Revising Technology Strategies In The High-Tech Electric Vehicle Industry

A Case Study into the new Stationary Charging Station (SCS)
Case Company: Elonroad Sweden

Adeeb Al-Adhami

Master's Thesis
2023

Division of Production Management
LUND UNIVERSITY, FACULTY OF ENGINEERING, LTH

Supervisors

Carl-Johan Asplund — Lund University, Faculty of Engineering, LTH
Karin Ebbinghaus — Elonroad

[Page intentionally left blank]

Acknowledgements

This master's thesis was written by Adeeb Al-Adhami. It represents the final milestone in the five-year Master of Science program in Electrical and Electronics Engineering with a specialization in Industrial Management, Business and Innovation at the Faculty of Engineering at Lund University, Sweden. The study was carried out in cooperation with Elonroad, a pioneer in electric road systems, based in Lund.

First and foremost, I am grateful to my supervisor at Lund University, Carl-Johan Asplund, whose expertise and mentorship have been crucial in shaping this research. His timely feedback and constant availability have been indispensable, and I cannot express my appreciation enough.

Next, I would like to express my sincere gratitude to Karin Ebbinghaus, my supervisor at Elonroad, for her guidance, feedback, and unwavering support during this project. Her prompt responses to my inquiries, facilitation of connections with interviewees both within and outside the organization, and valuable insights have been essential in the development of this master's thesis.

Additionally, I would like to convey my sincere appreciation to all the participants who graciously shared their time and knowledge during the qualitative interviews conducted for data collection. Their involvement has been vital in shaping this master's thesis; their contributions are deeply valued. A list of these participants can be found in Chapter 5.

I dedicate this master's thesis to my cherished family, whose unwavering support, encouragement, and patience have been instrumental throughout my academic journey, particularly during the research process. Their love and support have consistently fueled my motivation and aspirations.

Lastly, I am thankful to my friends and everyone who has offered their support throughout this academic journey. Your words of encouragement, emotional support, and assistance behind the scenes have been invaluable, and I am truly grateful for your unwavering commitment to my success.

Abstract

This master's thesis investigates the development and suggestion of a model for adapting and revising the technology strategies concerning Stationary Charging Stations (SCS), based on insights from relevant markets and stakeholders. This study particularly focuses on High-Tech Stationary Charging Stations in the Electric Vehicle (EV) charging industry, emphasizing Elonroad's new Stationary Charging Station (SCS) technology. The master's thesis background delves into the growing demand for effective charging infrastructure in the EV sector, highlighting the challenges faced by startups like Elonroad in launching new technologies.

The research for this thesis was conducted through an exploratory approach, resulting in qualitative data collection. Interviews were conducted with the main stakeholders from Elonroad, including its management and industry experts, to gain insights into the practical and strategic aspects of introducing SCS technology. In addition to these interviews, the study involved a thorough review of academic articles, academic literature, and internal documents to support and enrich the empirical findings. This approach ensured a comprehensive understanding of the topic, drawing from both firsthand expert opinions and established academic and industry knowledge.

The empirical findings reveal diverse perspectives from various stakeholders, including customers, partners, and Elonroad's management. These insights contribute significantly to understanding the dynamics of the EV charging market and the positioning of SCS technology within this landscape.

The research identifies several CSFs for Elonroad's new SCS technology within these categories: technological innovation, strategic management, customer relations, compliance, certification, and operational efficiency. A SCS Framework is developed, providing a strategic guide to help startups identify their own CSFs and navigate high-technology solutions in the EV charging industry.

The study concludes that Elonroad's SCS technology, while promising, faces challenges including safety concerns, the need for technological standardization, and market uncertainties. The SCS Framework developed in this master’s thesis is pivotal for startups like Elonroad, aiding in the effective implementation of high-tech solutions within the EV charging industry. It underscores the importance of strategic partnerships, market adaptability, and continuous innovation for achieving long-term success in the rapidly evolving EV charging sector.

Keywords: *EV charging industry, Electric vehicles, Electric Road System, Stationary Charging Station, Dynamic Charging Station, Elonroad.*

Table of Contents

List of figures

List of tables

List of Abbreviations

Abbreviation	Description
AC	Alternating Current
BEV	Battery Electric Vehicles
CAD	Computer-Aided Design
CTL	Chinese Coal-To-Liquid
DC	Direct Current
DCS	Dynamic Charging Station (Electric road)
ERS	Electric Road System
ERT	Electric Road Technology
EV	Electric Vehicle/Car
FCV	Fuel Cell Vehicles
GHG	Greenhouse Gases
HEV	Hybrid Electric Vehicle
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
ISO	International Organization for Standardization
IT	Information Technology
LCA	Life Cycle Assessment
NdFeB	Neodymium Iron Boron
PHEV	Plug-In Hybrid Vehicles
PM Emissions	Particulate Matter Emissions
REE	Rare Earth Elements
R&D	Research And Development
SCS	Stationary Charging Station or Semi- Dynamic Charging Station.
SmCo	Samarium Cobalt
TSCS	Traditional Stationary Charging Station

Chapter 1: Introduction

In this chapter, the subject and scope of the master’s thesis will be presented, including a detailed background followed by a problem discussion that leads up to the main purpose, the research questions and objective of the study, as well as delimitations. The target audience and Disposition of the master’s thesis is also presented.

1.1 Background

The climate impact of road traffic is significant and one of the biggest challenges to reducing the overall negative environmental and climate effects (Regeringskansliet, 2020). Ambitious climate goals set by a majority of the world’s states have led to the search for fossil-free alternatives to transportation systems. This has set in motion several projects worldwide for the electrification of road transport through electric road systems, with Sweden, Germany and the USA currently leading the way (Regeringskansliet, 2020). On behalf of the Swedish government, The Swedish Transport Administration has released an Electrification Program involving the assessment, planning, and implementation of a national electric road infrastructure. An electrified road system, or Electric Road Systems (ERS), in which electricity is transferred from the road to the vehicle for both propulsion and charging, has the potential to reduce reliance on fossil fuels, lower greenhouse gas emissions, and improve energy efficiency in the transportation sector.

Sweden is at the forefront of research on electric roads and the implementation of Electric Road Technology (ERT) for heavy freight transport, with several technology demonstrations during recent years. Sweden is planning on building the first permanent electric motorway by 2025, along 13 miles of European route E20, which connects Hallsberg and Örebro, located between Sweden's three major cities of Stockholm, Gothenburg, and Malmö (Butler, 2023). A charging infrastructure for electric cars based on ERT would enable autonomous wireless charging of stationary and moving electric vehicles, thereby simplifying the lives of electric vehicle drivers. ERS are an emerging field in the transport electrification process, allowing electric vehicles to charge their batteries while driving, and in so doing enabling a drastic reduction in EV battery size. There is therefore a great potential for adoption of ERS due to their expected contribution to efficiency gains.

In 2017 a national roadmap for the development of electric road systems was released for the 2018-2022 period (Trafikverket, 2017). There are currently three focus areas regarding technology for continuous, vehicle-related transmission of power from the infrastructure to electric road vehicles. These are 1) “conductive transmission via overhead lines”, (2) “conductive transmission via rails or conductors in the road”, and (3) “inductive transmission via electromagnetic fields from the roadbed”. Several different stakeholders have been developing and testing their electric road business, but none has taken a dominant position yet. These include Siemens, Elways, Alström & Electreon, Volvo AB, Bombardier, and Elonroad (ibid). The “conductive transmission via rails in the road” method is the one that shows the greatest potential due to advantages in safety and durability (Städje, 2022). Here there are two Swedish manufacturers, Elonroad and Elways who have conducted practical trials. Elonroad is a Swedish company providing ERT for the transmission of conductive energy from the road to vehicle-mounted power collectors. Elonroad is currently in the process of developing their business and ERT. Their solution is meant for both charging while driving as well as for stationary charging.

As the first permanent electric road in Sweden is scheduled to be ready by 2025, and another 3000 km of road by 2045 (Borglund, 2021), the race for position of influence is near to an end. The chosen technology for electric roads is expected to be announced at the beginning of 2023 (Städje, 2022).

1.1.1 Electric Road Systems and Stationary Charging Stations

Electric Road Systems (ERS) and Stationary Charging Stations (SCS) are both methods of charging electric vehicles (EVs), but they differ in terms of their approach.

ERS is defined as the dynamic transfer of power from the road to the vehicle while the vehicle is in motion. This could be accomplished using a variety of power transfer technologies, such as rail, overhead-line, and wire-less solutions (Sundelin et al., 2016). SCS, on the other hand, are fixed locations where EVs can be charged while parked.

The main advantage of ERS is that they provide a continuous source of power, potentially eliminating the need for frequent recharging stops. However, they require significant infrastructure investment to install and may face technical challenges related to implementation.

Stationary Charging Stations (SCS), on the other hand, are relatively easy to install and can be located in convenient locations such as parking lots, shopping centers, and public spaces. They allow EV drivers to charge their vehicles while parked, making them a practical solution for daily use.

The cost of implementing ERS will be high, and decision-makers will need to understand how mature various solutions are in comparison to conventional and alternative technologies (ibid). Although there are numerous ERS development and demonstration initiatives taking place all over the world, it is unclear which technological advancement is most appropriate for widespread adoption (ibid).

In terms of sustainability, both ERS and SCS have the potential to reduce the use of fossil fuels and promote the adoption of renewable energy sources. Both ERS and SCS are important components of the infrastructure needed to support the widespread adoption of EVs. Ultimately, the choice between these two methods may depend on factors such as cost, technical feasibility, and the specific needs of the local transportation system.

For an electric road system to function properly, several actors will be required to interact with each other (Regeringskansliet, 2020). *"The various roles in an electric road system consist of transport buyers, carriers, vehicle manufacturers, electricity traders, electric road operators, electricity network companies and road managers. All roles, apart from electric road operators, are already represented today by players in the market."* (Regeringskansliet, 2020).

Evaluating the level of industrial investment in the development of electric road networks is very challenging. In the 2017 article "*National Roadmap for electric road systems*" the Swedish Transport Administration mentions that automakers' perspectives on electric road systems range from being uninterested to dismissive. In essence, the focus seems to be on advancing technologies built on batteries and fuel cells. If ERS prove to be an effective idea for heavier vehicles and if the technology is suitable for cars, this attitude might be re-examined. If the technology can be applied to stationary charging as well, this could pave the way for the creation of dynamic charging systems.

1.1.3 Elonroad (Case Company)

Elonroad is a company founded by Dan Zethraeus in 2014 with an electric road and charging station concept using conductive charging, meant to charge all kinds of electric cars automatically while parked and while driving (Elonroad-Crunchbase, 2023). Elonroad was inspired by the limitations of traditional electric vehicle batteries, which hindered the adoption of clean transportation. To overcome this challenge, Zethraeus conceived an innovative idea – an electrified road system that charges electric vehicles while they're in motion, eliminating range anxiety and the need for extended charging stops (Elonroad, 2023). The basic idea is to install a conductive rail on top of the road and a charging module underneath the vehicle. While driving, a conductor will be lowered down to the rail, charging the vehicle`s battery. This solution is expected to exceed a 97% efficiency rate and can handle a capacity of up to 300kW (Elonroad, 2021).

Elonroads` Dynamic Charging Solution (DCS) consists of four main parts: power station, a road-rail, pickup and onboard charger. The power station takes electricity from the grid for every 1.5 km and distributes all the power to the road-rail. Inside the rails there are rectifiers that rectify the voltage to the vehicles at a constant 600-volt DC. A pickup with sliding contacts under the vehicles picks up the 600-volt DC from the road-rail to the onboard charger which charges the battery simultaneously while the vehicle is moving on the road.

Elonroad DCS also has a safety system. On the pickup there is an antenna sending a signal to the road. This detects the vehicle ID and the 1-meter segment switches on the power if all safety and operational parameters, such as vehicle alignment and ID verification, are met. It has a kind of an access control; the energy used can be measured and there is a billing solution built into the rail.

The billing solution device includes a sophisticated data link for data collection and analysis. Multiple functions are made possible by this, including the ability to charge particular users for their use of the route and the ability to identify who is using it and when. The road is powered in brief segments for safety reasons, so only the road portion that a car is driving over is powered (Elonroad, 2021).

Elonroad has so far conducted a trial deployment of their ERS in Lund, Sweden and in collaboration with the port of Helsingborg are testing their SCS technology on cargo vehicles in the port (ibid). According to Almestrand Linné, Sundström, and Hjalmarson (2020), there is presently no Swedish or European standard for ERS, and one of Elonroad's ultimate objectives is to establish such a standard.

1.2 Problem discussion

Sweden is committed to reducing greenhouse gas emissions and transitioning towards a more sustainable transportation system. The country aims to achieve a 70% reduction in emissions from the transport sector by 2030 compared to 2010 levels, and net-zero greenhouse gas emissions by 2045 (Trafikverket, 2017). Electric vehicles will play a critical role in meeting these ambitious targets.

In a report by the Andersson and Kulin (2018), it is estimated that the number of EVs in Sweden will increase significantly in the coming years. By 2030, the report predicts that there will be approximately 2.5 million EVs on Swedish roads, accounting for around 50% of the total passenger vehicle fleet (Andersson and Kulin, 2018). This growth will be supported by various incentives and policies, such as subsidies for EV purchases, tax reductions for electric company cars, and investments in charging infrastructure.

There are presently over 4,200 charging stations and over 27,000 charging points in Sweden, each with a unique type of connection and power supply (Energimyndigheten, 2020). To increase the number of EVs, a well-functioning infrastructure of public and private charging stations is required, and the charging station must also have the appropriate charging capability for its intended use.

The expansion of charging infrastructure will be essential to support the growing EV fleet in Sweden. The Swedish government has a proposal to allocate SEK 2.5 billion (approximately USD 240,8 million) for the period 2024-2026 to develop and expand charging infrastructure across the country (Regeringskansliet, 2023). This investment will enable the deployment of more public charging stations, including fast charging options, making EV ownership more convenient and accessible.

In 2022, the Swedish Transport Administration decided to build an electric road on the E20 between Hallsberg and Örebro, as part of the goal of reducing carbon dioxide emissions from freight traffic (Teknik, 2021). The Swedish Transport Administration has been testing four electric road technologies with four different companies: Siemens & Scania, Elways, Electreon and Elonroad, that are intended to supply mainly heavy road vehicles with electricity during operation. At the same time, the authority is preparing a decision on which of the technologies would be tested on a larger scale in a 20–30-kilometer pilot section (ibid).

In 2023, the Swedish Transport Administration suspended plans for what would have been Sweden's first permanent electric road, due to costs exceeding what was planned. The received bids for construction, electricity, and payment systems were higher than the budget could support (Trafikverket, 2023). Although this stage of the project is halted, the work towards Sweden's electric road expansion is not completely stopped. The project will now focus on analyzing ways to lower the costs and make the electric road feasible (ibid).

As Sweden strives for reduced greenhouse gas emissions through a shift to sustainable transportation, challenges arise in adopting new electrification technologies. The market's readiness for advanced technologies such as Elonroad's Dynamic Charging Stations (DCS) is uncertain, particularly if a single technology becomes standardized by the government.

Currently, the DCS technology by Elonroad is not ready for deployment, and the market's acceptance of it is not guaranteed. In parallel with their ongoing development of DCS, Elonroad has also started a pilot project with their partner and customer (Bring) to develop a new technology: Stationary Charging Stations (SCS). This development is not a shift away from DCS but an expansion of their technological portfolio to help Bring with its electrification challenges. Bring is a large transport & logistics company; one of their biggest customers is IKEA. By 2025, IKEA plans to convert its nationwide truck delivery service to 100% electric automobiles (IKEA, 2021).

The strategy behind Elonroad's development of SCS technology is multi-faceted: preparing the market for their DCS technology ensures that both stationary and dynamic charging would be compatible in the future; securing financial stability allows for continued investment in DCS; and a successful pilot project with Bring would demonstrate the viability of the new SCS technology. This could lead to wider adoption of SCS by other companies, including those in logistics, transportation hubs, ports, and the mining sector. Additionally, this could place DCS technology in contention for becoming a standardized solution in the future electric road system.

Elonroad is in the process of developing its commercial strategy for its high technology, with the aim of identifying applications, markets, and business cases that will drive the company's growth. The overarching goal is to contribute to the electrification of the transportation sector and reduce reliance on fossil fuels (Städje, 2022).

The main purpose of this master’s thesis is to develop and suggest a model for adapting and revising the technology strategies concerning Stationary Charging Stations (SCS), drawing upon insights from the relevant market and stakeholders. This objective is deeply connected with the current challenges and opportunities in Sweden's EV charging industry, as mentioned earlier.

The increasing demand for EVs, the expansion of charging infrastructure, and the varying readiness for advanced technologies like Elonroad's DSC and SCS technologies, highlight the need for innovative and adaptable strategies. This master's thesis aims to address these challenges by offering a model that helps startups like Elonroad tailor their technology strategies effectively, ensuring they align with market demands and stakeholder expectations.

1.3 Main Purpose

Develop and suggest a model for adapting and revising the technology strategies concerning SCS based upon insights from relevant markets and stakeholders.

1.4 Research questions

RQ1: Identifying and assessing how the implementation of the technology strategies concerning SCS, in relation to the future road map, has been (i.e. its strategic accommodation).

RQ2: Derived from these insights (see RQ1) identify the critical success factors (CSFs) which are relevant for the target market.

RQ3: Formulate and evaluate the potential risks for alternative technological strategies and their commercial possibilities.

RQ4: Critical evaluation of the proposed applied model (see the purpose) in adapting and revising the technology strategies.

1.5 Delimitations

This master's thesis primarily focuses on a select group of stakeholders, specifically the management at Elonroad, the investor/partner Almi Invest GreenTech, and the partner/customer Bring. It does not include a broader stakeholder analysis. The scope of this master's thesis is limited to the exploration of Elonroad's new Stationary Charging Station (SCS) technology.

The master’s thesis focuses only on the Swedish market. It does not include an analysis of market dynamics, a detailed assessment of competitors, an in-depth technical evaluation of the technologies, or considerations related to financial investments and capital injections.

The empirical data presented in this master’s thesis in Chapter 5 were gathered from interviews conducted in 2021, At that time, Elonroad was in its initial startup phase. Therefore, in this master’s thesis, Elonroad will be discussed and examined as a startup company.

1.6 Target audience

This master’s thesis is written in the Division of Production Management within the Department of Industrial Management and Logistics at the Faculty of Engineering (LTH), Lund University, Accordingly, the primary target audiences are:

1. **Academia:** This includes faculty members, students, and researchers who are engaged in the fields of sustainable transportation and electric vehicle (EV) infrastructure. The master’s thesis aims to contribute to academic discourse and research in these areas.

2. **EV Charging Industry:** This encompasses professionals at Elonroad, stakeholders within the EV charging infrastructure sector, and policymakers focused on sustainable transportation. The insights and recommendations provided in this master’s thesis are intended to aid in the understanding, implementation, and addressing of challenges associated with Stationary Charging Station (SCS) technology.

Overall, the goal of this master’s thesis is to present findings that are beneficial and informative for both the academic community and the EV charging industry, thereby facilitating knowledge exchange and practical application in these fields.

1.7 Disposition of the Master's Thesis

Chapter 1: Introduction

In this chapter, the subject and scope of the master's thesis will be presented, including a detailed background followed by a problem discussion that leads up to the main purpose, the research questions and objective of the study, as well as delimitations. The target audience and Disposition of the master's thesis is also presented.

Chapter 2: Methodology

In this chapter, the methodological choices for data collection and analysis will be explained, including the foundation for addressing the main purpose, the research questions and determination of CSFs. The rationale behind selecting specific research techniques and tools is discussed. The building of the theoretical framework (SCS Framework) will also be presented. By presenting the methodology, target groups will gain an understanding of how the research was conducted, and the credibility of the findings.

Chapter 3: Electric Roads & Electric Vehicles

This chapter provides a comprehensive background on the development of electric road systems (ERS) and electric vehicles (EVs), along with an overview of their key features and benefits. Furthermore, it examines various ERS technologies, charging infrastructure solutions, and Elonroad's technology. EV adoption factors in Sweden and influencing factors from an infrastructure perspective are also briefly discussed.

Chapter 4: Theoretical framework

In this chapter, foundational theories such as the Technology Roadmap and Critical Success Factors will be explained. The theoretical framework will be examined and categorized under three principal domains: Technology, Business, and Partnership. Within these domains, specific areas like Technology Strategy, Technology Audit, Diffusion of Innovations, Value Proposition Canvas, among others, are presented and explained.

Chapter 5: Empirical results (Findings)

This chapter presents and summarizes the results of the main stakeholder's interviews Elonroad's new SCS technology. The interview outcomes will be presented and organized into three main categories: Technology, Business, and Partners. At the end of this chapter, the key findings will be presented.

Chapter 6: Discussion

In this chapter, the key findings will be discussed with the main purpose and the research questions from the introduction (chapter 1). The discussion aims to provide the reader with a comprehensive understanding of the main purpose and RQs outcomes and their relevance to the master's thesis objectives.

Chapter 7: Conclusion

In this chapter, the main results of the master's thesis are summarized. It links the research findings to the development of a model for changing and improving SCS technology strategies, based on market and stakeholder insights. This chapter combines the responses to the research questions to address the thesis's main aim. It provides a clear overview of the important discoveries from the study of Elonroad's SCS technology and its impact on Elonroad and the wider EV charging industry. The focus is on how these findings help in making better technology strategies for startups like Elonroad with similar technology.

Chapter 8: Implications and Contributions

This chapter examines the implications and contributions of this master's thesis, focusing on its relevance to academia and the electric vehicle (EV) charging industry. It discusses the insights derived from the master's thesis, highlighting their significance and potential impact on the field. The chapter underscores the unique contributions of the study and suggests avenues for future research, expanding on the groundwork laid in this master's thesis.

[Page intentionally left blank]

Chapter 2: Methodology

In this chapter, the methodological choices for data collection and analysis will be explained, including the foundation for addressing the main purpose, the research questions and determination of CSFs. The rationale behind selecting specific research techniques and tools is discussed. The building of the theoretical framework (SCS Framework) will also be presented. By presenting the methodology, target groups will gain an understanding of how the research was conducted, and the credibility of the findings.

2.1 Introduction to the study methodology

Methodology refers to the approach that forms the basis of the master’s thesis. With the help of the chosen methodology, principles, and frameworks for how the work should proceed are established at an overall level. The choice of methodology is influenced by the purpose of the study (Höst et al, p. 29).

2.1.1 Research philosophy

Every researcher's view of the world is shaped by their unique experiences. These experiences influence the assumptions they make during research, affecting the outcomes of their study. Understanding one's research philosophy is essential for any researcher. As Saunders, Lewis, and Thornhill (2009) identify, the main research philosophies are pragmatism, interpretivism, realism, and positivism.

Pragmatism allows for the use of different research approaches (Saunders, Lewis, & Thornhill, 2009, p. 109). Interpretivism focuses on understanding the perspectives of those being studied, often used in business and management research (Saunders, Lewis, & Thornhill, 2009, p. 115,116). Realism is about objects existing independently of the researcher's thoughts, with variations in how reality is understood (Saunders, Lewis, & Thornhill, 2009, p. 114,115). Positivism, common in natural sciences, emphasizes structured, unbiased research for general conclusions (Saunders, Lewis, & Thornhill, 2009, p. 113,114).

This master’s thesis, aiming to develop and suggest a model for adapting and revising technology strategies for SCS, based on market and stakeholder insights, aligns with the interpretivist philosophy. It involves case-study research, primarily using qualitative data, to understand perspectives and adapt strategies effectively in the high-tech EV charging industry.

2.1.2 Research strategy

In the initial phase of research design, formulating a strategy is key. The problem being addressed and the approach taken are crucial in this formulation. The choice of a research strategy is also influenced by the researcher's philosophy, expertise in the field, research objectives, and available resources.

There are four primary methods for gathering and organizing data, each aligning with specific research outcomes and areas:

- **Descriptive:** This focuses on understanding how a particular thing or function operates.
- **Exploratory:** This aims for in-depth insight into the workings and implementation of a specific subject.
- **Explanatory:** This seeks to find relationships and explanations for how something functions.
- **Problem solving**: This is directed towards finding solutions to identified problems.

One or a combination of these methods could be selected for a master’s thesis (Höst et al, p. 29-30). Following Höst et.al. (2006, p.29-30), this master’s thesis adopts an exploratory methodological approach. This approach is chosen to build a solid knowledge base for further development of the study.

Primary data, collected through interviews, and secondary data, sourced from peer-reviewed articles and relevant, reliable sources, form the basis of the exploratory study.

This exploratory study is aligned with the main purpose: to develop and suggest a model for adapting and revising the technology strategies concerning SCS, utilizing insights from relevant markets and stakeholders. It involves exploring and understanding the dynamics of the market and stakeholder perspectives, crucial for adapting and revising technology strategies effectively in the high-tech industry, specifically for Elonroad's SCS technology.

2.1.3 Research method

As described by Höst et al. (2006), four distinct methods are commonly used in degree projects, each either fixed or flexible in nature:

- **Survey:** This method is used for extensive questions, aiming to compile and describe the current state of the subject being studied.
- **Case study:** An in-depth study of one or more cases where minimal influence is exerted on the subject.
- **Experiments:** A comparison of two or more alternatives, isolating a few factors to manipulate one of them.
- **Action research:** A closely monitored and documented study aiming to resolve a specific problem.

In a fixed methodology, the study is predefined, whereas in a flexible methodology, the study can adapt during the research process. Combining multiple methods and data types offers a more comprehensive understanding of the subject.

This master's thesis uses a case study approach, focusing on identifying strategies for effectively adapting and revising SCS technology in the context of a startup company. Case studies are particularly suitable for exploring specific real-world situations and understanding organizational processes. They are effective in addressing "why?", "what?", and "how?" questions (Johansson, 2007). Data collection typically includes techniques like interviews and observations, providing a deep insight into the technology strategies and stakeholder perspectives relevant to the EV charging market.

2.1.4 Choice of Method

The methodological foundation of this master's thesis is crafted to resonate with the distinct characteristics and research requirements of Elonroad's Stationary Charging Station (SCS) technology. The selected approach, incorporating interpretivist philosophy, an exploratory research approach, and a case study strategy, is underpinned by the qualitative nature of the study, as outlined by Höst et al. (2006, p. 30-33). This approach focuses on methods that organize and interpret qualitative data.

Interpretivism: This philosophy is chosen to understand the subjective experiences and perspectives related to the SCS technology. It is particularly suitable for examining the social and human aspects of technology adoption, such as stakeholder perceptions and decision-making processes. Interpretivism facilitates an in-depth exploration of the varying viewpoints within the EV charging sector regarding the SCS technology.

Exploratory Approach: This approach is suitable for investigating the relatively new and evolving SCS technology. It allows for flexibility and adaptability, enabling the study to uncover complex phenomena and generate novel insights in a dynamic field.

Case Study Method: Chosen for its capacity to provide a detailed examination of Elonroad's SCS technology within its real-life context, the case study method offers a comprehensive view of the technology's operation, perception, and interaction with business and technological factors. It is crucial for gaining in-depth insights into operational challenges and strategic business decisions.

These methodological choices ensure the research is precisely aligned with exploring the nuances of Elonroad's SCS technology. This approach provides the depth and flexibility required to effectively address the research questions, contributing to the development of a model for adapting and revising technology strategies based on insights from relevant markets and stakeholders.

2.3 Data collection

Data collection has been done mainly through the following sources:

- **Academic articles & literature**
- **Interviews**
- **Expert interview**
- **Internet research**
- **Internal documents and presentations**

2.3.1 Primary and secondary sources

In this study, primary sources like stakeholder interviews were the main form of data. Interviews, as primary sources, provide direct, uninterpreted information. They are structured conversations where the researcher learns about values, motives, and norms from respondents (Ornetzeder and Rohracher, 2006). To ensure clarity and avoid misunderstandings, measures were taken to enhance user engagement, which positively impacts sustainable technology dissemination (Ornetzeder and Rohracher, 2006). The interviews offered in-depth insights into user experiences with electric vehicle operation and contributed to understanding the implementation of Stationary Charging Stations (SCS).

Secondary sources include research articles, annual reports, and newspapers. They interpret primary data and are essential for understanding broader contexts. In this master's thesis, a thematic exploration of existing studies was conducted, providing diverse perspectives and identifying trends relevant to SCS technology. This analysis of previous research, a reliable technique in qualitative case studies (Bowen, 2009), supported the development of a model for adapting and revising SCS technology strategies based on market and stakeholder insights.

2.4 Approach

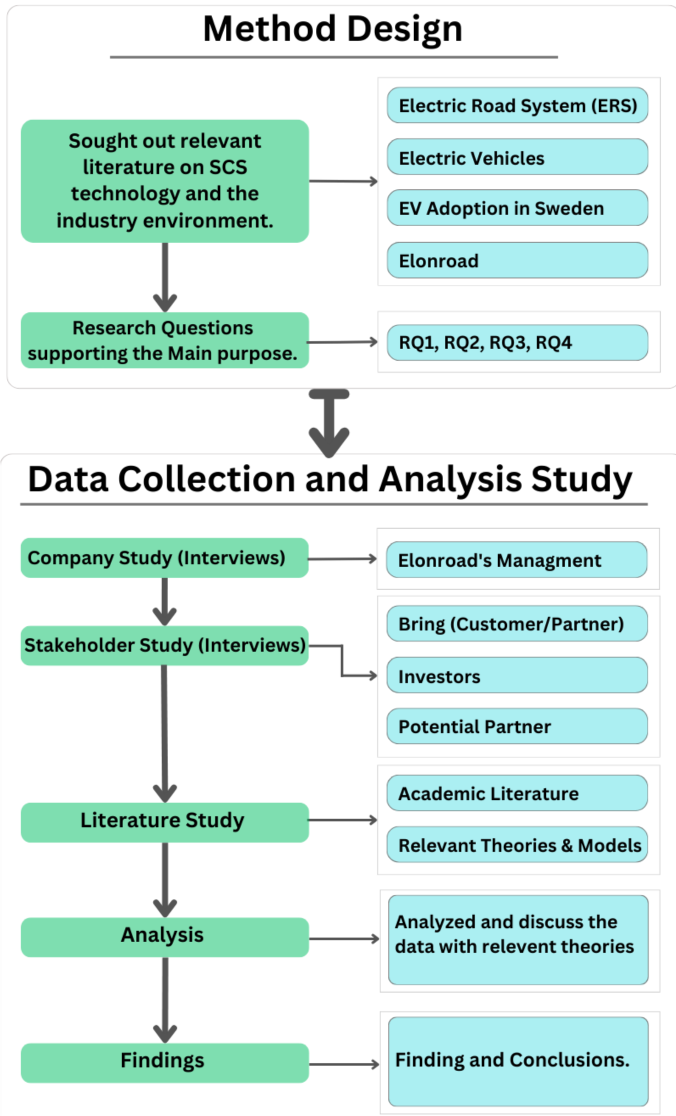

Figure 1: Flowchart for method design, data collection and analysis study.

2.4.1 Fact gathering

The fact gathering consisted of primary and secondary sources in the form of qualitative data. At the beginning of the study, fact gathering constituted the bulk of the information collection. This significantly deepened the knowledge and provided an overall picture for Elonroad, their SCS solution and critical success factors for high technology start-ups as well as for the SCS solution.

2.4.2 Interviews

In this master's thesis, the interview methodology was intricately designed to align with the interpretivist research philosophy, providing a deep understanding of Elonroad's Stationary Charging Station (SCS) technology through purposive sampling of participants. The semi-structured format, characterized by its open-ended questions, allowed for the flexibility of in-depth discussions, minimizing interviewer bias and enabling respondents to freely express their viewpoints (Höst et al., 2012).

This flexible format proved to be especially effective in both single and dyadic interviews. Single interviews facilitated a focused exploration of individual perspectives, while dyadic interviews captured the interactive exchange of ideas, providing a richer understanding of the shared and divergent opinions on the SCS technology (Morgan et al., 2013).

Within Elonroad, four single interviews were conducted, with the CEO, CTO, Senior Advisor, and Product Manager, chosen for their unique insights into the company's internal strategies and operations. Externally, interviews with investors, partners, and a customer from Bring added context regarding market forces and user experiences.

The CTO's interview was particularly valuable as an expert interview, offering a granular view of the technical aspects of the SCS technology.

The interviews were mostly conducted via online platforms like Microsoft Teams and Google Meet, with in-person sessions added for further relevant details.

These interviews have been recorded, transcribed, and translated from Swedish to English.

In summary, seven interviews were conducted with eight respondents. Among them, four were with Elonroad management, one of which being an expert interview, and three were external interviews. The interview questions can be found in Appendix B.

Internal Interviews

Name	Work title
Karin Ebbinghaus	CEO at Elonroad
Andreas Sörensen	Former CTO at Elonroad
Björn Dahlqvist	Senior Advisor at Elonroad
Anna Palmqvist	Production Manager at Elonroad

External Interviews

Name	Work title
Jörgen Bodin	Investment manager at Almi Invest GreenTech
Robert Bergqvist	Head of Innovation & Business Development at HEM
Siri Marie Hagen	Senior Advisor, Senior vice president business development HR and HSE. at Bring
Catherine Löfquist	Head of Sustainability at Bring

2.4.3 Analysis

For the analysis of qualitative data, a thematic analysis approach was employed. This involved a systematic process of coding the transcribed interviews to identify recurring themes and patterns. The integration of these findings with the literature review and secondary data sources enabled a comprehensive understanding of the critical success factors for Elonroad’s new SCS technology.

The qualitative data collected from the interviews underwent a careful coding process to extract meaningful insights. This coding was primarily categorized into three distinct areas: Technology, Business, and Partnerships.

Technology: This category included sub-themes such as Operation, Intelligent Infrastructure, and Commercial Product with Certification. These codes were used to identify discussions around the technical aspects of the SCS technology, focusing on operational efficiency, integration with existing infrastructure, and the process of obtaining necessary certifications.

Business: Within this category, the sub-themes included Good Team, Internalize Knowledge, Customer Communication, Customer Understanding, and Customer Expectation & Feedback. This coding was important in highlighting the business strategies of Elonroad, particularly in terms of team dynamics, knowledge management, and customer relations.

Partnerships: This coding area encapsulated aspects related to Elonroad’s collaborations and partnerships. It was crucial for understanding how external relationships contributed to the development and implementation of the SCS technology.

This systematic organization of data not only enhanced the clarity of the analysis but also ensured a comprehensive understanding of the interconnected dynamics between technology, business strategies, and partnerships in the context of Elonroad's new SCS technology.

2.5 Building the theoretical framework

This subchapter describes the development of the theoretical framework in relation to the research questions of this master’s thesis. It begins by explaining the reasoning behind the selection of the research questions and clarifies how they are connected to each other. Second, it explains how the theoretical framework and their theories have been chosen for the purpose of this master's thesis. At the end of this subchapter, we will have a clear picture of how the Figure 2: SCS Framework below has been developed.

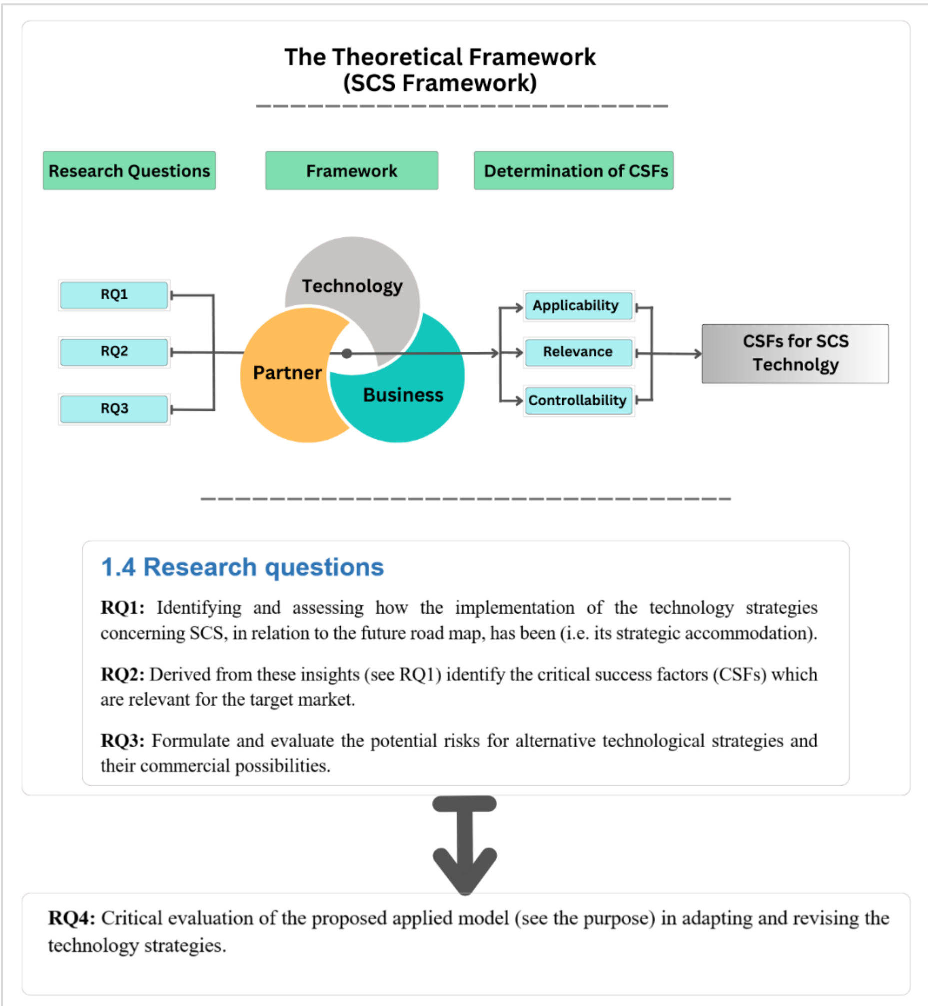

Figure 2: The SCS framework. This framework is to identify CSFs for new, high-technology startup companies within the EV charging industry.

2.5.1 Defining the Main Purpose

In this master's thesis, the main focus is on the development and suggestion of a model. This model is aimed at adapting and revising the strategies for the technology of Stationary Charging Stations (SCS). These adjustments and revisions are guided by information and feedback from the stakeholders, and market insights. To achieve this goal, the model relies on three critical questions: "Where Are We Now?", "Where Are We Going?", and "How Can We Get There?". These questions are essential for a well-structured strategy that helps to define the research questions of this master's thesis. They were inspired by a literature review and research by Musango and Brent (2015), as mentioned in section 4.1. The approach to these pivotal questions for creating an effective strategy is based on the methods of Carvalho et al. (2013) and Phaal & Muller (2009).

2.5.2 Defining Research Questions

The research questions in this master's thesis draw inspiration from two foundational elements. The first is the main purpose, guided by three critical questions: "Where Are They Now?", "Where Are They Going?", and "How Can They Get There?". The second element is the structured theoretical framework, composed of three categories: Technology, Business, and Partner, which establishes clear boundaries for the research scope. These categories ensure the study remains focused and relevant to the core aspects of the technology's understanding and implementation.

RQ1 - Strategic Accommodation ("Where Are They Now?"): The response to this question identifies how Elonroad has strategically accommodated its technology strategies for SCS with its future roadmap. This question examines "Where Are They Now?" regarding the technology's fit in the market and its effectiveness. It looks at how well the Stationary Charging Station technology is developed and how customers receive it. The goal is to understand how the technology performs and if it meets customer needs.

RQ2 - Critical Success Factors ("Where Are They Going?"): This question is positioned first as it establishes the foundational understanding of "Where Are

They Going?" by identifying what is considered successful from all main stakeholders' perspectives. It encapsulates the technology and business dimensions by looking at internal and external viewpoints vital for strategic direction. It provides an overall framework within which the success of the SCS technology can be gauged. Understanding these critical success factors also provides a foundation for the subsequent research questions, lending them contextual grounding.

RQ3 - Risk Assessment and Commercial Possibilities ("How Can They Get There?"): The final question aims to cover the question "How can They get there?" aspect of the roadmap by identifying possible roadblocks or challenges that Elonroad could face in the journey towards achieving its goals. Understanding these risk areas can help in crafting a well-informed strategic plan to mitigate such risks.

RQ4 - Critical Evaluation of the SCS Framework: This question involves a thorough examination of the SCS framework introduced in this master's thesis. It is answered in the conclusion chapter, where the framework is critically evaluated. The evaluation uses David Gray's 'Evaluation Rubric for Analytical Frameworks' to assess the framework systematically. This rubric checks the framework's completeness, usefulness, validation by data, clarity, ease of remembering, how well different parts work together, and its uniqueness. The purpose is to see if the SCS framework provides clear, practical, and evidence-based recommendations, particularly for emerging companies in the Electric Vehicle (EV) charging industry. This evaluation is key to understanding the effectiveness and applicability of the SCS framework in strategic decision-making within this field.

The research questions progress from assessing the current situation with technology strategies (RQ1), to defining critical success factors (RQ2), and strategizing future possibilities (RQ3). The final question, RQ4, critically evaluates the SCS framework, ensuring comprehensive examination and applicability. This structured approach ensures a thorough exploration from current status to future planning and evaluation. Each question is strategically positioned to build upon the findings of the previous, culminating in a well-rounded analysis.

2.5.3 Theoretical Framework (TBP Theories)

In this master's thesis, the development and suggestion of a model for adapting and revising technology strategies for Elonroad's Stationary Charging Station (SCS) is based on insights from the relevant market and stakeholders. This approach is structured within three main categories: Technology, Business, and Partner, reflecting a multi-dimensional view of innovation and strategy in high-tech startups.

Technology: This category is crucial as it involves in-depth analysis of Elonroad's SCS technology. It includes examining current technological understanding and implementation, capabilities, and future development plans. The Technology Strategy theory and the Technology Audit model are chosen and applied to gain insights into Elonroad's SCS technology and the company, supporting both primary and secondary data. For instance, the Technology Audit results from a student project at LTH, Lund University, are incorporated as secondary data (see Appendix A). Theories like the Diffusion of Innovation and the Technology Acceptance Model help analyze data from interviews and academic articles, focusing on the potential early adopters of the SCS technology.

Business: The success of SCS technology in the market relies on more than technical aspects; the business model's effectiveness is also key. The Value-Proposition Model are chosen and used to identify customer needs, benefits, and challenges, creating a value map to better understand consumer demand and customer value creation. Tools like the SWOT analysis and The Kano model assess Elonroad's market attractiveness and customer satisfaction.

Partner: Strategic partnerships are vital, especially for high-tech solutions like the SCS. Collaborations with industry, government, and academic institutions are crucial for success. The Triple Helix Model are chosen and used to highlight the importance of these collaborations for the effective commercialization of the SCS technology.

Each theory in the Technology, Business, and Partner framework contributes both individually to specific aspects and collectively to the overall strategy. This integrated approach ensures a comprehensive strategy for adapting and revising Elonroad's SCS technology strategies, as detailed in Chapter 4.

2.5.4 Determination of CSFs

Three key criteria were used for the identification of CSFs, as suggested by Rodrigues and Dorrego (2008):

Applicability: The factor must be relevant across the industry to all competitors.

Relevance: The factor must be of significant importance to the success within the industry.

Controllability: The organization must be able to exert influence or control over the factor.

For further details see section 4.2

2.6 Validity and Reliability of research

Validity and reliability are important to the overall robustness of the data, hence the developments to increase the volume of reliable data. According to several authors (Hunnicutt Hollenbaugh, 2015; Kelliher, 2005; Leoni, 2015; Bravi et al., 2021), in order to ensure the validity and reliability of data in a single case study, researchers can take the following steps:

1. **Use multiple sources of data:** Collect data from multiple sources such as interviews, observations, and documents to increase the reliability of the findings.
2. **Triangulation:** Use triangulation to cross-check the data from different sources to ensure consistency and accuracy.
3. **Member checking:** Share the findings with the participants to verify the accuracy of the data and interpretations.

4. **Peer review:** Have other researchers review the study to ensure that it is methodologically sound and that the findings are valid.

5. **Reflexivity:** Be aware of and transparent about the researcher's own biases and assumptions that may influence the study.

6. **Detailed description:** Provide a detailed description of the case study, including context, methods, and data analysis procedures, to increase transparency and allow for replication.

7. **Generalization:** While single case studies cannot be generalized to other cases or populations, researchers can increase external validity by selecting cases that are representative of a larger population or by using multiple case studies.

Reliability highlights the reliability of data collection and analysis with respect to random variations. In order to have a high reliability of the study, it is important that a thorough data collection and analysis takes place. To then describe how the author has gone about it allows the reader to assess how the author has worked.

The gathered information in this master’s thesis can be divided into two broad approaches, literature, and interview studies. As the literature study is broad and deep with many different sources, the reliability of the study increases. As the information gathering via interviews is not randomly selected but aimed at providing deeper knowledge, these reduce the reliability. However, by reporting the data from the interviewees, the reader is given the opportunity to check that the authors have interpreted the interviews correctly. (Höst et al, p. 41-42)

Validity proves that what is measured actually measures what is intended to be measured and that it thus focuses on systematic problems**.** (Höst et al, p 41-42)
As different sources have been used for the information gathering with reports, articles and information directly from Elonroad, investors, partners and customers as well as reputable literature, the risk that the analysis is done on the wrong theoretical basis is low.

2.6.1 Representativeness

Representativeness indicates the extent to which the conclusions are general (Höst et al, p. 41-42). The limitations of transferability in single case study research are that the findings cannot be generalized to other cases or contexts due to the unique nature of the case being studied (Kelliher, 2005). Transferability refers to the extent to which the findings of a study can be applied to other settings or populations. Single case studies are often criticized for their lack of generalizability, as they focus on a single case and cannot be used to make broader claims about a population or phenomenon. According to Johansson (2007) the case for study might be given and studied with an intrinsic interest in the case as such. In such a case the researcher has no interest in generalizing their findings. The researcher focuses on understanding the case. If the findings are generalised, it is done by audiences through "naturalistic generalisation".

However, researchers can increase transferability by providing rich descriptions of the case study and its context. Since this study involves a mapping of critical success factors for Elonroad and its SCS technology, it can be generalized to other companies with a highly comparable product offering. However, fully general conclusions are difficult to draw partly because of the limitations for this study and the sample of interviewees.

2.6.2 Source criticism

The sources used in the literature study are academic articles, research papers and information directly from Elonroad, investors, partners, and customers, which has resulted in the sources in the report being reliable and of high quality. The validity of the sources has also been checked to ensure high quality.

The company is largely willing to disclose information about their daily work and their business strategy, but not in detail, so the study is not too biased.

2.6.3 Ensuring Credibility and Trustworthiness.

To ensure the credibility and trustworthiness of the research findings, several validation techniques were employed. Triangulation was achieved by using multiple data sources, including interviews, academic literature, and industry reports. Additionally, reflexivity was practiced throughout the research process, where biases and assumptions were acknowledged and critically examined. This approach not only reinforced the integrity of the research but also enriched the depth of the analysis.

[Page intentionally left blank]

Chapter 3: Background of Electric Roads & Electric Vehicles

This chapter provides a comprehensive background on the development of electric road systems (ERS) and electric vehicles (EVs), along with an overview of their key features and benefits. Furthermore, it examines various ERS technologies, charging infrastructure solutions, and Elonroad's technology. EV adoption factors in Sweden and influencing factors from an infrastructure perspective are also briefly discussed.

3.1 Electric Road Systems: Concepts & Frameworks

ERS is a very recent idea, having developed within the past decade. Although its definition is not universally accepted, it is generally recognized as a system that allows dynamic power transfer between a vehicle and the roadways it is traveling on. ERS is usually divided into three categories (PIARC, 2018):

- **Inductive (wireless)**
- **Conductive (catenary/overhead)**
- **Conductive (in-road rail)**

These three ERS concepts use various technologies to accomplish the same primary function and service – automatically transferring power to electric cars at low and typical traffic speeds (quasi dynamic and dynamic). The energy is either transmitted to the vehicle's onboard battery unit or used to directly power the vehicle's propulsion system. All three principles may also be used for static (stationary) applications; however, this study considers static capabilities, not ERS systems. Rather than that, they are seen as ancillary or supporting technologies for EV charging. Additionally, static systems include conventional cable connections — the most commonly utilized mature form of EV charging (PIARC, 2018). Figure 3 illustrates each ERS principle.

Numerous players are involved in the development and commercialization of ERS, including research institutions and academics, automobile manufacturers, the freight sector, road administrations, small start-ups and spin-offs, construction firms, and technology manufacturers (PIARC, 2018).

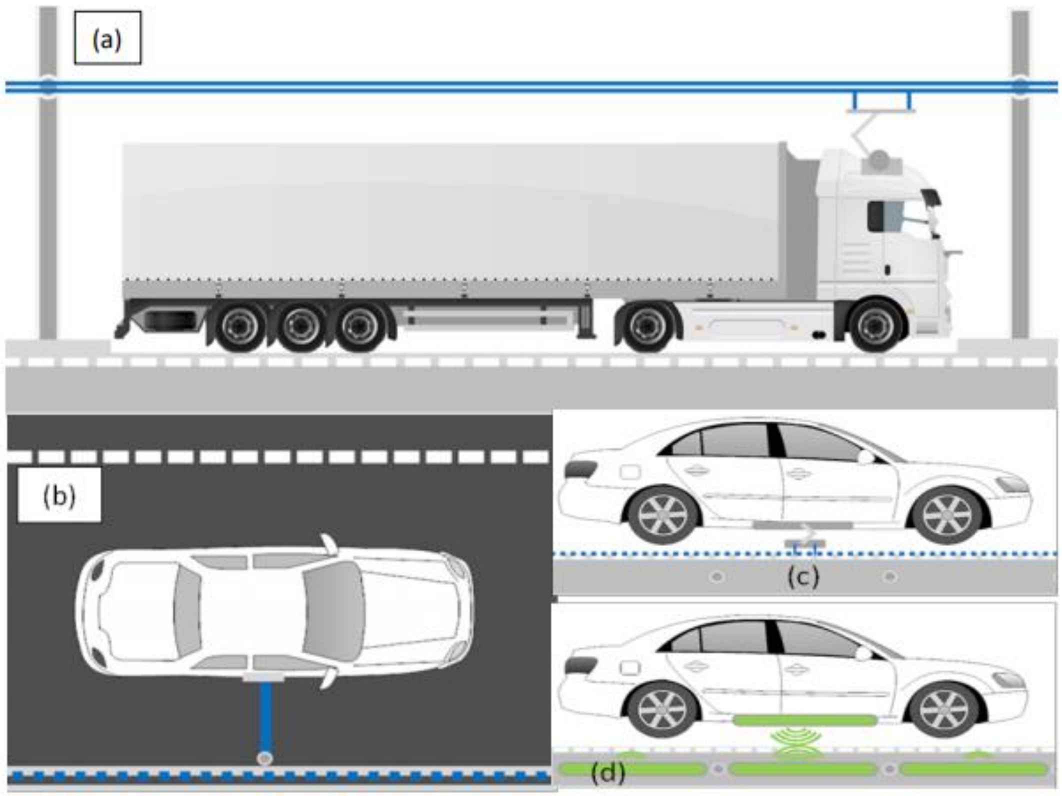

Figure 3: Types of ERS; [a] Conductive Overhead, [b] Conductive Rail (Side Rail), [c] Conductive Rail (Ground Rail), [d] Inductive (Wireless In-Road) (PIARC, 2018)

3.1.1 Inductive (wireless)

It was M. Hutin and M. Leblanc (1894) who first introduced the idea of dynamic inductive power transfer for transportation in their 1894 US patent (No. 527,857) for a current collector for electrically-propelled vehicles that does not require mechanical contact in between the collector and the power line (as applied to railways). However, this concept was not refined and adapted for modern vehicle travel until the late 1990s, with the first public demonstration of static shuttle bus charging in New Zealand (Sheng *et al.*, 2019). Several manufacturers arose in the early 2000s, commercializing the idea for static applications: start/end-of-route and opportunistic mid-route bus and shuttle charging. Simultaneously, with the introduction of electric cars and buses to the market, research and development inductive power transfer gained pace, with manufacturers, academics, and different research institutions contributing to the growing area, drawing on previous research (Shladover, S.E., 1992). The development of inductive systems has accelerated dramatically during the past eight years, with advancements fueled by various factors. These are:

- Road transport's effect on climate change and the subsequent legally binding/voluntary greenhouse gas emission reduction targets adopted in some form by the majority of countries worldwide
- The mass production and affordability of HEVs and EVs
- The inconvenient nature of static charging and its availability despite the limited range (km) of existing EV battery technologies
- The price, size, and weight of electric vehicle batteries
- Increasing prices of fossil fuels and their efficiency per ton/kilometre in comparison to electrified transport
- The quality of local air, pollution, and noise caused by internal combustion engines
- Long-term operating cost reductions vs fossil fuels
- Advancements in renewable energy technology and cost reductions (wind, hydro, solar PV).

The inductive ERS idea is based on energy transmission from coils buried in the road (primary) to coils placed in the vehicle (secondary) without wires. The grid electricity is converted to a high-frequency alternating current to create a changing magnetic field that is picked up by the coil underneath the car. The magnetic field induces a voltage on the pickup coil, which results in the passage of electric current via the pickup coils, resulting in inductive power transmission (PIARC, 2018).

This kind of ERS operates without contact and is capable of transmitting electricity over a changeable air gap. Inductive systems are classified into three types of components: in-road, on-vehicle, and roadside. Primary coils (usually copper Litz turnings with a ferrite core) and power cables placed under the road surface are in-road components. Multiple coils are placed in variable-length segments in dynamic applications. The secondary coil (also known as the pick-up unit) and control electronics are installed on the vehicle. Additionally, the vehicle must include components of an electric drive train, such as a battery and an electric motor. Grid connections, power inverters, transformers, cooling units, and communication systems are all included in the roadside components (PIARC, 2018).

When a complying vehicle travelling over a particular speed along the track is recognized, power from the roadside unit is immediately supplied to the primary coil section. The secondary coil passing over the primary coil generates an electromagnetic current, resulting in power transmission. Depending on the technology, power may be used to directly operate the propulsion system or charge the vehicle's battery. The schematic shown in figure 4 is a simplified representation of the inductive ERS architecture. The concept and components are the same for static applications, but the size and infrastructure needs are reduced (PIARC, 2018).

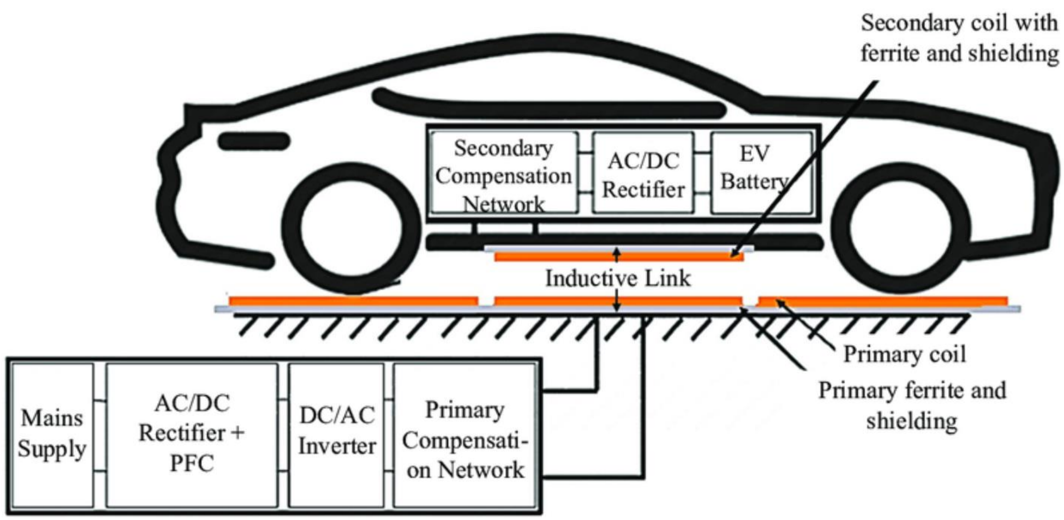

Figure 4: Inductive (Wireless) ERS Concept (ElGhanam et al., 2021)

3.1.2 Conductive (catenary/overhead)

Over a century of history, overhead conduction is the most established and mature concept of ERS systems. It was initially used for road transport in 1882 with the Siemens Elektromoto trolley bus system in Berlin, Germany. Trolley bus systems (in which a pantograph is permanently connected to the overhead wires) gained popularity in the 1970s and now number over 300 worldwide. The conductive overhead ERS is a direct development of the overhead rail and trolley bus technology. This technology transfers energy directly and continuously (often through a pantograph) between the vehicle and the power source (PIARC, 2018).

Similarly, overhead conductive ideas include on-vehicle and roadside components. Standard components include an extended pantograph (pick-up unit) and control electronics; furthermore, as mentioned in the inductive instance, the vehicle should include an electric drive train component, such as a battery and an electric motor. The roadside equipment comprises continuous masts carrying tensioned power cables and substations fitted with switchgear, power systems, rectifier diodes, controlled inverters, and communications networks (PIARC, 2018).

The roadside device supplies power to the overhead wires when a vehicle travelling at a certain speed is detected underneath the track. The pantograph on the top of the vehicle stretches automatically to make contact with the overhead wires. The pantograph transmits power to the vehicle's battery or propulsion system. Static applications work on the same principles as dynamic apps but are often smaller and need less infrastructure. Figure 5 illustrates the conductive overhead idea. The idea of dynamic conductive overhead charging for highway usage has advanced quickly over the past eight years, evolving into two main types of technology. There are two types of rail systems: catenary above and ground-level rail (PIARC, 2018).

Figure 5: Conductive (catenary/overhead) ERS Concept (PIRAC, 2018)

3.1.3 Conductive (in-road rail)

Conductive in-road rail ERS is similar to the overhead idea. It transfers energy directly between the power supply and the vehicle (through a mechanical arm/pantograph). It does, however, use segmented electrified rails embedded in or above the road surface. Its components are classified as follows: in-road, on-vehicle, and roadside. The term "in-road" relates to railways, electricity lines, and drainage systems. On-vehicle components include the pick-up unit (pantograph or mechanical arm) and associated control electronics, as well as the battery and electric motor. Transformers, grid hookups, and communications are all examples of roadside equipment. When a vehicle is spotted traveling down the rail track, the roadside devices electrify the segments. Once the vehicle is aligned with the track, a mechanical arm emerges from the rear/underside with the rail. The energy is subsequently transmitted to the battery or the propulsion system directly (PIARC, 2018). Figure 6 shows the conductive in-road rail idea.

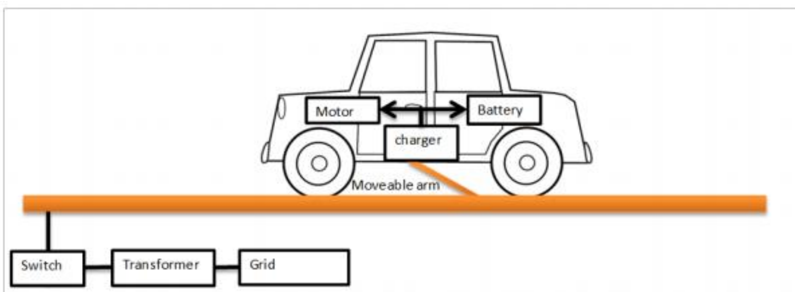

Figure 6: Conductive (in-road rail) ERS Concept (PIRAC, 2018)

3.1.4 Closed/Open-Loop Systems

There are two main implementation scenarios: closed-loop and open-loop. Closed-loop systems are highly regulated and often cover shorter distances along a predefined route. A closed-loop ERS, for example, might be installed on an industrial estate, a mining site, a port, or a metropolitan transit system. Vehicles generally follow the same route with consistent loads in these applications. Routes are usually isolated from public contact, i.e. bus lanes are separated from the main roadway and are located on private property. Within a closed-loop system, operators have more control over vehicle movements; the same brand of vehicles and just one kind of ERS manufacturer's system are utilized, minimizing the requirement for interoperability (PIARC, 2018).

An open-loop ERS system allows for the use of the same installation by many ERS compliant vehicles. There is no set path, just strategically placed dynamic portions. Vehicles of various brands/classes, ERS systems, charging needs, and communication protocols must coexist in the same area. Interoperability across disparate systems and payment communications is a critical requirement in open-loop situations. For instance, an ERS installation might be along a roadway accessible to any [ERS compliant] car. The operator of open-loop infrastructure has much less control over who uses, and when users use the system (PIARC, 2018).

3.1.5 Elonroad Dynamic Charge Station (DCS)

Elonroad's Dynamic Charging Station (DCS) is a conductive (in-road rail) charging infrastructure on the road. DCS consists of four main parts: power station, a road-rail, pickup and onboard charger. The power station takes electricity from the grid for every 1.5 km and distributes all the power to the road-rail. Insides the rails there are rectifiers that rectify the voltage to the vehicles, which is a constant 600-volt DC. A pickup with sliding contacts under the vehicles picks up the 600-volt DC from the road-rail to the onboard charger which charges the battery simultaneously while the vehicle is moving on the road (Elonroad, 2021).

Elonroad DCS also has a safety system. On the pickup there is an antenna sending a signal to the road. This detects the vehicle ID and the 1-meter segment switches on the power if all safety and operational parameters, such as vehicle alignment and ID verification, are met. It has a kind of access control; the energy used can be measured and there is a billing solution built in the rail (ibid).

The data is streamed throughout the road in all individual components to the cloud and this data can be used for many purposes. This data is important for a robust infrastructure. This system can also detect animals or an accident on the road and send warnings to the vehicle and operator (ibid).

3.1.6 Elonroad Stationary Charging Station (SCS)

With Elonroad's Stationary Charging Station (SCS), the vehicle can be automatically charged while you are parking without any extra cables. SCS technology resembles the Elonroad Dynamic Charging Station (DCS), the difference being that a short rail has been used instead of a long rail. SCS is an automatic park charger; after the vehicle is switched off the pickup goes down automatically and starts to charge. Elonroad can modify the stationary charging station according to customer preference, for example the onboard charger on the vehicles can be outside the vehicle. It will cost the customer less, but the customer won't be able to charge the vehicle dynamically on the road until an onboard charger is installed in the vehicle (Elonroad, 2021).

3.2 The Concepts of Electric Vehicles

Electric vehicles (EVs) are automobiles that are powered entirely or partially by electric motors. Electric vehicles are classified into four categories: battery electric vehicles (BEVs), plug-in hybrid vehicles (PHEVs), hybrid electric vehicles (HEVs) and fuel cell electric vehicles (FCEVs) (U.S. Department of Transportation, 2022). EVs, particularly battery electric vehicles (BEVs), which run on electricity rather than gasoline, have several advantages over internal combustion engine-powered vehicles. They emit no greenhouse gasses (GHGs) or criterion air pollutants on the road (Langbroek et al., 2017). The upstream pollution they generate may be much less severe, depending on the source of electricity utilized to charge the batteries and the energy intensity of manufacture (ibid).

3.2.1 Technology Concepts of Electric Cars

There were two main competing methods with vehicles when automobiles were first being developed: one that used an internal combustion engine (ICE) and another that used an electric generator. Thomas Davenport, an American inventor, created the first electric car in 1834. Benz and Daimler in Germany created the first automobile powered by an internal combustion engine (ICE) in 1886. Electric cars, which were powered by electric motors, had a significant share of the automotive market around the year 1900. A hybrid electric vehicle with an ICE range extender and wheel hub electric engines was already developed at the same time by F. Porsche. Before Henry Ford decided to use an ICE for the first mass-produced automobile in history in 1908, the two separate drive trains were in strong competition. By winning the competition in the early 20th century, ICE replaced battery-powered cars (BEV). This might have been one of the greatest mistakes in technological history from an environmental standpoint (Helmers and Marx, 2012).

In conclusion, the BEV is not a new example of "high tech," but rather a relatively straightforward technical idea that has been produced in mass quantities for more than 110 years. As a result, skilled workers can carry out e-conversion, or the change of new or used ICE to electric vehicles, with ease. On the other hand, modern lithium-ion battery technology, a requirement for the feasibility of most BEV in daily living, is connected to very recent developments in technology (Helmers and Marx, 2012).

3.2.2 Segments of Electric cars

The Zero Emission Act in California in the 1990s prompted the development of electric cars, which led to the creation of the hybrid vehicle by Toyota, improving energy efficiency. The success of the Toyota Prius helped spread the idea of electric cars worldwide, leading to the creation of plug-in hybrid vehicles (PHEV). All-electric and hybrid electric drives are different, with the latter consisting of at least two different energy converters (e.g., ICE and electric motor) and storages (e.g., fuel and battery). Fuel cell technology is also being developed, with a small series of fuel cell vehicles already in production or set to be released in the near future (Helmers and Marx, 2012).

Different car sizes impact the feasibility of electric cars (BEVs). As the weight of the vehicle increases, there is typically a need for greater battery capacity to maintain adequate range. However, this relationship may not be strictly linear, as factors such as battery technology and vehicle efficiency also play significant roles. Fully electric cars are mostly suitable for small- to mid-size cars due to weight limitations and battery costs. On the other hand, PHEV and FCEV are more useful in medium-size and large cars because only a small amount of energy needs to be carried in the battery; the energy density of compressed hydrogen is close to fossil fuels (Helmers and Marx, 2012).

3.2.3 Electric Vehicle Technical Components

The electric battery, electric motor, and motor controller are the three main parts of a BEV (Figure 7). A BEV's technical design is easier than an ICE's because it doesn't require a gearbox, an exhaust or lubrication system, a starting system, or even a cooling system.

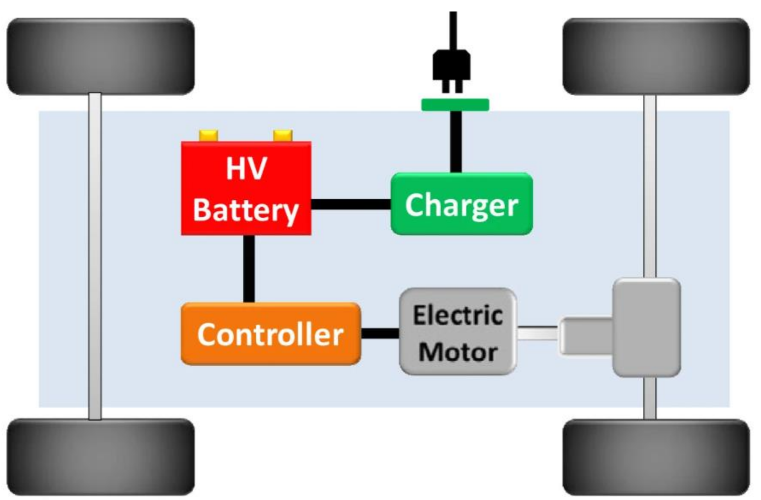

Figure 7: Key components of an electric vehicle. High voltage (HV) (Helmers & Max, 2012)

The battery is charged with energy when it is plugged into the power grid via a battery charger or when it is breaking, through recuperation. The charger is an extremely important part because, as of right now, its effectiveness can vary from 60% to 97%, wasting between 3% and 40% of the energy from the grid as heat. According to the load condition, the motor controller provides the electric engine with variable power. When used in a drivetrain, the electric motor transforms electrical power into mechanical force and torque. So far, central motors have been used in series BEV production; however, hub wheel electric motors are also feasible and would be ready for mass production (Helmers and Marx, 2012).

Modern, high-performance electric motors are built with permanent magnetic materials, the strongest of which include combinations of two metals containing the rare earth elements (REE) neodymium and samarium. NdFeB and SmCo magnets are typical materials. Since REEs are rare and a few countries, primarily China, restrict their export, this has raised some concerns about supply. Electric motors are classified into two types: alternating current (AC) motors and direct current (DC) motors. Depending on the individual use, permanent magnets can be used in AC and DC electric motors (Helmers and Marx, 2012).

Because they are less expensive, traction engines without magnets are quite common in electric vehicles. Induction motors are a type of AC motor that do not use REE. The Tesla Roadster, as well as the upcoming Tesla Model S and Toyota RAV4EV, have induction motors without REE. In detail, there are several electric engines available that do not use REE magnets: conventional mechanically commutated DC machines, asynchronous machines, load-controlled synchronous machines with electrical excitation, and switched reluctance motors. This gives the automobile industry some flexibility (Helmers and Marx, 2012).

3.2.4 Electric Car Batteries

Equipping electric cars with lead-acid batteries is still feasible and advantageous. While lead batteries powered just a portion of the vehicles used in California's 1990s interim electric vehicle boom, they already provided a driving performance comparable to conventional internal combustion engines. Today, commercially available small electric trucks are equipped with lead batteries ranging in capacity from 13 to 26 kWh, with a maximum range of 200 kilometers and a top speed of 60 kilometers per hour. Additionally, a portion of today's electric cars is fitted with lead-acid batteries. To ensure that future battery technology and materials are diverse, retaining Pb traction batteries for specific uses would be wise. Electric cars with shorter ranges, such as those used for intown driving, or so-called neighborhood electric vehicles, will be much less expensive to operate if lead-acid batteries instead of lithium-ion batteries power them. Additionally, there have been significant advancements in the performance of the lead battery due to the incorporation of a gel matrix and a gassing charge (Helmers and Marx, 2012).

However, Li-ion batteries' significant improvement in energy density is required for widespread electrification of automobiles to occur. Until the automobile was electrified in the 1990s, nickel-metal hydride batteries were used. However, they lack the required power and have a detrimental impact on the environment compared to Li-ion batteries. The Zebra cell, the only viable alternative to Li-ion batteries of comparable capacity, is based on molten salt and is thus limited to continuous daily use. Today, several Li-ion chemistries are available, and the price of Li-ion batteries continues to fall (Helmers and Marx, 2012).

3.3 EV Adoption factors in Sweden

Several factors have been identified in the literature that influence the likelihood of purchasing electric vehicles in Sweden. These factors can be broadly categorized into economic, technical, infrastructure, socio-demographic, and psychological factors (Liao et al., 2017; Hackbarth & Madlener, 2016; Egbue & Long, 2012; Jensen et al., 2013; Schuitema et al., 2013).

Economic factors play a significant role in the decision to purchase an electric vehicle (EV). Consumers are more likely to consider purchasing an EV if they perceive it as being more cost-effective than a conventional vehicle, particularly in terms of lower fuel and maintenance costs (Egbue & Long, 2012). Government incentives, such as tax breaks and subsidies, also impact the affordability of EVs and can increase their adoption rate (Hackbarth & Madlener, 2016; Liao et al., 2017). In Sweden, the introduction of the bonus-malus system, which rewards environmentally friendly vehicles with lower taxes and penalizes high-emission vehicles with higher taxes, has been shown to positively affect EV adoption (Jensen et al., 2013).

Technical factors also contribute to the decision-making process, with consumers evaluating the performance and range of EVs in comparison to conventional vehicles (Egbue & Long, 2012; Liao et al., 2017). For instance, concerns about the limited driving range of EVs and the availability of charging infrastructure may discourage potential buyers (Schuitema et al., 2013).

Infrastructure availability, particularly the presence and accessibility of charging stations, is a significant factor that can either facilitate or hinder EV adoption (Hackbarth & Madlener, 2016; Liao et al., 2017). In Sweden, the government has committed to expanding the charging infrastructure to support the growing EV market (Jensen et al., 2013).

Socio-demographic factors, such as age, gender, and education level, have also been found to influence the likelihood of purchasing an EV (Liao et al., 2017; Schuitema et al., 2013). For example, younger and more educated individuals are more likely to adopt EVs, as they tend to be more environmentally conscious and technologically savvy (Egbue & Long, 2012).

Finally, psychological factors, such as environmental concerns, social norms, and personal values, play a role in the adoption of EVs (Hackbarth & Madlener, 2016; Liao et al., 2017). Individuals with strong pro-environmental attitudes and beliefs are more likely to consider purchasing an EV (Schuitema et al., 2013). Furthermore, the influence of social norms, such as the opinions of friends and family, can also impact the decision to purchase an EV (Hackbarth & Madlener, 2016).

In conclusion, the decision to purchase an EV in Sweden is influenced by a combination of economic, technical, infrastructure, socio-demographic, and psychological factors. Understanding these factors can help policymakers and industry stakeholders develop targeted strategies to promote EV adoption in the future.

3.3.1 Influence factors from the infrastructure perspective

One of the key factors affecting the likelihood of purchasing EVs in Sweden is the availability of charging infrastructure (Sierzchula et al., 2014). A well-developed charging network is crucial for potential EV buyers, as it reduces range anxiety and ensures that they can conveniently recharge their vehicles (Egbue & Long, 2012). In Sweden, the government has been actively promoting the expansion of charging infrastructure, which has positively impacted the adoption of EVs (Nykvist & Nilsson, 2015).

Another factor to consider is the accessibility of public charging stations. Research has shown that the presence of public charging stations in urban areas significantly influences the decision to purchase an EV (Caperello & Kurani, 2012). In Sweden, the government has implemented policies to increase the number of public charging stations, particularly in densely populated areas (Liao et al., 2017). This has contributed to the growing popularity of EVs among Swedish consumers.

Additionally, the availability of fast-charging stations plays a crucial role in the adoption of EVs (Azadfar et al., 2015). Fast-charging stations allow EV owners to recharge their vehicles in a shorter amount of time, making long-distance travel more feasible (Neubauer & Wood, 2014). In Sweden, the expansion of fast-charging infrastructure has been supported by both public and private initiatives, further encouraging the adoption of EVs (Sopjani et al., 2019).

In conclusion, the availability of charging infrastructure is a significant factor influencing the likelihood of purchasing EVs in Sweden. The government's efforts to expand the charging network, increase the accessibility of public charging stations, and promote the development of fast-charging stations have all contributed to the growing popularity of EVs in the country. These factors, when considered as secondary data in the discussion chapter, can provide valuable insights into the broader context of EV adoption and infrastructure development.

[Page intentionally left blank]

Chapter 4: Theoretical framework

In this chapter, foundational theories such as the Technology Roadmap and Critical Success Factors will be explained. The theoretical framework will be examined and categorized under three principal domains: Technology, Business, and Partnership. Within these domains, specific areas like Technology Strategy, Technology Audit, Diffusion of Innovations, Value Proposition Canvas, among others, are presented and explained.

4.1 Technology Roadmap

Technology roadmapping has been acknowledged as a significant strategic management tool, facilitating the alignment of business objectives with technological capabilities. The simple yet profound concept has been widely adopted across various sectors, evolving from industrial practice rather than academic theory (Kerr & Phaal, 2020).

Companies like Motorola and BP were at the forefront, using roadmaps to strategically guide their technological investments and innovation activities. Motorola, in particular, was instrumental in popularizing the term through its publication in 1987, which articulated the benefits of the roadmap process (Kerr & Phaal, 2020).

Ding and Hernandez (2023) state that a comprehensive and rigorous definition was lacking even though technology roadmap and roadmapping have been previously defined by various authors. According to Ding and Hernandez (2023), Kerr and Phaal (2022) define roadmap as *"a structured visual chronology of strategic intent",* and roadmapping as *"the application of a temporal-spatial structured strategic lens". "The term "structure" relates to the governing framework that illustrates the interrelationships between evolving and developing markets, products, and technologies across time, thereby presenting both the commercial and technological perspectives in a roadmap."* (Ding and Hernandez, 2023)

Technology roadmaps are crucial for making informed decisions in technology development. They have become increasingly important in the electric vehicle (EV) charging infrastructure sector, helping companies to strategize, develop, and enhance their products and services (Phaal et al., 2004).

The Structure of the Roadmap

After conducting a literature review on the approaches and methods for developing a roadmap, Musango and Bent (2015) have observed in the literature that there is no single method that can be utilized when developing a roadmap. Generally, the methods, approaches and tools utilized are based upon the three key questions of the roadmapping process: *"where are we going?"; "where are we now?" and "how can we get there?"*.

The following table (Table 1) offers a description of each question.

Table 1: Fundamental questions for an effective roadmap. This table adapted from Carvalho et al. (2013) and Phaal and Muller (2009) cited in Musango and Brent (2015).

Question	Description
Where are we going?	This represents the vision, mission, objectives, goals and targets that the roadmap will be achieving.
Where are we now?	This represents the current state of technology development, products and market development.
How can we get there?	This represents the policy measures, action plans, research and development programs and strategies (both long- and short-term) that need to be implemented to achieve the vision, goals, objectives.

4.2 Critical Success Factors

The conceptualization of Critical Success Factors (CSFs), as discussed by Rockart (1979) as cited in Rodrigues & Dorrego (2008), is pivotal in strategic management and business research, serving as key indicators essential for the success of a company within a particular industry. This foundational perspective of CSFs underlines their significance in influencing a company's competitive position in its industry.

Building on this foundational work, the research also draws on Rodrigues and Dorrego's (2008) framework, which emphasizes the alignment of a company's core competencies with market-specific CSFs to achieve competitive advantage and superior market performance. Core competencies are understood as the organization's collective knowledge and are inimitable, integral to the organization, and superior relative to competitors, encompassing both tangible and intangible assets (Rodrigues & Dorrego, 2008).

4.2.1 Identification and Selection of CSFs

In line with the theoretical underpinnings laid out by Rodrigues and Dorrego (2008), the methodology for determining the CSFs for Elonroad's new Stationary Charging Station (SCS) technology involved a multi-perspective analysis considering the viewpoints of customers, partners, and the management of Elonroad.

Three key criteria were used for the identification of CSFs, as suggested by the literature:

Applicability: The factor must be relevant across the industry to all competitors.

Relevance: The factor must be of significant importance to the success within the industry.

Controllability: The organization must be able to exert influence or control over the factor.

Each of these factors aligns with the core competencies and market conditions required for the successful understanding and implementation of Elonroad's new SCS technology.

4.3 Technology Strategy

4.3.1 Introduction

According to Ford (1988), a good start to a better understanding of technology strategy is to identify what the core business is for a company, what skills are available within the company and what you can do, rather than what products or services you provide. Furthermore, Ford believes that it should not lock itself into which market it operates in at present, but analyze the company's technology in a broader spectrum. Rieck & Dickson (1993) believe that technology strategies are a process for companies to utilize their technological resources to achieve business goals. By technological resources it is meant personnel and competence as well as technology and products. Rieck & Dickson (1993) further explain that one should look at the company as a whole and not individual processes.

4.3.2 Content of a technology strategy

According to Ford (1988), technology strategies can be divided into three different parts:

- **Technology acquisition**
- **Technology management**
- **Technology exploitation**

These three parts are further developed by Davenport, Campbell-Hunt, & Solomon (2003) into a model that can be seen below in Figure 8.

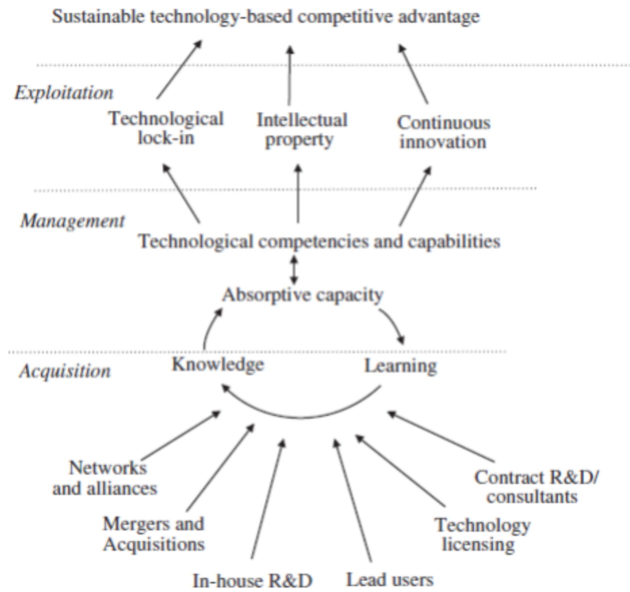

Figure 8: Framework for technology strategy (Davenport, Campbell-Hunt, & Solomon, 2003)

4.3.2.1 Technology Acquisition

When companies acquire technology, several different factors can come into play. For example, the size of the investment, the expected technological life, and also the importance of the investment can influence the decision on and, if so, how to acquire the technology. If the technology, for example, is extremely vital for the company, it may be most appropriate to acquire it internally.

Research and Development. If, on the other hand, the technology is not particularly important to the company and is a relatively simple technology, for example, external research and development should be chosen. Sometimes a mixture of the different alternatives can and should also be used. For example, you can outsource part of the development and the remaining part is developed internally. Depending on how the company is positioned in the current technology area, the most suitable alternative is chosen from the alternatives in the model:

- Networks & Alliances
- Acquisition or merger of companies
- Own research & development
- Lead users
- Licensing of technology
- Fully or partially external research & development

Networks & alliances

Ford & Thomas (1997) believe that one must understand the importance of technological resources not only in one's own company but also with other actors. They believe that a significant technology strategy also inevitably includes a network & alliance strategy. By entering into alliances or entering into networks, you can gain access to valuable technology without having to develop it yourself.

Acquisition or merger of companies

If another player has already developed the technology needed for a company, the company should consider acquiring or merging with that player instead of developing the technology itself.

Own research & development

If a company has a research & development department and thus has the capacity, you can develop the technology needed for the company.

Lead users

By identifying and interacting with so-called "lead users", customers whose needs can be applied to the broad masses within a certain time, companies can get valuable information and valuable ideas for future products or services. (Lüthje & Herstatt, 2004)

Licensing of technology

A company can benefit from a technology by entering into a licensing agreement with another company. In this way, you avoid development costs but on the other hand usually pay a fee to use the technology.

Fully or partially external research & development

A company does not necessarily have to develop the entire product or technology itself, but can choose to place parts or the entire development in an external research and development department.

4.3.2.2 Technology Management

For a successful management of technology (Ford, 1988) believes that the company should have approaches to handle the transfer of technology and information within the company between different divisions. Ford (1988) believes that a technology that is accepted within one department can be of great importance to another department. Furthermore, the company should develop its products or services in parallel with the development of its technology. (Ford, 1988) emphasizes the importance of maintaining its technological portfolio. This includes both maintenance and development of technologies.

An article by Davenport, Campbell-Hunt, & Solomon (2003), highlights the complexity of managing a technology strategy and emphasizes that it is not just about allocating technologies but also about technological human resources management. This means ensuring that people with the right technological competence are included in the value-creating processes. Furthermore, Davenport, Campbell-Hunt, & Solomon (2003) explain that one can simply say that technology management is about encouraging and further developing technology competence and technology capacity within the company, ie "absorption capacity".

4.3.2.3 Technology Exploitation

Ford (1988) believes that technology utilization is in many ways similar to technology acquisition. Furthermore Ford (1988) mentions four different ways of exploiting a technology:

- Use in the company's own products
- Outsourced manufacturing or marketing
- Joint Venture
- Licensing out the technology

Davenport, Campbell-Hunt, & Solomon (2003) further develop these four approaches into three categories:

Technological "Lock-in": Technological "Lock-in" means that you create a form of standard in the market. his approach can be good if it is difficult to protect the technology with patents and if it is easy to copy. By creating a form of industry standard, you protect your position in the market. This type of strategy also requires continuous innovation.

Intellectual property rights: By, for example, patenting your technology, you protect the technology from competitors. Depending on what the market looks like and how fast the development takes place, this can be a good alternative. Furthermore, one should also analyze what the competitors look like in comparison with the company. This is because if the company is relatively small, a larger competitor can simply ignore the patent protection as it is considered that any damages can be worth it.

Continuous innovation: Continuous innovation means that the company is constantly working to develop the product or service. In this way, you retain your potential "first mover advantage" and protect your technology and market position by being innovative and always at the forefront.

4.3.3 How to develop a technology strategy

There are several different angles to define and develop a technology strategy. Ford (1988) argues that a technology strategy is only as good as the analysis on which it rests. Rieck & Dickson (1993) report various questions companies can answer more easily develop and define this analysis. The questions are seen below in Table 2.

Table 2: The six tasks of technology strategy (Rieck & Dickson, 1993)

Task	Time-frame (Years)	Decisions
Setting horizons	20 +	Choice of industrial sector; technological implications of this choice
Industry forecasting	10–20	Future direction of industry; industrial revolution *vs* evolution
Technology positioning	5–10	Core technologies of firm; position relative to frontiers of science and technology
Determining technology availability	2–5	Information sources on technology; technology acquisition internal and external
Appropriating technology	1–2	Effective use of technology; getting new technology into operation
Managing technology	0–1	Efficient use of technology; continuous improvement of technology

Define the horizon

Rieck & Dickson (1993) believe that when companies define their vision for the future, they must identify which industry or industries they should operate in. In this phase, the industry is examined over the next 20 years, as the industry roughly defines the technological environment in which the company operates. The current industry in which the company operates defines most of the technologies that a company needs, but when defining its horizon, one must also weigh the pros and cons of changing direction. That is, identify if there are technological and or market advantages of switching or expanding into a new market.

Industrial forecasting

Once you have identified the industry or industries in which you will operate within 10-20 years, you look more closely at each industry. Instead of trying to identify which different types of products that will be introduced in these industries instead, one identifies the driving forces that affect the industry. By identifying the forces that affect the industry and then also the direction of the industry, one can identify in which direction the technological development in this industry will go (ibid).

Technology positioning

Rieck & Dickson (1993) believe that this part of the process is the essence of a company's technology strategy. In this step, companies should identify the strategic position in the industry that is best suited for the company, on the 5–10-year horizon. In many industries, the technological positioning is a direct function of the strategic positioning in the market (Porter, 1989). In this step, the company defines how they will use the technology to gain a competitive advantage. In technology-intensive industries, technological positioning will weigh more heavily in a company's strategy compared to less technology-intensive industries.

Determine the technological availability

In this step, the company should have developed an understanding of the identified technologies required and its significance both today and in the future. The procurement methods for the technologies are divided into three different parts, internal research & development, external research & development and a mixture of the two. This is done with the goal of examining the approximate time span 2-5 years. All three alternatives have their advantages and disadvantages, but according to Rieck & Dickson (1993), more and more companies seem to buy their technology from external players. Rieck & Dickson (1993) further believe that an increase in value can occur if one identifies synergy effects between the different technologies as competitive advantages often arise with clusters of technologies rather than with individual technologies.

Apply the technology

Once the company has identified the technologies they need and the source of the technologies, it is necessary to ensure that the technology is implemented in the next one to two years efficiently in the company. Rieck & Dickson, (1993) divide the application of technology into two parts. The first part is the economic aspect; knowledge is relatively expensive to produce but cheaper to disseminate. Therefore, they emphasize the importance of reducing the leakage of knowledge to competitors. The second part is about implementing and applying the technology in an appropriate way. For this to work well, it is required that those who work within the company with the technology overlap their work so that know-how and expertise are spread within the organization.

Technology management

The last part of this technology strategy is the implementation and management of technology. To create good conditions for the technology to be implemented and used in the right way, continuous development and improvement is required (Rieck & Dickson, 1993). A company's ability to gradually improve activities throughout the company creates better conditions for the implementation of technologies.

4.3.4 Technology Audit

4.3.4.1 Introduction

As previously mentioned, Ford (1988) believes that a technology strategy, just like other strategies, is only as good as the analysis it is based on. Furthermore Ford (1988) mentions that one way to do this analysis is to conduct a so-called Technology Audit. A Technology Audit is a tool that works in two steps to evaluate the company's technological position and based on this analysis create a technology strategy. A Technology audit does not have to be one-time occurrence but should be a continuous and recurring management process. On the other hand, it is common for the audit to be performed for the first time by an external consultant and then followed up continuously internally. An audit is a first step in creating an overall picture of the company's technologies, which then forms the basis for any technological investments and adjustments.

4.3.4.2 Content of a Technology Audit

Ford (1988) presents suggestions for areas with questions a company should be asked when working with a Technology audit:

What are the technologies and know-how on which our business depends?

Ford (1988) believes that the company should identify which technologies and know-how the company's core business is based on. The company should ask itself how these technologies were acquired - were they purchased from an external supplier or have they been developed within the company? Furthermore Ford (1988) believes that one should distinguish between different technologies. The technologies are divided into basic, distinctive and external technologies. The basic technologies are the technologies required to operate in the markets in which the company operates. The distinctive technologies are those that characterize the company in the market, and which also form the basis for the company's position. The external technologies are those that the company itself does not own and can, for example, be assembly or components for a product or the like.

Furthermore, it should also be identified whether the company should focus on developing competencies and technologies internally or whether they should be acquired through external suppliers.

Do we have a poor record bringing 'home-grown' technologies to market ?

Is this poor performance due to inadequacies in research, in development or in commercialization? Should we take steps to improve this performance, or accept our inadequacies and concentrate on searching for and acquiring new technologies from others?

How does our technology position compare to that of our customers?

When a new technology is launched, the gap between the company's technological know-how and the customer's technological know-how is larger.

This is illustrated in Figure 9, when the technological gap is larger, companies can (according to (Ford, 1988) take higher margins on their services and products. When the technological gap decreases and customers acquire knowledge in the area, they become less likely to pay for the services and products the company offers, which is why margins decrease over time for a given technology.

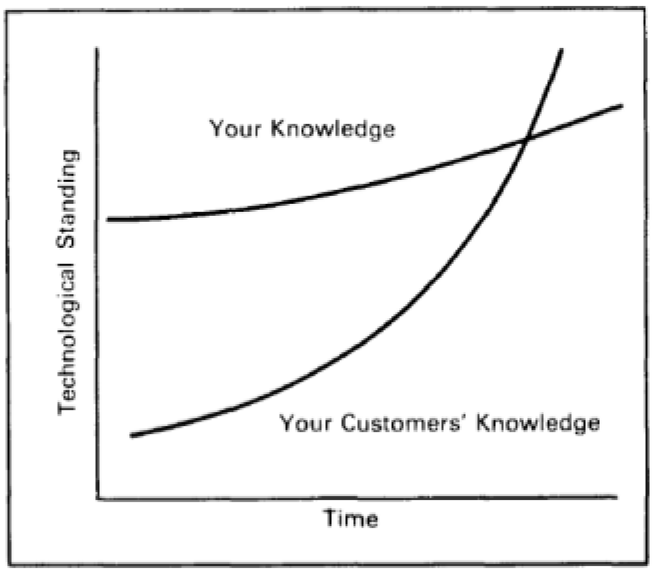

Figure 9: The shrinking technology gap (Ford, 1988)

Where in the technological life cycle are the technologies we depend on?

According to Ford (1988), by identifying where in the technological life cycle a technology is, it becomes easier to identify opportunities and risks of being dependent on this technology. For example, it can be dangerous to be dependent on old technologies as they will soon be completely interchangeable. Furthermore, there are also risks of being dependent on advanced technologies if you yourself do not have the opportunity to develop and further develop these with the help of internal Research and Development.

What are the internal and external technologies that can affect our existing and possible markets?

In order to be better prepared for changes in markets due to technologies, not only people with good insight into technology should be involved but also people with good insight into existing and potential markets. The technologies are not limited to those currently in the company, but the analysis also extends to external technologies. In this, according to Ford (1988), an open mindset is required so as not to overlook markets or technologies you may not be familiar with. Therefore, it is often common for external technology consultants and marketing consultants to be used in this part of the technology audit.

Is the company's strength in the product, the production or both?

Sometimes companies are very good at designing and developing products, a good example of this is Apple. According to Ford (1988), by identifying one's strengths, one can better make decisions about what should happen within the company and what should be purchased externally. By actively working with this analysis, the company increases its opportunities to create a higher margin on their products.

Does the company have technologies that are no longer useful to us but can be useful to other companies?

Often there are other markets for old technologies that are no longer of use to the company in the current markets. According to Ford (1988), these are often developing countries that have not come as far in IT technological development and demand. By identifying old technologies in the company and also which markets they can be useful in, you can create business that many companies currently overlook.

4.4 Technology Adoption

4.4.1 Diffusion of Innovations

The Diffusion of Innovations theory explains how new ideas and technologies spread throughout a society. Innovation diffusion can be a challenging and time-consuming process, even when the advantages are evident (Rogers, 1983). This process involves the communication of a new idea through various channels within a social system over a period of time (Rogers, 1983). Contrary to popular belief, innovations do not always sell themselves based on their benefits, and their adoption may be slower than anticipated by their creators (Rogers, 1983).

Four key elements are present in every diffusion research study and campaign: the innovation itself, communication channels, time, and the social system (Rogers, 1983). The adoption rate of innovations can be explained by their perceived characteristics, such as relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1983).

Relative advantage refers to the perception of an innovation being superior to its predecessor, while compatibility is the extent to which an innovation aligns with the values, experiences, and needs of potential adopters (Rogers, 1983). Complexity denotes the perceived difficulty of understanding and using an innovation, while trialability refers to the possibility of testing an innovation on a limited basis (Rogers, 1983). Finally, observability is the visibility of an innovation's results to others, which can influence adoption rates (Rogers, 1983).

Innovations that are perceived to have higher relative advantage, compatibility, trialability, and observability, and lower complexity, are more likely to be adopted rapidly (Rogers, 1983). Research has shown that relative advantage and compatibility are particularly crucial in determining an innovation's adoption rate (Rogers, 1983).

4.4.2 Technology Acceptance Model (TAM)

The Technology acceptance Model (TAM) is the result of efforts by researchers to understand the factors that influence people's approval or rejection of technology, particularly computers. However, its application has expanded to include a wide range of technological systems and tools. It concentrates on the internal beliefs and attitudes of users, with system technical design, user involvement in development, the development process, and how well the system fits its purpose influencing usage behavior. (Davis et al., 1989)

Researchers have studied user behavior from a social psychology perspective, with the Theory of Reasoned Actions (TRA) model being successful in explaining and predicting behavior. The TRA model shown in Figure 10, posits that a person's actual behavior is based on their behavioral intention (BI), which is influenced by two factors: attitude towards behavior and subjective norm (SN). Attitude towards behavior is affected by beliefs and evaluations, while SN is influenced by the motivation to adapt and normative beliefs. (Davis et al., 1989)

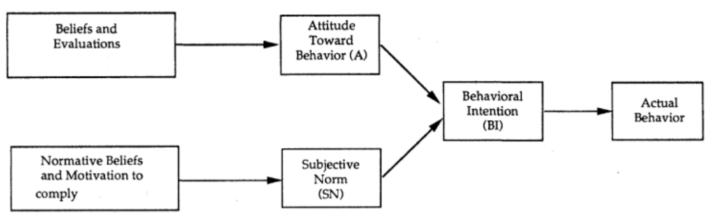

Figure 10: Theory of Reasoned Action (TRA), (Davis et al., 1989)

Fred Davis created the Technology Acceptance Model (TAM) from the TRA model to better understand the factors that influence information systems acceptance. TAM examines external factors affecting users' internal beliefs, intentions, and attitudes, and highlights two key beliefs: perceived usefulness and perceived ease of use. Perceived usefulness is based on an individual's estimation of the probability that a particular information system will enhance work performance. Perceived ease of use can be defined as how much effort is needed to use a system effectively. (Davis et al., 1989)

According to the TAM model, actual system use depends on behavioral intention (BI), which is directly impacted by perceived usefulness and attitude towards using. Attitude is influenced by both perceived usefulness and perceived ease of use, while external variables affect both perceived ease of use and perceived usefulness The TAM model is shown in Figure 11 (Davis et al., 1989).

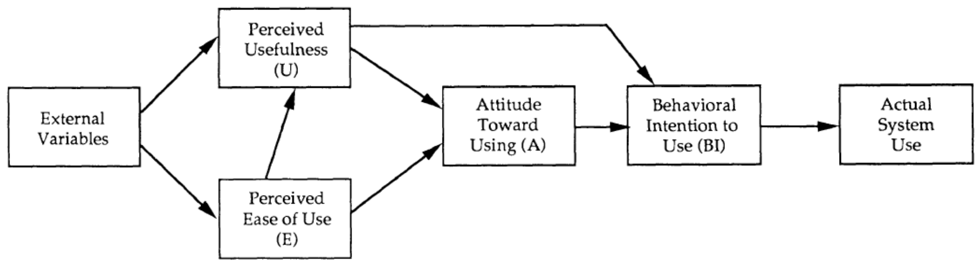

Figure 11: Technology Acceptance Model (TAM), (Davis et al., 1989)

TAM can help understand how people adopt new technologies by looking at their attitudes and beliefs towards the technology. For a high-tech startup, TAM can be used to understand the potential market for their product or service, as well as to identify any barriers to adoption that might need to be addressed.

4.5 Business

4.5.1 Value Proposition Canvas

Osterwalder et al. (2014) developed the Value Proposition Canvas (VPC), a useful model, from the Business Model Canvas. A value proposition is the benefits that consumers can anticipate from particular products or services. The purpose of the Value Proposition Canvas is to develop a value map that includes products and services, activities for generating gains and alleviating pains, and to map these items to a customer profile that includes the jobs, gain, and pain of the target market. The aim is to align the value map with the customer profile so that the customer's needs are satisfied by the solution. (Osterwalder, Pigneur, et al. 2014). Figure 12 provides an illustration of the Value Proposition Canvas.

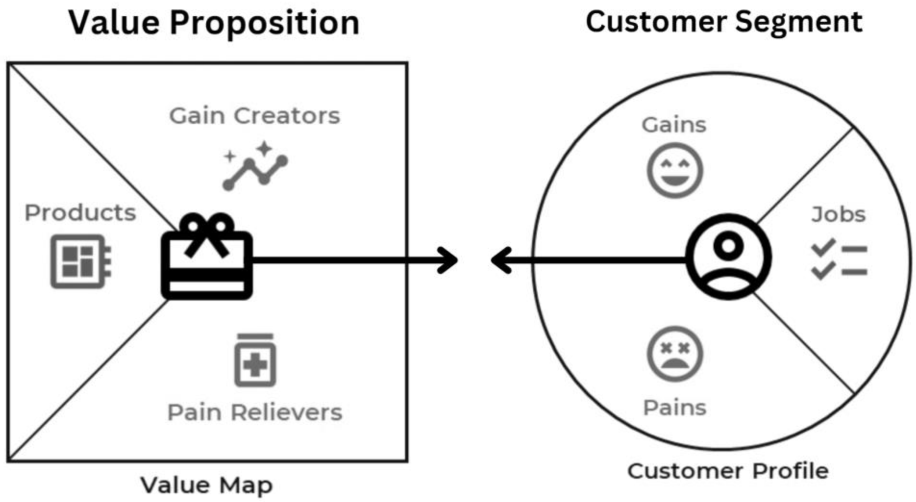

Figure 12: The Value Proposition Canvas. Figure adapted from Osterwalder, Pigneur, et al. 2014, pp 8-9

A Value Proposition Canvas practitioner begins by developing a customer profile. The customer profile contains the customer's job, pains, and gains. Customer jobs describe what the customer wishes to do and can be functional, social, or emotional. This can include tasks to accomplish, problems to solve, or needs to be met. Customer pains are obstacles that hinder or prevent the customer from completing a task. These can also be linked to the risks of not completing a task. Customer gains are anticipated or unexpected beneficial outcomes that a customer desires. There are functional gains, social gains, good feelings, and savings on costs. (Osterwalder, Pigneur, et al., 2014)

The Value Proposition Canvas practitioner creates a value map after creating a customer profile. The value map is made up of products and services, as well as pain relievers and gain generators. The products and services are formulated in a list and include the offering that is created for the customer. The products and services assist the customer in completing their jobs, and they only generate value when they are linked to the customer's jobs, pains, and gains. Physical/tangible, intangible, digital, and financial products and services are examples of these. Pain relievers explain how the products or services relieve the customer's pain. The gain creators explain how the products or services benefit the customer. (Osterwalder, Pigneur, et al., 2014)

B2B customer profiles vary from B2C customer profiles in that value propositions for B2B customers frequently require the evaluation of more than one stakeholder. Because each stakeholder has different jobs, pains, and gains to consider, separate customer profiles should be developed for each of them. Influencers, recommenders, economic buyers, decision makers, end users, and saboteurs are the various kinds of stakeholders in a B2B value proposition context. Influencers are people who usually influence decision makers. Recommenders are people who look for, evaluate, and recommend whether or not to purchase a product or service. Economic buyers are in charge of the budget and make the final purchase. These individuals are primarily concerned with the financial success of an investment. Decision makers have the final say on whether or not to purchase a product or service. The individuals who will ultimately benefit from the product or service are known as end users. Saboteurs are individuals who can hinder the process of finding, evaluating, and buying a product or service. (Osterwalder, Pigneur, et al., 2014)

Finally, the practitioner prioritizes the customer's pains, gains, and jobs and creates a match between the customer profile(s) and the value map. There are three kinds of fit: problem-solution fit, product-market fit, and business model fit. When evidence indicates that a customer cares about the jobs, pains, and gains in the customer profile, and the value proposition addresses these jobs, pains, and gains, the problem-solution fit happens. When customers are proven to be satisfied with the value proposition, the product-market fit happens. Finally, business model fit is achieved when the value proposition is effectively integrated into a business model. (Osterwalder, Pigneur, et al., 2014)

4.5.2 Why the Lean Start-Up Changes Everything

4.5.2.1 Introduction

Blank provides a brief overview of the evolution of lean start-up techniques in his article *'Why the Lean Start-Up Changes Everything'.* Importantly, Blank should explain how, when combined with other business trends, they can spark a new entrepreneurial economy (Blank, 2013).

"Lean start-up practices aren't just for young tech ventures. Large companies, such as GE and Intuit, have begun to implement them." (Blank, 2013)

The traditional approach to launching a new enterprise whether it's a tech startup, small or large business, involves a series of conventional steps (Blank, 2013). According to the old formula you need write a business plan, pitching it to investors, building a team, developing a product, and then selling it (ibid). However, this approach has resulted in a high failure rate for startups (ibid). In contrast, the lean startup methodology emerged in the early 2010s, aiming to minimize risks while improving the chance of success (ibid). It achieves this by prioritizing experimentation, customer feedback, and iterative design over elaborate planning (ibid). This approach has introduced new concepts like "minimum viable product" and "pivoting," which are integral to its success (ibid).

According to Blank (2013), the primary distinction between a company and a startup is that a company is executing a business plan, compared to a startup is searching for a scalable and repeatable business model. On this basis, the lean startup methodology defines three guiding principles:

1. Founders recognize that their ideas are just assumptions, so they don't waste time on extensive research or planning (Blank, 2013). Instead, they use a business model canvas to summarize their hypotheses (ibid). This diagram shows how a company creates value (ibid).

2. Lean startups use customer development to test their hypotheses in an iterative process (ibid). A more detailed explanation will be found in 4.3.2.2 below.

3. Lean start-ups use agile development in partnership with customer development to create minimum viable products (ibid). A more detailed explanation will be found in 4.3.2.3 below.

4.5.2.2 Principle two: Listen to your customers

The principle two of the lean startup methodology is customer development. During customer development a start-up looks for a successful business model based on customer feedback (Blank, 2013). They gather feedback from customers and create a minimum viable product, which is then shown to customers for further input (ibid). If feedback indicates that the initial hypotheses are wrong, the start-up either revises them or pivots to new ones (ibid). Once a successful business model is established, the start-up builds a formal organization and executes the plan (ibid). This iterative process involves several failures before finding the right approach (ibid).

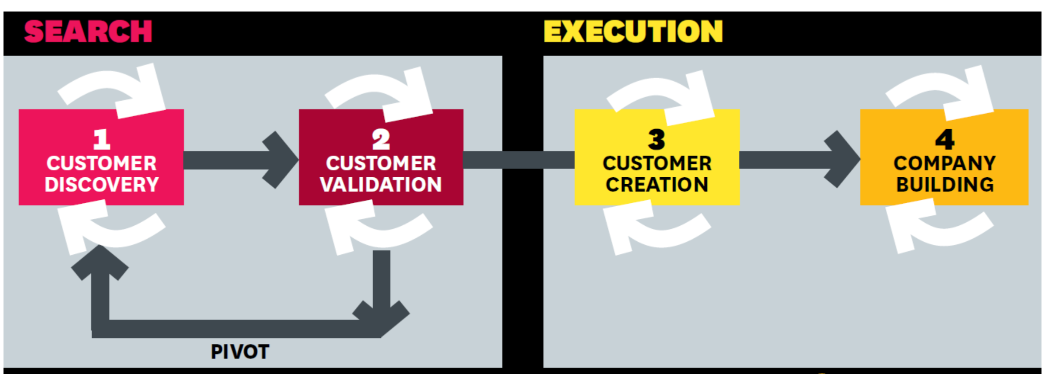

Figure 13: The Four Steps Epiphany. Iterative search, find & exploit also called Pivot (Blank, 2013)

1. **Customer Discovery:** Founders develop business model hypotheses and test assumptions about consumer demands before developing a minimum viable product to test the proposed solution on clients (ibid).

2. **Customer Validation:** All other hypotheses are still being tested, and the startup is attempting to validate user interest through first orders or usage of the product. If no one is interested, the company can "pivot" by revising one or more hypothesis (ibid).

3. **Customer Creation:** The product is polished, and the start-up generates demand by increasing marketing and sales spending, employing tested assumptions, and scaling the firm (ibid).

4. **Company Building:** The company moves from start-up stage, with a customer development team looking for answers, to functional departments implementing the model (ibid).

4.5.2.3 Principle three: Quick, Responsive Development

In principle three of the lean startup methodology, lean start-ups use agile development to generate minimal viable products in collaboration with customer development (Blank, 2013). Agile development involves short development cycles that avoid wasted time and resources, and iterative and incremental product development that does not assume knowledge of customer problems and product demands (ibid). It is the process by which start-ups develop and test their minimal viable products (ibid). Unlike traditional product development, when each stage occurs in sequential order and lasts months, agile development creates products in short, repetitive cycles (ibid). A startup creates a "minimum viable product" with only critical features, collects user input, and then starts over with a new minimum viable product (ibid).

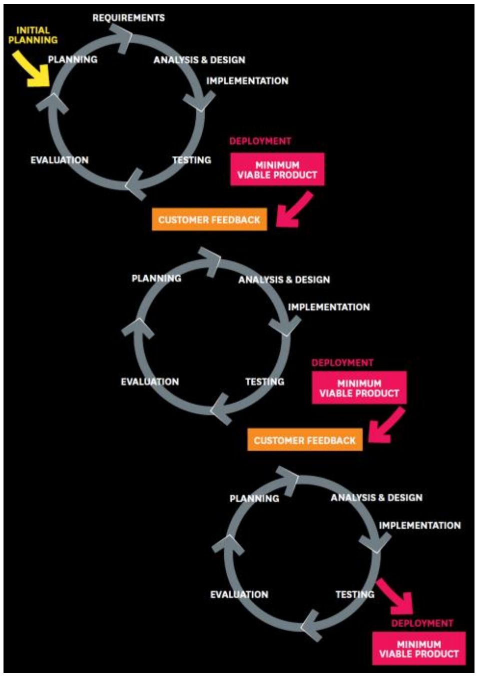

Figure 14: Quick, Responsive Development for "minimum viable product" (Blank, 2013)

4.5.3 SWOT - Analysis

Albert Humphrey developed the SWOT model in the 1960s as a strategic planning tool for analyzing an organization's strengths, weaknesses, opportunities, and threats. It helps companies to identify internal and external variables impacting their performance and developing plans to take advantage of their strengths and opportunities while avoiding their weaknesses and risks (Johnson et al., 2008).

The organization's internal resources, capabilities, and competencies are related to its strengths and weaknesses. These elements may include a company's financial resources, human resources, intellectual property, and brand reputation (Johnson & Whittington, 2012).

Opportunities and threats, on the other hand, are external factors that arise from the organization's environment. These factors can include political, economic, social, technological, environmental, and legal aspects (PESTEL), which can impact the organization positively or negatively (Johnson et al., 2008).

To apply the SWOT model, follow these steps below:

1. Identify the organization's strengths: Analyze the internal resources, capabilities, and competencies that give the organization a competitive advantage. For example, a strong brand reputation or a highly skilled workforce.

2. Identify the organization's weaknesses: Determine the internal factors that limit the organization's performance and hinder its ability to achieve its objectives. For example, outdated technology or high employee turnover.

3. Identify the organization's opportunities: Assess the external factors in the environment that can positively impact the organization's performance. For example, emerging markets or favorable government policies.

4. Identify the organization's threats: Examine the external factors in the environment that can negatively impact the organization's performance. For example, increased competition or regulatory changes.

5. Develop strategies: Based on the SWOT analysis, develop strategies to capitalize on the organization's strengths while addressing its weaknesses and threats.

4.5.4 The Kano Model

The Kano Model, proposed by Noriaki Kano and his colleagues in 1984, is a theoretical framework that classifies customer preferences and needs into distinct categories to better understand and predict customer satisfaction and product or service success. This model is widely used in product development, service design, and quality management to prioritize and address customer requirements effectively (Kano et al., 1984).

4.3.4.1 Classification of Customer Requirements

The Kano Model distinguishes customer requirements into three main categories: basic needs, performance needs, and excitement needs (Kano et al., 1984):

1. **Basic Needs:** Also known as must-be needs or dissatisfiers, these are the fundamental requirements that customers expect from a product or service. If these needs are not met, customers will be dissatisfied. However, fulfilling these needs does not lead to increased satisfaction, as they are taken for granted by customers (Kano et al., 1984).

2. Performance Needs: These needs, often referred to as one-dimensional needs or satisfiers, are directly related to customer satisfaction. When performance needs are met, customer satisfaction increases, whereas unmet performance needs result in dissatisfaction. These needs are typically associated with the core features and functionalities of a product or service (Kano et al., 1984).

3. **Excitement Needs:** Also known as attractive needs or delighters, excitement needs are features or characteristics that customers do not expect but appreciate when present. Fulfilling these needs can significantly enhance customer satisfaction, while their absence does not cause dissatisfaction (Kano et al., 1984).

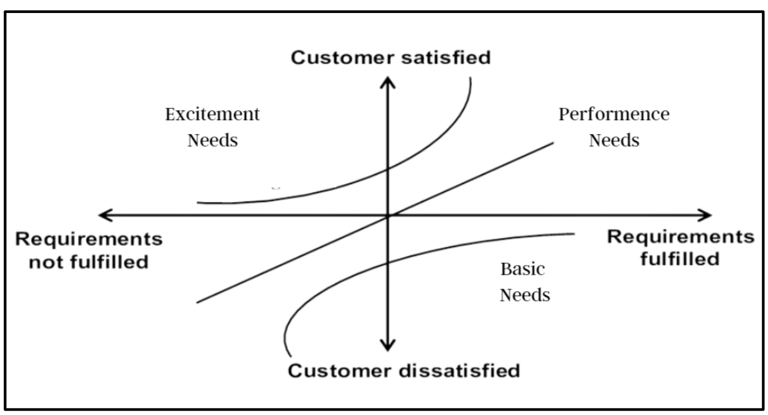

Figure 15: Kano model of customer satisfaction (Kano et al., 1984)

4.3.4.2 Implications for Product Development and Service Design

The Kano Model offers valuable insights for product development and service design by emphasizing the importance of understanding and addressing different types of customer needs (Kano et al., 1984). By identifying and prioritizing basic, performance, and excitement needs, organizations can develop products and services that better meet customer expectations and enhance overall satisfaction.

Furthermore, the model suggests that organizations should continuously innovate and adapt to changing customer preferences, as excitement needs may evolve into basic or performance needs over time (Kano et al., 1984). This highlights the importance of ongoing research, development, and improvement to maintain a competitive edge and deliver superior customer value.

In conclusion, the Kano Model provides a comprehensive framework for classifying and understanding customer needs and preferences, offering valuable guidance for product development, service design, and quality management. By focusing on the different categories of customer needs, organizations can create products and services that effectively meet customer expectations and enhance satisfaction.

4.5.5 SECI model by Nonaka and Takeuchi (1995)

The SECI model, developed by Ikujiro Nonaka and Hirotaka Takeuchi in 1995, is a theoretical framework that explains the process of knowledge creation and transfer within organizations. The SECI model stands for Socialization, Externalization, Combination, and Internalization. These four modes of knowledge conversion represent the process of transforming tacit knowledge (knowledge that is difficult to articulate and share) into explicit knowledge (knowledge that can be easily communicated and documented), and vice versa. See Figure 16 below.

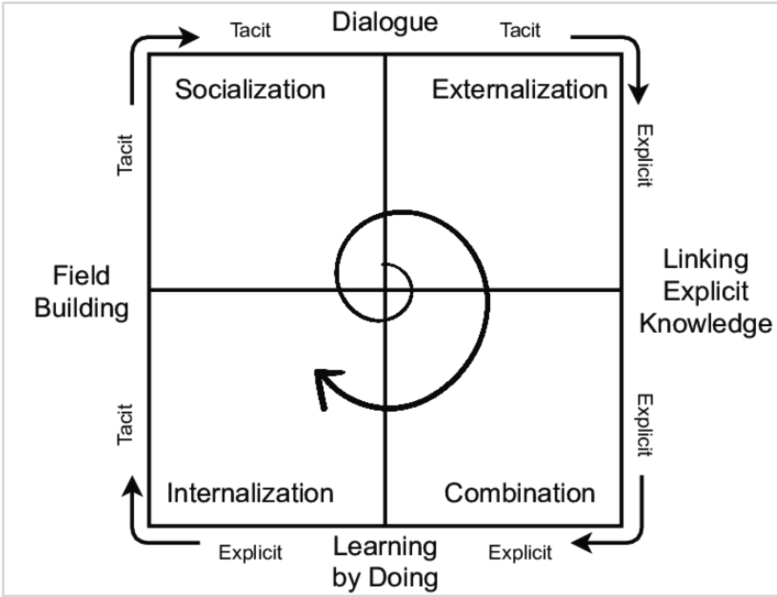

Figure 16: The knowledge-creating process: SECI model (Nonaka & Takeuchi, 1995)

1. **Socialization:** Tacit knowledge is shared through direct interaction, observation, and practice between individuals (Nonaka & Takeuchi, 1995). This phase involves face-to-face communication, where individuals engage in conversations, share experiences, and learn from one another. The process allows individuals to develop shared mental models and technical skills, fostering a collective understanding of the organization's values and practices (Nonaka, 1994).

2. **Externalization:** Tacit knowledge is transformed into explicit knowledge through the use of metaphors, analogies, or models (Nonaka & Takeuchi, 1995). This conversion process often takes the form of metaphors, analogies, or narratives, which help individuals communicate complex and abstract concepts more effectively (Nonaka, 1994). Externalization enables the organization to capture and disseminate knowledge, making it more accessible to others within the organization.

3. **Combination:** Different pieces of explicit knowledge are combined, organized, and integrated into more complex and systematic knowledge

(Nonaka & Takeuchi, 1995). This phase includes processes such as data analysis, categorization, and integration, which allow individuals to recognize patterns, develop new concepts, and establish relationships between different pieces of explicit knowledge (Nonaka, 1994). The outcome of the combination phase is the generation of new knowledge that can be further disseminated and applied throughout the organization.

4. **Internalization:** Explicit knowledge is converted into tacit knowledge through learning and practice, becoming part of an individual's internal knowledge base (Nonaka & Takeuchi, 1995). This phase typically involves learning-by-doing, where individuals apply new knowledge to their daily work, refining their skills, and deepening their understanding of the subject matter (Nonaka, 1994). Internalization leads to the development of individual competencies, which contribute to the overall knowledge base and capabilities of the organization.

The SECI model, applicable in diverse settings such as businesses, educational institutions, research organizations, and high-tech startups, plays a vital role in fostering knowledge creation, sharing, and management. By understanding and implementing this model, organizations can facilitate the flow of knowledge, promoting innovation and learning. In the context of high-tech startups, where rapid change and competition are prevalent, the ability to create and leverage knowledge becomes crucial for their success and innovation.

4.5.6 Clayton Christensen’s job to be done

Harvard professor Clayton Christensen says that when people buy a product, they are really "hiring" it to help them do a job they can't do on their own. If the job is done well, the customer will probably use that product again; if not, they will "fire" it and find a different solution (Christensen et al., 2016). According to Christensen, understanding the customer's "job to be done" is essential to the success of innovations because effective innovations help consumers solve problems and achieve their goals. In addition to assisting consumers make the necessary progress, it is essential to identify and address any inertia or anxiety that may prevent them from purchasing the product (ibid). Christensen also says that jobs are more than just a function; they have strong social and emotional aspects for the customer (ibid). The product is not just a product; it is a job that customers hire to solve their problems and give them an experience (ibid).

4.6 Partnership

4.6.1 The Triple Helix Model

The Triple Helix Model, a theoretical framework that examines the interaction between three key institutional spheres: academia, industry, and government. The model, developed by Henry Etzkowitz and Loet Leydesdorff in the late 1990s, offers valuable insights into the dynamics of collaboration and innovation in high-tech ecosystems (Etzkowitz & Leydesdorff, 2000).

According to Etzkowitz and Leydesdorff (2000), the Triple Helix Model is characterized by three main features:

1. **Institutional Layering:** The model acknowledges the existence of overlapping roles and responsibilities among the three institutional spheres. For example, governments may support research and development (R&D) within academia, while universities may engage in entrepreneurial activities.

2. **Reflexivity:** The Triple Helix Model emphasizes the importance of continuous learning and adaptation among the institutional spheres. This enables the development of policies and strategies that are responsive to the needs of the innovation ecosystem.

3. **Hybrid Organizations:** The model recognizes the emergence of new types of organizations that blur the traditional boundaries between academia, industry, and government. These hybrid organizations facilitate the transfer of knowledge and technology across the institutional spheres (Etzkowitz & Leydesdorff, 2000).

Implications of the Triple Helix Model

The Triple Helix Model has several implications for innovation and economic development:

1. **Collaboration and Knowledge Exchange:** The model emphasizes the importance of collaboration and knowledge exchange between academia, industry, and government. This can lead to the development of new technologies, products, and services that drive economic growth (Etzkowitz & Leydesdorff, 2000).

2. **Innovation Ecosystems:** The Triple Helix Model provides a framework for understanding the development of innovation ecosystems, such as those found in Silicon Valley, the Cambridge Cluster, and Shenzhen. These ecosystems are characterized by a high degree of collaboration and interaction between the three institutional spheres (Etzkowitz & Leydesdorff, 2000).

3. **Policy Development:** The Triple Helix Model can inform the development of policies and regulations that support innovation and competitiveness. By fostering collaboration between academia, industry, and government, policymakers can create an environment that encourages technological advancements and enhances global competitiveness (Etzkowitz & Leydesdorff, 2000).

4.7 Summary of Theoretical Framework

4.5.1 Technology

Technology Strategy:

- Summary: This focuses on using technology effectively to meet business goals, improve key skills, and understand all technology aspects.
- Relevance to Elonroad’s case study: Helps review Elonroad’s core business, understand its technology range, and plan its technology use for SCS technology success.

Technology Audit:

- Summary: Looks at a company's current technology status, giving a full picture of its technology, important for planning technology investments.
- Relevance to Elonroad’s case study: Provides insight into Elonroad's technology strengths and areas to improve, aiding decision-making for SCS technology.

Technology Adoption and Diffusion of Innovation:

- Summary: Elucidates how technologies proliferate within a society, focusing on elements like innovation attributes, communication channels, and societal systems.
- Relevance to Elonroad’s case study: Helps in understanding the possible adoption rate of the SCS technology, identifying barriers, and assessing the technology's perceived advantages.

4.5.2 Business

Value Proposition Canvas:

- Summary: Outlines what customers expect from products, linking this with their needs, wants, and problems.

- Relevance to Elonroad’s case study: Useful in checking if SCS technology meets customer needs, finding its special features, and improving its offerings.

Why the Lean Startup Changes Everything:

- Summary: Supports quick testing, getting customer opinions, and updating products based on this feedback.
- Relevance to Elonroad’s case study: Provides a way to test how customers respond to SCS technology and make continuous improvements.

SWOT Analysis:

- Summary: A strategic assessment tool that highlights an organization's strengths, weaknesses, opportunities, and threats.
- Relevance to Elonroad’s case study: Helps understand the market competition and Elonroad’s own strengths and weaknesses for SCS technology.

The Kano Model:

- Summary: Categorizes customer needs into basic, performance, and excitement needs.
- Relevance to Elonroad’s case study: Offers insights into what the target market for SCS technology really needs and wants.

SECI Model by Nonaka:

- Summary: Focuses on how organizations create and share knowledge.
- Relevance to Elonroad’s case study: Helps in understanding the knowledge dynamics between Elonroad and potential stakeholders, and in identifying knowledge gaps.

Clayton Christensen's Job to Be Done:

- Summary: Explains that products are hired by customers to perform specific jobs, including functional, social, and emotional aspects.
- Relevance to Elonroad’s case study: Guides the development of SCS technology to effectively meet the diverse needs of consumers, addressing both practical and emotional requirements.

4.5.3 Partner

The Triple Helix Model:

- Summary: Describes how universities, businesses, and governments work together for innovation and economic growth.
- Relevance to Elonroad’s case study: Helps in finding key partners like academic institutions, industry peers, and government for expanding SCS technology.

In essence, these theoretical frameworks serve as pillars for understanding, evaluating, and projecting Elonroad's new SCS technology. Offering a diverse perspective, from technology strategy to potential partnerships, they ensure a comprehensive analysis of Elonroad's innovative venture.

[Page intentionally left blank]

Chapter 5: Empirical Results (Findings)

This chapter presents and summarizes the results of the main stakeholder’s interviews Elonroad's new SCS technology. The interview outcomes will be presented and organized into three main categories: Technology, Business, and Partners. At the end of this chapter, the key findings will be presented.

5.1 Technology

When asked about what Elonroad sees as the key success factors of stationary charging, Björn Dahlqvist senior advisor at Elonroad replied that *“The most critical success factor is that the technology is perceived by consumers as a much better alternative than today’s cable dependent alternatives.”* If the technology is perceived as a much better alternative to the existing one, then there will be a willingness to pay for the technology, meaning it will be easier to bring it to the market. He believes that for a stationary charging station technology to be successful, it should work well and provide substantial added value compared to traditional charging methods. He emphasizes the importance of simplicity, flexibility, and ease of installation, which should be fast, smooth, and inexpensive, without causing too much disturbance to the user.

Karin Ebbinghaus CEO at Elonroad, argues the strength of the solution will depend on its ability to demonstrate effective performance.

5.1.1 Operations

Several informants have mentioned working seamlessly as an important factor for end user satisfaction. Working seamlessly is an important success factor for Elonroad, something that the company's management is highly aware of and actively considers throughout the development stage. *“The semi-dynamic charging should be "seamless" from using them in a garage to charging stationary, and you should not have to do any upgrades if electric roads arrive six months early for example, but it should function directly on electric roads as* *well. Stationary charging must be adapted to reflect the charging technology for electric routes." (*Bergqvist, 2021). *"The digital infrastructure for payment on electric roads must also function "seamlessly". In this case, seamless indicates that there will be no need for enhancements or the like, and that the technology will work for both stationary and dynamic charging on electric roads" (*ibid).

"*There should be no technical deficiencies, such as sustaining water damage, and that stations should be durable and safe over an extensive period of time, simply sustainable both technically and operationally. There should be no operational downtime, meaning that there should be good customer service"* (Bodin, 2021). Catherine Löfquist, head of sustainability at Bring emphasized the importance of security and service presence for the stationary charging station. "*It is also essential to provide good customer service, which means quickly resolving any issues that the end user may encounter." It should be designed in a way that any potential problems can be solved quickly to avoid any interruptions in service.*

Jörgen Bodin (Investment manager at Almi Invest GreenTech), the investment manager for Almi Invest, focused on the technical aspects of the charging station. Bodin emphasized that safety risks must be factored into consideration, and that the charging station must be designed with a reliable seal and be durable without becoming too expensive to operate.

5.1.2 Intelligent infrastructure

Robert Bergqvist (Head of Innovation & Business Development at HEM) highlights the importance of viewing electric roads as intelligent infrastructures that can facilitate different services and allow companies to innovate and create services based on the electric road. This suggests that a key success factor for Elonroad's charging station is their ability to provide an infrastructure that is more than just a means of charging vehicles but also enables other value-added services. "*It is not only possible to see the electric road as a kind of stupid charging infrastructure, but you have to see the electric road as an intelligent infrastructure"* (Bergqvist, 2021). Robert Bergqvist (Head of Innovation & Business Development at HEM) believes that Sweden's current dilemma is the large number of clients who own or are considering purchasing electric vehicles, who have a common misconception that charging infrastructure consists solely of conventional cable charging stations. He believes that there is a lack of knowledge that has to be addressed in order for people to grasp the many charge options available. If this issue is not solved, Sweden risks investing considerably in subsidizing traditional stationary charging stations that will be obsolete in five years.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) emphasizes the high degree of safety and intelligence present in Elonroad charging station technology. The intelligent infrastructure allows for simple identification, traffic monitoring, and billing based on usage data, making it future-compatible. This demonstrates the significance of safety and intelligence in Elonroad's charging stations, which can be a critical factor in attracting consumers and partners.

Andreas Sörensen (former CTO at Elonroad) notes that Elonroad's (SCS) full-service solution includes the installation of charging stations and charging rails. The smart road also collects data on charging cycles, energy consumption, and vehicle location, which can be used for customer feedback and other purposes. This emphasizes the need for a comprehensive solution that includes not only the charging infrastructure, but also data collection and management capabilities.

5.1.3 Commercial product with certification

According to Karin Ebbinghaus, their product is not yet certified, so it cannot be sold commercially. They can only sell pilot projects due to the absence of a commercial product.

Additionally, Jörgen Bodin (Investment Manager at Almi Invest GreenTech) emphasizes the significance of certification, specifically the need to acquire a CE mark. He believes that obtaining CE certification for the solution is the most important item from a technical standpoint, as it would demonstrate the product's durability, including the lowered rail. This indicates that certification is essential to the product's commercial viability.

5.1.2 Business

5.2.1 Good Team & Internalize knowledge

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) considers a strong team to be the most essential factor for startups. Having a capable and motivated core team is crucial to a startup's success, as they may need to alter their strategies and approaches over time. Consequently, a strong team is the most essential factor for startups.

Siri Marie Hagen, senior advisor, senior vice president of business development, HR, and HSE at Bring, concurs that it is crucial for small businesses to make sound hiring decisions because they are susceptible to the negative effects of a poor recruitment. She also emphasizes the significance of adopting an agile approach to work, swiftly resolving any errors that arise during the pilot phase to prevent recurrence. Lastly, she suggests establishing a culture of accountability to create a solid foundation for the company's future success.

According to Karin Ebbinghaus, Elonroad utilizes multiple digital tools, such as Teams and ClickUp, to disseminate knowledge and information between teams. The team's knowledge is kept up-to-date through weekly meetings, encouragement of further education, and the sharing of knowledge on their platforms. The production and engineering teams conduct daily stand-ups, and technology lead meetings to discuss the week's tasks are conducted every Monday, with a follow-up on Friday. Karin Ebbinghaus (CEO) noted that there is no mechanism in place to ensure that knowledge remains within the organization if an employee departs, which she views as a weakness. However, Karin Ebbinghaus (CEO) stated that they could improve by appointing a knowledge manager to oversee information sharing. The organization has a transparent platform where all content is accessible to everyone, and they encourage accountability and information research when necessary.

5.2.2 Customer communication (Understanding, expectation & feedback)

Siri Marie Hagen (Senior Advisor, Senior vice president business development HR and HSE at Bring) states that it is difficult to answer the query regarding the value of Elonroad technology because the company is not yet operational. She expresses optimism that the technology will save time by charging while loading and unloading and may allow for the use of smaller batteries in the future. She adds, however, that this is more of a long-term goal that would necessitate Elonroad to become more widespread.

Catherine Löfquist (Head of Sustainability at Bring) emphasizes the significance of a straightforward and efficient charging procedure for drivers, as it has an influence on their work environment.

Catherine Löfquist (Head of Sustainability at Bring) explains that finding a suitable place to charge at the dock can be difficult, especially if you want to have a higher power on the charging. The higher the power, the thicker the cables, and it can be challenging to find a safe place that is not affected by weather conditions such as snow or vehicle movement. Therefore, they believe that charging at the dock is necessary for efficiency, and Elonroad's stationary charging station technology can simplify this process.

The main benefit of stationary charging, according to Catherine Löfquist (Head of Sustainability at Bring), is that it requires no effort from the driver as they can simply park the car and let it charge by itself. She believes this benefit applies to both short- and long-term scenarios. However, she notes that this benefit is not directly related to stationary charging and that the technology can be even more beneficial when the electric vehicle can be charged while driving with the dynamic charging station on the road.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) explains that what makes Elonroad interesting to invest in is not only that it works well as a stationary charging solution, but also offers the possibility of charging while driving in future, which he sees as providing greater societal and sustainability benefits.

According to Andreas Sörensen, former CTO at Elonroad, a slightly cheaper solution for stationary charging could be offered to customers that only works for stationary charging and not for electric roads. This solution would allow customers to charge their vehicles without plugging in a cable, providing convenience for transport companies and others who use vehicles often and don't want to waste time. The solution would involve having a small charger in the vehicle that can be used for slow charging overnight, and a larger charger for faster charging. However, if a large fleet has few charging points, this could become a more expensive solution than a traditional charger that sits outside the vehicle. If customers choose the more expensive solution with chargers in the vehicle, they could still modify the vehicle in the future to make it compatible with electric roads.

Andreas Sörensen (former CTO at Elonroad) explains that it's not always easy to know what customers really want because what they say they want may not be specific enough. Customers may say they want a stationary charging solution, but they may not know what exact features they want, such as compatibility with electric roads or the charging speed they need. There are also other factors to consider, such as how long the vehicle needs to charge and how much the charger will cost. Therefore, it's important to ask questions and clarify what customers really want before presenting a charging solution.

Robert Bergqvist (Head of Innovation & Business Development at HEM) believes that an important value that Elonroad adds is collaboration. He thinks that if Elonroad developed their technology without talking to potential customers, the product wouldn't be as good as it could be. He emphasizes the importance of arriving at customer value and believes that development should be based on that.

Björn Dahlqvist (Senior Advisor at Elonroad) suggests that customers may not always know what they want, especially when it comes to creating new markets. He cites Steve Jobs' opinion that it is the responsibility of the company to inform customers about their needs and wants. Karin Ebbinghaus (CEO) says that their solution seems to meet potential customers' needs better than other existing solutions. A concrete example is that their solution allows for fast charging while loading and unloading, which can save time and increase productivity. Björn Dahlqvist (Senior Advisor at Elonroad) adds that their solution makes it easier for drivers as they don't have to deal with cables and plugs, and can simply drive over a stationary charger to start charging automatically.

5.2.3 Timing

According to Karin Ebbinghaus (CEO), one of Bring's biggest customers is IKEA. By 2025, IKEA plans to convert its nationwide truck delivery service to 100% electric automobiles (IKEA, 2021).

Björn Dahlqvist (Senior Advisor at Elonroad) emphasizes the importance of timing in startups, where having the right combination of technology, team, and business model at the right time is crucial for success. He cites the example of Elonroad, where a stationary charging station (SCS) is currently the right choice compared to electric roads, which require more time to establish. He believes that hitting the market at the right time is critical, and the current time window for rolling out large volumes of stationary charging stations (SCS) is open for cars and larger vehicles.

When asked about how much need the existing and potential market has for stationary charging, Björn Dahlqvist says that the trend for electric vehicles and charging needs is large today and will grow exponentially in the future, so it's not necessary to know the exact figure for market needs.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) mentions looking at different stationary charging solutions and in order to invest, the offer has to allow for significant sustainability and climate impact gains. They are not interested in investing in traditional charging stations as they are not unique and there are many of them. Elonroad is interesting because it provides not only stationary charging but also the possibility of charging on the go, resulting in greater societal and sustainability benefits.

5.3 Partners

Robert Bergqvist (Head of Innovation & Business Development at HEM) suggests that semi-dynamic charging infrastructure like the one provided by Elonroad can help municipalities introduce stationary charging for their transport. He believes that this will encourage users to start parking on such charging rails and make them discover how easy it is to charge their vehicles without having to plug in a cord, ultimately making ERT more accessible by removing barriers and thresholds.

Karin Ebbinghaus (CEO) says that the company is looking for dynamic and opportunistic partners. They do not have specific levels for partnership and are flexible in their approach. They enter into a partnership when they realize that there is a business benefit for both of them. Karin Ebbinghaus (CEO) and Björn Dahlqvist (Senior Advisor at Elonroad) discuss the importance of having a strategic partner for the development of stationary charging station (SCS). Ebbinghaus (CEO) mentions that a vehicle manufacturer would be a desired partner as it would make it easier to adapt the vehicles right from the start. Dahlqvist suggests that Scania, Volvo, or Daimler could be potential partners as they already have pickups or the ability to attach pickups as a standard when designing and building their trucks. He believes it would be easier and more preferred in the model than when you need to do "a retrofitting" afterwards when the car is ready.

Robert Bergqvist (Head of Innovation & Business Development at HEM) emphasizes the importance of involving users as partners, whether they are municipalities or companies like DHL and Bring, in the early stages of developing a product or service to avoid creating something that is not relevant to their needs. He believes that it is important to understand the needs of existing partners or customers like Bring to avoid developing products like stationary charging station that do not contribute value to them for example.

Bjorn Dahlqvist (Senior Advisor at Elonroad) adds that a partnership is intriguing if it can generate value for both Elonroad and the other party. They are not required to have specific written partnership terms. To generate business value for both parties, the company must be adaptable and nimble in its approach to partnerships. They must also have a clear vision for the company's future in order to determine whether a partnership is compatible with Elonroad's goals.

Siri Marie Hagen (Senior Advisor, Senior vice president business development HR and HSE at Bring) believes that the success of start-ups like Elonroad depends on a number of external factors, such as having car manufacturers as partners, having a strong customer case and commitments, and having solid commission agreements and delivery time guarantees with suppliers.

Robert Bergqvist (Head of Innovation & Business Development at HEM) mentions that the municipality and the energy company want a technology supplier for the entire life of the facility. To ensure the supplier's involvement throughout the life of the facility, he suggests creating a "revenue stream" for them. He believes that some kind of partnership is necessary to keep capex low and share opex between the operator and the technology supplier.

Robert Bergqvist (Head of Innovation & Business Development at HEM) is talking about creating incentives to invest in the charging infrastructure, which can be governed by charging for the service and then investing the revenue earned in it. He emphasizes that the ease or difficulty of charging for the service is a significant factor in creating such incentives.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) believes that apart from logistics companies, there are other potential markets and customers interested in stationary charging. These include terminals, larger ports, and the mining industry. He also suggests that charging while driving at low speeds in fenced areas could also be a potential market in the future.

According to Jörgen Bodin (Investment Manager at Almi Invest GreenTech), ensuring the attractiveness and ease of adoption of ERT is crucial for enhancing the overall offer to customers. He proposes that the acquisition of electric vehicles equipped with pre-installed pick-up, coupled with the involvement of additional stakeholders, may serve as a viable strategy for reducing costs. According to him, the primary concern is to ensure that the pick-up and on-boarding charger are user-friendly for customers.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) suggests that Elonroad needs to mitigate the challenge and risk of other actors investing in different solutions by building an ecosystem of partners who believe in their electric road solution. Hence, it is crucial for them to form alliances and involve other stakeholders in their ecosystem to surmount this obstacle. In order to achieve its objectives, Elonroad must establish itself as a leading contender for future prospects and engage with partners who are invested in and committed to advancing the project in a positive direction. Although other alternatives may not exhibit superior technical or economic characteristics, there exists a possibility that they may be marginally more advanced than Elonroad in terms of temporal progression, possess greater financial resources, or have more extensive networks. In order to maintain a competitive edge, Elonroad must effectively persuade potential partners of the credibility and relevance of their solution. The task at hand entails persuading stakeholders that Elonroad is not only a viable alternative, but rather the optimal solution.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) highlights the importance of political factors in the success of companies. Political decisions can influence trends, determine areas of investment and create market conditions that can make it easier for companies to enter new markets. Government grants and support programs play a significant role in reducing the barriers to entry for new technology and business models. Therefore, regulations and market conditions set by the authorities can have a considerable impact on the success of companies, especially those in renewable energy or sustainable industries.

Andreas Sörensen (former CTO at Elonroad) explains that they receive a large number of requests for stationary charging, and that they have collaborators who assist with the chargers. They concentrate on the technology of the electric road circuits, the vehicle’s pickup technology, and the overall assembly.

According to Siri Marie Hagen (Senior Advisor, Senior vice president business development HR and HSE at Bring), as customer and partner we intend to contribute to Elonroad with feedback for development, help create publicity, and enable new collaborations through our large network. Catherine Löfquist (Head of Sustainability at Bring) adds, Bring can help Elonroad with practical tests and giving good feedback.

According to Jörgen Bodin (Investment Manager at Almi Invest GreenTech), the market that should be prioritized first for stationary charging is the one with the highest consumer demand. As it aligns with their short-term goals, logistics companies and other businesses that utilize terminal areas and ports are a good and essential first market for stationary charging. There is a strategic advantage to deploying stationary charging in locations where it is the next logical step from smaller charging loops.

Jogren Bodin (Investment Manager at Almi Invest GreenTech) believes it is essential to advance to the next level and incorporate charging while driving (Dynamic Charging Station), even if on a smaller scale at first, in order to develop with customers. He believes the market to be significant, but he cannot provide specific numbers. He asserts that the market is unquestionably vast and expanding.

5.4 The risk areas associated with Elonroad investing in Stationary Charging Stations

Björn Dahlqvist (Senior Advisor at Elonroad) discusses the potential risk of having electric roads and stationary charging as two separate development tracks. Instead, he emphasizes the need to find as many synergies as possible between the two tracks to maximize benefits. This would require finding ways to generate revenue in the short and medium term for stationary charging while also investing in the long-term potential of electric roads. While there may be some differences in technology between the two tracks, it is important to find useful synergies between them. Dahlqvist sees this as an opportunity rather than a risk, but notes that there is a risk of the two tracks drifting apart. Dahlqvist emphasizes that having two separate development tracks for electric roads and stationary charging would require a significant investment of time and resources. This could be a risk for the companies involved in these developments. "*It is strategically wise to use stationary charging as a steppingstone towards developing electric roads. This is because it can stimulate the development of both tracks and generate revenue in the short term for businesses.*"

Andreas Sörensen (former CTO at Elonroad) is unsure about the risks of investing in stationary charging as he believes that it is difficult to predict how customer needs will expand and which solutions will be the most popular. He suggests that it is important to allocate development time and resources to the right solutions and choose wisely which solutions to focus on.

5.5 Elonrod's strengths and weaknesses seen from the main stakeholder's perspective

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) believes that Elonroad's strengths include a strong and innovative base technology, a competent team, and a professional board which makes the team under development feel strong. However, as a startup, they face challenges such as limited resources, difficulty penetrating the market, and the ability to make strategic investments on their own balance sheet. To overcome these weaknesses, it is important for Elonroad to establish partnerships and bring other actors into their ecosystem.

Elonroad's assets, according to Siri Marie Hagen (Senior Advisor, Senior vice president business development HR and HSE at Bring), are its team and CEO, as well as its innovative wireless charging technology for electric vehicles. According to Hagen, the technology's weakness is that it requires installation of components on both the vehicle and the charging station, which may not be fast or simple to do on your own. In addition, there may be certain requirements or dependencies associated with the technology.

Chatherine Löfquist (Head of Sustainability at Bring) mentions a strength of the technology being that it can be installed easily without major interventions, but also points out that the need for installation on the car can be a threshold. Additionally, the fact that it is a new technology and not widely available is a weakness. Despite this, Löfquist believes in the technology because of its simplicity and potential to make charging easier.

Löfquist also thinks that Elonroad has done a good job with networking and being visible in the market.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) highlights the convenience of not having to leave the vehicle to plug it in for charging. This makes the process easier and problem-free, saving time and avoiding mistakes that could occur otherwise.

Robert Bergqvist (Head of Innovation & Business Development at HEM) thinks that Elonroad's strength is its innovative technology and that it has a service that can be delivered by them as an operator along with the infrastructure, which can differentiate it from the current traditional charging solutions with cables. The weakness of the company lies in its small size, which may not support the company as much as it needs, especially when compared to bigger players like Siemens. If Elonroad wants to enter into a partnership with an electric road supplier and build a 50-60 km electric road in Halmstad, it would require a balance sheet that can support the risk or a partnership with someone who can provide that support.

Karin Ebbinghaus (CEO) explains that the challenges for electric road and stationary charging are essentially the same. Both require an onboard charger. The main difference for the stationary charging station is the need to develop a safety system that prevents people from reaching under the vehicle when it's stationary. This is not a problem for the dynamic charging station.

[Page intentionally left blank]

Chapter 6: Discussion

In this chapter, the key findings will be discussed with the main purpose and the research questions from the introduction (chapter 1). Thia chapter provides the reader with a comprehensive understanding of the main purpose and RQs outcomes and their relevance to the objectives of this master's thesis.

6.1 The Value Proposition Canvas for Elonroad's SCS Technology

The Value Proposition Canvas for Elonroad's SCS technology demonstrates a strong alignment between the needs, pains, and gains of logistics companies, and the solutions and benefits provided by Elonroad. It underlines how Elonroad's new SCS technology can significantly contribute to overcoming the challenges faced by customers in transitioning to electric fleets, improving their operations and environmental impact. Furthermore, it should be noted that the majority of insights for this Value Proposition Canvas are derived from the comprehensive study on automated wireless conductive charging of electric vehicles, conducted by RISE Viktoria and Volvo Cars (Gustavsson et al., 2017). This also provides a strong foundation for the analysis, bringing in expert viewpoints and in-depth research.

6.1.1 Customer Segment: Logistics Companies

Customer Jobs:

1. **Efficient EV Charging:** Companies need a reliable, seamless charging solution for their electric vehicles to ensure minimal downtime and maximum operational efficiency.

2. **Automatic Charging:** Companies are looking for an automatic, driver-independent charging solution to eliminate human errors such as forgetting to plug in charging cables.

3. **Simplified Infrastructure:** Logistics companies require user-friendly charging infrastructure that can be easily integrated without complex installations or procedures.

4. **CO2 Emission Reduction:** Companies aim to reduce their carbon footprint, making a green solution a must-have feature in their charging infrastructure.

5. **Compatibility:** Companies require a universal charging solution for various EV models in their fleets, including a possibility of future charging solutions that can enable EVs to be charged while driving, using Dynamic Charging Stations.

Customer Pains:

1. **Decreased Operational Time:** When drivers forget to plug in charging cables, the vehicle charging is insufficient, leading to reduced productivity and increased downtime.

2. **Limited Infrastructure Data:** The lack of comprehensive data from traditional cable-based charging stations hinder effective fleet charging planning and management.

3. **Safety Concerns:** Charging electric vehicles, particularly at high power levels, can pose safety risks, especially during winter when charging cables may become concealed in the snow.

4. **Regulatory Issues & Weight Limitations:** The weight of batteries in light-duty trucks can lead to regulatory issues, reducing loading capacity and impacting logistics efficiency.

Customer Gains:

1. **Productivity Enhancement:** Intelligent infrastructure providing comprehensive monitoring and strategic planning of vehicle charging activities can significantly improve service and operational efficiency.

2. **Seamless Charging Experience:** Companies gain from an easy-to-use and seamless charging process, enhancing operational efficiency.

3. **Enhanced Safety:** Improved safety measures during the charging process can alleviate safety concerns and potential incidents.

6.1.2 Value Map

Products and Services:

1. **Automatic Wireless Charging:** Elonroad's SCS offers a stationary charging station with the possibility of dynamic charging in the future, simplifying the charging process.

2. **Retrofitting Services:** Elonroad ensures compatibility with existing EVs, expanding its utility.

3. **Data Services:** Elonroad provides charging cycles and vehicle behavior data for enhanced logistics operation insights.

Pain Relievers:

1. **Automatic Wireless Charging:** Elonroad's SCS technology eliminates the need for drivers to plug in charging cables, thus reducing vehicle downtime and enhancing productivity.

2. **Intelligent Charging Solution:** Elonroad's SCS technology provides comprehensive data on each vehicle's charging status, enabling logistics companies to better plan their fleet's charging needs.

3. **Safe Charging:** Elonroad's new SCS technology minimizes potential charging hazards with features like safety checks and interruption of power transfer in case of safety issues.

4. **Adaptable to Regulations and Load Capacity:** Elonroad's new SCS technology with future dynamic charging options can reduce vehicle weight, assisting logistics companies in overcoming regulatory issues and weight limitations related to heavy batteries.

Gain Creators:

1. **Ease of Use:** Elonroad's AI-enabled, user-friendly SCS makes the charging process more manageable.
2. **Insightful Data:** Detailed charging and vehicle behavior data provided by Elonroad can enhance logistics companies' operations.
3. **Reduced Downtime:** Elonroad's efficient charging solution minimizes downtime, promoting smooth and efficient logistics operations.
4. **Subscription Services:** Elonroad could offer subscription services for easy access to the charging infrastructure, making it more convenient for logistics.

6.1.3 Summary of the VPC

Elonroad's SCS technology, based on the Value Proposition Canvas, aligns with the needs, pains, and gains of logistics companies transitioning to electric fleets. The study relies on insights from RISE Viktoria and Volvo Cars' research on automated wireless conductive charging for EVs.

For Logistics Companies:

- **Needs:** Reliable EV charging, automatic and driver-independent charging, simplified infrastructure, CO_2 emission reduction, and compatibility across EV models, including dynamic charging options.
- **Pains:** Reduced operational time from forgotten plug-ins, insufficient infrastructure data, safety concerns with traditional charging, and regulatory & weight issues from battery use.
- **Gains:** Enhanced productivity from intelligent infrastructure, seamless charging experience, and improved safety during charging.

Elonroad's Offerings:

- **Products:** Automatic wireless charging with future dynamic options, retrofitting services for existing EVs, and vehicle behavior and charging data.
- **Pain Relievers:** Elimination of manual plug-ins, insightful charging status data, safety features, and solutions to regulatory and weight issues.
- **Gain Enhancers:** User-friendly, AI-driven system detailed operational data, reduced vehicle downtime, and potential subscription-based access to infrastructure.

6.2 Critical Success Factors for Elondroad's Stationary charging station

6.2.1 Technology

Seamlessness

Several respondents have stressed working seamlessly and creating a user-friendly experience is a common aspect. A user-friendly experience entails having a seamless integration between the charging station and the vehicle with no operational downtime, no technical deficiencies and good customer service. Dahlqvist, Bodin (Investment Manager at Almi Invest GreenTech) and Löfquist (Head of Sustainability at Bring) agree that good customer service and quick problem-solving capabilities are crucial to ensure uninterrupted service. *"It is also essential to provide good customer service, which means quickly resolving any issues that the end user may encounter"* (Löfqvist, 2021). Good customer service ensures that issues are resolved quickly, minimizing interruptions in service. Seamlessness is crucial for end user satisfaction. This factor is related to Rogers' (1983) Diffusion of Innovations theory, specifically the compatibility and complexity characteristics, as well as the Technology Acceptance Model

(TAM) (Davis, 1989), which emphasizes the importance of perceived ease of use. Both theories agree that a seamless technology will increase the likelihood of adoption. This factor aligns also with Oliver's (1980) Expectation-Confirmation Theory, highlighting the crucial role of exceptional customer service in ensuring customer satisfaction and promoting long-term adoption of a technology.

Safety is another factor affecting seamlessness. Respondents Bodin (Investment Manager at Almi Invest GreenTech) and Löfquist (Head of Sustainability at Bring) mentioned that the importance of safety and safety risks must be factored into consideration. The stationary charging stations (SCS) should be durable and safe over an extensive period of time (Bodin, 2021). Safety can be classified as a basic need according to the Kano Model, meaning that customers expect SCS to be safe and durable over an extended period. Failure to meet this requirement would result in customer dissatisfaction. Löfquist (Head of Sustainability at Bring) notes that finding a suitable place to charge at the dock with traditional charging stations can be challenging, especially when higher power charging is required. The thickness of the cables needed for higher power charging makes it difficult to find a safe location that is not affected by weather conditions or vehicle movement. These challenges can hinder the efficiency of the charging process, causing delays and inconveniences for customers. However, Löfquist (Head of Sustainability at Bring) sees potential benefits in Elonroad's stationary charging station technology, which can simplify the charging process at the dock. By providing a stationary charging solution that eliminates the need for cables, the technology can help address some of the challenges of finding suitable charging locations. The convenience and ease of use that stationary charging provides can contribute to a more efficient and streamlined charging process, ultimately benefiting both customers and businesses.

However, fulfilling this requirement alone does not lead to increased customer satisfaction according to the Kano Model as it is taken for granted by customers. To achieve customer satisfaction, both performance needs and excitement needs have to be considered and fulfilled. For Elonroads` SCS this would mean providing a seamless charging experience and a user-friendly interface as this feature is not expected by customers but would enhance their satisfaction if present. Therefore, to improve customer satisfaction with SCS, it is essential to fulfill basic needs such as safety, meet performance needs such as efficiency and seamlessness, and consider incorporating excitement needs such as advanced features and functionalities. The Kano Model provides a useful framework for understanding customer requirements and prioritizing product development efforts.

Löfquist (Head of Sustainability at Bring) asserts that the primary benefit of stationary charging is its convenience, as drivers can simply park their vehicle and let it charge by itself. This advantage applies to both short-term and long-term charging scenarios such as dynamic charging, making it a desirable solution for electric vehicle owners. This convenience factor is an essential consideration for customers seeking a charging solution that can seamlessly integrate into their daily routines. However, Löfquist (Head of Sustainability at Bring) notes that the benefits of stationary charging are not solely confined to its convenience factor. When combined with dynamic charging solutions that allow electric vehicles to charge while driving on the road, the technology can be even more beneficial (Löfquist, 2021). Dynamic charging has the potential to reduce the need for large battery capacities in electric vehicles, thereby reducing their overall weight, cost, and carbon footprint.

RISE Viktoria and Volvo Cars have conducted a study, *"Förstudie om automatiserad sladdlös konduktiv laddning av elbilar",* to evaluate the feasibility and potential of using conductive ERT to automatically wirelessly charge EVs (Gustavsson et al., 2017). Use cases, general requirements, characteristics influencing detailed requirements, potential hazards, and recommendations for structured system safety analysis have been documented (ibid). The strengths, limitations, and maturity of Elonroads` and other companies` technological solutions have been investigated. These are some general requirements and characteristics for charging of standstill car that affect detailed requirements for Elonroads` SCS technology:

General requirements

- Easy to use and approach (manual or automatic parking shall be possible)
- Safe to use both inside and outside the car (no electrical hazards)
- The vehicle shall be connected and communicate with EV infrastructure (payment if applicable, easy to find)
- Should work under all environmental conditions (snow, dirt, rain etc.)
- Should comply with all existing automotive and electrical standards

Intelligent infrastructure

Many respondents highlighted the importance of viewing electric roads as intelligent infrastructure. According to Robert Bergqvist (Head of Innovation & Business Development at HEM), it is essential to consider electric roads as intelligent infrastructure that can facilitate different services and allow companies to create innovative services based on them. Thus, Elonroad's charging station should not only be a means of charging vehicles, but it should also provide an infrastructure that enables other value-added services to be offered. "*It is not only possible to see the electric road as a kind of stupid charging infrastructure, but you have to see the electric road as an intelligent infrastructure"* (Bergqvist, 2021). Bodin (Investment manager at Almi Invest GreenTech) emphasizes the high degree of safety and intelligence present in Elonroad charging station technology. The intelligent infrastructure allows for simple identification, traffic monitoring, and billing based on usage data, making it future-compatible. This demonstrates the significance of safety and intelligence in Elonroad's charging stations, which can be a critical factor in attracting consumers and partners.

Andreas Sörensen (former CTO at Elonroad) notes that Elonroad's (SCS) full-service solution includes the installation of charging stations and charging rails. The smart road also collects data on charging cycles, energy consumption, and vehicle location, which can be used for customer feedback and other purposes. This emphasizes the need for a comprehensive solution that includes not only the charging infrastructure, but also data collection and management capabilities.

Intelligent infrastructure enables the provision of value-added services and better data management. This factor relates to Porter's (1985) Competitive Advantage theory, which emphasizes the role of innovation in creating and sustaining a competitive advantage. The concept of intelligent infrastructures is supported by the Smart Cities Framework (Harrison et al., 2010), which encourages the integration of technology in urban planning. They argue that these infrastructures play a critical role in enabling cities to become more efficient, sustainable, and resilient. Intelligent infrastructures are designed to be interconnected, adaptive, and capable of providing real-time information to improve the quality of urban services (Harrison et al., 2010). In conclusion, intelligent infrastructures are a valid success factor for Elonroad's SCS technology.

Product Certification

Interviewees also noted the importance of obtaining product certifications to ensure compliance with industry standards and gain consumer trust (Sörensen, Bodin, 2021). Respondent Jörgen Bodin (Investment Manager at Almi Invest GreenTech) highlights the importance of obtaining a product certification, which is critical for its durability and commercial viability. However, Karin Ebbinghaus (CEO) mentions that their product is not yet certified, preventing them from selling it commercially, and they can only market it for pilot projects. Product certification is vital for the commercial viability of the product. This factor can be linked to the Institutional Theory (DiMaggio & Powell, 1983), which posits that organizations seek legitimacy through conformity to established norms and regulations. The theories suggest that obtaining certification will increase the adoption rate of the technology and enhance its legitimacy.

CE marking is a significant indicator that shows that a product satisfies the health, safety, and environmental protection standards set by the European Union. This mark allows products to be sold within the European Economic Area (EEA) without additional requirements. The importance of CE marking lies in ensuring the safety of consumers, preventing trade barriers within the EEA, providing consumers with a level of assurance, and complying with legal requirements for certain products (European Commission, 2021).

Inexpensive operation

Affordable operation is crucial for the competitiveness of Elonroad's SCS technology (Bergqvist, Bodin, 2021). Interviewees stressed the need to minimize operational costs to attract customers and incentivize adoption (Hagen & Löfquist, 2021; Dahlqvist & Karin Ebbinghaus, 2021). According to Porter's Cost Advantage and Differentiation Advantage theory, firms can achieve a competitive advantage through either a cost advantage or a differentiation advantage (Porter, 1985). A cost advantage is attained when a firm can produce its goods or services at a lower cost than competitors, allowing it to offer lower prices or achieve higher profit margins. On the other hand, a differentiation advantage is achieved when a firm offers unique products or services that are perceived to be superior by customers, enabling it to charge premium prices and increase customer loyalty (ibid).

6.2.2 Business

Timing

Dahlqvist (Senior Advisor at Elonroad), Ebbinghaus (CEO), and Bodin (Investment Manager at Almi Invest GreenTech) all recognize the criticality of timing as a factor in the success of startups, particularly for Elonroad. The importance of timing is evident in their discussions, and it is likely a key success factor for Elonroad (SCS), as well as for startups in general. *"It is critical that we hit the market at the right time, and right now, large volumes of stationary charging stations are being rolled out, especially for cars and larger vehicles. So, having a good approximation of the time window is key if we want to be part of the journey."* (Dahlqvist, 2021).

Timing is a crucial factor for the success of any technology, particularly in emerging markets. Timing is a critical factor that can determine the success or failure of a business, weighing more than having a great business model or team (Gross, 2015). Therefore, entrepreneurs need to ask themselves if consumers are ready for their offering, be honest with themselves and partners, and launch at the right time to increase their chances of success (ibid).

Björn Dahlqvist (Senior Advisor at Elonroad) posits that having the right combination of technology, team, and business model at the right time is crucial for success. He gives Elonroad as an example and contends that the timing is currently ideal for implementing Elonroad's stationary charging station (SCS) since the establishment of electric roads will take some time. He further suggests that it is important to proceed with initiatives such as stationary charging stations, while waiting for electric roads to have secure funding in the form of investors and the right timing to be fully established. According to Dahlqvist, the present time window for introducing a large number of SCS for cars and larger vehicles is open, but it is uncertain how long it will remain open.

Early adopters can drive the adoption of technology like Elonroad's SCS system according to the Diffusion of Innovation theory. Rogers' Diffusion of Innovation theory (1983) identifies early adopters as a vital group in the innovation adoption process. These individuals are more likely to adopt new ideas or technologies ahead of the majority (ibid). Early adopters generally possess a higher social standing, increased financial means, and better access to information compared to their peers (ibid). They also tend to be well-connected, opinion leaders, and influential in their networks, playing a crucial role in accelerating the diffusion of innovations (ibid). The interviews suggest that stakeholders are optimistic about the technology's potential for time-saving and increased efficiency (Hagen, Lösfquis, 2021; Ebbinghaus, Dahlqvist, 2021), therefore the company should capitalize on this advantage and possible momentum and bring its technology to market at the right time to gain a competitive edge.

Robert Bergqvist (Head of Innovation & Business Development at HEM) emphasizes the importance of timing in customer acceptance. Elonroad's early entry into the market and proactive engagement with industry partners (Palmqvist, 2021) is beneficial for gaining a competitive edge.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) mentions looking at different stationary charging solutions with the intent of investing, and according to him the offer has to allow for significant sustainability and climate impact gains. Traditional stationary charging stations (TSCS) do not meet their criteria as they are not unique and there are numerous options available. However, Bodin (Investment Manager at Almi Invest GreenTech) finds

Elonroad's offering of stationary charging station (SCS) and the ability to not only charge stationary but charging while driving (dynamic charging) to be interesting due to the greater societal and sustainability benefits it provides.

Good Team

Another success factor for startups according to Jörgen Bodin (Investment manager at Almi Invest GreenTech) and Siri Marie Hagen (Senior Advisor, Senior vice president business development HR and HSE at Bring) is having a strong team. The interviews with Bodin and Hagen highlight the importance of team strength for startups. According to Bodin, a capable and motivated core team is essential for startups to succeed, as they may need to alter their strategies and approaches over time. Hagen emphasizes the significance of sound hiring decisions for small businesses and adopting an agile approach to work, quickly resolving errors during the pilot phase to prevent recurrence. She also suggests establishing a culture of accountability to build a solid foundation for the company's future success.

A good team can be crucial in ensuring that the SCS technology aligns with market needs and customer expectations. This is supported by Rieck & Dickson's (1993) model of technology strategy which emphasizes the role of a strategic fit between the organization and its environment. Ford (1998) argues that the ability to develop and execute an effective technology strategy is crucial for an organization's success. In this context, a good team with diverse expertise and backgrounds, as emphasized by Hagen (Senior Advisor, Senior vice president business development HR and HSE at Bring) and Jörgen Bodin (Investment Manager at Almi Invest GreenTech), can contribute to the development and execution of such a strategy for Elonroad's SCS.

Internalized knowledge

In Karin Ebbinghaus' interview, she explains how Elonroad uses digital tools for knowledge and information dissemination between teams. They have weekly meetings, encourage further education, and share information on their platforms to keep the teams up-to-date. However, the absence of a mechanism to retain knowledge within the organization is a weakness that Ebbinghaus (CEO) identifies. Nonaka and Takeuchi's (1995) SECI model of knowledge creation stresses the importance of internalizing knowledge within an organization. The model suggests that a successful technology strategy requires the effective management and transfer of knowledge (ibid).

Customer communication (understanding, expectation & feedback)

Insights provided by Hagen, Löfquist, Dahlqvist, Ebbinghaus and Bergqvist are consistent with The Kano Model (Kano et al., 1984) and the Jobs-to-be-Done (JTBD) (Christensen et al., 2016) theories, both emphasizing the importance of understanding customer needs and preferences. According to the Technology Acceptance Model (TAM) (Davis, 1989), customer understanding, expectation and feedback are crucial success factors for enabling technology adoption as it posits that perceived usefulness and perceived ease of use are essential determinants of user acceptance of technology. Involving users early in the development process, as suggested by Robert Bergqvist (Head of Innovation & Business Development at HEM), can help ensure that technology meets customers' needs and expectations, thus increasing the likelihood of technology adoption.

When asked about what Elonroad sees as the critical success factors of stationary charging Björn Dahlqvist (Senior Advisor at Elonroad) replied that *"The most critical success factor is that the technology is perceived by consumers as a much better alternative than today's cable dependent alternatives."* If consumers perceive the stationary charging technology to be a much better alternative to the existing one, they are more likely to accept and adopt it. Additionally, the willingness to pay for the technology could be seen as an indicator of perceived value, which is linked to perceived usefulness in the Technolology Acceptance Model (TAM) (Davis,1989).

Elonroad respondents are aware of and agree on several aspects regarding customer expectations, such as:

- **Fast charging while loading and unloading:** Customers expect their solution to allow for fast charging to save time and increase productivity. (Ebbinghaus, 2021)

- **Easy-to-use charging process:** Customers want a charging solution that is easy for drivers to use, without having to deal with cables and plugs. (Dahlqvist, 2021)

- **Automatic charging:** Customers expect a solution where drivers can simply drive over a stationary charger to start charging automatically. (Dahlqvist, 2021)

- **Decreased battery weight:** Customers want a solution that enables them to reduce the need for large batteries. (Hagen, 2021)

Sörensen (former CTO at Elonroad) and Dahlqvist (Senior Advisor at Elonroad) point out that customers may not always be aware of their own needs, particularly in the context of emerging markets, which can make it difficult for companies to develop products that cater to these requirements. For example, customers might express a desire for a stationary charging solution, but they may be unsure about the specific features they seek, such as compatibility with electric roads or the optimal charging speed. As these factors may influence customers' decisions, it is crucial to address them to ensure that the proposed solution aligns with the customers' needs and constraints. In-depth communication with customers is necessary to gain a comprehensive understanding of their preferences and expectations. This approach enables companies to develop products that are tailored to the customers' specific requirements and expectations, ultimately increasing the likelihood of successful product adoption. By asking questions and clarifying customer expectations, companies can develop solutions that better address their target audience's requirements, leading to more successful and satisfying outcomes in the market.

The Lean Startup methodology (Blank, 2013) emphasizes the importance of using customer feedback to develop a minimal viable product (MVP). This approach ensures that the product meets the needs and preferences of customers. The Lean Startup methodology is a theory that supports the insights provided by Jörgen Bodin (Investment Manager at Almi Invest GreenTech), who mentions the importance of customer feedback in shaping the development of Elonroad's SCS. Bergqvist (Head of Innovation & Business Development at HEM) asserts that the value Elonroad brings to the market stems from its commitment to collaboration. He argues that if the company had developed its technology in isolation, without consulting potential customers, the resulting product may not have been as successful or beneficial as it could be.

By emphasizing the need to arrive at customer value, Bergqvist (Head of Innovation & Business Development at HEM) underscores the critical role that customer-oriented development plays in creating successful products. The concept of customer value suggests that product development should focus on addressing the needs and wants of customers, as this approach can lead to more effective and desirable solutions. Consequently, companies like Elonroad can achieve a competitive advantage in the market by adopting a customer-centric approach to product development.

Catherine Löfquist (Head of Sustainability at Bring), Dahlqvist (Senior Advisor at Elonroad) and Hagen (Senior Advisor, Senior vice president business development HR and HSE at Bring) identify the primary advantage of stationary charging as its ability to charge the vehicle automatically without requiring any effort from the driver, as well as reducing the need for large batteries. This benefit applies to both short and long-term scenarios. However, she notes that this benefit is not unique to stationary charging and that the technology's true potential lies in dynamic charging stations that allow for vehicle charging while driving on the road. Bodin (Investment Manager at Almi Invest GreenTech) also notes that Elonroad's appeal as an investment opportunity is not solely based on the success of its stationary charging solutions. He also sees the company's potential to offer charging while driving solutions in the future as a significant factor in its investment appeal. The dynamic charging solutions could bring substantial societal and sustainability benefits by reducing the need for large battery capacities in electric vehicles, extending their range, and decreasing their overall carbon footprint.

6.2.3 Partners

Elonroad's partnerships with logistics companies, industry players, government agencies, and strategic partners demonstrate their commitment to fostering a network for the development and implementation of their technology strategy. As an example, Elonroad's partnership with Bring, H22, and Vilan at DHL (Palmqvist, 2021) showcases the company's focus on collaboration. Elonroad's (2020) go-to-market strategy also included an action roadmap outlining the most crucial tasks to be accomplished in 2020–2024, including significant beachhead initiatives and partnerships.

Elonroad specializes in catering to niche market segments and customizes solutions for individual projects, as evidenced by their pilot project with the Swedish Transport Administration. Collaborating with users, such as municipalities and companies like DHL and Bring, during product development ensures that the SCS develops according to user expectations (Berqvist). According to Ebbinghaus (CEO) and Dahlqvist, establishing partnerships with vehicle manufacturers like Scania, Volvo, or Daimler is crucial for adapting vehicles to the stationary charging infrastructure from the start and avoiding retrofitting later on.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) states that prioritizing markets with high consumer demand, such as logistics companies, terminal areas, and ports, helps Elonroad align with its short-term goals. Working closely with customers like Bring enables gathering feedback, creating publicity, and new collaborations through their extensive networks (Hagen and Löfquist, 2021).

According to Bodin (Investment Manager at Almi Invest GreenTech), building alliances and engaging with partners committed to advancing the project helps to mitigate risks and secure the success of Elonroad's solution. Adopting a nimble and adaptable approach to partnerships, without rigid partnership terms, allows Elonroad to generate business value for both parties and align with the company's vision.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) highlights the importance of political factors in the success of companies. Political decisions can influence trends, determine areas of investment and create market conditions that can make it easier for companies to enter new markets. Government grants and support programs play a significant role in reducing the barriers to entry for new technology and business models. Therefore, regulations and market conditions set by the authorities can have a considerable impact on the success of companies, especially those in renewable energy or sustainable industries.

The Triple Helix Model emphasizes the importance of collaboration and knowledge exchange between academia, industry, and government for innovation and economic development. Elonroad's partnership strategy appears to be closely aligned with this model, as demonstrated by their commitment to fostering a network for the development and implementation of their technology strategy. One of the key implications of the Triple Helix Model is the development of innovation ecosystems characterized by a high degree of collaboration and interaction between the three institutional spheres (Etzkowitz & Leydesdorff, 2000). Elonroad's partnerships with logistics companies, industry players, government agencies, and strategic partners, as well as their go-to-market strategy, showcase the company's focus on collaboration.

Furthermore, the Triple Helix Model can inform the development of policies and regulations that support innovation and competitiveness (Etzkowitz & Leydesdorff, 2000). Elonroad's focus on leveraging political decisions and government grants to reduce entry barriers and create favorable market conditions for their technology (Bodin, 2021) aligns with this aspect of the model. By actively engaging with partners committed to advancing their project, Elonroad mitigates risks and secures the success of their solution.

Elonroad's partnership strategy reflects the principles of the Triple Helix Model by emphasizing collaboration and knowledge exchange between various stakeholders, including academia, industry, and government. Their approach to partnerships, focus on niche market segments, and leveraging of political decisions and government grants are all consistent with the model's implications for innovation and economic development.

6.3 The identified risk areas with Elonroad investing in the new Stationary Charging Stations (SCS)

The risk areas associated with Elonroad investing in SCS include safety concerns, the need for synergy between electric roads and stationary charging, attracting investors, competition from similar solutions, standardization of technology, and uncertain market trends.

Karin Ebbinghaus (CEO) expresses a safety concern for example when expressing the need for a safety system to prevent accidents while charging. *"What we need to develop in particular is a safety system that means that you cannot reach under the vehicle when you are standing still. We don't have that. We don't have this problem when charging while driving, for example."* (Ebbinghaus, 2021)

Björn Dahlqvist (Senior Advisor at Elonroad) brings attention to the risk of having electric roads and stationary charging stations develop as separate entities. He emphasizes the importance of finding synergies between the two tracks to maximize benefits and prevent the risk of disjointed development.

Jörgen Bodin (Investment Manager at Almi Invest GreenTech) acknowledges the risk that other companies with similar or different charging solutions might be more attractive to investors. To address this Elonroad must demonstrate a market difference in sustainability and climate impact compared to its competition. There is a risk that successful pilot projects could lead to similar solutions being implemented at multiple charging stations, creating intensive competition in the market.

Standardization of technology is another risk area. If governments standardize a different technology for electric roads, Elonroad's dynamic charging may face challenges. This highlights the importance of staying updated with regulatory developments and ensuring that Elonroad's technology aligns with the industry standards.

Andreas Sörensen (former CTO at Elonroad) expresses uncertainty regarding the risks of investing in SCS, as customer preferences and market trends are difficult to predict. To mitigate this risk, it is essential to allocate development time and resources effectively, focusing on the right solutions that cater to market demand and customer needs.

Addressing these risks will require strategic planning, effective resource allocation, and continuous monitoring of market developments.

6.4 What are Elonroad's strengths, weaknesses, opportunities, and threats (SWOT)?

The following SWOT-analysis provides an overview of the strengths, weaknesses, opportunities and threats associated with Elonroad`s SCS technology, combining the insights from the empirical results. The discussion of these analysis will serve as a foundation for identifying strategic recommendations to enhance Elonroad's prospects in the competitive and rapidly evolving industry.

Strengths:

1. **A strong, innovative, and potentially disruptive base technology:** Elonroad's SCS technology offers a unique and differentiated approach to charging electric vehicles, focusing on seamless integration and the potential for both stationary and dynamic charging.

2. **A competent team with a professional board, and an experienced management team with a clear vision:** The company's leadership has demonstrated the ability to create and execute a strategic vision, which can be essential for the technology's success.

3. **Easy installation without major interventions, and likely low-cost installation on asphalt:** The SCS technology's ease of installation allows for quicker implementation and lower costs compared to more complex charging solutions.

4. **Excellent networking and market visibility efforts:** Elonroad has successfully established partnerships with key industry players, government agencies, and potential customers, creating awareness of its technology and building credibility.
5. **Short segments powered only under vehicles, improving electrical safety in urban environments:** This design feature minimizes safety risks associated with electrified surfaces, making the technology more appealing for urban settings.
6. **The pantograph does not require lateral movement and has an open design:** This feature simplifies the charging process and allows for better compatibility with various vehicle designs.
7. **Strong commitment to sustainability and reducing fossil fuel dependency:** Elonroad's technology aligns with global trends towards cleaner energy and reduced carbon emissions, increasing its relevance and appeal.

Weaknesses:

1. **A small-sized company with limited resources, facing difficulty penetrating the market:** Elonroad's size and resources may hinder its ability to scale and compete with larger companies with more extensive financial and operational capabilities.
2. **Limited market presence and brand recognition:** As a relatively new player, Elonroad may face challenges in building brand recognition and trust among potential customers.
3. **Installation on the vehicle can be a limiting factor:** Vehicle manufacturers must adapt their designs to be compatible with Elonroad's charging system, which may create resistance or delays in adoption.

4. **Elevation can be perceived as disturbing:** The raised charging mechanism may be seen as visually disruptive, potentially causing hesitance among urban planners or potential customers.

5. **Early stage of development:** The technology is still in its early stages, and its long-term viability and performance have yet to be proven.

6. **Dependency on regulatory approval and industry standardization:** Elonroad's success depends on meeting regulatory requirements and becoming an accepted industry standard, which may be uncertain or subject to change.

7. **Financial constraints due to the capital-intensive nature of the technology:** Developing, deploying, and scaling the technology requires significant investment, which may be challenging for a small company.

Opportunities:

1. **Increased interest in electric roads globally:** Growing global interest in electric roads presents a significant opportunity for Elonroad's technology to gain traction and market share.

2. **Low cost of electricity compared to other fuels:** The relatively low cost of electricity can make electric vehicle charging solutions more attractive than traditional fuel sources.

3. **Need for automatic stationary charging stations:** A growing demand for convenient and automated charging solutions can drive adoption of Elonroad's SCS technology.

4. **Need for charging while driving:** The ability to charge vehicles while driving addresses range anxiety and can significantly increase the appeal of electric vehicles.

5. **Growing demand for EVs and charging infrastructure:** The ongoing shift towards electric vehicles creates a growing market for charging infrastructure and innovative charging solutions.

6. **Potential collaborations with automotive manufacturers, charging providers, and utility companies:** Partnerships with key industry players can accelerate technology development, adoption, and market penetration.

7. **Expansion into international markets:** As demand for electric vehicles and charging infrastructure grows globally, Elonroad has the opportunity to expand its presence into new markets and regions, increasing its customer base and revenue potential.

Threats:

1. **That electrical safety requirements are not met:** If Elonroad's SCS technology fails to meet stringent electrical safety standards, it may face regulatory barriers and public skepticism, impeding its adoption.

2. **That electric roads are not implemented:** If the concept of electric roads does not gain widespread acceptance, the potential market for Elonroad's technology could be limited.

3. **That some other electrical road solution becomes the standard:** Competition from alternative electric road solutions could threaten Elonroad's ability to become the industry standard, limiting its market share and growth potential.

4. **Competition from other charging solutions and emerging technologies:** The rapidly evolving EV charging landscape presents a constant challenge, as new technologies and competitors could undermine the appeal and relevance of Elonroad's SCS technology.

5. **Uncertain regulatory environment and potential changes in government policies:** Changes in government policies or regulations could create obstacles for the implementation and adoption of electric road solutions, including Elonroad's SCS technology.

6. **Public skepticism and resistance to adopting new technology:** As with any innovative technology, public skepticism, and reluctance to embrace new solutions may hinder the adoption of Elonroad's SCS technology.

In summary, the discussion of the SWOT analysis highlights the promising aspects of Elonroad's new SCS technology and the company's ability to govern the challenges associated with the evolving EV charging landscape. By building on its strengths, addressing its weaknesses, and capitalizing on market opportunities, Elonroad can potentially become a major player in the EV charging infrastructure industry. However, the company must remain vigilant and adaptive in the face of potential threats, such as competition, regulatory changes, and public skepticism.

6.5 Summarizing and Identifying the CSFs

In this subchapter, the identified critical success factors from the previous sections in the discussion chapter will be presented through a systematic classification into specific category titles to improve clarity and facilitate easier identification of each strategic area of focus. Each of the critical success factors will be identified and selected according to three criteria by Rodrigues and Dorrego (2008): Applicability, Relevance and Controllability, see Section 4.2.

The chosen factors are the following:

1. Technological Innovation and Development:

- **Seamless:** The term "Seamless" has two definitions according to the respondents:
    - Catherine Löfquist, Head of Sustainability at Bring, defines seamless as a condition where there is no operational downtime and customer service is excellent.
    - For Robert Bergqvist, Head of Innovation & Business Development at HEM, seamless means that the SCS technology

will not require upgrades and will function effectively for both stationary and dynamic charging on electric roads in the future.

- **Intelligent infrastructure:** It refers to advanced systems and not just charging vehicles but also supporting innovative services, safety features, and data management. The intelligent infrastructure also collects data on charging cycles, energy consumption, and vehicle location, which can be used for customer feedback and other purposes. The intelligent infrastructure allows for simple identification, traffic monitoring, and billing based on usage data, making it future-compatible.

- **Developing Minimum Viable Product (MVP) with customer feedback:** Jörgen Bodin (Investment Manager at Almi Invest GreenTech) and Robert Bergqvist (Head of Innovation & Business Development at HEM) emphasize the critical role of customer feedback in the development of Elonroad's SCS technology, which reflects the principles of the Lean Startup methodology. This approach, as highlighted by Blank (2013), underscores the significance of integrating customer feedback to create a minimal viable product (MVP) that resonates with consumer needs and preferences.

- **Standardization:** Standardization of technology is another risk area and could be an important factor in the success of Elonroad’s technology. If governments standardize a different technology for electric roads, Elonroad's dynamic charging may face challenges. This highlights the importance of staying updated with regulatory developments and ensuring that Elonroad's technology aligns with the industry standards. (Investment Manager at Almi Invest GreenTech)

2. Strategic Management:

- **Skilled and cohesive team:** A strong team has been identified as crucial for startup success by Bodin (Investment Manager at Almi Invest

GreenTech) and Hagen (Senior Advisor, Senior vice president business development HR and HSE at Bring), who suggest that a motivated core team is essential, especially when startups need to change strategies. The value of making good hiring decisions and fostering a culture of accountability in startups is emphasized, which is deemed critical for future success. Rieck & Dickson's model, which highlights the importance of aligning technology with market needs, supports this view. It is argued that a diverse and competent team is essential in developing and executing a successful technology strategy, vital for startups like Elonroad's new SCS technology.

- **Internalization of knowledge and expertise:** The importance of internalized knowledge for startup success is highlighted in Karin Ebbinghaus' interview, where a gap is identified due to the absence of a retention mechanism for organizational knowledge at Elonroad. It is emphasized that the dissemination of information is actively conducted through digital tools and continuous learning efforts. Nonaka and Takeuchi's SECI model of knowledge creation is cited, emphasizing that the internalization of knowledge is critical to an organization's success, especially in the execution of a technology strategy. This model indicates that the management and transfer of knowledge are key components in ensuring the effectiveness of such strategies.

- **Strategic partnerships and collaboration:** The role of strategic partnerships and collaboration is emphasized as vital for the success of startups, particularly in the context of Elonroad's technology. It is reported by Ebbinghaus (CEO) and Dahlqvist (Senior Advisor at Elonroad) that flexible partnerships, especially with vehicle manufacturers like Scania, Volvo, or Daimler, can significantly facilitate the integration of charging technology from the outset. Bergqvist (Head of Innovation & Business Development at HEM) highlights the need for early user involvement in product development to ensure relevance to their needs, and Bodin (Investment Manager at Almi Invest GreenTech) underscores forming an ecosystem of committed partners to mitigate the risk of competing solutions. Additionally, Bodin points out the influence of political support in fostering favorable market conditions for new technologies, and partnerships are crucial for maintaining a competitive edge and advancing technology in line with market demands.

- **Strategic timing:** The significance of strategic timing for startups is expressed through the lens of Elonroad's approach to electric vehicle charging solutions. It is highlighted by Ebbinghaus that IKEA intends to transition to electric vehicles by 2025, indicating a growing market for electric charging infrastructure. Dahlqvist (Senior Advisor at Elonroad) stresses that the alignment of technology, team, and business model with market readiness is critical, noting the current opportunity for stationary charging stations given the rising trend in electric vehicle use. Furthermore, Bodin (Investment Manager at Almi Invest GreenTech) discusses investment considerations, favoring innovative solutions like Elonroad that promise larger sustainability impacts over traditional options. These observations collectively emphasize the essential need for startups to carefully choose the right moment to enter the market and to grow their business.

3. **Customer Relations:**

- **Customer understanding:** The significance of understanding customer requirements is highlighted by the challenge of pinpointing their actual needs, as expressed by Andreas Sörensen. Customers might express a need for a stationary charging system without precise details about features like electric road compatibility or desired charging speed. Other considerations include the charging time and cost implications. Hence, thorough inquiries are necessary to capture and clarify the exact desires of customers before suggesting a specific charging solution (Sörensen, 2021).

- **Customer education**, **awareness:** The significance of customer education and awareness is underlined by the notion that consumers may not fully recognize their needs, particularly in emerging markets. Björn

Dahlqvist (Senior Advisor at Elonroad) points out that it falls upon the company to enlighten customers about what they require and desire, echoing Steve Jobs' perspective on corporate responsibility in consumer education. Such enlightenment is essential for fostering market growth and ensuring that product offerings align with consumer needs that may not yet be fully realized by the customers themselves (Dahlqvist, 2021).

- **Consumer perception:** The perception of consumers is deemed crucial for the success of stationary charging, as stated by Björn Dahlqvist. It is believed that if the technology is seen as a significant improvement over existing cable-based systems, consumer acceptance and uptake are enhanced. Moreover, the consumers' readiness to pay may reflect the value they perceive, which aligns with the concept of perceived usefulness within the Technology Acceptance Model (TAM) (Dahlqvist, n.d.; Davis, 1989).

4. Compliance, Certification, and Safety:

- **Regulatory compliance:** Regulatory compliance is fundamental for businesses such as Elonroad, which are innovating in renewable energy and sustainable industries. Partnerships with logistics companies, industry players, and government agencies, underlined by Elonroad's actions, are essential for navigating and adhering to relevant laws and market conditions established by political decisions. These collaborations not only facilitate adherence to regulations but also help in shaping policies that support innovation and economic growth, as suggested by the Triple Helix Model (Etzkowitz & Leydesdorff, 2000). Government support programs are highlighted as pivotal in diminishing barriers for novel technologies and business models, indicating that regulatory compliance is not just about following rules but actively engaging in the regulatory environment to foster company success (Bodin, 2021).

- **Safety and safety risk management:** The importance of safety and risk management for stationary charging stations (SCS) is underlined by the potential hazards they may pose. It is indicated that a system is required to prevent accidents, like ones that could happen when a person could reach under a vehicle while stationary (Ebbinghaus, 2021). The durability and safety of such systems are considered fundamental, as per the Kano Model; customers expect them to be reliable and safe over time, with any failure likely to result in dissatisfaction.

- **Product certification:** The significance of product certification is emphasized as essential for compliance with industry standards and for building consumer trust (Sörensen, Bodin, 2021). It is expressed that this certification is critical to the product's longevity and marketability, as noted by Bodin (Investment Manager at Almi Invest GreenTech). Moreover, without certification, a product like Elonroad's is limited to being marketed only for pilot projects, not for widespread commercial sale (Ebbinghaus, 2021).

5. Operational Efficiency:

- **Cost-effective operations:** Cost-effective operations are highlighted as critical for the competitive edge of Elonroad's new SCS technology (Bergqvist, Bodin, 2021). It is crucial to keep operational costs low to make the technology appealing and to promote its adoption among customers (Hagen & Löfquist, 2021; Dahlqvist & Ebbinghaus, 2021). As per Porter's framework, businesses gain competitiveness by either cost advantage, producing more affordably than others or differentiation advantage, offering distinctive, superior products or services (Porter, 1985).

According to Rodrigues and Dorrego (2008), the process of identifying and selecting Critical Success Factors (CSFs) is dynamic rather than static, depending on the customer characteristics and condition of the competition.

Therefore, many of the factors listed earlier have the potential to be critical for success.

However, two factors, namely Standardization and Consumer Perception, are to be excluded as they do not meet the criterion of controllability; they are influenced by external forces beyond the company's direct control.

[Page intentionally left blank]

Chapter 7: Main conclusions

In this chapter, the main results of the master's thesis are summarized. It links the research findings to the development of a model for adapting and revising SCS technology strategies, based on market and stakeholder insights. This chapter combines the responses to the research questions to address the thesis's main aim. It provides a clear overview of the important discoveries from the study of Elonroad's SCS technology and their impact on Elonroad and the wider EV charging industry. The focus is on how these findings help in making better technology strategies for startups like Elonroad with similar technology.

RQ1: Identifying and assessing how the implementation of the technology strategies concerning SCS, in relation to the future road map, has been (i.e. its strategic accommodation).

In addressing the first research question, this master's thesis concludes that Elonroad's implementation of its Stationary Charging Station (SCS) technology strategy aligns effectively with its envisioned future roadmap. The strategic accommodation of the SCS technology is evident in several key aspects:

- **Effectiveness for Customers:** The SCS technology is positioned as a potentially effective solution for both existing and potential customers. By addressing the limitations of conventional stationary charging methods and integrating dynamic charging compatibility, Elonroad's SCS technology meets the evolving charging needs of electric vehicle (EV) users. This enhances user convenience and supports the wider adoption of EVs. The SCS technology's seamless integration with EV infrastructure, cost-effective operations, and focus on safety and regulatory compliance make it an attractive option for customers.

- **SWOT Analysis Insights:** The strengths of Elonroad's SCS technology lie in its innovative design, strategic vision of the team, ease of installation, and commitment to electrical safety and sustainability. However, challenges such as the company's small size, limited resources, and the need for vehicle installation adaptations are evident. Opportunities present in the shift towards electric roads and the growing demand for automated charging solutions offer considerable potential for growth. Concurrently, Elonroad must navigate threats like meeting electrical safety requirements, acceptance of electric roads, competition, and regulatory uncertainties.

- **Strategic Partnerships:** The development and scaling up of Elonroad's SCS technology heavily rely on strategic partnerships. Collaborations with vehicle manufacturers are crucial for integrating SCS technology into EVs from the design stage, ensuring seamless integration. Partnerships with logistics companies, government agencies, and research institutions play a significant role in advancing the technology, gaining necessary approvals, and fostering market acceptance. These alliances are instrumental in mitigating market competition risks and in the technological adoption process, reinforcing Elonroad's business model and expediting the deployment of SCS technology.

In conclusion, Elonroad’s strategic implementation of its SCS technology demonstrates a comprehensive approach to aligning with its future roadmap. By continuously innovating, adapting to market needs, and forming strategic partnerships, Elonroad can effectively navigate the challenges and capitalize on the opportunities within the EV charging infrastructure market. This strategic accommodation is crucial for the long-term success and sustainability of Elonroad's SCS technology in the evolving landscape of EVs and charging solutions.

RQ2: Derived from these insights (see RQ1) identify the critical success factors (CSFs) which are relevant for the target market.

Several critical success factors for Elonroad’s new SCS technology were identified and discussed through the thesis. These are the following (See Figure 18):

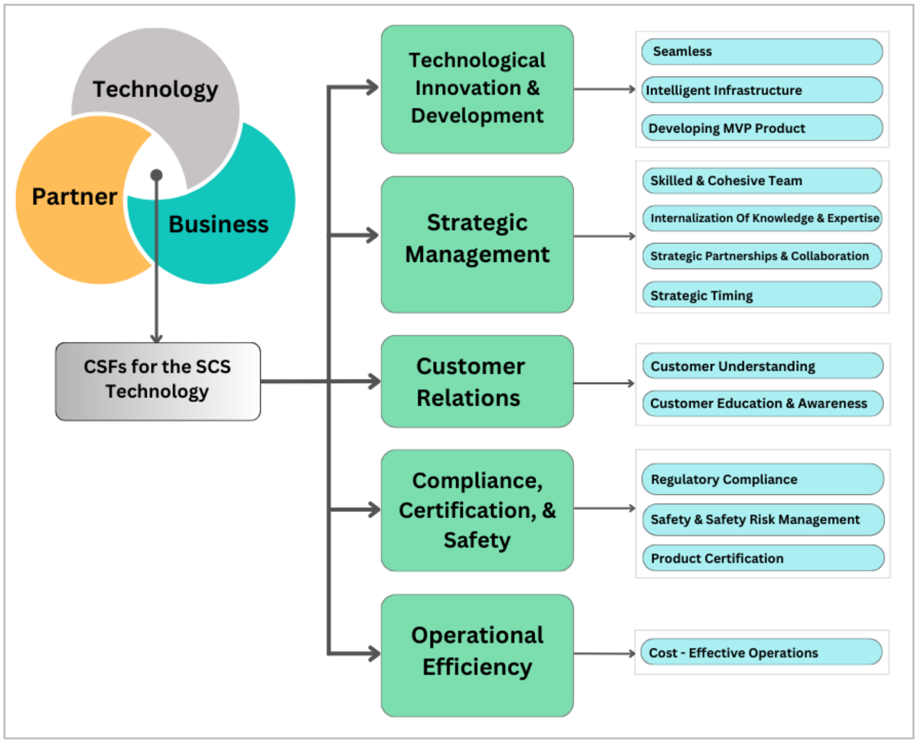

Figure 17: The critical success factors for Elonroad's new SCS technology.

- **Technological Innovation and Development:** The CSFs theory by Rodrigues and Dorrego (2008), emphasizes the importance of leveraging core competencies to meet market CSFs. Elonroad's focus on seamless integration, intelligent infrastructure, and developing a Minimum Viable Product (MVP) with customer feedback underlines its commitment to technological excellence, which is central to its core competencies and addresses the market's need for innovative charging solutions.

- **Strategic Management:** Organizations should develop strategies that leverage their strengths to meet market needs. Elonroad's strategic management approach, forming strategic partnerships, timing their market entry, and building a skilled team, are aligned with this premise. Moreover, internalizing knowledge and expertise is critical to maintaining the distinctive competencies required for competitive advantage.

- **Customer Relations:** Rodrigues' theory suggests that customer satisfaction is a key component of success. Thus, understanding customer needs and educating them about the product is imperative. Elonroad's emphasis on customer understanding and education addresses this requirement directly, aiming to satisfy and even anticipate customer needs.

- **Compliance, Certification, and Safety:** The CSF framework also indicates the necessity for regulatory compliance and safety management, which are applicable to all competitors in the industry and control possibilities for the company. Elonroad's focus on these areas ensures adherence to industry standards, which is essential for gaining customer trust and securing a competitive position.

- **Operational Efficiency:** Finally, the significance of distinctive strategies based on the critical functional areas. Operational efficiency and cost-effectiveness are essential to Elonroad's strategy, ensuring that it can deliver value to customers and stakeholders more effectively than its competitors.

In conclusion, Elonroad's strategic emphasis on technological innovation, strategic management, customer relations, compliance, certification, safety, and operational efficiency emerges as fundamental to the competitive positioning of its SCS technology. These identified critical success factors reflect a comprehensive approach to meeting and exceeding market expectations, which is imperative for securing a sustainable advantage in the evolving landscape of electric vehicle charging solutions.

RQ3: Formulate and evaluate the potential risks for alternative technological strategies and their commercial possibilities.

Elonroad's investment in stationary charging stations (SCS) comes with several risk areas. The most critical risk is safety concerns. CEO Karin Ebbinghaus stresses the need for a safety system that prevents accidents during charging. Without such a system, there is a danger to users, which could lead to serious injuries and damage Elonroad's reputation.

The next significant risk is the need for synergy between electric roads and SCS. If these two develop separately, it may result in wasted resources and missed opportunities for innovation and efficiency. Björn Dahlqvist, Senior Advisor at Elonroad, highlights the importance of integrating these systems to maximize their potential.

Attracting investors is also a risk area. Jörgen Bodin from Almi Invest GreenTech points out that investors may prefer other companies if Elonroad cannot demonstrate a clear market difference in sustainability and climate impact. Competition from similar solutions could reduce Elonroad's attractiveness to investors.

Standardization of technology is a crucial risk. Elonroad's SCS must align with industry standards, or else it could become obsolete if government standards favor a different technology.

Market trends are uncertain, and as Andreas Sörensen, the former CTO at Elonroad, suggests, investing in SCS is risky due to unpredictable customer preferences. Elonroad needs to focus on developing the right solutions that cater to market demands.

In conclusion, while Elonroad's SCS technology presents innovative opportunities, it also faces significant risks, particularly in safety, integration with electric roads, investor attraction, technological standardization, and market trends. Addressing these risks requires a strategic approach that prioritizes safety and synergy, demonstrates market uniqueness, aligns with industry standards, and is adaptable to customer needs and market changes. Prioritizing these risks accordingly can guide Elonroad towards a more secure and promising future in the SCS market.

RQ4: Critical evaluation of the proposed applied model (see the purpose) in adapting and revising the technology strategies.

The SCS framework has been critically evaluated. This evaluation critically reviews the proposed model for adapting and revising technology strategies in the context of this master's thesis. David Gray's "Evaluation Rubric for Analytical Frameworks" is employed as a methodological tool for this purpose.

This rubric assesses the strength, usefulness, and clarity of the SCS Framework. It applies a systematic approach to evaluate if the framework can provide actionable and evidence-based recommendations. This process aims to enhance the framework's applicability, especially for emerging companies in the high-tech Electric Vehicle (EV) charging industry.

The rubric comprises seven criteria: Comprehensiveness (how complete it is), Utility (usefulness), Validation (support by data), Clarity (ease of understanding), Memorability (remembering it), Integration (how well parts work together), and Differentiation (offering something new). These criteria are essential in determining the effectiveness of a framework in strategic decision-making.

1. **How complete it is (Comprehensiveness)**: The SCS framework covers all important areas for identifying critical success factors (CSFs) in high-tech EV charging solutions. It looks at different viewpoints from various stakeholders, suggesting it can be used in many situations within this industry. It seems that no major part is left out.

2. **Useful (Utility)**: The SCS framework appears useful as it helps startups like Elonroad to find and use CSFs. It answers important strategic questions for startups in the EV charging industry, showing its practical use.

3. **Proven by Facts (Validation)**: For validation, real evidence is needed. The SCS framework comes from qualitative research, like interviews and literature reviews, showing an effort to base it on real-world evidence. However, to truly validate the SCS framework, its effectiveness in helping startups to identify and use CSFs needs to be seen.

4. **Easy to Understand (Clarity)**: The SCS framework is clearly laid out and uses familiar categories such as 'Technology', 'Business', and 'Partner'. It simplifies complex ideas by visually organizing and connecting different parts of the framework, making it easier to understand.

5. **Easy to Remember (Memorability)**: With its visual layout and clear sections, the SCS framework should be easy to remember. It follows a structured path from the main purpose through research questions to CSFs, which helps in remembering and using it.

6. **Well-Connected (Integration)**: The SCS framework shows integration by logically linking research questions with the framework's elements and CSFs. It explains how different parts like technology, business strategy, and partnerships work together to identify CSFs.

7. **Unique (Differentiation)**: The SCS framework is unique because it focuses on CSFs for startups in the EV charging industry, which is a specific area not widely covered by other models. It combines business and technology aspects with partnership strategies in a way that may be different from other models.

Overall, the SCS framework meets many requirements for a successful and strong analytical tool. It is comprehensive, useful, clear, memorable, well-integrated, and offers a unique perspective in its field. More evidence, such as case studies of its use by startups, is needed to fully validate its effectiveness in the real world.

[Page intentionally left blank]

Chapter 8: Implications and Contributions

This chapter examines the implications and contributions of this master's thesis, focusing on its relevance to academia and the electric vehicle (EV) charging industry. It discusses the insights derived from the master's thesis, highlighting their significance and potential impact on the field. The chapter underscores the unique contributions of the study and suggests avenues for future research, expanding on the groundwork laid in this master's thesis.

8.1 Contribution to Academia and Industry

This master's thesis significantly contributes to both academic research and the EV industry, especially in developing a model for adapting and revising technology strategies for startups with Stationary Charging Station (SCS) technology.

1. Adaptable Model for Technology Strategy - SCS Framework (Figure 2)

The creation of the SCS Framework marks a key academic contribution. Illustrated in Figure 2, this framework is designed to assist for example startups in adapting and revising their technology strategies, particularly for high-tech solutions like SCS. It acts as a comprehensive guide, helping both academics and industry practitioners to understand and implement effective technology strategies within the EV charging domain. Furthermore, the adaptability of this framework allows for its application to other high-tech startups in the same industry, provided the research context is appropriately adjusted.

2. Flexible Approach to Identifying CSFs for SCS Technology (Figure 17)

Another major contribution is the identification of adaptable Critical Success Factors (CSFs) for SCS technology, as detailed in Figure 17. These factors, being dynamic and modifiable, are pertinent for example to any startup employing similar high-tech solutions in the EV charging sector. Startups can use this framework to choose and evaluate their own CSFs, based on the criteria outlined by Rodrigues and Dorrego (2008), as shown in the final part of Figure 2 and Section 4.2.1. This flexible method of pinpointing CSFs allows for a wider applicability among various startups in the EV charging industry, increasing their chances of success in a competitive environment.

In summary, these contributions not only add valuable insights to academic literature but also offer practical tools and frameworks that can aid startups and established companies in the EV charging industry. They provide a foundation for further research and application in the field, emphasizing the importance of aligning technology development with business models and strategic partnerships for successful implementation.

8.2 Suggestions for Further Research and Practices

Based on the findings of this master's thesis, a few key areas for further research and practical applications are suggested:

1. **Adaptability to Different Markets**: Future research should explore how the SCS Framework can be adapted for startups in sectors beyond the EV charging industry. This would examine the framework's flexibility in varied technological contexts.

    - **Practical Application**: Startups and established companies could apply these findings to modify their strategies and business models, enhancing adaptability and resilience in different market segments.

2. **Long-Term Impact of CSFs**: Conducting long-term studies to track the evolution of Critical Success Factors (CSFs) over time would provide valuable insights into their dynamic nature in fast-changing markets.

- **Practical Application**: This information can help EV sector startups and established companies continuously refine their strategies and operations to meet changing market and technological needs.

3. **Technological Standardization**: Investigating the challenges and opportunities in standardizing technologies like SCS within governmental and regulatory frameworks would be beneficial. This could include policy analysis and impact assessments.

    - **Practical Application**: Insights from this research can help businesses navigate regulatory landscapes more effectively and advocate for favorable standards and policies that align with their technological innovations.

4. **Customer Behavior and Preferences**: Investigating customer behavior in relation to new EV charging technologies can reveal market demands.

    - **Practical Application**: The results can inform customer-focused product development and marketing, ensuring technologies align with user needs and preferences.

These suggestions are aimed at broadening understanding in EV charging and offering practical guidance for startups in developing adaptable and effective technology strategies.

[Page intentionally left blank]

References

Text and figure sources

Almestrand Linné, P., Sundström, L. and Hjalmarson, M. (2020) Standardisation for electric road systems: A review of ITS standards for the development of electric roads. VTI rapport 1041A. Gothenburg: VTIAvailable at: http://vti.diva-portal.org/smash/get/diva2:1430101/FULLTEXT02.pdf [Accessed: 3 March 2023].

Andersson, A. and Kulin, D. (2018a) Elbilsläget 2018 by Power Circle - Infogram. Available at: https://infogram.com/elbilslaget-2018-1h1749rjvkrq4zj [Accessed: 3 September 2023].

Azadfar, E., Sreeram, V. and Harries, D. (2015) 'The Investigation of the Major Factors Influencing Plug-in Electric Vehicle Driving Patterns and Charging Behaviour'. Renewable and Sustainable Energy Reviews, 42, pp. 1065–1076. DOI: 10.1016/j.rser.2014.10.058.

Blank, S. (2013) 'Why the Lean Start-Up Changes Everything'. Harvard Business Review, 1 May. Available at: https://hbr.org/2013/05/why-the-lean-start-up-changes-everything [Accessed: 7 March 2023].

Borglund, Ann-Sofie (2021). Så Ska Framtidens Elvägar Utvecklas. Energi. Available at: https://www.energi.se/artiklar/2021/september-2021/sa-ska-framtidens-elvagar-utvecklas/ [Accessed: 8 March 2023].

Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. Qualitative Research Journal, 9(2), 27-40. DOI: https://doi-org.ludwig.lub.lu.se/10.3316/QRJ0902027

Bravi, L. et al. (2021) 'Advantages and Disadvantages of Developing an Enterprise Resource Planning to Manage Quality in an Accredited Reality. COSMOB S.p.A Case Study'. International Journal of Quality and Service Sciences, 13(2), pp. 253–267. DOI: 10.1108/IJQSS-04-2020-0052.

Butler, A. (2023) Sweden Is Building World's First Permanent Electrified Motorway. Mail Online. Available at: https://www.dailymail.co.uk/sciencetech/article-12028829/Sweden-building-worlds-permanent-electrified-motorway.html [Accessed: 7 May 2023].

Caperello, N., & Kurani, K. S. (2012). Households' stories of their encounters with a plug-in hybrid electric vehicle. Environment and Behavior, 44(4), 493-508.

Carvalho, M. M., Fleury, A. & Lopes, A. P. (2013). An overview of the literature on technology roadmapping (TRM): Contributions and trends. Technological Forecasting and Social Change, 80, 1418-1437.

Christensen, C.M. et al. (2016) 'Know Your Customers' "Jobs to Be Done"'. Harvard Business Review, 1 September. Available at: https://hbr.org/2016/09/know-your-customers-jobs-to-be-done [Accessed: 8 March 2023].

Davenport, S., Campbell-Hunt, C., & Solomon, J. (2003). The dynamics of technology strategy: an exploratory study. R&D Management 33, 5, , 481-499.

Davis, F. D. (1989) 'Technology Acceptance Model (TAM)', in Fred D. Davis, Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, Vol. 13, No. 3, pp. 319-340.

Davis, F.D., R.P. Bagozzi, and P.R. Warshaw (1989). "User Acceptance of Computer Technology: A Comparison of two Theoretical Models". In: Management Science 35.8, pp. 982–1003.

DiMaggio, P.J. and Powell, W.W. (1983) 'The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields'. American Sociological Review, 48(2), p. 147. DOI: 10.2307/2095101.

Ding, B. and Ferràs Hernández, X. (2023) 'Case Study as a Methodological Foundation for Technology Roadmapping (TRM): Literature Review and Future Research Agenda'. Journal of Engineering and Technology Management, 67, p. 101731. DOI: 10.1016/j.jengtecman.2023.101731.

ElGhanam, E., Hassan, M. and Osman, A. (2021) (4) 'Design of a High Power, LCC-Compensated, Dynamic, Wireless Electric Vehicle Charging System with Improved Misalignment Tolerance'. Energies, 14(4), p. 885. DOI: 10.3390/en14040885.

Elonroad. (2021). Elonroad info Bring 2021. [Unpublished company presentation].

Elonroad. 2023. Join Us and Transform the Way Charging Is Done Globally. *Elonroad*. Available at: https://careers.elonroad.tech/ [Accessed: 26 October 2023].

Elonroad - Crunchbase Company Profile & Funding (2023). Crunchbase. Available at: https://www.crunchbase.com/organization/elonroad [Accessed: 21 October 2023].

Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. Energy Policy, 48, 717-729.

Energimyndigheten, (2020) Laddinfrastruktur i Sverige. Available at: https://www.energimyndigheten.se/klimat--miljo/transporter/laddinfrastruktur/laddinfrastruktur-i-sverige/ [Accessed: 14 November 2023].

European Commission. (2021). CE marking. Available at: https://single-market-economy.ec.europa.eu/single-market/ce-marking_en [Accessed: 8 March 2023].

Etzkowitz, H. & Leydesdorff, L. (2000) 'The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations', Research Policy, Vol. 29, No. 2, pp.109-123.

Ford, D. (1988). Long Range Planning, 85-95.

Ford, D., & Thomas, R. (1997). Technology strategy in networks. Int. J. Technology Management, vol. 14, Nos 6/7/8, 596-612.

Gross, B. (2015) Bill Gross: The Single Biggest Reason Why Start-Ups Succeed | TED Talk. Available at: https://www.ted.com/talks/bill_gross_the_single_biggest_reason_why_start_ups_succeed/transcript [Accessed: 13 April 2023].

Gustavsson, M.G.H. et al. (2017) Förstudie om automatiserad sladdlöskonduktiv laddning av elbilar. Available at: https://urn.kb.se/resolve?urn=urn:nbn:se:ri:diva-33082 [Accessed: 6 April 2023].

Hackbarth, A., & Madlener, R. (2016). Willingness-to-pay for alternative fuel vehicle characteristics: A stated choice study for Germany. Transportation Research Part A: Policy and Practice, 85, 89-111.

Harrison, C. et al. (2010) ‘Foundations for Smarter Cities’. IBM Journal of Research and Development, 54, pp. 1–16. DOI: 10.1147/JRD.2010.2048257.

Helmers, E. and Marx, P. (2012) ‘Electric Cars: Technical Characteristics and Environmental Impacts’. Environmental Sciences Europe, 24(1), p. 14. DOI: 10.1186/2190-4715-24-14.

Hunnicutt Hollenbaugh, K.M. (2015) ‘Increasing Leadership Behaviors in Counselor Education Doctoral Students via Study Abroad Experiences: A Single Case Study Approach’. In Journal of Counselor Leadership and Advocacy. pp. 170–183. DOI: 10.1080/2326716X.2015.1066277.

Hutin, M. and Leblang, M. (1894) Current Collector for Power Supply Lines of Electrically Propelled Vehicles without Mechanical Contact Between the Collector and the Power Supply Line, Patent US527857A

Höst, Martin m fl. Att genomföra examensarbete. 1 edition. Studentliteratur AB, 2006. ISBN 9789144005218

IKEA. 100% Electric Home Delivery - IKEA. Available at: https://www.ikea.com/kr/en/customer-service/services/delivery/100-electric-home-delivery-pub35c1d4a4 [Accessed: 14 April 2023].

Jensen, A. F., Cherchi, E., & Mabit, S. L. (2013). On the stability of preferences and attitudes before and after experiencing an electric vehicle. Transportation Research Part D: Transport and Environment, 25, 24-32.

Johansson, R. (2007) ‘On Case Study Methodology’. Open House International, 32(3), pp. 48–54. DOI: 10.1108/OHI-03-2007-B0006.

Johnson, G., Scholes, K., & Whittington, R. (2008). Exploring Corporate Strategy. 8th edition. Pearson. ISBN 978-0-273-71192-6

Johnson, G., & Whittington, R. (2012). Fundamentals of Strategy. 2nd edition. Pearson. ISBN 978-0-273-75725-2

Kano, N., Seraku, N., Takahashi, F., & Tsuji, S. (1984). Attractive quality and must-be quality. Journal of the Japanese Society for Quality Control, 14(2), 39-48.

Kelliher, F., 2005. Interpretivism and the pursuit of research legitimisation: An integrated approach to single case design.

Kerr, C. and Phaal, R. (2020) ‘Technology Roadmapping: Industrial Roots, Forgotten History and Unknown Origins’. Technological Forecasting and Social Change, 155, p. 119967. DOI: 10.1016/j.techfore.2020.119967.

Langbroek, J.H.M., Franklin, J.P. and Susilo, Y.O. (2017) ‘Electric Vehicle Users and Their Travel Patterns in Greater Stockholm’. Transportation Research Part D: Transport and Environment, 52, pp. 98–111. DOI: 10.1016/j.trd.2017.02.015.

Leoni, L. (2015) ‘Adding Service Means Adding Knowledge: An Inductive Single-Case Study’. Business Process Management Journal, 21(3), pp. 610–627. DOI: 10.1108/BPMJ-07-2014-0063.

Liao, F., Molin, E., & van Wee, B. (2017). Consumer preferences for electric vehicles: a literature review. Transport Reviews, 37(3), 252-275.

Lüthje, C., & Herstatt, C. (2004). The Lead User method: an outline of empirical findings and issues for future research. R&D Management 34, 5, 553-568.

Morgan, D. et al. (2013) 'Introducing Dyadic Interviews as a Method for Collecting Qualitative Data'. Qualitative Health Research, 23. DOI: 10.1177/1049732313501889.

Musango, J.K. and Brent, A.C. (2015) (4) 'A Roadmap Framework for Solar Aided Power Generation in South Africa'. Journal of Energy in Southern Africa, 26(4), pp. 2–15. DOI: 10.17159/2413-3051/2015/v26i4a2087.

Neubauer, J., & Wood, E. (2014). The impact of range anxiety and home, workplace, and public charging infrastructure on simulated battery electric vehicle lifetime utility. Journal of Power Sources, 257, 12-20.

Nonaka, I., & Takeuchi, H. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. New York: Oxford University Press.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. Organization Science, 5(1), 14-37.

Nykvist, B., & Nilsson, M. (2015). Rapidly falling costs of battery packs for electric vehicles. Nature Climate Change, 5(4), 329-332.

Oliver, R. L. (1980). A cognitive model of the antecedents and consequences of satisfaction decisions. Journal of Marketing Research, 17(4), 460-469.

Ornetzeder, M. and Rohracher, H. (2006) 'User-Led Innovations and Participation Processes: Lessons from Sustainable Energy Technologies'. Energy Policy, 34(2), pp. 138–150. DOI: 10.1016/j.enpol.2004.08.037.

Osterwalder, A., Pigneur Y., et al. (2014). Value Proposition Design. John Wiley & Sons, Inc., Hoboken, New Jersey.

Phaal, R., Farrukh, C. J., & Probert, D. R. (2004). Technology roadmapping—a planning framework for evolution and revolution. Technological Forecasting and Social Change, 71(1-2), 5-26.

Phaal, R. & Muller, G. (2009). An architectural framework for roadmapping: Towards visual strategy. Technological Forecasting and Social Change, 76, 39-49.

PIARC. 2018. Electric Road Systems: A Solution for the Future? A PIARC Special Project. https://visaozero2030.pt/wp-content/uploads/Electric_Road_Systems_solution_future.pdf. (accessed 12 October, 2021).

Porter, M. E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. Free Press.

Porter, M.E. (1989) 'How Competitive Forces Shape Strategy'. In Asch, D. and Bowman, C. (eds.) Readings in Strategic Management. London: Macmillan Education UK, pp. 133–143. DOI: 10.1007/978-1-349-20317-8_10.

Regeringskansliet (2020),Två år med Elektrifieringskommissionen – en sammanfattning Available at: https://www.regeringen.se/contentassets/2d116eb604404aa7b09a1a414c6a2e40/sammanfattning-av-tva-ar-med-elektrifieringskommissionen/ [Accessed: 5 December 2022].

Regeringskansliet, (2023) Förstärkning av stöd till laddinfrastruktur. Regeringskansliet. Available at: https://www.regeringen.se/pressmeddelanden/2023/09/forstarkning-av-stod-till-laddinfrastruktur/ [Accessed: 3 December 2023].

Rodrigues, H.S. and Dorrego, P.F. (2008) 'Critical Success Factors and Core Competencies'. Encyclopedia of Networked and Virtual Organizations, p. 364.

Rieck, R. M., & Dickson, K. E. (1993). A Model of Technology Strategy. Technology Analysis & Strategic Management, Vol. 5, No. 4, 397-409.

Rogers, E. M. (1983). Diffusion of innovations. New York: Free Press.

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research methods for business students (5th ed.). Pearson Education.

Schuitema,G., Anable, J., Skippon, S., & Kinnear, N. (2013). The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. Transportation Research Part A: Policy and Practice, 48, 39-49.

Sheng, M.S. et al. (2019) 'Inductive Power Transfer Charging Infrastructure for Electric Vehicles: A New Zealand Case Study'. In 2019 IEEE PELS Workshop on Emerging Technologies: Wireless Power Transfer (WoW). 2019 IEEE PELS Workshop on Emerging Technologies: Wireless Power Transfer (WoW). London, UK: IEEE, pp. 53–58. DOI: 10.1109/WoW45936.2019.9030685.

Shladover, S.E. (1992) Highway Electrification and Automation, UC Berkeley, California Partners for Advanced Transportation Technology

Sierzchula, W., Bakker, S., Maat, K., van Wee, B., 2014. The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy 68, 183–194.

Sopjani, L. et al. (2019) 'Involving Users and User Roles in the Transition to Sustainable Mobility Systems: The Case of Light Electric Vehicle Sharing in Sweden'. Transportation Research Part D: Transport and Environment, 71, pp. 207–221. DOI: 10.1016/j.trd.2018.12.011.

Städje, J. (2022) 'ELVÄGAR'. Energinyheter.se, 29 August. Available at: https://www.energinyheter.se/20220830/27064/elvagar

Sundelin, H., Gustavsson, M.G.H. and Tongur, S. (2016) 'The Maturity of Electric Road Systems'. In 2016 International Conference on Electrical Systems for Aircraft, Railway, Ship Propulsion and Road Vehicles & International Transportation Electrification Conference (ESARS-ITEC). 2016 International Conference on Electrical Systems for Aircraft, Railway, Ship Propulsion and Road Vehicles & International Transportation Electrification Conference (ESARS-ITEC). Toulouse, France: IEEE, pp. 1–5. DOI: 10.1109/ESARS-ITEC.2016.7841380.

Teknik, T./ N. (2021) Sveriges får sin första permanenta elväg. Available at: https://www.nyteknik.se/fordon/sveriges-far-sin-forsta-permanenta-elvag/307192 [Accessed: 8 November 2023].

Trafikverket (2017) National Roadmap for Electric Road Systems. Available at: https://bransch.trafikverket.se/contentassets/becf6464a8a342708a143e7fe9e5f0ef/national_roadmap_for_electric_road_systems_20171129_eng.pdf [Accessed: 5 December 2022].

Trafikverket. (2023) Vi avbryter upphandlingen för Sverige första permanenta elväg. Trafikverket. Available at: https://www.trafikverket.se/vara-projekt/projekt-i-orebro-lan/sveriges-forsta-permanenta-elvag/nyheter-for-sveriges-forsta-permanenta-elvag/2023/vi-avbryter-upphandlingen-for-sverige-forsta-permanenta-elvag/ [Accessed: 8 November 2023].

U.S. Department of Transportation (2022) Electric Vehicle Types. Available at: https://www.transportation.gov/rural/ev/toolkit/ev-basics/vehicle-types [Accessed: 10 June 2022].

Primary Data

Bergqvist R., Head of Innovation & Business Development at Hem, Sweden. Online interview (2021, 24 June)

Bodin J., Investment Manager at Almi Invest, Sweden. Online interview (2021, 01 July)

Dahlqvist B., Senior Advisor at Elonroad, Sweden. Online interview (2021, 17 August)

Ebbinghaus K., CEO at Elonroad, Sweden. Online interview (2021, 05 July) & (2021, 17 August)

Löfquist C., Head of Sustainability at Bring, Sweden. Online interview (2021, 06 July)

Marie Hagen S., Senior Advisor, Senior vice president business development HR and HSE at Bring, Sweden. Online interview (2021, 06 July)

Palmqvist A., Production Manager at Elonroad, Sweden. Online interview (2021, 23 June)

Sörensen A., CTO at Elonroad, Sweden. Online interview (2021, 14 July)

Appendix A: Technology Audit

This technology audit for Elonroad was conducted by a group of students at LTH, Lund university in 2020. The master's students are Daniel Mittel, Amjad Belbisi, Amalia Paulsson and Tatiana Orlova. Supervisor: Carl-Johan Asplund (LTH head of course Technology Strategy). The students on the Technology Strategy course gave me written permission to use their findings as secondary data.

-What are the technologies on which the company business depends?

Elonroad's core technological strengths consist of the ability to charge electric vehicles, EVs, both dynamically and statically, regardless of the type of vehicle. The ability to charge an EV while it's in motion extends the range in which the passenger can drive without the need for stopping to charge the vehicle's battery. Elonroad relies on the production of the rails that they use on the roads to make it possible for customers to charge their cars while driving. Without these rails, the company would not be able to operate; this is why this technology can be seen as their basic technology.

What makes Elonroad stand out is that their electric rails are implemented with software capable of identifying the vehicle's energy consumption in order to bill the driver accordingly. Moreover, this software provides essential data from inbuilt sensors in the rails that can predict weather conditions and start a melting function to prevent freezing of the rails. Their innovation consists of mounting the rails on the top of the road. The rails are only 4 cm high and 35 cm wide with inclined sides of only 10 degrees to avoid disturbing or causing any notable inconveniences when driving over them while changing lanes. The rails are mounted on the road and are divided into shorter segments that charge passing vehicles as they are detected above. Elonroad is also working on a solution where they can use a submerged version of the rails. In that way, the construction will be completely merged into the road structure at the same level as the asphalt. These technologies - software capabilities, sensors, short segments of rails and mounting both on the top of the road and into it are considered as distinctive technologies that give strong competitive benefits to Elonroad.

As most product development and production of prototypes is done in-house, there are not so many external technologies that are used, but future plans include more extensive collaboration with other actors in the industry. However, they have a consultation from Sigma who helps them with CAD (computer-aided design) during product development stages, where they can modify the construction. They have also been collaborating with Hydro in the production of an aluminum profile since 2018 that will contain electronics in the next more immersed version of the rail. Besides that, recruiters also suggest different software consults to Elonroad, but the plan is to hire engineers so they can be a part of the team and work constantly on the development of the project.

-Does the company have a poor record in bringing 'home-grown' technologies to the market?

The company has not yet expanded into the market but is currently in the process of doing so. Elonroad started as a project with Lund University and then became a part of a larger group project called Evolution Road that helped them to attract more investment. As stated in the interview, they are now more focused on development and production as they still do not have a business model to commercialize their product.

- How does their technology position compare to that of their customers?

EVs have been around for a while now, Tesla being one of the frontrunners in recent years. Relying on the existing technology where big batteries power the vehicles until they're needed to recharge isn't the most efficient method. Imagine all cars were replaced with today's EVs, for instance, Teslas. Not only would it require vast amounts of Lithium for the batteries, but would also require thousands of fast-charging stations being installed throughout the country. Recharging the battery to 100% takes approximately 75 minutes. Imagine now that large numbers of people have the same idea of getting away from the city for the weekend; this could lead to huge lines at the recharging stations because of everybody queuing up to charge their batteries at the same time.

With the right infrastructure in place, all vehicles equipped with a transceiver under their body, “The Pic Up”, will be able to charge while parked or in motion. The same road could power e.g. cars, buses, and trucks, with the same conductive rail, consequently fulfilling several needs with the same design. It would also eliminate the need for EVs to stop and recharge their batteries when low. By simply going to the nearest electric road, the driver would be able to continue until they’ve reached their destination or decided to pit stop.

Elonroad has not only thought about the hardware side of this technology but also is developing software where customers would be able to benefit hugely from the technology. For example, the rails can send a warning to the driver if there is some unnatural inconvenience going on a kilometer distance ahead. This adds value to their technology and can attract more customers.

Social trends show that customers are increasingly conscious about climate change and carbon emissions, yet many are put off by EVs’ high prices largely due to high battery costs. Theoretically, with an electric road concept, batteries in EVs could be reduced by 20-70% of their size. This solution provides a cheaper alternative means of zero-emission transportation.

-What is the life cycle position of the technologies on which they depend?

Recently there have been discussions about the efficiency of EVs and the huge batteries they use. Elonroad has therefore realized the situation with today’s EVs. The technology that the company uses has not passed the launch phase yet and is still in its development phase, where it starts to get into the market and get attention as one of the solutions for making the batteries smaller and consuming less critical materials.

Due to the lack of existing technology compatible to work with Elonroad electric road system, this has paved the way for Elonroad to develop most of the technology in-house. Their core strategy consists of doing a lot of R&D and finding the right competent people so that the knowledge stays in-house. By cooperating and building the right partnerships, technology can develop even further.

-What are the emerging or developing technologies both inside and outside the company which could affect their current or prospective markets?

The electrification of vehicles isn't necessarily something new. Today, several companies, such as Electreon, Elways, Honda, and Siemens, are all competing and actively developing new solutions to reduce transport's carbon footprint. Most EVs today require big,

expensive batteries to fulfil the driver's needs and compete with non-electric vehicle's driving range. However, with Elonroad's patented electric road system, not only will the price of EVs drop in connection with the reduced need of big batteries, but it will even allow the vehicles to transport more cargo or passengers at the time due to all the excess weight being removed.

Making these roads do however require heavy investments. The first cost estimates for 1 km, double-sided electric road are approximately 1 million euros. This might seem expensive at first, but it's important to understand that all the roads wouldn't be implemented with a conductive rail. Driving one kilometer on electric-powered road transfers enough energy to drive another three kilometres. Roads with the most frequent traffic, in combination with EVs battery, will allow drivers to get to their destinations.

Elonroad, being one of the frontrunners in this technology, requires a lot of expertise for the system to work. This has forced them to build and develop more in-house due to the lack of existing cost-effective technology, some of which would preferably be outsourced as Elonroad would like to concentrate its efforts on the road. Their solution is to find suitable, capable partners to build strong alliances which will allow them to gain more knowledge and further develop their technology.

Seeing as this technology is still in its testing/development phase, uncertainties may arise. For instance, determining the different components lifetime and maintenance costs will prove to be difficult providing an exact estimate on. Having said that, calculations do underline that electrifying roads is a cheaper and efficient way to go.

Possible threats to the market could be fuel cell-driven electric vehicles, FCEVs, which are based on vehicles having hydrogen tanks that convert into electricity, charging a battery. Today, this technology isn't very efficient as a lot of energy goes to waste during the conversion. However, in a few years' time, the fuel cell efficiency might improve introducing a new effective wave of zero-emission vehicles.

-Are the company's strengths in product or production technologies or both?

The company's core strength lies within its patented Elonroad system, hence the product. The ability to reduce the size of heavy, expensive batteries in EVs while still electrifying the whole transport industry could prove to be huge.

The production is still done in-house because of the close link required between the production and the product development team. The team needs to understand the product in order to re-evaluate the design of the product and make improvements. Therefore, the production, for the time being, is still in-house as they are still in the development phase and not ready to sell commercially. At this stage, Elonroad is focused on both the product and production. Further down the line, once the product is fully developed, the production could potentially be outsourced.

-Does the company achieve the optimum exploitation of the technologies they have?

Elonroad is still in the development stage, the technologies they develop can be optimised in many ways. In fact, Elonroad has actually already started implementing some properties to the rails. For example, the fact that the rails can be heated to meltdown snow and ice is one way of optimizing the technology. There are also plans for the future on using the sensors on the rails to help drivers of the vehicles in many ways.

Because of the many ways that this technology can be optimized there is actually a need for a closer partnership with companies that can provide essential external technologies. For example, the type of charging they use is conductive charging. This means the vehicle should be connected to the rails by movable arms, known as “The Pic Up”, mounted beneath the car. Elonroad struggles with finding suppliers that can produce “The Pic Up" needed for this rail profile. If Elonroad finds a partner that can produce “The Pic Up” for them, they can set all their focus on developing the rail itself and save both time and resources.

According to the CEO at Elonroad, they are planning on a collaboration with Volvo Cars where they can integrate the software embedded in the rails with the cars’ software systems. This would allow Volvo to exploit their already existing software by finding new opportunities on how to use them and possibly advance and add value to the user experience. The combination of software could pave the way for autonomous cars in the future.

Elonroad being a small business, can’t afford to wait around a couple of years for new clients. Therefore, they’re constantly trying to adapt their concept, opening the door to new business. At this point in time, they’re in talks with Boliden AB, a mining company, evaluating whether their technology could be integrated into the mining industry, powering heavy dumpers. Another potential field they’re looking into are ports, for instance, powering cranes which are needed for loading and unloading cargo.

-Does the company have technological assets, which are no longer of use to them, but which may be of value to other companies?

Due to the short time since Elonroad was founded and because of this modern technology, it is difficult for the company to already have some technological assets that they do not put to use. This can surely be something that the company can consider in the future when they stop using or develop some technologies.

-Will the company's technology be attractive in a longer perspective?

Since there is currently no established market definition for electrical roads, we can only measure the market growth potential against related product types. An example would be to look into the EV market, which is growing rapidly and is projected to do so for the next 20 years.

Hence the relevance of complementing products to EV, such as charging solutions will most likely grow as well. The next relevant question to ask is whether electrical roads are the EV charging solution of the future or if supplements will be launched more successfully. Factors such as the competitors and partnerships, i.e. the business ecosystem, will have a determining impact on the future of electrical roads. The market comprises a pool of multiple actors such as EV owners, electricity providers, road owners and operators etc., and they must all find themselves receptive towards electrical roads for the technology to expand.

We can't predict the future, but comparing Elonroad's electric road system to their competitors, gives us confidence that they'll be around for a while. Providing a cheap, easily mountable, safe, effective, environmentally friendly alternative for EVs to operate is a very relevant technology for this day and age. The company's mindset of trying to further develop their technology, making it applicable to other industries, building new strong partnerships, gaining more knowledge and evolving their expertise, adds to our confidence that Elonroad will be a force to be reckoned with for years to come.

Appendix B: Interview Questions

1 Internal Interviews

1.1 Karin Ebbinghaus - CEO

1. **Kan du berätta kort om din karriär och din bakgrund? När och varför har du blivit VD för företaget?**
2. **Vad arbetar du med just nu?**

Den stationära laddningen

1. **Vad är det kortsiktiga och långsiktiga målet med den stationära laddningen?**

2. **Tänker ni bara sälja produkten (den stationära laddningen) eller har ni också planer för att sälja tjänster i form av prenumeration? Vilka i så fall?**

   Finns andra tjänster som ni tänker sälja?

3. **Vilka ser du som är de viktigaste framgångsfaktorerna med den stationära laddningen när det gäller en affärmodell eller teknologi?**

4. **Har ni några planer att sälja den stationära laddningen utanför Sverige och vilka marknader skulle ni tänka er att fokusera på?**

Konkurrenter

5. **Har vi konkurrerande teknologier? Vilka?**

6. **Vilka är dem viktigaste konkurrenter?**

7. **Tänker ni samarbeta med era konkurrenter för att standardisera teknologin?**

8. **Hur stor påverkan har era konkurrenter på den befintliga och potentiella marknaden?**

Internalisera kunskap

11. **Kan du förklara hur kunskap och information sprids mellan team?**

12. **Har ni några mekanismer för att säkerställa kunskapsdelning mellan anställda?**

13. **(Denna fråga gäller endast VD, produktägare och CTO) Har ni några mekanismer för att säkerställa att kunskapen stannar vid Elonroad om en anställd lämnar företaget?**

14. **Hur ser Elonroad till att medarbetarnas kunskaper är uppdaterade?**

15. **Hur mycket är vi synliga för världen och potentiella kunder/partner?**

16. **Är det viktigt för er att samla kunskap externt för att utveckla kunskapsbasen?**

Övrigt

1. **Vill ni lägga till något annat?**

1.2 Andreas Sörensen – CTO

Allmänna tekniska information från Andreas

Generella frågor

1. **Kan du berätta kort om din karriär och din bakgrund?**

2. **Vad arbetar du med just nu och hur länge har du varit på företaget?**

About Technology

3. **Vad är skillnaden mellan elvägar teknologin och den stationära laddningen teknologin?**

   De som äger stationära laddningen, kommer de att kunna ladda med elvägar i framtiden?
4. **Var i livscykeln befinner sig teknologierna som vi förlitar oss på?**
   4.1. Försöker vi utveckla allt själva istället för att köpa in en del?

5. **Är företagets styrkor i produktionsteknologi eller produktteknologi eller bägge?**

Stationära laddningen

6. **Vad är den största nyttan med den stationära laddningen på kort och långsikt?**

7. **Vad är styrkor och svagheter på er stationära laddning jämfört med konkurrenter?**
8. **Vilka är de största utmaningar med att utveckla och tillverka den stationära laddningen?**

9. **Vad anser ni t.ex riskerna är med att satsa på den stationära laddningen just nu inkl teklonogi?**

10. **Vilka ser du som är de viktigaste framgångsfaktorerna med den stationära laddningen när det gäller en affärmodell eller teknologi?**

11. **Varför tar era potentiella kunder in ert erbjudande? Vad kommer kunderna att ”få hjälp med” mha ert erbjudande när det gäller stationära laddningen?**

12. **Är det lätt att veta vad kunderna verkligen vill ha? Skiljer det sig från vad de säger att de vill ha?**

13. **Finns det några strategiska partners som kan vara viktiga för Elonroad och för er vid utvecklingen av den stationära laddningen?**

Övrigt

14. **Vill ni lägga till något annat?**

- **Skulle det vara okej om jag kontaktar dig ifall jag har några uppföljnings- eller förtydligande frågor?**

- **Finns det någon information som du har delat med dig idag som är konfidentiell och därför inte bör ingå i examensarbetet?**

- **Kan jag ta med ditt namn och titel i mitt examensarbete, eller vill du vara anonym?**

1.3 Björn Dahlqvist - Senior Advisor & Karin Ebbinghaus – CEO

1. **Kan du berätta kort om din karriär och din bakgrund?**

2. **Vad arbetar du med just nu och hur länge har du varit på företaget?**

Kund och partnerskaprelation

1. **Vilka typer av partner är företaget öppet för? Varför?**

2. **Vilket värde tillför den befintliga partner för Elonroad just nu med den stationära laddningen och på vilka områden? (Tex Bring)**

3. **Finns strategiska partners som kan vara viktiga för företaget vid utvecklingen av den stationära laddningen?**

4. **Vad har ni för strategier eller planer för att attrahera nya kunder med betalningsvilja/förmåga för att köpa den stationära laddningen?**

5. **Hur mycket resurser lägger ni på att skaffa nya kunder eller nya partner för den stationära laddningen ?**

6. **Varför tar era potentiella kunder in ert erbjudande? Vad kommer kunderna att ”få hjälp med” mha ert erbjudande?**

7. **Hur vet ni att detta är de vill ha dvs behöver? Är det lätt att veta vad kunderna verkligen vill ha?**

Marknad

8. **Är vi duktiga på att ta egenutvecklad teknologi dvs den stationära laddningen till marknaden?**

9. **Hur stort behov har den befintliga och potentiella marknaden för den stationära laddningen?**

10. **Finns några andra potentiella marknader och kunder som har intresse för den stationära laddningen?**

Övrigt

11. **Vad anser ni t.ex riskerna är med att satsa på den stationära laddningen just nu inkl teklonogi**

12. **Vilka ser du som är de viktigaste framgångsfaktorerna med den stationära laddningen när det gäller en affärmodell eller teknologi?**

13. **Vill ni lägga till något annat?**

1.4 Anna Palmqvist - Production Manager Elonroad

Generella frågor

1. **Kan du berätta kort om din karriär och din bakgrund?**

2. **Vad arbetar du med just nu och hur länge har du varit på företaget?**
   Svar:

About Technology

3. **Vad är skillnaden mellan elvägar teknologin och den stationära laddningen teknologin?**

4. **Kan du beskriva användning av dessa teknologier (elvägar och stationära laddningen) redan idag?**

5. **Var i livscykeln befinner sig teknologierna som vi förlitar oss på?**
   5.1. Försöker vi utveckla allt själva istället för att köpa in en del?

6. **Hur kan den stationära laddningen komma att påverka våra nuvarande och potentiella marknader?**

7. **Kan den stationära laddningen teknologin skapa möjligheter för nästa teknologi i framtiden dvs elvägar? Hur i så fall?**

8. **Vilket värde tillför den stationära laddningen teknologin för företaget på kort och lång sikt?**

9. **Är företagets styrkor i produktionsteknologi eller produktteknologi eller bägge?**

10. **Är vi duktiga på att ta egenutvecklad teknologi till marknaden?**

11. **Har vi konkurrerande teknologier? Vilka?**

12. **Vilka är dem viktigaste konkurrenter?**

Kund- och partnerskaprelation

13. **Vilka partner har ni?**

14. **Vilket värde tillför partner för Elonroad och på vilka områden?**

15. **Inom vilka områden har ni samarbete med partner för att producera rätt teknologi/produkt för marknaden?**

16. **Hur stor påverkan har partner på teknologi utveckling av den stationära laddningen?**

17. **Finns strategiska partners som kan vara viktiga för företaget vid utvecklingen av den stationära laddningen?**

18. **Inom vilka områden har ni samarbete med kunden att producera rätt teknologi/produkt för kunder?**

19. **Hur kunderna experter som kan hjälpa med teknologi utveckling av den stationära laddningen?**

20. **Varför tar era potentiella kunder in ert erbjudande? Vad kommer kunderna att ”få hjälp med” mha ert erbjudande?**

    20.1. **Hur vet ni att detta är de vill ha dvs behöver? Är det lätt att veta vad kunderna verkligen vill ha?**

Avslutning

13. **Är det något du vill tillägga?**

2 External interviews

2.1 Jörgen Bodin (Investment manager) - Almi Invest GreenTech

Generella frågor

3. **Kan du berätta kort om din karriär och din bakgrund?**

4. **Vad arbetar du med just nu och hur länge har du varit på företaget?**

Faktorer som avgör framgång för nystartade företag

5. **Enligt dig, vilka interna faktorer som avgör framgång för nystartade företag som Elonroad?**

6. **Enligt dig, vilka externa faktorer som avgör framgång för nystartade företag som Elonroad?**

Investering

7. **Enligt dig, Varför ska man investera i Elonroads teknik istället för konkurrenter med liknande teknik?**
8. **Enligt dig, Hur en investerare kan veta att Elonroads teknik är en rätt teknik för framtiden?**

Partnarskap och samarbete

9. **Vilken typ av samarbete har ni med Elonroad?**

10. **Om Elonroad inte hade funnits vem skulle ni tänka samarbeta med när det gäller stationära laddningen och varför?**

11. **Enligt dig, Vad är Elonroads styrkor och svagheter?**

Marknad

12. **Vilken marknad bör prioriteras initialt för den stationära laddningen och varför?**

13. **Hur stort behov har den befintliga och potentiella marknaden för den stationära laddningen?**

14. **Finns några andra potentiella marknader och kunder som har intresse för den stationära laddningen?**

15. **Enligt dig, Finns några planer eller strategier som Elonroad bör göra för att attrahera nya kunder med betalningsvilja/förmåga för att köpa den stationära laddningen?**

Stationära laddningen

16. **Vad är den största nyttan med den stationära laddningen på kort och långsikt**?

17. **Vad anser ni t.ex riskerna är med att satsa på den stationära laddningen just nu inkl teknologi**

18. **Vilka ser du som är de viktigaste framgångsfaktorerna med den stationära laddningen när det gäller en affärmodell eller teknologi?**

Övrigt

19. **Vill ni lägga till något annat?**

2.2 Robert Bergqvist - Chef för Innovation & Affärsutveckling

Generella frågor

1. **Kan du berätta kort om din karriär och din bakgrund?**

2. **Vad arbetar du med just nu och hur länge har du varit på företaget?**

Partnarskap och samarbete

3. **Vilken relation eller förhållande har du/ni till Elonroad och inom vilka områden? (T.ex Affärsmodell, partnerskap eller marknad)**

4. **Vilken typ av samarbete har ni med Elonroad?**

5. **Har ni samarbete med andra aktörer för stationära laddningen eller elvägar lösningen än Elonroad?**

6. **Vilket värde tillför Elonroad för er just nu och specillet med ”den stationära laddningen” / elvägar?**

7. **Finns det några strategiska partners som kan vara viktiga för Elonroad och för er vid utvecklingen av den stationära laddningen?**

8. **Enligt dig, Vad är Elonroads styrkor och svagheter?**

9. **Vad har ni för strategier eller planer för att attrahera nya kunder med betalningsvilja/förmåga för att köpa den stationära laddningen och prenumerera med era el tjänster?**

10. **Varför tar era potentiella kunder in ert erbjudande? Vad kommer kunderna att ”få hjälp med” mha ert erbjudande när det gäller stationära laddningen?**

11. **Är det lätt att veta vad kunderna verkligen vill ha? Skiljer det sig från vad de säger att de vill ha?**

Marknad

12. **Vilken marknad bör prioriteras initialt för den stationära laddningen och varför?**
13. **Hur stort behov har den befintliga och potentiella marknaden för den stationära laddningen?**
14. **Finns några andra potentiella marknader och kunder som har intresse för den stationära laddningen?**

Stationära laddningen

15. **Vad är den största nyttan med den stationära laddningen på kort och långsikt?**

16. **Vad anser ni t.ex riskerna är med att satsa på den stationära laddningen just nu inkl teklonogi**

17. **Vilka ser du som är de viktigaste framgångsfaktorerna med den stationära laddningen när det gäller en affärmodell eller teknologi?**

Övrigt

18. **Vill ni lägga till något annat?**

2.3 Siri Marie Hagen (Bring) (Senior vice president of business development HR and HSE.) och Catherine Löfquist (Hållbarhetschef på Bring)

Generella frågor

1. **Kan du berätta kort om din karriär och din bakgrund?**

2. **Vad arbetar du med just nu och hur länge har du varit på företaget?**
   Svar:

Partnarskap, samarbete och kunder

3. **Varför har ni blivit partner och kund med Elonroad? Och vilken typ av samarbete har ni med dem?**

4. **Enligt dig, vilket värde tillför Elonroad för er just nu och speciellet med ”den stationära laddningen”?**

5. **Som partner till Elonroad, vad tänker ni att bidra med till Elonroad när det gäller den stationära laddningen?**

6. **Om Elonroad inte hade funnits vem skulle ni tänka er att samarbeta med när det gäller den stationära laddningen och varför?**

7. **Enligt dig, Vad är Elonroads styrkor och svagheter?**

8. **Hur stort behov har ni till den stationära laddningen just nu? Hur och när tänkte ni på det här behovet?**

9. **Enligt dig, Finns det andra kunder som är intresserade att ha en lösning som den stationära laddningen?**

Stationära laddningen

10. **Vad är den största nyttan med den stationära laddningen på kort och långsikt?**
11. **Vad anser ni t.ex riskerna är med att satsa på den stationära laddningen just nu inkl teklonogi från partnerskap och kund perspektiv.**
12. **Vilka ser du som är de viktigaste framgångsfaktorerna med den stationära laddningen när det gäller en affärmodell eller teknologi?**

Faktorer som avgör framgång för nystartade företag

13. **Enligt dig, vilka interna faktorer som avgör framgång för nystartade företag som Elonroad?**
14. **Enligt dig, vilka externa faktorer som avgör framgång för nystartade företag som Elonroad?**

Övrigt

15. **Vill ni lägga till något annat?**