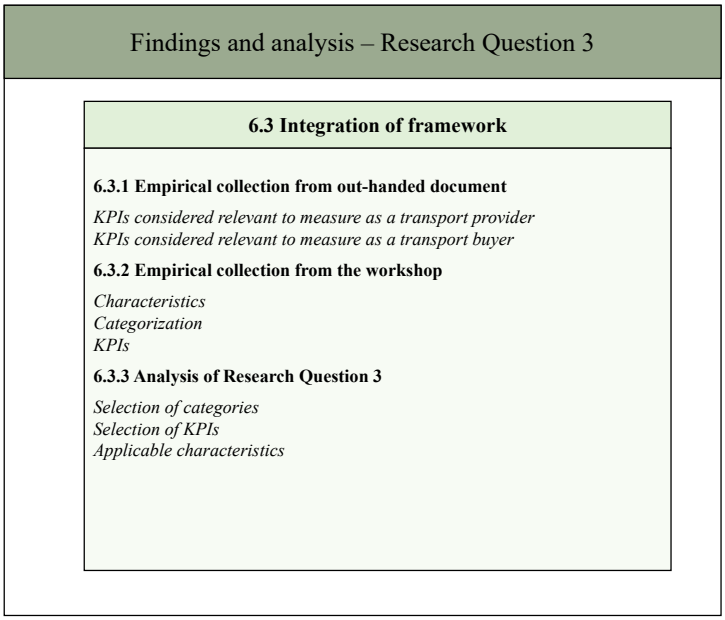

Figure 6.6: Structure of the findings and analysis connected to Research Question 3.

6.3.1 Empirical collection from out-handed document

The majority of the KPIs have been mentioned by several of the participants, where this section will highlight the KPIs being most frequently mentioned and thereby seen as most relevant, or the ones not being mentioned at all and thereby considered as irrelevant.

Although the out-handed document also included characteristics, it is something that will not be presented below as all respondents' answers were in line with what was introduced during the *Chapter 2 Company description*, where it is highlighted which characteristics the Partner Company uses.

KPIs considered relevant to measure as a transport provider
All delivery service elements have a high score from the answers, indicating the importance of maintaining a high delivery service regardless of what kind of fuel is used. The most mentioned KPI by the Partner Company is *delivery reliability*, indicating the importance of always deliver on time to a customer. All cost parameters are also frequently mentioned by the Partner Company. However, there is a clear majority where all participants answering *cost saving/ton CO_2 emission reduced* being of relevance to measure, further a requirement to develop this measurement to be broken down on unit level as well. Another KPI that combines costs and service, is *cost per additional unit or vehicle*, which is argued to put a price on flexibility, thus relevant when having a business model built upon TaaS.

The most highlighted operational KPIs are *system utilization* and *hardware utilization*. These KPIs indicates the importance of having a continuous follow-up on both vehicle fleet, the coverage of operations and wear and tear of the vehicle, as well as how well optimized and utilized the system is. Additionally, *number of transports performed*, *vehicle fill*, *distance travelled*, *deviations from schedule* and *transport capacity*, are all KPIs that describe operational performance and capacity.

The Partner Company further believes the importance for transport providers to follow up *battery utilization* and *battery management*, KPIs highly mentioned in the survey. Strongly related to the battery utilization is the *fuel consumption*, *fuel price*, *charging time*, *energy efficiency* and *energy-mix*. How these parameters are optimized and further carried out in daily operations affect the *CO_2 emissions*, mentioned by all respondents as crucial. The mentioned KPIs related to utilization of both vehicle and system, together with emissions, strongly relate to the *life cycle perspective*. The life cycle KPI is not directly mentioned in the survey as crucial, but the majority highlight that the whole value chain is critical, thereby indicating that the KPI is of importance.

KPIs considered relevant to measure as a transport buyer
The Partner Company consider the delivery service elements being crucial to measure as a transport buyer, where *delivery reliability* is the most significant one. Lead time will however only be measured by transport providers. When looking at costs, Partner Company believes the only relevant KPI for transport buyers to measure is *delivery costs*, and more precisely a *leasing cost* or what the Partner Company calles it, a *service package cost*, i.e., a monthly fee based on customers requirements regrading service and volume.

The Partner Company believes *number of transports performed*, *deviations from schedule* and *distance travelled* is of relevance for transport buyers to follow-up during operation. This vary from what the Partner Company believes is of relevance for a transport provider to measure, where focus has shifted towards solely operational performance. Deviations from schedule could further be seen as directly related to measuring delivery reliability, and thereby being included in the importance of maintain a high service level.

A focus has shifted from the over-all hardware and software utilization, as transport buyers should fore and foremost evaluate operational performance through delivery service. However, as the Partner Company's business model allows transport buyers to custom the TaaS, *fuel consumption* and *fuel price* is considered relevant for transport buyers not including this in the Service Level Agreement. Several further believes transport buyers should follow-up on *charging time*, *charging efficiency* and *battery utilization*, however there is a divided opinion.

Further, transport buyers should evaluate and follow-up how well transport providers are performing on sustainability related KPIs. CO_2 *emissions* is mentioned by the majority, but the Partner Company request an additional, more broad sustainability KPI. However, the Partner Company do not think that transport buyers should measure nor follow up how well the transport providers is performing in eco-driving nor the life cycle perspective.

6.3.2 Empirical collection from the workshop

Characteristics
The Partner Company is collecting a lot of data in their daily operations, a result of being digitalized and further the importance of apply the characteristics *real-time data-driven*, *measurable*, and *time-based* on KPIs. Additionally, it is important to have control over all collected data, enabling *traceability*, and *transparency*. The majority of the participants believe that KPIs also should be *communicable* and *understandable*, enabling an eased dialogue with transport buyers.

Categorization
According to the Partner Company, there is a gap between their business offer, TaaS, and the degree of maturity, and knowledge level of transport buyers. TaaS is included in the Service Level Agreement (SLA), where the Partner Company should deliver agreed units to a certain place at a specific time to a pre-determined cost, to transport buyers. By this, the Partner Company argues the customers do not need to request any further information since the transport buyer really should see the TaaS as a "transport as a service" and thereby be satisfied if the transport keeps what is promised in the SLA. However, the Partner Company experience that transport buyers still measure the majority of the KPIs themselves, whereby they do not rely on the agreed level of TaaS. To succeed in making transport buyers move away from micromanaging the daily operations, the Partner Company argues that they need to build trust with transport buyers. One way of doing this, is by increase the transparency and understanding of how the Partner Company is operating, enabling customers to be fully reliant on TaaS. It is desired to not have any additional requests besides the agreed SLAs, but supplementary KPIs are needed to be communicated towards customers to gain trust.

A categorisation discussed during the workshop was further to categorize KPIs in two categories. The first category contains KPIs used and displayed during the sales process, and could be called *solution KPIs*. The second category contains KPIs that should be measured in daily operations, *operational KPIs*. For example, the battery capacity or amount of vehicles is frequently mentioned by the Partner Company as something important to measure and further something the customers are curios about. However, these KPIs could be communicated during the sales process to build a trust to the system, but thereafter not being of relevance for daily operations. The operational KPIs should, on the other hand, be of interest for the existing customers to follow-up in daily operations. These KPIs should according to the Partner Company be able to be tracked real-time in their software platform, enabling continuously updates of performance, such as *distance traveled electric* and *transport work*.

KPIs
The majority believes that KPIs related to *delivery reliability, quality*, *delivery precision* and *delivery cost, i.e. leasing cost or service package cost* should be measured by transport buyers. Further, *flexibility* is the core of the Partner Company's business since service is built upon being flexible towards customers and meeting their demands. Since the Partner Company believes in being data-driven, they need to implement a KPI measuring flexibility and how it affect the operational business. Further, the Partner Company experience flexibility being one of the main concerns from transport buyers in dialogues during the sales process and when putting up new systems. As mentioned in the out-handed documents, a KPI measuring costs for adding one additional unit or vehicle in the solution, could be a potential KPI. *Transport work*, *life cycle emissions*, CO_2 *emissions*, *battery utilization* and *vehicle fill*, are KPIs mentioned as important for transport buyers to measure, even though they are outside the pre-determined TaaS set-up. The participants in the workshop express a request of a KPI that can indicate how sustainable the Partner Company's TaaS is. Further, such KPI can act as the Partner Company's Unique Selling Point (USP), enabling them to differentiate on the market. However, they need to, in the right way, communicate what the environmental benefits are when transition to their solution. Today, the Partner Company have a vague idea of what should be included in such KPI, but highlight all operational activities having a lower environmental affection compared to other types of vehicles.

6.3.3 Analysis of Research Question 3

Based on the workshop, the empirical collection of out-handed documents and the framework designed during Research Question 2, the framework should be adjusted to the Partner Company's business, i.e. enable to answer Research Question 3, which is as follows:

> *Research Question 3: How could the framework be adjusted to suit Partner Company?*

Selection of categories
New suggestions have emerged during the workshop regarding how the framework can be categorised to fit the Partner Company's TaaS. As the empirical data underlying Research Question 2 did not focus on the Partner Company specifically, although internal interviews were conducted, adjustments of the framework should be made. The workshop highlighted a categorization according to when specific KPI should be communicated to transport buyers, i.e. categorization after different *communication phases*. As the Partner Company finds it challenging to communicate specific KPIs to new customers, and as transport buyers find it complex to understand the concept of electric road freight and TaaS, such categorization can facilitate the communication gap. The categorization enable to structure the building of a relationship, highlighting what KPIs to be communicated during the sales process when the Partner Company could educate transport buyers, what KPIs transport buyers should evaluate when an established cooperation exist, and what KPIs should be agreed within the SLA. This, in turn, can ease the way how TaaS is presented, making transport buyers move away from old habits, measuring all detailed KPIs connected to fossil-driven road freight even though evaluating electric one.

Today, the Partner Company has an unique sales processes for each transport buyer, i.e., customer dialogues and contracting always follow different processes. So far, tailoring the sales process has been a winning concept as strong relationships have been built up, however time consuming. As the Partner Company's customer base grows, there should be a standard of when specific KPIs should be raised to facilitate both efficiency during internal processes and future relationships between the Partner Company and transport buyers.

The categorization based on *stakeholder* will further highlight the responsibility of who measures the KPI and will remain the same as the framework developed during Research Question 2 had, where stakeholder position spans the horizontal column of the framework. *The areas of the transport system* will additionally remain the same within the adjusted frameworks vertical column. All included KPIs within the framework will be needed to be measured by the Partner Company, but the transport buyer category will be broken down into three sub-categories; *solution, operational*, and *SLA* KPIs, indicating what KPIs they should be aware of. Therefore, some KPIs will belong to none, all, or some of these sub-categories.

Solution KPIs should be raised during early dialogue with the transport buyer, partly to educate, which thus minimizes the knowledge gap in the relationship, and partly to raise TaaS, making transport buyers curious. Building trust with the customer early on is necessary to show that the Partner Company can perform, and keep promises. The idea is to, at an early stage, capture all elements of how the Partner Company described its TaaS:

> *A fixed, minimum amount of volume are shipped with electric vehicles on monthly cost with a predetermined frequency on available infrastructure.*

The *operational* category include KPIs that the transport buyer monitors and evaluates through their software platform, as real-time data is essential for operational performance evaluation, according to the majority of the transport buyer interviewees. Further, this means that operational KPIs are only necessary when there is an existing relationship with a customer, and a solution is implemented.

KPIs that should be written in a Service Level Agreement (SLA) are not continuously monitored but rather KPIs that should be evaluated, for example, every quarter. However, this category specifies what the customer pays for; thus, the promise and relationship are built up by KPIs being contracted.

See Table 6.22 for what categories are included within the adjusted framework.

Table 6.22: Categorization within the adjusted framework.

Areas of the transport system	**All KPIs** *Measured by Partner Company*	***Characteristics***	**Solution KPIs** *Communicated by Partner Company to transport buyers during the sales process to build trust for the solution*	**Operational KPIs** *KPIs displayed on software platform, enabling operational follow-up for transport buyers*	**SLA** *KPIs related to agreed KPIs and which transport buyers themselves measures*
Delivery Service Costs Operational electric Planing and optimization Environmental impact					

Selection of KPIs
The designed framework in Research Question 2 is based on KPIs requested by the market, and as the Partner Company has available data to measure all these KPIs, there is no need to adjust the framework to the Partner Company regarding what KPIs to include, wherefore they are recommended to measure all.

Delivery service KPIs are the basis for the Partner Company's TaaS, where *delivery reliability* will be most vital for transport buyers and transport providers. Reliability constitutes *delivery precision and quality*, whereas all three KPIs should be communicated to transport buyers, thus included in the categories of solutions, operational, and SLA, to overcome concerns regarding electric road freight cannot deliver with the same precision as fossil-fueled one. Due to further validation from literature, Oskarsson et al. (2013); Lee et al. (2015) confirm the importance of the delivery service where these parameters should be included in the Partner Company's framework.

Additionally, *flexibility* becomes a critical KPI for the Partner Company as it is said to be the core of their TaaS. Further, this should be communicated during the sales process to demonstrate different flexible solutions when establishing an electric road freight system. In addition, flexibility should be included in the SLA to allow the customer to build trust and thus evaluate whether the Partner Company is fulfilling the agreed flexibility. Flexibility implies an additional cost to add an extra unit or an extra delivery, for example, within a specific predefined time frame. Flexibility is something that traditional road freight is evaluated with, which means that transport buyers know the meaning of such a KPI. For the Partner Company to be unique, they should find a way to expand this concept further and overcome transport buyers' concerns regarding flexibility when going electric. In conclusion, it is therefore considered necessary for the Partner Company to raise flexibility early when explaining TaaS.

Investment and operational costs will be for internal evaluation only, as the Partner Company intends to deliver a complete package of services within a *service package*. The service package is recommended to be communicated early in the sales process, thus a solution KPI, and contracted in the SLA. The cost of the service package, in turn, depends on the type of offer the customer chooses, therefore, depending on the type of flexibility the customer wants to be able to get. One challenge could however be to communicate how the service package will take form, as transport buyers, during the interviews, mentioned it hard to grasp leasing costs, thus change old habits. However, Zero Emission Transportation Association (2022) argues there are several cost-related benefits for the transport buyers when transitioning to TaaS. Fore and foremost, there is a reduced risk for the transport buyers since they do not need to invest in any new electric vehicles nor concern about infrastructure, solely paying for the monthly cost of the service package. Further, Zero Emission Transportation Association (2022); Skeete (2018) highlight other operational benefits indirectly affecting the leasing costs, or the service package cost, such as better optimized routes and thereby being more fuel efficient. Transport buyers would rather pay for what they consider "what is transported," i.e., they want to pay a delivery cost per delivery. For the Partner Company to reach out to these customers, they must explain TaaS and perhaps offer flexibility in their transport package to cooperate with transport buyers who have a different mindset.

The Partner Company should additionally, during the sales process, focus on communicating *how much the customer can save in costs when CO_2 emissions are reduced.* The main incentive for customers to switch to electricity is because of sustainability aspects, and finding an USP that shifts the focus away from customers' concerns that electric transport has expensive investment costs, can increase attractiveness (Zero Emission Transportation Association, 2022). Furthermore, such a KPI should also be traceable in the software platform; this is due to customer demand to, in turn, be able to monitor, evaluate and benchmark their emissions reductions against their own customers.

Further, *the number of transports performed electric* should be enabled to be monitored by the customer in the software platform. In addition, it should be included in the SLA as the Partner Company promises to reach a certain level, something transport buyers wants to follow up on. Moreover, this KPI is easy to grasp, understand and embrace, indicating that the Partner Company is also recommended to communicate this as a solution KPI, at least before electric vehicles are seen as a hygiene factor in society and trust exist.

Fuel price was not included in the previously designed framework but is considered relevant to include in the Partner Company's framework, as the transport buyer can choose to contract, either with or without the inclusion of fuel. The KPI should therefore be contracted within the SLA, and communicated in the sales process. Additionally, the Partner Company can choose to include the energy-mix to further market themselves and set a level on how green and sustainable their solution is.

Transport buyers want to measure *transport work*, something disagreed by the Partner Company. However, analyzing obtained answers from all empirical collection, it can be recommended that the Partner Company should raise transport work as a solution KPI. Transport buyers are namely used with the terminology as it has been a core KPI within fossil-driven road freight, whereby the KPI can be easily adapted and understood. Further, World Business Council for Sustainable Development (2016) mentions that transport work are a KPI that can be used to compare transport powered by different types of fuels. One way could be to modify the KPI to fit the Partner Company's business model, which enable to communicate and market TaaS through a new definition of transport work. In that case, transport buyers can understand the solution during the sales process as they can refer to an already known KPI, which will facilitate further relationships.

Vehicle fill and *empty running vehicles* might only be interesting for some transport buyers to track, as the KPIs underpin how well optimized the Partner Company's transport offers are. Further, it is significant to be transparent with the KPIs as curious transport buyers want to know how environmentally sustainable the actual transport activities are. Customers should however rely on the Partner Company to optimize the transports to minimize the environmental impact while maintaining an efficient flow with no downtime.

The *distance traveled electrically* is a significant KPI transport buyers benchmark towards their customers. Further, transport buyers request to follow up the KPI in real-time during operations. However, the KPI should not be contracted, as the SLA is more about promising specific times, volumes and frequencies, rather than how far vehicles drive. The KPI is neither a solution KPI as the focus, during the sales process, instead is on the ability to run optimized routes electrically.

Transport buyers have described it complex to understand electrical systems, explaining why the Partner Company, during the initial dialogue, is educating and sharing knowledge. Therefore, the solution category consist of educational and technical KPIs which facilitates an initial understanding of how the Partner Company's electric road freight and digitalized system works. Transport buyers have expressed curiosity about batteries, how they work, how often charging of electric vehicles should take place, and how to be sustainable with an electric solution. *Energy efficiency, battery capacity, charging time, charging and grid capacity*, *frequency of fueling*, *battery utilization* and *density of charging* exist as solution KPIs, transport buyers want to understand but not should evaluate further. Educating transport buyers early on will be necessary to overcome barriers to entry to electric road freight. On the other hand, as transport buyers buys a service, they do not have to understand the complexity behind the actual operation performance (Monois and Bergqvist, 2019; Zero Emission Transportation Association, 2022; Tongur and Engwall, 2014). Therefore, it is a constant trade-off between the new servitization of the transport and what transport buyers are used to measure, where the Partner Company should strive to fulfill both demands by transport buyers, but also highlight their USP regarding TaaS.

Understanding how much the electric vehicles are running concerning downtime is linked to *hardware and system utilization*; two KPIs considered essential only for the Partner Company to monitor. However, the *driving range* is an important KPI according to transport buyers, whereby it should be communicated in an early dialogue. The KPI indicates which routes can be electrified, and gives further understanding of how the system is built. In addition, driving range is linked to distance traveled and transport weight, whereas the customer demand to measure driving range in the software platform. This further enables customers to see how efficient the system is.

Additionally, transport buyers are interested in *transport capacity*, as it becomes essential to know, during the sales process, how much coverage of transport buyer's flow that can be electrified. If the solution is good and trust enables a relationship to develop, transport buyers wants to further see how much capacity exist to scale their fleet. Transport capacity is also linked to transparency when it comes to service issues. Therefore, transport capacity builds trust with the customer by showing that backup exists if a vehicle breaks. Further, the transparency enable transport buyers to evaluate the Partner Company's promises regarding delivery service in the SLA.

Energy consumption shows efficiency and sustainability, where low consumption means less impact on the environment. Highlighting how much energy is required for electric road freight, and how this measure compares to the consumption of fossil-fuelled vehicles is essential to highlight during the sales process. Transport buyers highlight a demand to, on an operational level, follow-up this KPI, where the Partner Company can favor if they including energy consumption in the software platform. Further, if energy consumption is visualized in the software platform, transport buyers can learn correlations between consumption being dependent on other parameters such as weather conditions and traffic.

Non of the respondents to the out-handed document mentioned *eco-driving* as important, something that contradicts what previously was highlighted during internal interviews, i.e., the significance to communicate TaaS and its sustainable benefits. The majority of the transport buyers mention eco-driving to be a great KPI when evaluating actual environmental impact during transport activities, and as eco-driving can be an incentive for transport buyers to choose the Partner Company over another electric service provider, it is considered important to communicate it as a solution KPI. In turn, transport buyers have a significant impact as they possess the demand, wherefore the Partner Company also should enable existing customers to track eco-driving during operations, as well as contract a measure of eco-driving within the SLA. Possibly, driver knowledge can lead to an improved KPI of eco-driving, where one way could be to become certified in eco-driving by training drivers and transport buyers. So far, this KPI is not fully defined, whereas it is up to the Partner Company and the customer to agree on what parameters should be included in the SLA.

Emissions during the activity is an essential KPI to communicate to transport buyers during sales, operations, and SLA, as savings in CO_2 emissions often are the most significant incentive to turn electric (Zero Emission Transportation Association, 2022). As transport buyers request to evaluate sustainable performance, it will be essential for them to evaluate whether the promised sustainability parameters within the TaaS solution is fulfilled. *Emissions during the life cycle* is so far a KPI that is not defined. Moreover, it is not easy to calculate the KPI as it requires the Partner Company to further collaborate with other stakeholders throughout the supply chain. However, it is essential to highlight this KPI during the sales process. As mentioned, transport buyers are curious about TaaS, where *battery lifetime*, the *after-market situation* of the electric vehicle, and how the energy that fuels the vehicle is produced, i.e., the *energy-mix* are examples to highlight to fulfill transport buyers' demand. Additionally, Transportföretagen and HUI Research (2020) mention that KPIs that take into account the whole supply chain is of importance when formulating new KPIs connected to electric road freight.

For the convenience of the reader, the three sub-categories within the transport buyers perspective, with included KPIs are displayed in Figure 6.7.

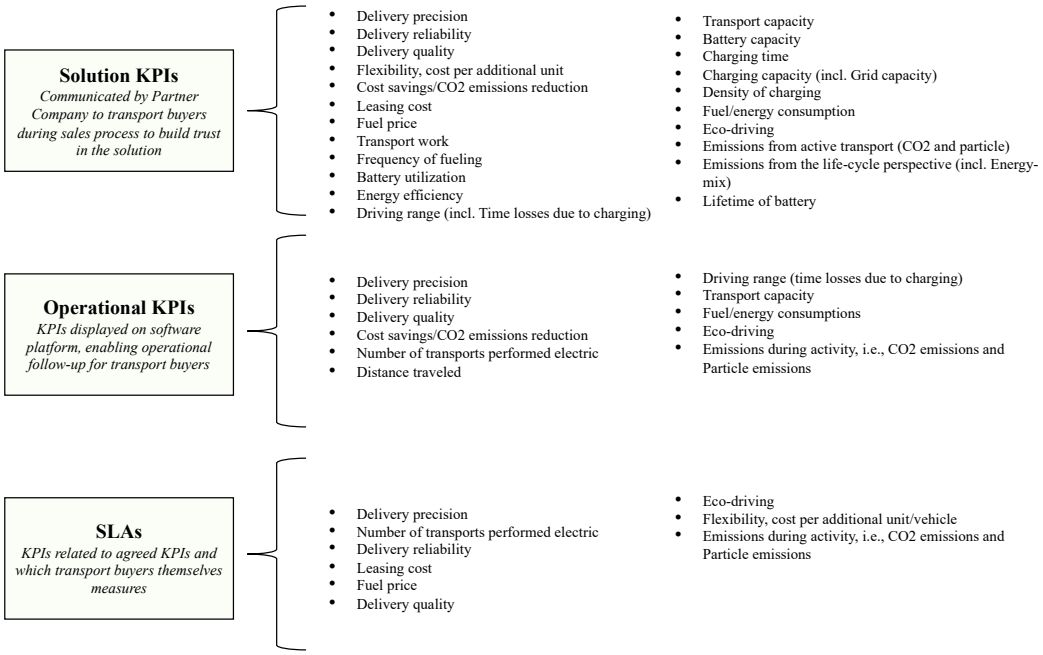

Figure 6.7: Categorization and included KPIs communicated to transport buyers.

Applicable characteristics

As mentioned during the selection of characteristics, when designing the framework within Research Question 2, KPIs and how they are used determine the characteristics they have. Furthermore, most characteristics are closely linked to each other, meaning that if all KPIs in a framework are described with all applicable characteristics, the framework becomes challenging to read, and too detailed. Included KPIs in the Partner Company's framework are almost identical as the one included within the already designed framework, meaning that the same characteristics can be applied. However, a brief analysis should be made regarding what desired characteristics the Partner Company have, in order to suit their TaaS.

Real-time data-driven on the software platform, *measurable*, *time-based*, *traceable*, and *transparent* were characteristics that the Partner Company highlighted as necessary during the workshop. Only the characteristics measurable and time-based were not included in the previous designed framework, as measurable has been considered indirectly applied to a KPI if, for example, traceability is present. The same argument can be applied on the characteristic time-based, which is implicit when a KPI is measurable. Furthermore, the importance of KPIs being *communicable* and *understandable* was also highlighted during the workshop, confirmed by previous internal interviews.

Related to a standard is a demanded characteristic, partly from the workshop, partly from internal interviews. However, this characteristic are not used for KPIs within Partner Company today, but has been chosen to be included within the framework. Therefore, Partner Company is recommended to establish internal standards on several chosen KPIs. Furthermore, internal standards can develop, becoming industry standards, which in turn can enable easier benchmark in the future.

In *Chapter 2 Company description* and during internal interviews, *customer-oriented*, *aggregated*, *relevant*, *useful*, and *cost-based*, are characteristics highlighted. So far, the characteristic customer-oriented have been the only one included in the designed framework. Relevant and useful are two essential characteristics when developing KPIs, but are considered to underpin the concept of KPIs and the general meaning of measurements and evaluations, whereas they will not be highlighted in the Partner Company's framework. Furthermore, customer-oriented is an essential characteristic that the market also highlights, probably due to the joint market effort trend linked to the development of electric road freight. Cost-based is only highlighted by one internal interviewee and is considered not so relevant from the market's point of view. Therefore this will be excluded from the framework. Aggregated is, however, a characteristic that is considered to be worth including in the framework. If KPIs are scalable, it will ease development as the Partner Company's system expands. If KPIs can be applicable to all possible demands, customization will be favoured where the Partner Company can suit KPIs after specific needs. Further, if KPIs in the framework can be aggregated, it will ease the adaptability of the framework as the Partner Company's system or business model scales or changes.

The Partner Company do not highlight the importance of KPIs being *sustainability-related*, something that can be debatable. To not highlight this as essential, can partly be because they already expect their TaaS to be sustainable, whereas respondents to the out-handed document and participants in the workshop forgot to highlight this perspective. Partly it may be because people at the Partner Company do not see the importance of transport buyers demanding KPIs that can be evaluated in a way that visualizes performance regarding environmental impact. The fact that there is a great demand from the market to evaluate KPIs on a sustainable level makes the Partner Company be recommended to further use this characteristic, further explaining why it is included in the framework.

Table 6.23 conclude the analysis and highlight which characteristics are considered to be of most relevance to include in the Partner Company's framework.

Table 6.23: Characteristics included in the Partner Company's framework of KPIs.

Categorization in the framework
Traceable
Real-time data in software platform
Related to a standard
Aggregated
Customer-oriented
Transparent
Understandable
Communicable
Sustainability related

The adjusted framework with chosen KPIs, characteristics, and categories, will be presented in *Chapter 7 Conclusion*.

Chapter 7

Conclusion

This chapter describes the study's conclusion and thereby fulfills the study's purpose, i.e., to design a framework of KPIs linked to electric road freight, and further adjust the framework to the Partner Company. Answering the purpose of the study can be done by answering the three Research Questions and the connected Sub-questions. Further, this is done by first describing which KPIs exist in traditional road freight, which characteristics these usually have, and how such KPIs are typically categorized in a framework. After that, it is clarified which KPIs are included in the developed framework, what characteristics they have, and how they are categorized to fit electric road freight. Lastly, the chapter presents the adjusted framework to the Partner Company.

7.1 Conclusions

This chapter presents the conclusions of the study based on the analyses connected to the study's Research Questions. For the convenience of the reader, the purpose of the study is:

> *The purpose of this study is to design a framework of KPIs to measure and evaluate electric road freight and further adjust the framework to Partner Company.*

One framework for measuring and evaluating electric road freight has been developed. The framework has been developed by primarily looking at the market perspective, where subsequently KPIs, characteristics of KPIs, and categories are captured to create a framework that is in line with transport buyers' demand and maturity level in terms of understanding KPIs related to electric road freight. Other external interviews with transport providers, associated organizations, and OEMs have further contributed to the market's point of view.

Based on Kaparias and Bell (2011); Harvey et al. (2016); McKinnon (2009); Gonçalves et al. (2015); Bouchery et al. (2010); Haponava and Al-Jibouri (2016) various studies, this study chose to create a process to fit the design of the framework with KPIs related to electric road freight. Additionally, internal interviews and an internal workshop were held to adjust the framework to the Partner Company. These steps show that the framework can be tailored smoothly and efficiently to the Partner Company and fit companies with other business models to spread the understanding of electric road freight through a simple and understandable framework. Furthermore, literature about transport and the development of electric road freight has also been used to understand which KPIs have been used in traditional road freight and what needs to be adjusted to fit electric ones. Literature on commonly used KPIs, the characteristics of KPIs, and the categorization of KPIs in frameworks have also been studied, and different authors' processes for developing frameworks of KPIs. The detailed development process has made the framework robust, and the dynamic categorization enables the framework to be updated as new KPIs emerge, which is almost a requirement in such a technology-intensive sector, as the electrification of transportation.

The following parts of the conclusion are subsequently divided according to the process developed and thus follow the structure of answering each Research Question separately.

7.1.1 Framework of KPIs within traditional road freight

The purpose of answering the first Research Question was to understand how traditional, fossil-driven road freight is measured. Further, to find out what KPIs, characteristics, and categories traditionally are used within such frameworks.

The awareness that traditional road freight is environmentally damaging exists, something transport buyers are starting to embrace as they request more sustainable solutions than what previously have been demanded. However, the most commonly used KPIs within traditional road freight are KPIs connected to delivery service and costs. Additionally, several detailed operational KPIs are needed to monitor daily operations but vary depending on stakeholder position. However, what can be concluded is that both transport buyers and providers should evaluate CO_2 emissions to force the industry to move toward zero-emission road freight. Nevertheless, due to the lack of standards, almost all businesses have their way of sustainability measurements, making it challenging for transport buyers to evaluate how sustainable the transport provider's solutions are.

Transport buyers are those considering characteristics to be of most importance. Further, transport buyers want KPIs to be transparent, enabling them to track measurements and follow-up, preferably with data, to make demands on transport providers if, for example, delivery service is not met. However, a conclusion is that the characteristics of KPIs are relatively unmentioned, which might explain why no standard exists on what requirements KPIs should have, making it hard for transport buyers to set strict requirements for the purchase of fossil-fuelled road freight. Additionally, many characteristics are interdependent, which can create confusion in relationships if there is no common understanding of KPIs and where the responsibility in measurement and monitoring lies. This further means that communicable and market-related characteristics of KPIs become more critical than internal characteristics of KPIs.

Categorizing KPIs linked to traditional road freight is hard to capture due to a lack of information sharing during interviews. However, it is concluded that despite all stakeholders dividing their KPIs in a tailored, business-specific way, the categorization of internal and external and business units is confirmed by interviews and literature to be common. Transport buyers highlight that it is easy to understand KPIs if categorized according to external or internal use, enabling them to capture the right KPIs that are of interest to follow up before, during, and after the transport operation.

7.1.2 The designed framework for electric road freight

The second Research Question aimed to design a framework of KPIs that fit electric road freight, highlighting what KPIs to include, what categorizations could be used, and what characteristics included KPIs could have.

The analysis concludes that characteristics of electric road freight remain the same as traditional road freight in many ways since the transport itself is supposed to be performed equally. However, some differences can be seen, fore and foremost, the shift towards a more digitalized transport, requiring more transport data to be communicated between stakeholders and customers, but also data to be displayed in real-time. This requires characteristics such as based on real-time data, communicable, transparency, stakeholder-orientated and customer-orientated being of greater focus. Further, the shift towards becoming more aware of the transport's environmental impact implies characteristics such as traceability and sustainability-related also playing a vital role.

It can be concluded that transport providers still are considered to measure most KPIs used within traditional road freight, even when the road freight sector electrifies. However, new KPIs have emerged related to charging, batteries, software system, and the environment. Most of these KPIs are necessary to display to transport buyers for transparency and understanding. However, many of the KPIs are related to planning or qualities not based on activity performance and therefore considered too detailed or technical to be communicated externally to transport buyers. KPIs relevant for transport buyers are instead KPIs based on operational performance; thus, more aggregated KPIs that are easy to understand and composed of several technical parameters measured by transport providers.

One conclusion is that transport buyers are curious to understand how operational performance will be affected by being electrified. However, once there is an understanding of the more complex and technical measurements, transport buyers do not require to follow up on the performance of each detailed parameter within the system. Therefore, it will be necessary for transport providers to easily communicate KPIs similar to those previously used in traditional road freight to create a shared understanding of what electric transport involves. A critical parameter for transport buyers is eco-driving, which indicates a shifted focus to reach an increasingly efficient, optimized solution, showing an awareness of becoming more environmentally sustainable.

The framework will have one main categorization on the horizontal column, divided after internal and external stakeholders, in this case, transport providers and transport buyers. On the vertical column, the framework will have a categorization after areas of the transport system, where the areas were identified after selecting KPIs. Since most of the empirical collection request KPIs, categorization, and characteristics related to sustainability or environmental impact, one underlying categorization to the vertical column, areas of the transport system, is sustainability. The designed framework is visualized in Table 7.1.

Table 7.1: The framework conducted.

Categorization	**Transport provider (internal)**		**Transport buyer (external)**	
Areas of the transport system	**KPI**	***Characterisics***	**KPI**	***Characteristics***
Delivery Service	Delivery precision	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*	Delivery precision	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*
	Delivery reliability	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*	Delivery reliability	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*
	Lead time (packing and lashing, deviations from schedule)	*Based on real-time data, traceable, understandable*		
	Delivery quality	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*	Delivery quality	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*
	Flexibility	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*	Flexibility	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*
Costs	Investment costs, (pay-off further related to life time)	*Understandable, stakeholder-oriented*	- Delivery cost - Cost savings / ton CO2 emission reduction	*Understandable, customer-oriented, based on real-time, transparent*
	Operational costs	*Based on real-time data, customer-oriented, transparent,*		
Operational electric	Number of transports performed	*Traceable, based on real-time data, customer-oriented, transparent, understandable*	Number of transports performed	*Traceable, based on real-time data, customer-oriented, transparent, understandable*
	Distance traveled	*Traceable, based on real-time data, customer-oriented, transparent, understandable*	Distance traveled	*Traceable, based on real-time data, customer-oriented, transparent, understandable*
	Transport weight	*Traceable, based on real-time data, customer-oriented, transparent, understandable*	Transport work	*Traceable, based on real-time data, customer-oriented, transparent, understandable*
	Transport work	*Traceable, based on real-time data, customer-oriented, transparent, understandable*		
	Vehicle fill	*Traceable, based on real-time data, sustainability related*	Eco-driving	*Traceable, based on real-time data, susatinability related, customer-oriented, understandable, related to a standard*
	Empty running vehicles	*Traceable, based on real-time data, sustainability related*		
	Frequency of fueling	*Based on data, customer-oriented, understnadable*		
	Battery utilization	*Based on rela-time data, related to a standard, transparent, sustainability realted*		
Planing & Optimization	Energy efficiency	*Based on rela-time data, related to a standard, transparent, sustainability realted*	Driving range	*Based on real-time data, transparent, sustainability related, stakeholder-oriented,*
	Driving range (timelosses due to charging)	*Based on rela-time data, related to a standard, transparent, sustainability realted*		
	Transport capacity	*Based on rela-time data, related to a standard, stakeholder-oriented*		
	Battery capacity	*Related to a standard*		
	Density of charging	*Based on real-time data, related to a standard, stakeholder-oriented*		
	Hardware utilization (ev. Operational electric)	*Based on rela-time data, related to a standard*		
	Charging time	*Based on data*	Charging time Loss of operational time	*Based on real-time data, related to a standard*
	Charging capacity, + grid capacity	*Based on real-time data, related to a standard*		
Environmental impact	Eco-driving + Driver knowledge	*Related to a standard, customer-oriented, sustainability related*	Eco-driving	*Traceable, based on real-time data, susatinability related, customer-oriented, understandable, related to a standard*
	Life time of battery	*Related to a standard, sustainability related*		
	Fuel consumption	*Based on real-time data, communicable, related to a standard*	Emission from activity Emissions saved	*Based on real-time data, communicable, related to a standard, sustaonability related, transparent, traceable*
	Emissions during activity i.e. CO2 emissions and Particle emissions	*Based on real-time data, related to a standard, sustainability related, transparent, traceable*		
	Emission from Life cycle perspective, incluing energy-mix	*Based on real-time data, related to a standard, sustainability related, transparent, traceable*		

7.1.3 The adjusted framework to the Partner Company

The framework conducted during Research Question 2, has further been adjusted to fit the Partner Company's business model, aiming to answer the last Research Question. However, almost all KPIs and characterises are still relevant to include within the Partner Company's framework. In contrast, the main difference is how the KPIs have been categorized in a suitable way to ease communication between the Partner Company and transport buyers.

Due to transport buyers' old habits of purchasing transport based on the number of deliveries, there might be a challenge to explain and thus change transport buyers' attitudes and behaviors by signing up for a monthly leasing cost or costs for offered service packages. Electrification is, except for being highly expensive, technical, and new on the market, also more complex than the traditional one, meaning that the adjusted framework can help the Partner Company communicate and explain its offer on the market. Further, the framework aims to build trust with new transport buyers, and increase the understanding of how electric road freight operates, thus facilitating a more accessible communication for the Partner Company to take market shares by scaling their network. For this reason, the adjusted framework is categorized by both areas within the transport system, like the previously conducted framework, and on communication phases.

Additionally, the Partner Company needs to be transparent towards transport buyers, explaining details of how TaaS in electric road freight works. By being more detailed towards transport buyers, an understanding and trust are built up, and with trust for the system, transport buyers become mature enough to join the solution.

When a discussion with transport buyers is held, the focus should be on communicating KPIs connected to the high service level maintained, the possibility of flexibility, and the many environmental benefits of electric road freight. Consequently, the Partner Company can better communicate its solution in a trustful and sustainable way. Further, the adjusted framework will enable new processes and ease communication with transport buyers, highlighting the USP of the Partner Company's system. The adjusted framework is visualized in Table 7.2.

Table 7.2: The framework adjusted to the Partner Company.

	All KPIs *Measured by Partner Company*	***Characteristics***	**Solution KPIs** *Communicated by Partner Company to transport buyers during sales process to build trust for the solution*	**Operational KPIs** *KPIs displayed on software platform, enabling operational follow-up for transport buyers*	**SLA** *KPIs related to agreed KPIs and which transport buyers themselves measures*
Delivery service	Lead time (packing och lashnig, devitions from schedule)	*Based on real-time data, traceable, understandable*			
	Delivery precision	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*	x	x	x
	Delivery reliability	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*	x	x	x
	Delivery quality	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*	x	x	x
	Flexibility, cost per additional unit/ vehicle	*Based on real-time data, traceable, understandable, customer-oriented, transparent, communicable*	x		x
Costs	Investment costs, (pay-off further related to life time)	*Understandable*			
	Cost savings / CO2 emission reduction	*Understandable, customer-oriented, based on real-time, transparent, aggregated*	x	x	
	Operational costs	*Based on real-time data, customer-oriented, transparent,*			
	Leasing cost	*Understandable, customer-oriented, based on real-time, transparent, aggregated*	x		x
Operational electric	Number of transports performed electric	*Traceable, based on real-time data, customer-oriented, transparent, understandable, aggregated*		x	x
	Fuel / energy price	*Based on real-time data, communicable, related to a standard*	x		x
	Transport weight	*Traceable, based on real-time data, customer-oriented, transparent, understandable*			
	Transport work	*Traceable, based on real-time data, customer-oriented, transparent, understandable*	x		
	Vehicle fill	*Traceable, based on real-time data, sustainability related, aggregated*			
	Empty running vehicles	*Traceable, based on real-time data, sustainability related*			
	Distance traveled	*Traceable, based on real-time data, customer-oriented, transparent, understandable, aggregated*		x	
	Frequency of fueling	*Based on data, customer-oriented, understnadable*	x		
	Battery utilization	*Based on rela-time data, related to a standard, transparent, sustainability realted*	x		
Planing and optimization	Energy efficiency	*Based on rela-time data, related to a standard, transparent, sustainability realted*	x		
	Driving range (timelosses due to charging)	*Based on rela-time data, related to a standard, transparent, sustainability realted*	x	x	
	Transport capacity	*Based on rela-time data, related to a standard*	x	x	
	Battery capacity	*Related to a standard*	x		
	Hardware utilization	*Based on rela-time data, related to a standard*			
	System utilization	*Based on rela-time data, related to a standard*			
	Charging time	*Based on data*	x		
	Charging capacity, + grid capacity	*Based on real-time data, related to a standard*	x		
	Density of charging	*Based on real-time data, related to a standard*	x		
Environmental impact	Fuel/ energy consumption	*Based on real-time data, communicable, related to a standard*	x	x	
	Eco-driving (+ driver knowledge)	*Related to a standard, customer-oriented, sustainability related*	x	x	x
	Emissions during activity i. e. CO2 emissions and Particle emissions	*Based on real-time data, related to a standard, sustainability related, transparent, traceable, aggregated*	x	x	x
	Life time of battery	*Related to a standard, sustainability related*	x		
	Emission from Life cycle perspective, incluing energy-mix	*Based on real-time data, related to a standard, sustainability related, transparent, traceable*	x		

Chapter 8

Discussion

This chapter discusses the results from the study by presenting general discussions on the methodology, where the empirical collection, subjectivity aspects, and other aspects related to methodological choices are highlighted. The chapter concludes by discussing the work in a broader context, thus future studies.

8.1 Discussion of the results

Analyzing the KPIs included in the designed framework for electric road freight, most KPIs can also be applied to traditional road freight. Further, this may increase the framework's applicability to companies as they, even during pilots when only adding a few electric vehicles to their fleet, can use the framework. Besides, this was not anticipated beforehand but indicates that the transport sector is progressing slowly, meaning the industry is still developing and gaining knowledge in how to evaluate electric road freight specifically.

Furthermore, the KPIs included in the framework are built up by other KPIs, which have not been included even though they could be validated by literature and empirical data. The fact that the study resulted in KPIs being so tightly connected and that companies used different descriptions of the same KPIs was the basis for the selection. However, not including all KPIs made the framework easier to grasp and further tailor it to the Partner Company. A too detailed framework could have been challenging to integrate within a business; therefore, the result could be seen as reasonable as a first design of how a framework of KPIs linked to electric road freight could be designed. To further create robustness within the framework, validation and adjustments are needed after the framework has been adequately tested in several operations. Once then, it can be further detailed or aggregated up to best evaluate what transport buyers value.

Additionally, the results were more comprehensive than the study had initially anticipated. KPIs that require external data, i.e., data that transport providers do not measure themselves but must collect from other stakeholders, were needed to be communicated by transport buyers. For example, KPIs related to emissions during the life cycle require transport providers to collect data from other stakeholders before sharing a broad KPI with transport buyers. Further, the study found KPIs that not previously have been clearly defined, which the study had not initially expected to capture. For example, the KPI connected to eco-driving is a broad KPI that the industry has not yet clearly defined.

Initially, the aim was to only focus on KPIs based on data collected by the transport providers themselves and put a great emphasis on operational KPIs. However, as the purpose of the study has been exploratory, and as the process developed in the frame of reference highlighted the importance of finding demanded KPIs, the perspective on what KPIs to include in the framework could develop as market demand required a broader framework with not only operational KPIs. Further, this was discussed with the Partner Company, resulting in a framework of KPIs of a more comprehensive nature. Mainly, transport buyers highlighted the importance of understanding the entirety of electric road freight and not minor details of specific parts of the transport activity. The fact that transport buyers wanted to capture a system perspective thus made it reasonable that the study's results were broader than initially intended. Since the results did not focus exclusively on only KPIs measured during operations, the framework became more comprehensive than expected, spanning different areas of the transport system, thus showing a clear picture of what transport buyers value.

As for the KPIs, many of the found characteristics are interlinked. Furthermore, they have roughly the same meaning and thus build on each other, whereas the authors of this study only chose to include several characteristics within the framework. The fact that the characteristics are market-oriented with a strong focus on that transport buyers quickly can access data is not surprising. Further, this is probably a consequence of electrification's requirement for a joint power gathering where stakeholders have to cooperate and thus have closer relationships than previously needed in the transport sector.

The framework resulted in a cross-functional breakdown of KPIs in terms of categorizations. The stakeholder perspective means that it is easier to create a similar framework, also focusing on other stakeholders. Furthermore, categorizing the transport system areas suggested a more dynamic approach that can allow companies to tailor the framework to their needs. The result would have been different if a different categorization had been made. However, it can be discussed how the chosen areas of the transport system were named. For some stakeholders, these areas may be irrelevant, making integration difficult. A more attractive and renderable framework might have been created if these categories' names had been adjusted or left blank. However, this is a simple adjustment, whereby the categorization is considered reasonable.

Within the Partner Company's framework, several KPIs from the more general designed electric framework are excluded. However, the Partner Company are recomended to measure most KPIs mentioned in the designed electric framework since the KPIs constitute the base of what KPIs are communicated to transport buyers. Hence, compared to the framework for electric road freight, the Partner Company's framework focuses more on KPIs related to TaaS, such as service package costs, resulting from internal preferences rather than external demands. Before creating the Partner Company's framework, the hypothesis was that it would be more in line with the previously designed framework during Research Question 2. Instead, the framework resulted in categories primarily based on communication and a few KPIs that transport buyers should follow up. On the contrary, this might show the Partner Company's Unique Selling Point (USP) more precisely, where they genuinely believe in their business model.

One discussion that remains is the generalizability of the results. Although many external and internal interviews were conducted, the empirical collection studied only a few companies. The result would probably have differed if other companies and other roles had been interviewed. In the case of transport buyers and transport providers, there were generally more similarities in the responses than differences. It was undoubtedly clear that transport providers were more aware of KPIs, especially when it comes to KPIs measuring electric road freight. On the other hand, transport buyers were curious about the subject but did not possess as much knowledge regarding how electric road freight works and, thus, how companies should measure it. Therefore, it is reasonable that the electric framework includes many KPIs that constitute a solid description to increase understanding. However, the fact that similar answers were collected from these two stakeholders suggests that the results would have been similar regardless of which companies were interviewed. Whether the results would have been identical if the study had been conducted abroad is difficult to predict. However, as Sweden is far ahead in technology development and therefore at the forefront of electrification of road freight, the study would probably find different results.

As the first designed framework was developed, without involvement from the Partner Company, it enabled an increased degree of generalisability. However, for the framework to be further applied in practice, it needs to be adapted and tailored to specific businesses. Therefore, the framework requires businesses to collect the framework's data and to measure the KPIs contained in the framework. Moreover, it can be commented that the framework may not be as generalizable enough to be implemented by all types of companies working with electric road freight, which partly may be due to a lack of literature collection, making the framework not comprehensive enough. Partly, KPIs included are not in line with existing measurements and standards within the company's operational activities.

8.2 Reflection of the methodological approach

Regarding the study's methodological choices, a discussion can be held regarding whether the choices were good and what outcome there would have been if other methodological choices had been made.

8.2.1 Interviews

Firstly, it can be discussed how the empirical collection was conducted. Since the study was qualitative, the interviews constitute a significant part of the information gathered for the analysis and the conclusions. Semi-structured interviews were based on predetermined topics of discussion, which required adequately designed questions. Appropriate questions should reflect what was demanded to be found not to miss important information. The questions were further developed before the interviews, implying a challenge in capturing all intended to be captured. Additionally, questions were also discussed with the supervisor at the Partner Company to ensure relevance and the proper structure.

Criticism of the interviews can be the approach whereby no targeted "yes and no follow-up questions" were asked if the interviewee did not cover all parts of what was demanded. Further, this means that if the interviewee did not mention, for example, a particular KPI, the authors of this study did not ask further questions. Therefore, the semi-structured interviews may have resulted in some interviewees not highlighting KPIs that they might be measuring. Additionally, this means that such KPIs were subsequently missed during the empirical collection and could result in an information gap. However, a choice was made not to ask such follow-up questions or send out a list with predetermined KPIs before or afterward each interview session. If the study had used complementary methods, it could have captured additional information, and the study might have had a broader spectrum of KPIs. However, the study decided not to since the purpose of the interviews was to capture what stakeholders considered most important. Excluding such methods enabled interviewees to only focus on and highlight the most important KPIs used or demanded in their business. Many KPIs are relatively self-explanatory and build on each other, explaining why emphasis was placed on that the interviewees themselves should highlight the most vital KPIs used for evaluation and benchmarking electric road freight.

8.2.2 Subjectivity aspects

A subjectivity aspect is whether the interview responses were interpreted and analyzed to reflect reality as closely as possible. Subjectivity can be seen as an indirect consequence built into the interpretations when creating the framework. The authors of this study may have had an idea before the interviews regarding the answers collected. Further, this may have influenced the results. Additionally, the choice of stakeholders interviewed and interviewees can also be discussed. When interviewees were selected, it was done in consultation with the Partner Company, which influenced who was interviewed. There may be an existing relationship between the supervisor at the Partner Company, and the interviewees who were contacted, which may have resulted in the selected interviewees having a history of possessing the same skills or sharing similar perspectives on the issue in question. Additionally, this may have caused similar responses, whereas the reality could not be described in an entirely accurate and differentiated manner as initially sought.

Further discussed is that internal interviews were included when developing the framework. There were several advantages to having the Partner Company's interview responses in creating the framework; for example, interviewees possess a high level of knowledge and work closely with electric road freight, and have been in the traditional road freight industry for a long time. However, the study's results have been affected by the subjectivity of internal interviewees, but as the empirical collection has been triangulated, it is considered acceptable. Additionally, the internal workshop confirmed the KPIs in the adjusted framework at the Partner Company, which strengthened the robustness of the KPIs included, which also supported the first developed framework.

8.2.3 Process for conducting the framework

The starting point of the developed process can further be discussed as to whether it is comprehensive enough and adapted right for the study's purpose. However, as many studies have been reviewed, spanning several sectors and relatively recently published, it is considered reliable enough to provide the right conditions for creating the framework. However, technology development related to electric road freight is high-speed, whereas the framework may no longer be as relevant in a few years. Further, this may depend on how transport buyers value different evaluation principles and thus have other preferences on what should be communicated and benchmarked when making transport procurement decisions. Additionally, this is also evident in some of the KPIs contained in the framework; some KPIs are still not fully developed. However, this can be seen as positive as the framework will become even more comprehensive and transparent once such definitions occur.

Further, the study can make further comments regarding selecting the KPIs, the accompanying characteristics, and the categories in the framework. The selection was primarily based on the interview responses received, not necessarily the number of interviewees confirming, for example, the KPI, but rather the relevance of the KPI to the interviewee's knowledge and the significance of the KPI to the technology development and maturity of the market. It is therefore concluded that the selection was made on four grounds. Firstly the study evaluated the relevance of the KPI in terms of the frequency of responses where transport buyers' answers were most significant. Further, the interviewee's expertise was considered, followed by literature confirmation. Lastly, the selection was based upon the maturity of the KPI in terms of transport buyers' awareness of how electric road freight can be evaluated with that KPI, i.e., how understandable the KPI is assessed to be. Although the selection was based on interview responses received from internal and external interviewees, the study cannot guarantee that the same framework would have been created if other people had conducted the same research. The selection would have been more objective if all KPIs found had been included in the framework and not just a selection of them.

8.2.4 Adjustments to fit the Partner Company

As the framework was tailored to the Partner Company's internal business, it can be discussed how valid and applicable the framework will be in the future, something considered uncertain. Due to that the Partner Company's business environment are dynamic, several changed might be needed during the upcoming years. On the other hand, the framework has been created to adapt to updates. Another way to conduct the study, to make it even more tailored to the Partner Company and thus enable it to be more robust for future changes, could have been to use the Partner Company's business model as a starting point and, after that, create a more market-based framework. However, subjectivity would have been more difficult to avoid if this method had been chosen. Starting from the market perspective, creating a more general framework first and then adapting it to the Partner Company is considered successful as the adjusted framework contains KPIs validated by external interviews and literature, which would have been ignored if the Partner Company had been the starting point.

A further point of discussion is that the workshop, together with the Partner Company, did not have time to highlight the characteristics linked to the KPIs in the framework that much. However, what could have improved the results would have been to discuss which characteristics each KPI should have as a description during the workshop. Further, this would have facilitated a discussion during the workshop and possibly increased the understanding of the meaning of each KPI, something that could be added as further work. However, one conclusion that can be drawn is that the characteristics do not determine the KPIs but rather that the KPIs determine the characteristics.

8.3 Future work

The study conducted and described in this report focuses primarily on the market perspective and the Partner Company. As the Partner Company wanted to create a framework that they could use mainly in the sales process, starting from the transport buyer's perspective, more interviews should lift the framework further and capture an even broader market perspective. Several aspects can be explored in more detail to further develop and build on this study.

Furthermore, this study only deals with developing a framework with KPIs that can potentially be used to measure and evaluate electric road freight. Thus, the study does not describe the practical implementation of the integration, neither by the Partner Company nor by other stakeholders. Therefore, the next step could be to implement the integration and ensure it is carried out well. Further action could be to review how well the framework is adapted to what is intended to be measured. Thus, the framework could be evaluated and validated, as it had opened up possibilities for iterations and updates of included KPIs, categories, or characteristics. It could be that several of the KPIs in practice are not considered relevant to monitor or that some are more difficult to monitor and evaluate than assumed in this study. Further, this may be because some KPIs require external data or are not defined but rely on soft values to be translated into measurable values.

Of course, all literature could not be searched due to the large volume of literature on the subject, which means that not all possible KPIs have been found. Additionally, several KPIs found by empirical evidence could not be validated in the study by literature. Future work could therefore be to deep dive into additional literature to identify possible KPIs that could be relevant to measure. Further, this will be an appropriate area to investigate as electric road freight evolves, meaning that many new studies are continuously published. In addition to more stakeholder interviews, more interviews with similar businesses like the Partner Company may need to be analyzed. However, this may require a broader market perspective than focusing only on the Swedish market but could result in more possible and appropriate KPIs and framework designs.

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Appendix A

Interview Questions - Unstructured internal at the Partner Company

This interview guide has been used as a starting point when conducting internal, unstructured interviews at the Partner Company.

1. What is the process with the customer today?
2. Describe how yu are working with partnerships with stakeholders in the market
3. How does the Partner Company work with KPIs today?
4. What do you see as opportunities and barriers to the electrification?

Appendix B

Interview Questions - Semi-structured internal at the Partner Company

This interview guide has been used as a starting point when conducting internal, semi-structured interviews at the Partner Company. The interviews have had the aim to capture the Partner Company's perspective on traditional road freight and electric road freight KPIs.

1. Describe the Partner Company's offering
2. Describe the process from the moment you contact the customer until the customer is on your journey and signs a contract
    - Which Teams are involved in which activities?
    - Is there a standard process for how you collaborate and partner with customers?
    - Is it most common for you to contact transport buyers, or do they contact you often?
3. How do you price your offer?
    - Do you differ from other similar companies like the Partner Company to demonstrate positive aspects of electric transport when it comes to benchmarking?
4. What do you measure today?
    - How is data collected, and what data do you collect?
    - How and what data is presented on the software platform?
5. When, in the process are KPIs communicated?
    - How do you work with these KPIs?
    - What KPIs do you have?
    - How are these KPIs broken down, i.e., categorized?
6. How do you work with SLA, and/or how do you communicate performance with the customer?
    - Are SLAs linked to KPIs today?

- Do you tailor KPIs to each specific customer today, or are there generic ones?

7. Why do customers usually choose the Partner Company?
    - Are there differences in what customers demanding, requesting?
8. What do you think customers will demand in the future?
    - What KPIs do you think will be necessary to communicate?
9. What do you at the Partner Company want the customer to demand/see the Partner Company as?
10. What do you feel is the maturity of electric road freight in the market?
    - What are KPIs used to measure electric road freight in the market?

Appendix C

Interview Questions - Semi-structured external with stakeholders

The following interview guides have been used as a starting point when conducting external, semi-structured interviews with original equipment manufacturers (OEMs), transport providers (TP). transport buyers (TB), and associated organizations (AO).

Transport providers and OEMs

1. Tell us about your role in the company!
2. What is company XXX situation regarding electrification?
    - How does XXX work it today?
    - What is XXX goal?
    - When comparing electric to fossil driven: which are the most crucial challenges/ differences/ possibilities while benchmark and operating?
3. How do XXX works with KPIs?
    - Which KPIs are used operationally?
    - Which KPIs are used while communicating with customers/ in communication with potential customers?
    - How do you categorize these KPIs? E.g. depending on business unit/ vary between stakeholder groups etc.
    - Is there any demands on the KPIs to be of certain characteristics such as measurable, be applicable on all sectors etc.?
4. How is customers working with KPIs towards you?
    - What kind of data would customers like to follow-up on?
    - What do customers prioritize/ value the most when looking at data?
    - Could you share an example of a customer case?

- What is the general maturity and common knowledge of electric transports at the market/ customers knowledge level?

5. Visionary picture of the future
    - How do you believe electrification will look like in the future?
    - What will be prioritised and in focus for daily operations?

Transport buyers

1. Tell us about your role in the company!
2. What is company XXX situation regarding electrification?
    - How does XXX work it today?
    - What is XXX goal?
    - When comparing electric to fossil driven: which are the most crucial challenges/ differences/ possibilities while benchmark and operating?
3. How do XXX works with KPIs?
    - Which KPIs are used operationally and related to transport?
    - Which KPIs are used while communicating with customers och partners?
    - How do you categorize these KPIs? E.g. depending on business unit/ vary between stakeholder groups etc.
    - Is there any demands on the KPIs to be of certain characteristics such as measurable, be applicable on all sectors etc?
4. What does XXX value while buying or working with transport?
    - What kind of data would XXX like to follow-up on?
    - Could you share an example of a transport provider case?
    - What is the general maturity and common knowledge of electric transports at the market/ customers knowledge-level?

Associated organizations

1. Tell us about your role in the company!
2. What have you noticed as the greatest demand on the market while transforming into electric transport?
    - How have this change evolved over time?
    - Can you see any differences in how transport have been benchmarked and what KPIs are used?
    - When comparing electric to fossil driven, which are the most crucial:
        - Challenges?
        - Differences?
        - Possibilities/ Enablers?
3. Maturity of the market
    - Which are the most crucial challanges for the deveolpment of the market?
    - How does different Associated industry organisation work with this transformation?
    - Which differencies are seen depending on type of transportation? How could this be used to gain knowledge?
    - How does companies in the transport sector benchmark themselves today?
4. Visionary picture of the future
    - How do you believe electrification will look like in the future?
    - What will be prioritised and in focus for daily operations?

Appendix D

Literature search

The following appendix shows how the literature search was conducted during the study; see Figure D.1.

Table D.1: The literature search process used when conducting the literature review.

Word/ words	Search engineer	Settings/ filter	Hits	Read/used articles	Other
Transportation of goods	Unisearch	advanced + publications	256 167		
Electric vehicle	Unisearch	advanced + publications	372 677		
Transportation of goods KPI Vehicle	Unisearch	advanced + publications	29	2	
KPI OR "Key performance indicators" Transportation Electric vehicle	Unisearch	advanced + publications	19	1	
"Electric vehicle" "Electric truck" Sweden	Unisearch	Advanced + peer review only on english, 2019 - 2022	326	2	
Key performance indicator*	Scopus	article title/ abstract/ keyword	10551		
Key performance indicator* Transport	Scopus	article title/ abstract/ keyword	382		
KPI OR "Key performance indicator" "Road freight" OR transport* Electrification OR electric*	Scopus	article title/ abstract/ keyword	35	6	
KPI OR "Key performance indicator*" "Road freight"	Scopus	article title/ abstract/ keyword	7	3	2 linked articles used as well
"Method* for KPI"	Scopus	article title/ abstract/ keyword	3	1	3 linked articles used as well
"Service level agreement*"	Scopus	article title/ abstract/ keyword	7631		
"Service level agreement" Transport OR road OR vehicle	Scopus	article title/ abstract/ keyword	239		
"Service Level Agreement" Transport*	Scopus	article title/ abstract/ keyword	167		
"Service level agreement" KPI OR "key performance indicator*" OR "performance measures" Transport OR road OR vehicle	Scopus	article title/ abstract/ keyword (2015 - present)	5	3	3 linked articles used as well

Appendix E

Workshop

Following discussion questions have been used when holding the workshop with selected people at the Partner Company. This workshop aimed to discuss, primarily, transport buyers' requests and demands of KPIs connected to electric road freight, compiled from answers from the empirical collection. Further, choose what KPIs need to be measured to fulfill customer satisfaction and then make the relevant KPIs communicable and understandable for transport buyers with help of a categorization. The workshop was divided into two discussion parts; where the first part was an individual exercise to select important KPIs and categories, while the second part was more of a discussion in smaller groups to make selected KPIs understandable and grouped in categories.

First Discussion

1. First, a list was handed out with demanded or requested KPIs to measure, expressed by transport buyers in interviews. To meet transport buyers' demand, the participants should speculate what the Partner Company needs to measure on an operational level to be able to reach customer satisfaction,
2. Secondly, each member should highlight which performance measurements the Partner Company measure today,
3. Thirdly, participants should mark KPIs requested by customers that, in turn, were considered was irrelevant/ outdated to measure,
4. Thirdly, each individual should mark what KPIs they thought would be of relevance to measuring on an operational level that the Partner Company is not currently measuring today,
5. Lastly, a wrap-up and summary were executed to capture exciting insights or comments.

Second Discussion

1. From discussion 1, each participant had compiled a list of measurements that the Partner Company needed to measure to meet transport providers' demands. To ease the process of communicating these KPIs to customers, they might need to be communicated in another format, whereas the participants were grouped in two groups to start a second discussion. The authors of this study participated in each group, taking notes and making sure to keep track of the right topics.
2. Firstly, broader measurements that, according to the participants, should be specified in a more specific manner were addressed. For example, battery management could be broken down into more detailed operational measuring points,
3. Secondly, measurements that should remain the same according to the participants were highlighted. For example, delivery precision could remain the same as both the Partner Company, and transport providers use this KPI that frequently that a translation of the KPI only should confuse,
4. Thirdly, the participants should address what KPIs might have a dependence on each other, such as charged time and charged capacity, which, in turn, could be compiled to charged efficiency.
5. Lastly, a wrap-up and summary were executed to capture exciting insights or comments.

Table E.1 show the list that was handed out during the workshop.

Table E.1: The out-handed list during the workshop.

Interview answers from stakeholders	**Discussion 1**			**Discussion 2**		
Performance measurements	**Partner Company measure this today (specify how and unit)**	**Irrelevant measurement**	**Partner Company does not measure this today BUT is considered relevant to measure**	**The measurement should be broken down into more detailed operational measuring points. Describe!**	**The measurements should remain the same**	**The measurement should be compiled together with other measurements and be communicated in a broader manner. Describe!**
Lead time						
Delivery reliability						
Delivery quality						
Delivery precision						
Flexibility						
Investment costs						
Operational costs						
Delivery costs						
Number of transports performed						
Vehicle fill						
Empty running vehicles						
Distance traveled						
Transport weight						
Number of vehicles						
Deviations from schedule						
Transport work						
Number of electric vehicles						
Life time of vehilce						
Weather condition						
Fuel price						
Type of fuel/energy used i.e. type of vehicle						
Energy content						
Frequency of fueling/charging						
Fuel/energy consumption						
Fuel/energy efficiency						
Eco-driving						
Ratio of used fuel/energy type						
Charging time						
Charging capacity						
Charge efficency						
Battery management						
Battery utilization						
Battery capacity						
After market on batteries						
Life-time on batteries						
CO2 emissions						
Particle emissions						
KPI index related to life cycle						
Lifecycle efficency						