Business Strategy for Seamless Charging of BEVs

Exploring the Automotive Industry, the Users, and the EV Business Ecosystem

Master's Thesis in Master's Programmes Management and Economics of Innovation and Quality and Operations Management

NICOLE ASCARD
SARA WINGÖ

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF ENTREPRENEURSHIP AND STRATEGY

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020
www.chalmers.se
Report No. E2020:43

REPORT NO. E 2020:43

Business Strategy for Seamless Charging of BEVs

Exploring the Automotive industry, the Users, and the EV Business Ecosystem

NICOLE ASCARD
SARA WINGÖ

Department of Technology Management and Economics
Division of Entrepreneurship and Strategy
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020

Business Strategy for Seamless Charging of BEVs

Exploring the Automotive Industry, the Users and the EV Business Ecosystem

NICOLE ASCARD

SARA WINGÖ

CEVT contact: Cédric Monnay & Ulrika Westerling

Supervisor: Hans Löfsten, Division of Entrepreneurship and Strategy

Examiner: Hans Löfsten, Division of Entrepreneurship and Strategy

Master's Thesis E2020:043

Department of Technology Management and Economics

Division of Entrepreneurship and Strategy

Chalmers University of Technology

SE-412 96 Gothenburg

Telephone +46 31 772 1000

Typeset in LaTeX

Printed by Chalmers Reproservice

Gothenburg, Sweden 2020

Business Strategy for Seamless Charging of BEVs

Exploring the Automotive Industry, the Users and the EV Business Ecosystem

NICOLE ASCARD

SARA WINGÖ

Department of Technology Management and Economics

Chalmers University of Technology

Abstract

All industries changes and evolves over time, where the automotive industry is no exception. Stricter emission regulations, together with technological trends influences both the business situation and the quest for competitive advantage. The thesis aims to bring insights for creating a business strategy for seamless charging of BEVs, by investigating how automotive actors can gain competitiveness by enabling charging infrastructure. To answer the research question, the three different areas of understanding the industry, understanding the users, and understanding the EV business ecosystem was explored in this master thesis.

The theoretical framework builds upon literature of industrial transformation, diffusion, and business models. The thesis had a qualitative research approach with 22 semi-structured interviews, with carefully selected actors within the EV business ecosystem. The empirical data shows a mix of opinions from the different actors and the data was sorted and structured into the following sections: Actor views on BEVs, Charging and Charging Infrastructure, Actor's Way of Working regarding Electromobility, Collaboration between Actors, Sustainability and Actor Views on the Future. Charging infrastructure can be viewed as a complement to cars, increasing the value of cars.

The analysis is divided into the aforementioned three areas. Understanding the industry is related to diffusion of EVs, charging infrastructure and differences between charging infrastructure and gas stations. Understanding the user implies exploring the consumer perspective, where charge anxiety, range anxiety and price concerns were touched upon. The third area of the analysis explore the business perspective of charging infrastructure, where the EV business ecosystem is linked to the economics of charging infrastructure, its relation to sustainability and the responsible actor in the EV business ecosystem. By managing change, a firm can gain competitiveness which together with business model for charging infrastructure is further explored in the discussion.

This study was performed in collaboration with the innovation centre CEVT, hence, their role in the ecosystem is discussed. The thesis has mapped different stakeholders that are connected to charging infrastructure and interviewed different actors to gain a deeper understanding of their roles, the EV industry, the end-users and the EV business ecosystem they all interact in. Charging and charging infrastructure are key parts in the industrial transformation of the automotive industry. In conclusion, to create a plan for learning and adapting to industry changes by innovating existing business models, automotive industry actors could gain competitiveness by enabling Charging Infrastructure for BEVs.

Keywords: Electric Vehicle, Business Strategy, Charging Infrastructure, Business Model Innovation, Diffusion, Industrial Transformation, Business Ecosystem.

Acknowledgements

This master thesis was conducted during the spring of 2020 for the institution of Technology and Management and Economics at Chalmers University of Technology. The study has been performed in collaboration with CEVT, an R&D and innovation centre located in Gothenburg. The study included 30 higher education credits and was the final work of the master's degree programs within Management and Economics of Innovation and Quality and Operations Management.

We would like to express our gratitude to the people who made it possible for us to write this thesis. Firstly, many thanks to our supervisor at the division of Entrepreneurship and Strategy, Hans Löfsten. Your continuous feedback and assistance during the thesis writing process has been of great importance. The quality and the overall structure of the thesis was greatly improved due to valuable insights throughout the study.

Moreover, we are grateful for all the valuable resources that many employees at CEVT contributed and guided us with during the project. We especially want to thank our advisors at CEVT, Cédric Monnay and Ulrika Westerling, who guided us during the whole process by continuous support and their expertise within charging and batteries, and thanks for always taking the time to answer our questions.

Lastly, we would like to thank all interviewees from the EV Business Ecosystem for their willingness to share thoughts and insights, it has been of great importance for our project.

Nicole Ascard and Sara Wingö, Gothenburg, June 2020

Contents

List of Figures

List of Tables

Acronyms

AI - Artificial Intelligence

B2B - Business to Business

BE - Business Ecosystem

BEV - Battery Electric Vehicle

CEVT - China Euro Vehicle Technology

EV - Electric Vehicle

FCEV - Fuel Cell Electric Vehicle

HEV - Hybrid Electric Vehicle

ICE - Internal Combustion Engine

IoT - Internet of Things

LCA - Life Cycle Assessment

M&A - Merge and Acquisition

NEV - New Energy Vehicle

OEM - Original Equipment Manufacturer

PHEV - Plug-in Hybrid Electrical Vehicle

R&D - Research and Development

ROI - Return of Investment

SDG - Sustainable Development Goal

TCO - Total Cost of Ownership

V2G - Vehicle to Grid

Glossary

Ambidextrous Organisation - An organisation that can simultaneously exploit existing competences while exploring new opportunities for future development. (Grant, 2019)

Business Model - The overall logic of a business and the basis on which it generates revenues and profits. (Grant, 2019)

Business Strategy - Refers to how a firm competes within a particular industry or market. Also known as competitive strategy. (Grant, 2019)

Charging Box - The physical attribute of a charging point. Usually installed at homes.

Charging Event - Services or happenings while vehicles are charged.

Charging Infrastructure - Charging Infrastructure for supplying the electric vehicles with power.

Charging Point - An interface that is capable of charging one electric vehicle at a time.

Charging Station - An element in an infrastructure that supplies electric energy for the recharging of plug-in electric vehicles, such as BEVs and PHEVs.

Corporate Strategy - A firm's decisions and intentions with regard to the scope of its activities (its choices in relation to the industries, national market, and vertical activities within which it participates) and the resource allocation among these. (Grant, 2019)

Dominant Design - A product architecture that defines the look, functionality, and production method for the product and becomes accepted by the industry as a whole. (Grant, 2019)

Housing Cooperative - An economic association, usually abbreviated BRF, which owns real estate with residential buildings, and its members hold owner shares.

Key Success Factors - Sources of competitive advantage within an industry.(Grant, 2019)

Open Innovation - An approach to innovation where a firm seeks solutions from organisations and individuals outside the firm and shares its technologies with other organisations. (Grant, 2019)

Power Conversion - Converting electric energy from one form to another such as converting between AC and DC; or changing the voltage or frequency; or some combination of these.

Powertrain - Encompasses every component that converts the engine's power into movement. From the engine through to the rotating wheels.

Seamless - Hazel free or flawless. Something works without inconvenience. Having no awkward transitions, interruptions, or indications of disparity.

Seamless Charging - Charging without inconvenience.

Tier 1 - Tier one suppliers are companies that supply parts or systems directly to OEMs.

1

Introduction

The following chapter is intended to provide an initial portrayal of the research. First, the background of the research project is presented, including technological trends and industry changes. Then, the company, of which the study is performed in collaboration with, is presented. Thereafter, the problem analysis is described followed by the purpose of the study, the research question and lastly, the limitations of the study.

1.1 Background

There are several different types of electric vehicles (EVs), namely Battery Electric Vehicle (BEV), Plug-In Hybrid Electric Vehicle (PHEV), Hybrid Electric Vehicle (HEV), and Fuel Cell Electric Vehicle (FCEV). The rechargeable electric battery, that powers the vehicle, is large in the cases of BEV and PHEV, and it is in need of *external charging*. However, in the case of a HEV, which is mainly powered by a normal combustion engine, the battery is smaller than the other EVs. The smaller battery of a HEV is charged internally by acceleration motions and does not require external charging. Moreover, a FCEV is fuelled by hydrogen, which then, internally is converted to electricity. (C. Monnay & U. Westerling, personal communication, January 23, 2020)

External charging of BEVs and PHEVs can be achieved by three different approaches: plug-in charging, inductive charging or through battery swapping. (Amsterdam Round Table Foundation and McKinsey & Company., 2014). Plug-in charging implies that the car is plugged into a source of electricity by a charging cable. Whereas, inductive charging means that the charging is executed wirelessly underneath the car through an electromagnetic field generated through the surface. Further, battery swapping implies that a low charged battery is changed to another, fully charged battery. (Amsterdam Round Table Foundation and McKinsey & Company., 2014)

The charging of BEVs can be performed at different speeds and is categorised in normal charging or fast charging. Normal charging is the most common alternative, which could be performed in connection to any wall socket, usually this is done at home. Fast charging requires higher power than the standard of a wall socket and is therefore in need of a more advanced converter. Fast charging is usually performed at charging stations, which is enabled by charging infrastructure providers. (Amsterdam Round Table Foundation and McKinsey & Company., 2014). EVs and charging are influenced by *Technological Trends* and *Automotive Industry Changes* which further will be explored.

1.1.1 Technological Trends

For the megatrend electrification to gain momentum, Cornet et al. (2019) claim that policy makers and governments play an important key role in order to enable the diffusion of electromobility. This is accordant to what Beeton and Meyer (2014) claims about the last two mentioned stakeholders holding the key role of enabling the diffusion of the EVs and their innovative disruption possibilities.

Today, China has the largest automobile market and the country is strongly moving forward with the electrification trend (Chen, Zhao, Hao, & Liu, 2018). According to the China State Council (2012), the term New Energy Vehicle (NEV) is used to describe EVs if, and only if, the vehicle is classified as one of the following powertrain types; BEV, PHEV, and FCEV. Chen et al. (2018) state that the Government of China is taking a more active role in the Business Ecosystem of EVs on a regional level with creating both incentives for customers to buy electrical vehicles and incentives for automotive Original Equipment Manufacturers (OEMs) to produce more New Energy Vehicles. In short, the government created a credit score system for car manufacturers to receive credits by producing NEVs and paying fines for traditional Internal Combustion Engine (ICE) vehicles. This regulatory push has, among other factors, led to China becoming the largest NEV market in the world.

Together with Electrification, there are three other technology-driven megatrends, Autonomous Driving, Connectivity, and Shared Mobility according to Cornet et al. (2019). These four trends are reinforcing each other and are said to disrupt the automotive industry.

1.1.2 Automotive Industry Changes

In addition to the previously mentioned megatrends of autonomous driving, connectivity, electrification, and shared mobility, there are also the global trends of digitalisation and servitisation. New business models stemming from the latter trends have transformed other industries, and the automotive industry should be no exception. All previous trends are paving the way for new mobility ecosystems where the actors are still yet to be clearly identified. Hence, the need to adapt and reinvent themselves has never been stronger. Each actor in the current EV Business Ecosystem needs to identify their new role in the future ecosystem. Some OEMs try to move from the traditional car manufacturer role in the EV Business Ecosystem into meeting the future demands of new fleet actors and autonomous vehicles and offer related services. An example of a car manufacturer to servitise their core product is Tesla, who is enabling their users to use their product more seamlessly by installing charging stations and integrating a service into their product offering, thus, creating a seamless user experience for their end-users. Furthermore, Cornet et al. (2019) stresses the fact that shaping the new mobility ecosystem derives from a joint collaboration effort from policy makers, stakeholders, and automotive industry players.

Gao, Kaas, Mohr, and Wee (2016) have anticipated that EVs will penetrate the automotive industry due to the factors of stricter emission regulations, lower battery costs, more widely available charging infrastructure, and increasing consumer acceptance. Further the authors claim that the interaction of consumer pulls and regulatory push, are the main factors to determine the speed of adoption. Tougher emissions regulations will encourage OEMs to invest in e-mobility and alternative powertrain technologies, thus electrification is required to meet the average fleet CO_2 target.

In the following two subsections, the two factors, as previously mentioned by Gao et al. (2016), of stricter emission regulations and more widely available charging infrastructure, will be further discussed.

1.1.2.1 Stricter Emission Regulations

Besides the key technological trends, there are also environmental trends that will create an impact on the automotive industry. Environmental changes and global warming drive regulatory trends towards stricter emission regulation globally. In 2015, all United Nations Member States adopted the 17 Sustainable Development Goals (United Nations, 2015b) and also, the Paris Agreement (United Nations, 2015a) was adopted the same year by most of the world nations. These are just two examples of global actions to combat climate change, and regulatory forces are expected to accelerate in the future. In the future, stricter sustainability policies from governments might push manufacturers to adapt their business model.

Today's traditional linear production models cause degradation and resource scarcity, leading to negative externalities. (PricewaterhouseCoopers, 2019) Such linear management model goes against the 12th Sustainable Development Goal *"Ensure sustainable consumption and production patterns" (United Nations, 2015b), p. 14.* and the *take-make-waste approach* is not viable in the long-term. However, by adopting a circular business model and creating more value from existing resources, e.g. maintaining the value of a product, PricewaterhouseCoopers (2019) claims that companies with a forward-looking approach could find opportunities to secure long-term revenue by becoming a part of the circular economy.

From a life cycle perspective, a typical BEV in Europe, is more sustainable than a traditional ICE vehicle, according to Hampshire, German, Pridmore, and Fons (2018). A Life Cycle Assessment (LCA) assesses the environmental impact from four different stages, namely raw materials, production, use and vehicle end of life. In the first two phases, raw materials, and production, BEVs generate a higher environmental impact than ICE vehicles. However, this is later compensated by the third phase of the in-use part, where BEVs are more sustainable than ICE vehicles. There are many factors affecting this statement, but it is the electricity mix that is the most crucial for the sustainability aspect. When charging a BEV with *'clean'* electricity (stemming from renewable energy sources), it is much more sustainable to drive a BEV than an ICE car. In different circumstances, when charging a BEV with *'dirty'* electricity (stemming from coal energy) it is slightly more sustainable to drive a ICE car than a BEV (Hampshire et al., 2018). With vehicles powered by fossil fuel (ICE), it is hard to achieve the low levels of CO_2 that are set by the United Nations by 2045 (Hampshire et al., 2018). The environmental aspect of CO_2 emissions stemming from the vehicle in-use part is one reason why EV sales most likely will increase in the future and might have a considerable impact on the traditional ICE car sales.

1.1.2.2 Availability of Charging Infrastructure

Besides the factor of stricter emission regulation, the factor of more widely available charging infrastructure, is described by Gao et al. (2016), as a key enabler for EV diffusion. Even though there are more charging infrastructure today, it is still considered by consumers and users to be lacking. Seamless charging of the BEV is perceived as a common obstacle by EV users and by potential users. Different continents have different standards of chargers in the market, see Appendix 2 for visualisation. Lacking charging infrastructure is slowing down the adoption rate of BEVs. The total experience of using the electrical vehicle becomes significantly less seamless, meaning less easy, less convenient, and less smooth to use, if the charging experience is problematic and not hazzlefree.

1.1.3 Company Description of CEVT

The company China Euro Vehicle Technology AB (CEVT) is mainly an Innovation and Research and Development (R&D) centre. The research area of this study was selected on behalf of CEVT, hence, the project was conducted in collaboration with CEVT, who supported the researchers with knowledge, expertise and industry insights. CEVT's operations include R&D of architecture, systems, components and other manufacturing solutions, as well as, design solutions for cars (China Euro Vehicle Technology AB, 2019). CEVT's business is business to business (B2B) related and the company's main product is modular architecture platforms for vehicles.

CEVT serves as an innovation centre for all brands of Zhejiang Geely Holding Group Limited (Geely Holding Group), which in turn, CEVT is owned by (Zhejiang Geely Automobile Holdings Limited, 2020). The company operates under Zhejiang Geely Automobile Holdings Limited (Geely Auto Group), the correlations are visualised in Figure 1.1.

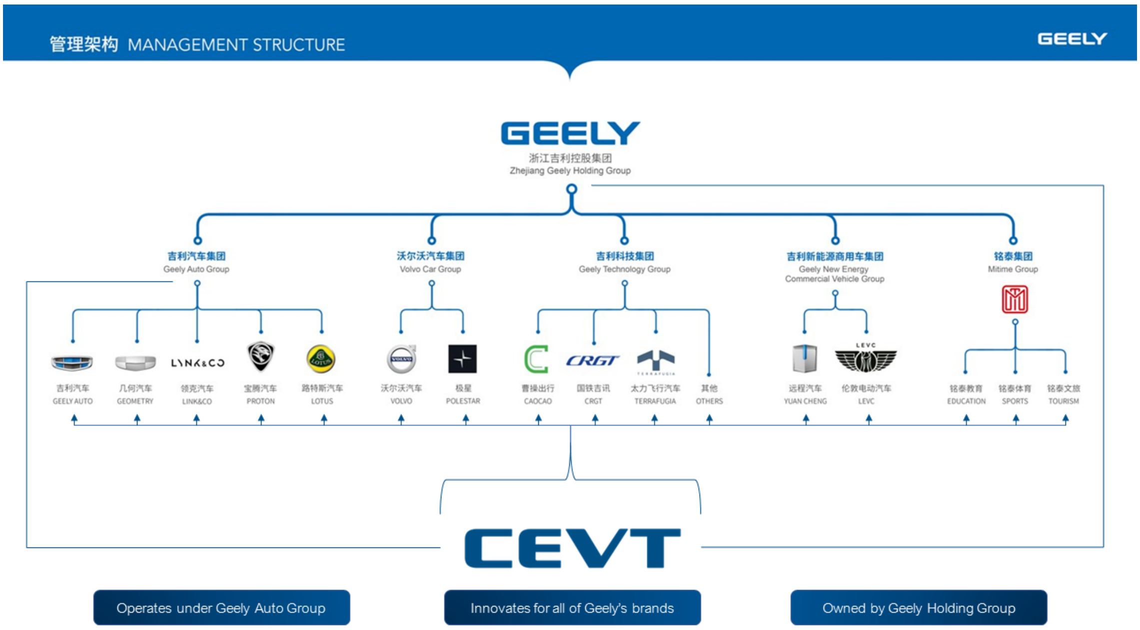

Figure 1.1: CEVT's Role in Geely Holding Group's Organisational Structure (C. Monnay & U. Westerling, personal communication, January 23, 2020)

CEVT was established in February 2013 in order to provide key components and modular architectures for new vehicles (Zhejiang Geely Holding Group Limited, 2020). The company is located in Sweden, more precisely in Gothenburg and Trollhättan (China Euro Vehicle Technology AB, 2019). In 2018, CEVT had about 2000 employees and the revenue were about 4,2 billion SEK (China Euro Vehicle Technology AB, 2019). CEVT's vision is *"to be a world leading innovation center, creating mobility solutions for a different tomorrow"* (China Euro Vehicle Technology AB, 2018), p.4, which implies taking a leading position in the ongoing transformation regarding questions about digitalisation, changing consumer behaviour and preferences, resource scarcity and climate change. (China Euro Vehicle Technology AB, 2018)

The company aims to find smarter ways within mobility in order to meet the demands of the future's global market. CEVT focus on the following four areas: software development, modular development, virtual engineering and innovation (China Euro Vehicle Technology AB, 2020). CEVT's main product is modular architecture platforms that enables flexibility and thereby gives the possibility to meet different customer requirements in a cost efficient way (China Euro Vehicle Technology AB, 2020). Figure 1.2 shows one modular platform established by CEVT. Following CEVT roadmap, the company is developing electrified vehicle platforms for future mobility needs, such as HEV, PHEV or BEV (C. Monnay & U. Westerling, personal communication, January 23, 2020).

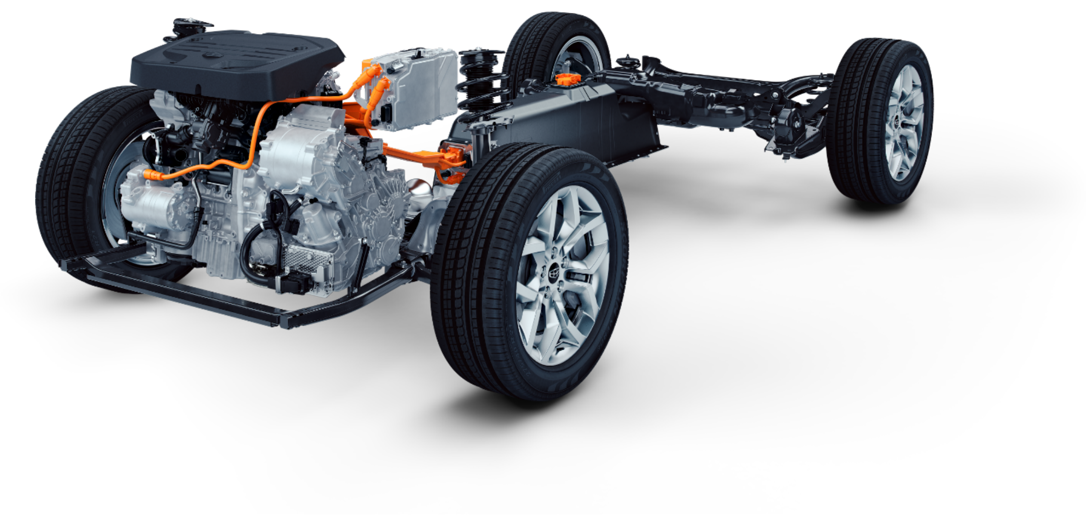

Figure 1.2: Compact Modular Architecture made by CEVT (China Euro Vehicle Technology AB, 2020)

To put it into context, CEVT is today operating between *Core Component Suppliers* and *EV OEMs*, as a core system supplier delivering platforms to new EVs. Hence, the company is located on the *Supply side* of the Business Ecosystem, as described by Beeton and Meyer (2014), see Figure 1.3. The traditional role of an OEM today in the Business Ecosystem is to stay in the Supply side. However, some automotive OEMs are diversifying and expanding their business model focus to enter the intermediaries' side as charging station enablers or to the demand side of car sharing fleets. An example of an OEM facilitating the adoption rate of their product is Tesla, who is also active on the *Intermediaries side* of the Business Ecosystem. Tesla has their own fast-charging stations and expanded their role to also become an *Infrastructure Provider*. (Tesla Inc., 2019)

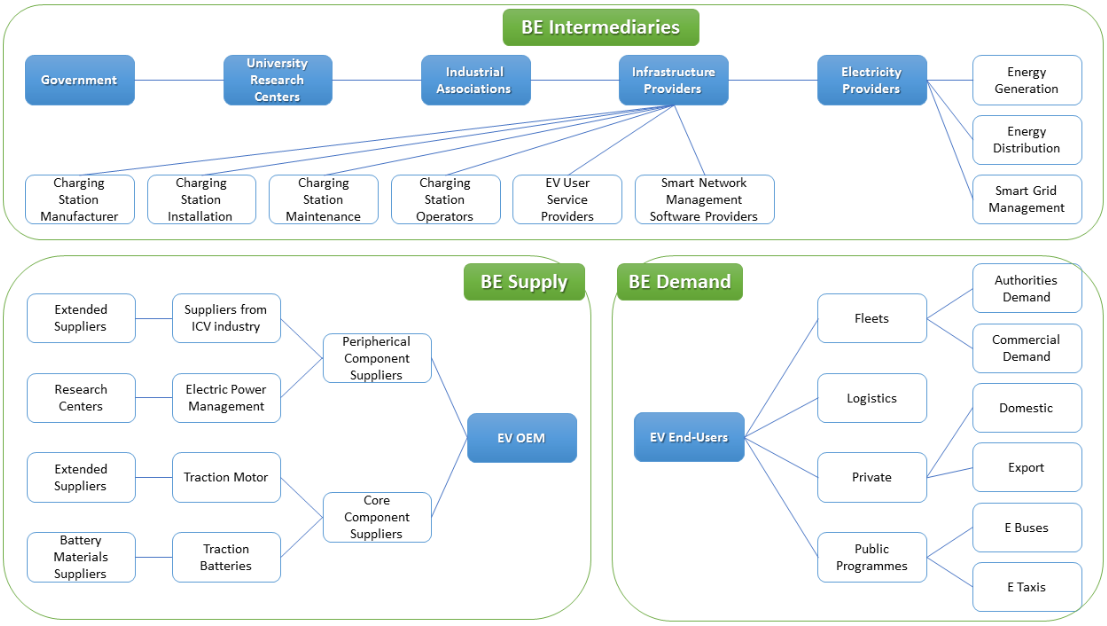

Figure 1.3: Business Ecosystem of Electric Vehicles, modified version (Beeton & Meyer, 2014), p.219.

1.2 Problem Analysis

To conclude, the environmental, technological, and market changes will all put a strain on incumbent companies and stakeholders in the automotive industry. In order to stay competitive in this ever-changing landscape and survive the industrial transformation, new strategies need to form and result in new business model innovation. As previously identified, one of the key factors to raise the adoption speed of BEVs, is the charging infrastructure. In the EV Business Ecosystem, as visualised in Figure 1.4, the role of the charging infrastructure providers remains uncertain, although a small rise in actors trying to offer charging services. Figure 1.4 depicts

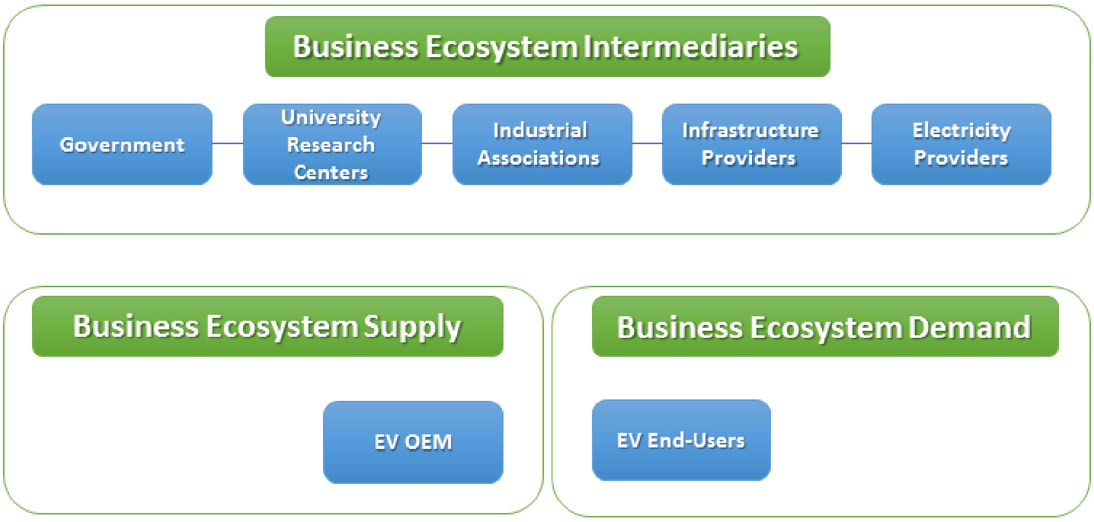

Figure 1.4: EV Business Ecosystem Cross-Sectional Structure simplified and modified version (Beeton & Meyer, 2014), p.219

the key actors in the Business Ecosystem in a simplistic way, with the key actors being the Government, University and Research Centres, Industrial Associations, Infrastructure Providers, Electricity Providers, EV OEMs and EV End-Users. In Figure 1.4, CEVT is located in the Business Ecosystem Supply Side.

To meet the future sustainability goals, it might be necessary for nations to make a complete switch to BEVs. This put higher requirements on the infrastructure, especially related to the charging of BEVs. Since it is a complex system, a collaboration between stakeholders is necessary to achieve new strategies. Like in the example of Tesla's business model regarding taking ownership installing charging stations, thus, becoming an infrastructure provider, and providing their end-users with a full solution combined with services to their core product, the electrical car. In general, in the automotive industry, the ownership of charging stations is fluid and the responsibility for the charging event is not decided upon yet.

As the traditional automotive industry is coping with a potential disruption, an

EV OEM could use their current resources and capabilities to stay competitive. But, in order to do that, C. Christensen, Craig, and Hart (2001) state that it's important for a company to not become biased by their current skills of today, but by aligning them to match future customer needs. EV OEMs has knowledge and experience in developing vehicles and a new business opportunity could be to play a key role in the future Business Ecosystem to enable external charging station solutions by joining forces with other stakeholders. Who those stakeholders could be depends on how the future EV Business Ecosystem will look like and which the incumbent actors are. To meet future customer demands regarding BEVs, there is a need for a strategy regarding supply of charging stations.

This thesis is an external analysis providing insights concerning key elements in the EV Business Network which could be used as a basis for decisions regarding business models for future mobility.

1.3 Purpose

This thesis aims to investigate a business strategy related to charging of BEVs. By providing insights that could be used as a foundation for which role an EV OEM could take in a future EV Business Ecosystem, the insights could indicate how to stay competitive on the market in the future. By understanding existing and potential future actors and their roles connected to the charging event and how the charging of BEVs could be conducted in the future, it could lead to a proposal for a potential position EV OEMs could take to gain market share in future markets.

1.4 Research Question

Based on the purpose of the thesis, which is to investigate a business strategy related to charging of BEVs, a basis for decision will be prepared. Hence, one research question have been concretised to answer the aim of the study.

How could automotive industry actors gain competitiveness by enabling charging infrastructure for BEVs?

The research question aims to find a basis for decisions for business strategies, regarding how EV OEMs can gain competitiveness in an EV Business Ecosystem. Since the EV Business Ecosystem is a complex system, a collaboration between stakeholders is necessary to achieve new strategies. The thesis will explore currently existing stakeholders and collaborations in the EV Business Ecosystem and which ones could possibly exist in the future network. Since this study is performed in collaboration with CEVT, the automotive industry's role in the network will be further explored and where EV OEMs could strategically position themselves to achieve high performance and sustainable competitiveness. For traditional auto OEMs to survive the industrial transformation, new strategies need to form and result in new business model innovation.

1.5 Limitations

This thesis focuses on BEVs, i.e. full electric cars, due to the nature of vehicles' needs of charging infrastructure and its sustainability aspects. The study does not accommodate PHEVs, HEVs, FCEVs and ICE vehicles. Regarding charging alternatives, the research mainly focuses on plug-in charging, hence, inductive charging and battery swapping is not included. As previously stated, there are many megatrends influencing the market, although this thesis focuses mainly on the trend of electrification. Furthermore, since all the interviewed companies in this study are located within the region of Sweden, the study is based on the Swedish market. However, other regions are touched upon as well. The company CEVT is widely grouped into the stakeholder group of EV OEMs throughout the following chapters, until Chapter 6, where CEVT's role and position will be discussed.

2

Theoretical Framework

The theoretical framework is divided into two sections, first the industrial transformation of the automotive industry is outlined followed by a section containing Business Models and why it may be necessary for companies to innovate their business model in order to stay competitive in the evolving market. The chapter is concluded with a summary of the theoretical framework.

2.1 Industrial Transformation

As previously stated in Chapter 1, there are several megatrends that are influencing businesses and industries all over the world. In general, technology development has created the phenomena of digitalisation, which in turn has enabled businesses to offer completely new types of services that was previously not possible. This has led to many changes in many industries, especially in the product based companies where many firms either turned into a service oriented company or attached new services to their product.

The next section will detail the forces that can reshape a whole industry or rendering it obsolete by the creation of a new one. To understand competitive behaviour and the determinants of profitability, the external factors that impact industries shall be examined and then extend the analysis with additional influencing forces, where the perspectives of business models, complements and ecosystems are included.

According to Grant (2019), strategy is about achieving success and in order to have a *successful strategy* there are three factors that need to be in place and enabled by effective implementation. The first factor is goals that are consistent and long term, the second factor is profound understanding of the competitive environment and the third factor is objective appraisal of resources. Unless they have an effective implementation, each of these common elements in successful strategies are useless.

Competitive advantage was defined by Michael Porter as a firm's ability to beat its competitors. Porter (1985) highlights the three generic strategies of cost leadership, differentiation strategy and focus strategy in order to create sustainable competitive advantage. According to Grant (2019), competitive advantage can emerge through external sources of change like technological change or through internal sources of change, like creation of strategic innovation. In the essence of Schumpeter's *creative destruction*, which changes the industry structure from innovation within the industry, strategic innovation can generate competitive advantage through business model innovation and new strategies. Business model innovation can work as a disruptive force on incumbent companies. (Grant, 2019)

2.1.1 Industry Analysis

Since it is important to understand the environment that the company is operating in, the next part will introduce how industry analysis can be done. The second factor that was mentioned above about analysing the competitive environment, an industry analysis is suitable. Industry analysis is useful both on business-level strategies and corporate-level strategies according to Grant (2019).

Osterwalder et al. (2013) claims that it's more important than ever to systematically examine the business environment due to the increasing complexity of the economic landscape, larger uncertainties and severe market disruptions. In order to stay competitive and create sustaining business models, companies will have to monitor the changes and re-shape their strategy.

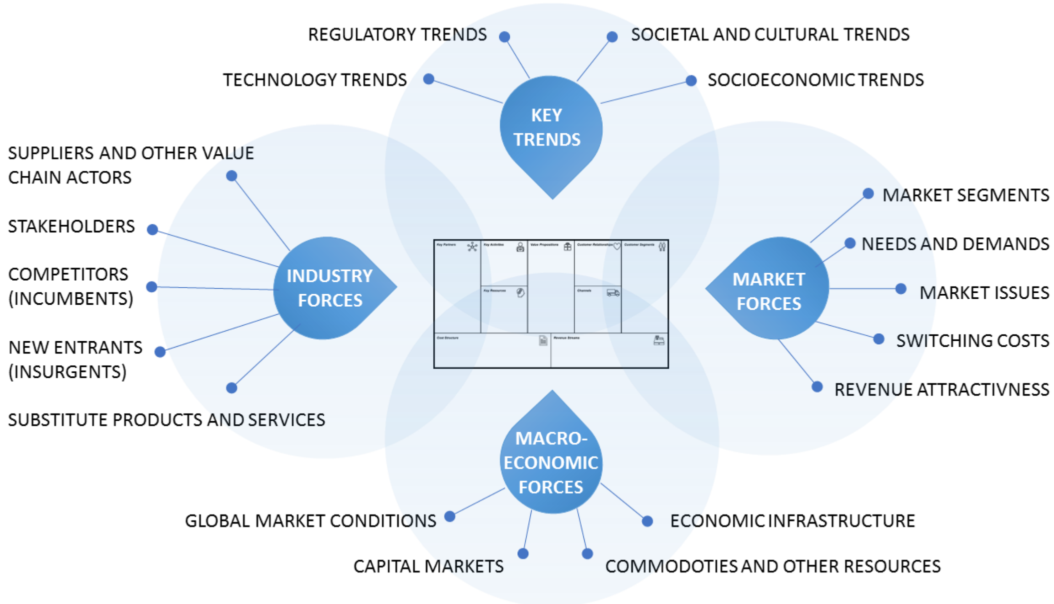

Figure 2.1: Forces and trends influencing business models by Osterwalder et al. (2013), p.201.

Osterwalder et al. (2013) names four different areas that affect the business models of organisations, see the visualisation of this in Figure 2.1. The four areas are key trends, market forces, industry forces and macroeconomic forces. With some foresight, *the key trends* that shape the arena of the firm can be reflected upon and they consist of technology trends, regulatory trends, societal and cultural trends and socioeconomic trends. To study *the market forces*, a market analysis can be done to understand key customer issues in the arena of the firm. The market forces consist of market segments, needs, and demands, market issues, switching costs, revenue attractiveness. Examining *the industry forces* are part of competitive analysis and traces key actors in the firm's space. Industry forces consist of competitors (incumbents), new entrants (insurgents), substitute products and services, suppliers and other chain actors and stakeholders. With the knowledge of macroeconomics, *the macroeconomic forces* can be studied. Those forces consist of global market conditions, capital markets, commodities and other resources and economic infrastructure. (Osterwalder et al., 2013)

While Osterwalder et al. (2013) encourages firms to strategically examine the environment in which they function with the aforementioned four areas, Grant (2019) on the other hand, enlightens some inefficiencies by analysing all the external influences that impacts a firm's decisions and its performance, and it may result in too much information to handle. Grant (2019) does not disregard macrolevel factors as unimportant, but rather instead moves the focus to how these factors affect the firm's industry environment and select what is more vital. Grant (2019), p.61 further states that *"the core of the firm's business environment is formed by its relationships with three set of players: customers, suppliers and competitors. This is its industry environment."* Hence, it's key to analyse the implications of such macrolevel factors for competition, customers and suppliers within the industry that the firm operates in.

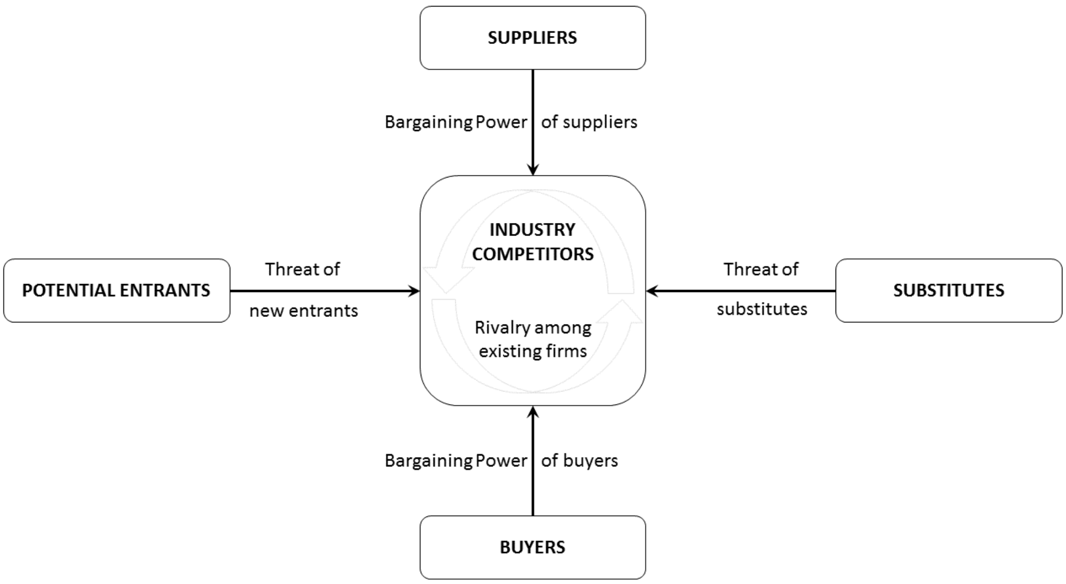

Figure 2.2: Porter's five forces of competition framework (Porter, 1985), p. 05.

Essential components of strategy analysis is to understand the industry environment of the firm and the most popular framework to analyse the external environment is

Michael Porter's *Framework of the Five Competitive Forces,* see Figure 2.2, that determine industry profitability, according to Grant (2019). In addition, the framework can also be used to analyse industry attractiveness and to understand why some industries have been historically more profitable. Aaker and McLoughlin (2010) adds that the framework can also be applied to markets and submarkets within an industry for profitability analysis. Porter (1985) named the five competitive forces as the following: *the entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers,* and *the rivalry among the existing competitors.* Porter (1985) emphasises that the five forces determine the industry profitability due to their strong influences on prices, costs and investments. Moreover, Porter (1985) describes that the strength of each force is determined by a number of key structural variables and some of the elements of industry structure are shown in Figure 2.3.

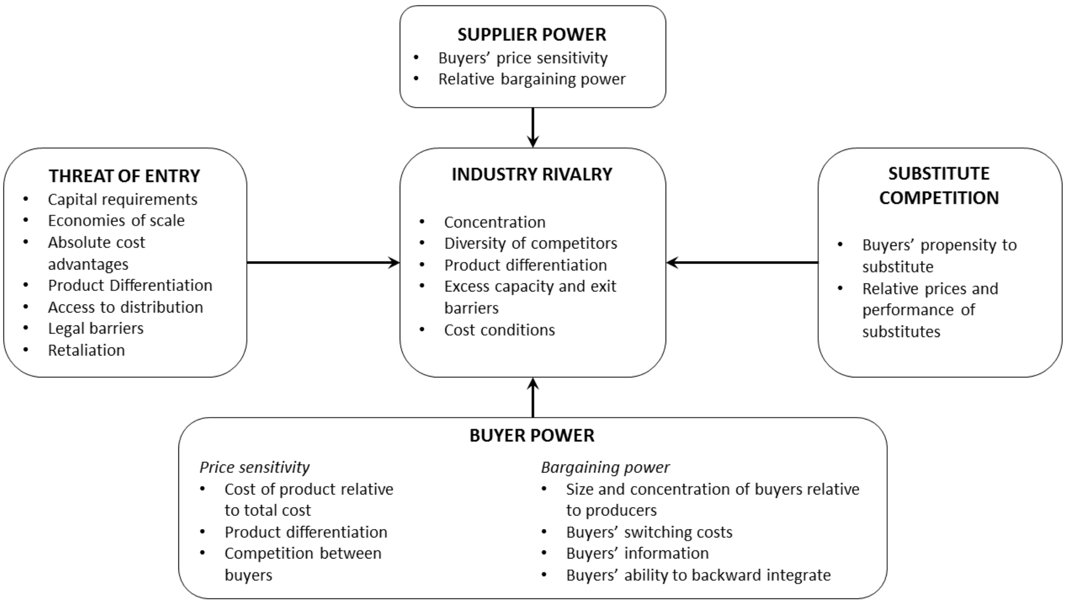

Figure 2.3: The structural determinants of the five forces of competition (Porter, 1985), p. 06.

The industry structure is not static and can be changed over time when it evolves, where strategic choices made by firms can influence the industry structure and change the competitive pressure. Also, Porter (1985) mentions that strategic innovation can be discovered in the process of using the framework. Grant (2019) says that there are two ways to use industry analysis to develop strategy. One is to create strategies to alter the industry structure and the other is creating strategies to position the company in order to handle competition or weak spots. Porter (1985) exemplify cautiousness with strategies that change industries, because they can either improve or destroy profitability in the industry.

In the automotive industry, the degree of profitability can be examined by applying Porter's Five Forces Framework according to Grant (2019). The trends that are transforming the industry can be applied and expose how these trends will change the industry structure and thus the profitability. Each force can be classified with their strength, both on how strong or weak the force has been in the industry historically, but also on how it will increase or decrease its strength in the future. (Grant, 2019)

To start, alternative modes of transportation, e.g. bicycles or public transport, are a substitute to cars. *The threat of substitutes* is deemed low today, but the impact on profitability is expected to increase, due to the higher concerns for the environment and congestion in cities, both leading to an increase in the substitute of alternative modes of transportation. *The threat of new entrants* is increasing, mainly by new manufacturers of EVs and the internalisation by Chinese automakers. Thus, having a negative impact on the profitability in the automotive industry. (Grant, 2019)

The bargaining power of buyers is weak and features distribution through franchised dealers. However, the force of *the bargaining power of suppliers* is increasing, where suppliers control key technologies and consolidation occurs among component suppliers. This force will have a big impact on the profitability in the automotive industry in the coming years, when new suppliers like software companies and battery manufacturers emerge. (Grant, 2019)

Internal rivalry in the car industry is high where the market is categorised with many players competing to sell enough cars to generate financial viability. In addition, the automobile market is also categorised with large excess capacity, high barriers to exit, high fixed costs, and large scale economies. Some examples of changes in industry structure are a decrease in demand of cars, unleashed by changed mobility behaviours, and excess capacity to continue, due to the hard exit barriers and governmental support. Automotive manufacturers who are competing for market share may reduce the number of producers through merge and acquisitions. (Grant, 2019)

2.1.2 Technology Diffusion

In the automotive industry, there are currently many technological changes that drive industrial transformation of the car industry. The world's first electrical car was invented already a century ago (C. M. Christensen, 2011) but was later out conquered by the traditional car with the powertrain of an internal combustion engine (ICE). The ICE car has dominated the world ever since the early days of Henry Ford in 1908 (Kim & Mauborgne, 2015), where cars started their journey to be mass produced. Until then, the automobile market was not disrupted. These cars are fuelled up with either gasoline or diesel unlike the EV who is charged with electricity.

Since the 90s, a new emerging market started to evolve when the car manufacturing companies started to invest in R&D for EVs (C. M. Christensen, 2011). It was not until the year of 2010 that the first commercial full battery EV was put to the market. C. M. Christensen (2011) coined the term *disruptive innovation*. A disruptive innovation is one that, when introduced, creates a new market, and eventually goes on to interfere with existing markets. While these sorts of innovations are often tied to new technology, it is typically an innovative application of the technology, rather than the technology itself, that changes markets. According to C. M. Christensen (2011), an innovation has the potential to disrupt a market when it targets a previously unserved or underserved consumer base, typically by simplifying an existing product to make it more accessible and affordable, thereby undermining that market's status quo. There are several factors driving the disruption and transformation of the transport industry. Aside from regulatory demand on the industry, there are, according to Seba (2014), four main drivers of the clean energy disruption and transportation. Namely batteries, EV, autonomous vehicles and ride-hailing.

"Electric Vehicles (EVs) are connected, mobile, information technology platforms."
- Seba (2014), p.12

Seba (2014) describes how the cost curves of these technologies will disrupt the ICE car manufacturing industry. Since Seba (2014) claims the EV to be an IT product as well, it should also be influenced by Moore's Law. Moore's Law shows how the technology of microprocessors improves every year with 41%, which leads to 41% better products. One example is the cost per kilowatt-hour ($ /kWh) for lithium-ion batteries between the years of 1995 and 2009 who improved at a 14% rate (Seba, 2014). Arbib and Seba (2017) states that EV is a superior product compared to ICE cars and that the EV is disrupting the ICE car industry from above. Transport as a Service, that uses on-demand and autonomous EVs will disrupt both the ICE car industry and the energy industry.

2.1.3 Industry Evolution and Strategic Change

The same way as a product goes through a product life cycle, the same evolution applies to the industries that produce the products. Grant (2019) describes the industry life cycle as of four different phases, as depicted in Figure 2.4, and it is mainly affected by the two forces of demand growth and the creation and diffusion of knowledge that is driving its evolution. Each phase has certain characteristics and by examining an industry it can also be placed somewhere in the industry life cycle. (Grant, 2019)

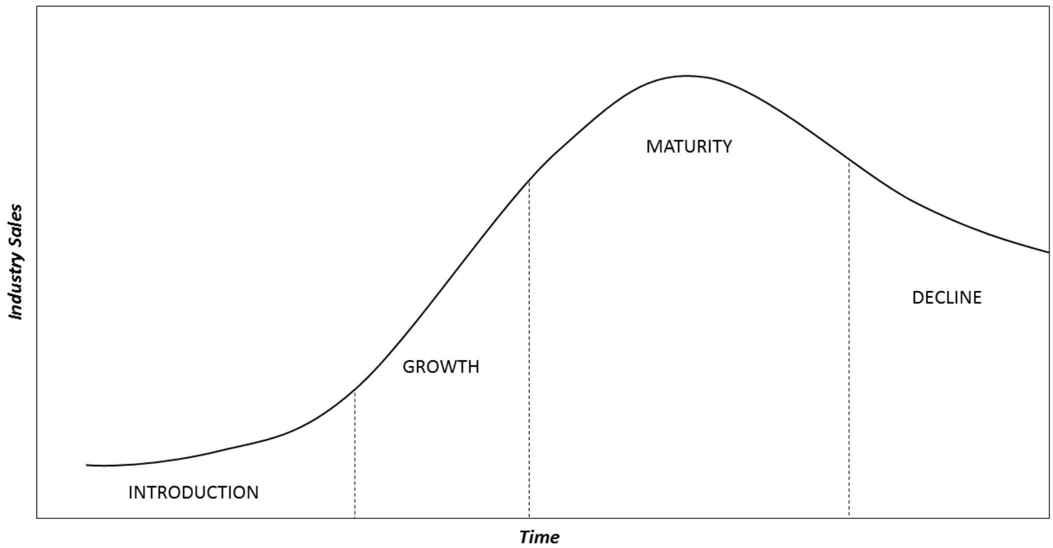

Figure 2.4: The Industry Life Cycle (Grant, 2019), p.191.

The introduction phase in the industry life cycle is categorised with low industry sales where market penetration is still low and the technology is still new and under development. In the introductory stage, there are many different competing technologies and rapid product innovation. Products tend to have poor quality with frequent design changes and there are only a few companies competing for market share. (Grant, 2019)

When the industry sales increases, the industry life cycle hits *the growth phase* and the technologies are improving and a dominant design is emerging. The standardisation of the dominant technology builds brands and now rapid process innovation occurs, as well as merge and acquisitions. Competition intensifies with new companies entering the market, some are purchased, and some companies exit the market. (Grant, 2019)

In the space between the growth stage and *the maturity phase* the mass market is entered and during the maturity stage there is a shift in focus from competing companies, a shift from product innovation to process innovation. A dominant design reduces uncertainty and efforts on product innovation. A dominant design increases a stronger focus on processes, efficiency and economies and scale. The behaviour from the customer changes in this stage due to their increased knowledge and price sensitivity. Regarding manufacturing and distribution, overcapacity emerges in the maturity phase and key success factors consist of cost efficiency through capital intensity and scale efficiency. When the industry consolidates, firms who chose the wrong technology will be shake-outed. (Grant, 2019)

After market saturation, the industry sales are decreasing as the industry life cycle enters the last phase, *the decline stage*, where the appearance of new substitute products occurs. Demand becomes obsolete and price wars distinguish the competition. (Grant, 2019)

An example of the industry life cycle in the automotive industry was when Ford model T became the dominant design and after the product innovation of cars slowed down, other companies increased their process innovation and managed to lower the price of the car by decreasing the production cost. The assembly was designed to mass produce cars and the high volumes gave economies of scale. Later in time, Toyota introduced the known concept of Lean production from innovating their processes. From 2018, both EV and autonomous driving started to transform the automobile industry. (Grant, 2019)

As the industry life cycle originates from the product life cycle concept, there is an additional concept of industry evolution stemming from the latter, which was created by Geoffrey Moore, where he defines the different stages in terms of the *user* instead of the product. This framework describes the first users as *innovators* and *early adopters*, where focus lies on product functionality and product price premiums. It is when the product also met the needs of reliability for a larger audience and this group of users is called *early majority*. The next user group is the *late majority* and they grow once product and vendor reliability issues have been taken care of. (C. M. Christensen, 2011)

Competition analysis can be done on different levels according to Granstrand (2016), where two main areas can be distinguished, namely competition among actors and competition among products and technologies. Granstrand (2016) elaborates on different levels where the analysis can be conducted. Companies compete over consumer's budgets and their other spending's, new product generations outcompete old ones, alternative technologies with the same function compete with each other, systems competition and lastly, competition between product brands. (Granstrand, 2016)

Industries change and the companies within them face numerous challenges from *organisational adaptation* which leads to *strategic change* is required, states Grant (2019). There are different barriers to change and to cope with technological change is challenging in all phases of the industry life cycle. According to Tushman and Anderson (1986), technological change can enhance competencies of incumbent companies while others are competence destroying. Established firms adapt differently depending if the new innovation is either on an architectural or component level. Both the strategy and the activity system of a firm will be heavily impacted if the innovation brings architectural changes to the product. An example of *architectural innovation* is the battery electric car engine which requires complete changes in the entire car design and puts up new demands for the car manufactures to create new charging systems. Where the engine of a HEV was a less influential innovation because it did not force the automobile OEMs to reconfigure the car design. (Grant, 2019)

C. M. Christensen (2011) distinguishes new technology in two ways, it is either sustaining or disruptive. *Sustaining technologies* incorporate improvements on existing products, while *disruptive technologies* carry different attributes than existing technology. Initially, disruptive technologies underperform incumbent technology and they carry a new value proposition.

Granstrand (2016) describes product innovation with an *S-curve* which embodies the evolution of technical performance over time, see Figure 2.5. A series of both minor and major cumulative innovations results in continuous changes. Granstrand (2016) explains that the phenomenon of the *"sailing effect"* derives from the case of two competing technologies, where the new technology gives the old technology a boost of improvement. In the case of the sailing ships versus steam engine boats, when the steaming boats were introduced to the market, the old technology the sailing ships, outperformed the new and inferior technology. However, with time, Granstrand (2016) said this relationship changed and the new technology became superior and disrupted the old one from underneath. C. M. Christensen (2011) described that the leading shipbuilders followed their loyal customers, the ocean shipping companies, and hence, they failed to transition to steam power. By time, the steam-powered ships evolved and accomplished faster transoceanic journeys than sailing ships.

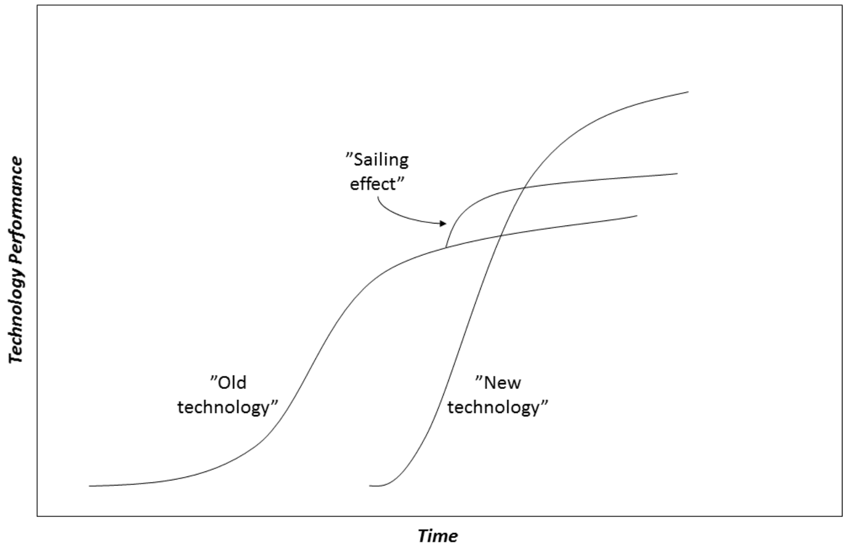

Figure 2.5: S-curves for competing technologies and the sailing effect (Granstrand, 2016), p.192.

Managing change requires dual strategies and organisational *ambidexterity*, where the company both focuses on today and tomorrow. There are more ways to manage strategic change and to combat organisational inertia, for example through new leadership and scenario analysis or the company can create a perception of a crisis to initiate change. Strategic change requires building new capabilities and developing new capabilities is hard due to the path dependency of the firm. (Grant, 2019)

2.1.3.1 Shift of Focus from Hardware to Software within the Automotive Industry

Huge investments have been made to improve the technology of ICE vehicles and capital is tied to the technology that creates value for the traditional car manufacturers. As mentioned in Chapter 1, the automotive industry stands in front of the challenge to cope with the transformation that is needed in order to reach United Union's sustainability goals, where electrification is one important aspect.

Kuhnert, Stürmer, and Koster (2018) argues that if automotive manufacturers and suppliers want to remain successful, they need to offer customer-oriented innovations, which is an ability most of the actors within the industry are struggling with. On a list of the World's 10 Most Innovative Companies, only one automotive OEM, Tesla, appears (Kuhnert et al., 2018). Kuhnert et al. (2018) claim that the reasons for why auto OEM's are struggling to be innovative is because they are experts in the field of refining capabilities connected to hardware. In order to make an automotive OEM innovative, resources instead need to be allocated on R&D of software, services as well as feasibility and the modularisation of vehicles. New technical solutions allow the vehicles to be connected where software needs to be integrated with the hardware to reinforce the value of the vehicle. From being a company developing hardware to become a company working with software is a challenge, and traditional auto OEMs as well as their suppliers will be vulnerable during the transformation of the industry. An additional aspect is that new actors are entering the market, who challenge the traditional automotive OEMs in terms of market share. Lastly, Kuhnert et al. (2018) states six actions, that auto OEMs could relate to in order to facilitate the transition, which are: R&D investments regarding software and services, investments in electrification, developing customised products, adjust business models into being more mobility service oriented, integrate software and hardware with each other and finally reviewing of business proposal.

2.1.3.2 Servitisation

Kryvinska, Strauss, and Greguš (2015) define servitisation as a company's transition from being a manufacturer to being a service provider. The transition is seen as beneficial for customers as well as suppliers, however the change does not occur without some challenges. Kryvinska et al. (2015) pinpoint three challenges, namely restructuring of the organisation, development of new capabilities and transforming the business model from a transaction based business model to a business model based on relationships. The purpose of servitisation is to gain strategic, financial, or marketing benefits.

Mahut, Daaboul, Bricogne, and Eynard (2017) claims that when servitisation of the automotive industry is performed, it is an iterative process striving towards services. Earlier, value has been created by technical development of product performance offerings where mass production was the first step followed by mass customisation and tangible assets generally improved. Traditionally, suppliers and car manufacturers controlled the automotive industry as a result of the increased demand of ownership of cars in order to increase personal mobility. However, today's more mature market where technological achievements have gotten a saturation effect, new opportunities related to mobility has occurred for customers as well as providers. Mahut et al. (2017) implies that new actors has emerged offering mobility as a service, rather than a product, which Apple, Google and car sharing through car pool firms are examples of.

2.1.4 Business Ecosystem

Although Porter's Five Forces Framework is a great tool for strategy analysis, it carries a few limitations in more dynamic industries according to Teece (2007) and Jacobides (2011). Further, Teece (2007) argues that it misses the aspect of the role of *complements*, i.e. products that add value to the product, in contrast to a substitute product which reduces the value of the product. Further, the Five Forces framework does not include the role of *business ecosystems* and the value that originates from partnerships. Teece (2007), p.1325 defines a Business Ecosystem as *"the community of organisations, institutions, and individuals that impact the enterprise and the enterprise's customers and supplies."* and where co-dependency exist between the members. Teece (2007) bases his theory from Schumpeter's view on competition and also puts a strong focus on how innovation can change competition and generate economic change.

Jacobides and MacDuffie (2013) describes how value migrates within the business ecosystem between its parts. The business ecosystem is influenced by the external factors of technology, regulators, and the evolving customer preferences. Jacobides and MacDuffie (2013) also explains how to manage the value migration by identifying four strategic bottlenecks. A firm could manage the value within a business ecosystem by becoming a *"guardian of quality"* to manage how the product is viewed by customers and the network and protect the brand. Securing the firm's value by *becoming irreplaceable* in the business ecosystem, for example by becoming a system integrator like Apple. The value within a business ecosystem can shift when customer preferences change and by *taking advantage of the new needs* a firm can capture the value. In the quest for value, a firm can *redefine the value chain* and redefine its role within it, e.g. IKEA moved the assembly of furniture to their customers. Jacobides (2011) describes how a company can deal with industry changes by redefining its role and responsibilities and may see to other actors needs in order to strengthen their position. Jacobides(2011) further elaborates on establishing an architectural thinking in the company and establish a clear view of the ecosystem to be able to connect with others, in order to not miss valuable opportunities. Hence, it is of importance to leverage in the ecosystem, claim a dominant position and secure it with architectural thinking of the ecosystem and industry to gain competitiveness.

Another way to manage the business ecosystem is by using business models to exploit opportunities and formulate strategies according to Grant (2019). More complex business ecosystems have emerged in the light of digital technologies and these new ecosystems include more diverse and complex business models. The concept of business models will be further elaborated on in the next chapter. Digital innovation is frequently associated with platform business models, but platforms are not restricted to digital markets. A key strategic question is whether to create a product strategy or a platform strategy. Grant (2019) states that both Apple and Google started off with a product strategy but later realised they could capture more value with the creation of a platform strategy for their products.

2.2 Business Models

The automotive industry stand in front of challenges since the business environment is changing due to the transformation from a market dominated by ICE-vehicles into a market consisting of electrified powertrains. OEM's business models are adapted to the traditional market and in order to stay relevant and be competitive on the market tomorrow, they need to update their business models and make the new business model more customised to the developing market.

2.2.1 The Concept of Business Models

There are several different definitions of a business model but according to Grant (2019), a Business Model is described as a simplified portrayal of a business. Further, Grant (2019) claim that a business model is the basis and overall logic of a business that generates profit and revenue. Traditionally, strategy is viewed too narrowly and therefore, business models are useful in order to broaden the horizons and thereby more complex business situations could be managed. In other words, by usage of a well-defined business model, the strategy analysis could be extended. Historically, enterprise's businesses used to be quite simple but due to digital technologies, more complex business ecosystems have emerged which in turn has increased the need for business model innovation. In order to get an overview and to understand complex business ecosystems that has emerged as a result of new and upcoming technologies due to digitalisation, enterprises need to update their business models to cope with new situations and to benefit by new opportunities to make money. It is a critical point, if companies do not follow the development and adapt to new situations, it is a risk of falling far behind other enterprises and thereby be completely competed out. (Grant, 2019)

2.2.2 Business Model Innovation

Grant (2019) claim that enterprises could generate competitive advantage through strategic innovation. Strategic innovation refers to finding new ways to compete with rivals and serve customers. Additionally, four decades ago McKinsey & Co coined the difference between *Same game strategies* which is using classic rules, and *New game strategies* where the rules are rewritten completely. Later on, the term *Business Model Innovation* which implies to capture and/or create value within an industry. Furthermore, Grant (2019) states that most new enterprises entering Fortune 500 in 1997 and a decade ahead owned their success to innovative business models. Björkdahl and Holmén (2013) claim that discovering new products or services is not a part of business model innovation. Instead, business model innovation is about redefining an already existing product or service, finding new ways regarding the delivery to the customer and innovate how enterprises could profit from customer offerings.

An example of Business Model Innovation as a complement to a parent company's core business is Daimler's launch of Car2go (Osterwalder et al., 2013). The core business of Daimler is to produce and sell cars, but by identifying the global trend of faster urbanisation, Car2go was launched with the purpose to correspond to new customers requirements by providing flexible mobility for city dwellers. Car2go is a service built like a 24-hour carpool fleet. Cars are scattered all over town which can be booked in advance, thereafter, the vehicle could be used as long as needed. When the car is to be returned, it is parked anywhere within the city limits. (Osterwalder et al., 2013)

2.2.3 Business Model Canvas

According to Osterwalder et al. (2013), to be aligned regarding the definition of a business model is crucial for rewarding discussions about business model innovation, therefore, Osterwalder et al. (2013) introduced the framework *Business Model Canvas*. The framework could be used as a tool in order to simplify discussions and descriptions of business models since the concept becomes a common language between all parties. The business model canvas consists of nine building blocks that together create the canvas. Each part is included in the logic behind a company's strategy to make money, however, each part could be analysed and managed on their own. In Figure 2.6, a visualisation of a business model canvas is presented including all the nine areas: *Customers Segments*, *Value Propositions*, *Channels*, *Customer Relationships*, *Revenue Streams*, *Key Resources*, *Key Activities*, *Key Partnerships* and *Cost Structure* (Osterwalder et al., 2013). In this report, three of these areas are further explored which are *Customers Segments, Key Resources* and *Key Partnerships.*

2.2.4 Customer Segments

It is essential to understand the customers and their needs. To identify market needs, C. M. Christensen (2011) differentiates between listening to what customers say and what they do. A methodology to get a deeper understanding of the users is called *Design Thinking.* Bertolotti, Di Norcia, and Vignoli (2018) describes Design Thinking as problem solving and innovation through a human-centred approach, where humans and their needs are prioritised in the design process. Moreover, Carlgren, Elmquist, and Rauth (2014) claims that the process is performed iteratively, where customers are put in focus with the aim to create empathy for the user, and thereby develop a customised product or service. To learn from mistakes and to try

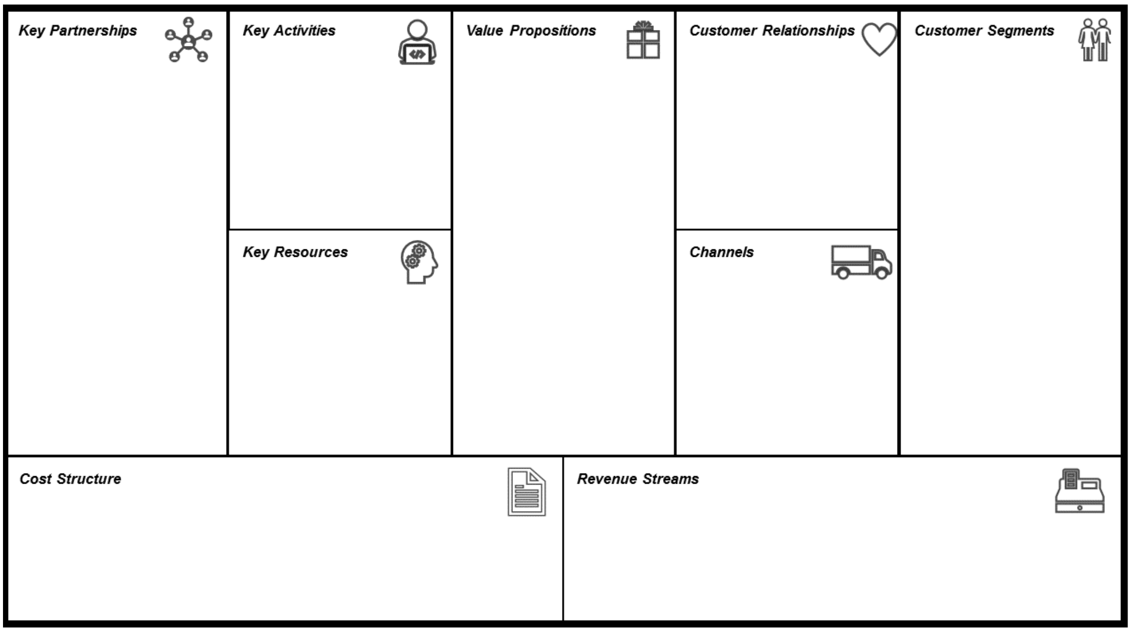

Figure 2.6: Business Model Canvas (Osterwalder et al., 2013), p.44.

ideas by prototyping are also essential parts of the process. Design Thinking is an adaptive methodology and could therefore be applied to increase the innovativeness of any organisation within any areas. (Carlgren et al., 2014)

2.2.5 Key Resources

Grant (2019) distinguishes between the resources and the capabilities of a company. *Resources* are portrayed as the firm's ownership of productive assets and *capabilities* implies the enterprises abilities. Organisational capability is created as a result of a combination of resources and capabilities, the company cannot provide competitive advantage by itself but needs to be put together. In Figure 2.7, the relation between resources, capabilities and competitive advantage is visualised. Resources could be divided into three segments namely tangible, intangible, and human. *Tangible resources* are physical assets such as productions related investments and financial resources. In the automotive industry, tangible resources are usually investments linked to development of ICE-vehicles and to improve the technology through increased production efficiency by for instance the Lean Production methodology. *In-*

tangible Resources are related to patents, trademarks, trade secrets and copyrights of a firm. Together they create a firm's *Intellectual Property* which is a strategic resource whose importance has grown. Moreover, a company's reputation could be viewed as resource, as well as relationships who provide a company with inputs, know-how and access to information. The brand is also related to a firm's reputation and could be seen as a resource. Lastly, organisational culture is seen as a resource since it influences the company's capabilities and effectiveness. *Human Resources* refers to the productive effort and skills an organisation's employees offer. Stability of employments is value adding since finding employees with the right knowledge for a specific task will affect the motivation. Further, communication and collaboration capacity are viewed as a resource. (Grant, 2019)

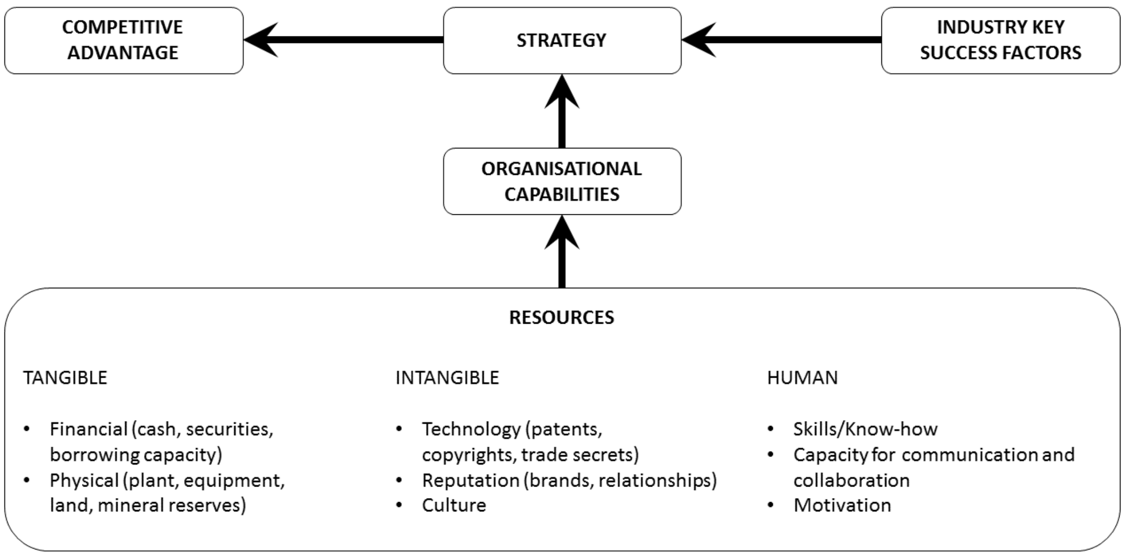

Figure 2.7: The links between resources, capabilities, and competitive advantage (Grant, 2019), p.113.

2.2.6 Key Partnerships

The central part in a business is the customers, according to Ford et al. (2011). Without customers, there is no business and without business there is no job. A business should not be seen as singular occasions but instead as series of interactions since when a product is manufactured, there are several steps from raw material until a complete product in produced. These steps create a series of activities which depends on each other in a complex pattern and can create chain reactions in the supply chain. The interactions in this complex system requires collaboration between the different actors and thereby relationships as well. Some customer relationships could be higher rated than others, for instance, if long-term investments are made, the relationships could be viewed of higher importance. It is the most common that enterprises have a few close customer relationships of high importance. (Ford et al., 2011)

Osterwalder et al. (2013) describes the network of suppliers and partners of high importance as *Key Partnerships*. As mentioned, it could be important for companies to update their business model to adapt to the emerging market. Key partnerships are a part of the Business Model Canvas, which as mentioned, could be used in order to analyse and discuss a business model. By optimising key partnerships, a company's value creation could be increased.

Osterwalder et al. (2013) mention three reasons for entering partnerships, the first reason is linked to *optimisation*, it is not sustainable for a company to own all resources on their own or to perform all activities, the distribution of resources and activities could instead be optimised by partnerships. The partnership could be organised through shared infrastructure or outsourcing which could decrease the costs for all parties. The second reason for partnership is connected to *decrease of risks* *and uncertainty.* However, it is common to enter partnership and cooperate within certain areas while continue to compete within other areas. The Blu-ray technology is an example where several actors cooperated to develop the technology, but they competed since all parties sold their own products integrated with the Blue-ray technology. The third and Osterwalder et al. (2013)'s last reason for partnership is related to *procurement of certain resources and activities.* Osterwalder et al. (2013) claim that there are few companies owning all resources or performing all activities linked to a business model, instead, by letting external companies perform certain activities or deliver resources the firm could extend their capabilities.

2.2.6.1 Strategic Alliances

Partnership can be segmented into four different types according to Osterwalder et al. (2013), which will be further elaborated on below. To start, *Strategic Alliances* is the term for when two or several companies collaborate in order to reach the same goal according to Grant (2019). The strategic alliance could either be between two or more *non-competitive companies* or between two or more *competitive companies* (Osterwalder et al., 2013). Further, Osterwalder et al. (2013) describes two additional ways of alliances, where one is *joint venture* to develop new companies and lastly, *the relationships between buyers and suppliers* that works as a reinforcements of continuous deliveries. These four different alliances are different types of partnerships which is shown in Figure 2.8.

The link between the parties in a strategic alliance does not include ownership in general but instead includes agreements of activities (Grant, 2019). An example is *Star Alliance* which is a collaboration between 25 airlines with the aim to link frequent flier programs and to code share flights. Strategic alliances can benefit firms in many ways, where one is to partner with another company that inhibits the capabilities that the firm is missing internally. Another benefit with forming

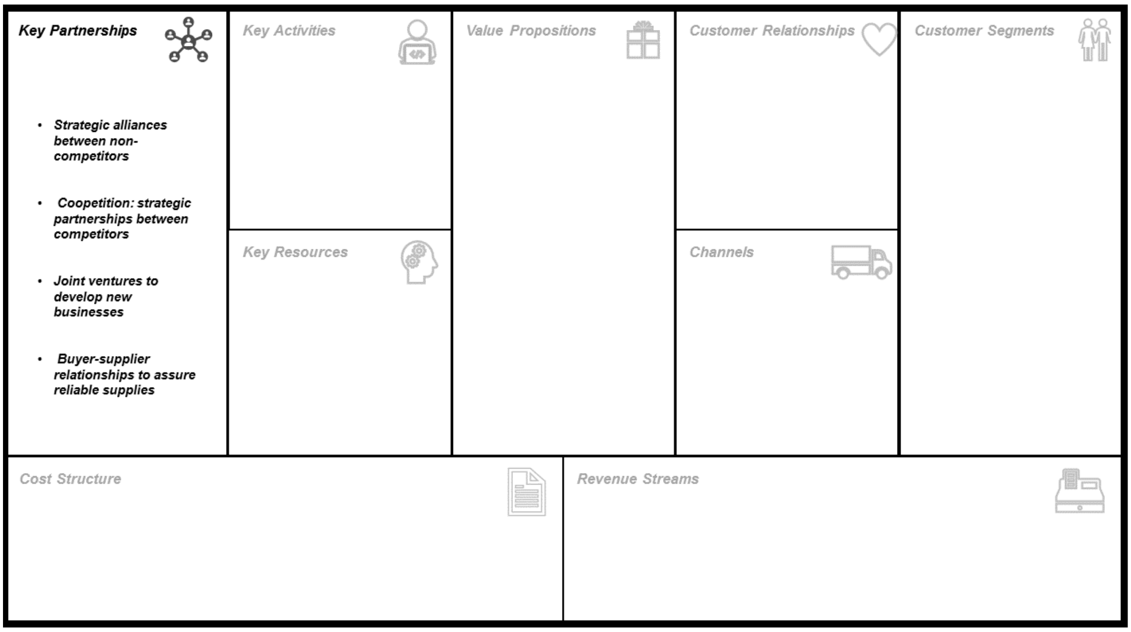

Figure 2.8: Key Partnerships in the Business Model Canvas (Osterwalder et al., 2013), p.44.

or joining a strategic alliance is to share the costs and reduce the high investments that are required to build an ecosystem. An example of an alliance is the partnership between Tesla and Panasonic where they used Tesla's capabilities related to the automotive industry and knowledge regarding solar together with Panasonic's expertise connected to batteries. The major output of this alliance is their joint production of battery packs at Tesla's Gigafactory in Nevada. Another way to extend businesses is to perform vertical integration which BYD is an example of. BYD is a Chinese lithium battery producer who produce the worlds cheapest battery packs. Further, BYD is vertically integrated into lithium mining. (Grant, 2019)

2.2.6.2 Open Innovation

Grant (2019) describes *Open Innovation* as an innovative process where organisations share their technologies externally aiming to contribute to the development of new technological solutions. By usage of open innovation, companies are forced to widen their views and seek for solutions outside their area of expertise. Wilhelm and Dolfsma (2018) claims that companies within asset-intensive and mature markets, like the automotive industry, are struggling to open knowledge boundaries since they are rigid regarding change of internal innovation processes. The innovations connected to the automotive industry implies that knowledge from several scientific fields such as material science aiming for lightweight material, consumer electronics like infotainment and chemistry related to lithium batteries. Due to the wide knowledge field, which is needed now, it is becoming excessively problematic to solve the knowledge internally since it is expensive. Car manufacturer's efforts to obtain innovations externally has increased and they have embedded themselves in collaborations with different actors in networks for cooperation. (Wilhelm & Dolfsma, 2018)

2.3 Summary of Theoretical Framework

In the theoretical framework, the two main areas are *Industrial Transformation* and *Business Models*. According to Grant (2019), it is important to understand the competitive environment, in order to create a successful strategy. The first area includes essential components of strategy analysis to understand the industry environment of the firm, where the main tools included are industry analysis by Porter's five forces and technology diffusion theory. According to Osterwalder et al. (2013) there are four areas of forces and trends that influence business models, which are *key trends, market forces, industry forces* and *macroeconomic forces*. The *Five Forces of Competition Framework* by Porter (1985) consists of the five competing forces: entry of new competitors, threat of substitutes, bargaining power of buyers, bargaining power of suppliers and rivalry among existing firms. *The industry life cycle* has four stages, namely introduction, growth, maturity and decline (Grant, 2019). According to C. M. Christensen (2011) technologies could be divided into sustaining or disruptive. Granstrand (2016) states that the evolution of technical performance over time could be described by an *S-curve*. Due to the diffusion of EVs, there is a *shift of focus from hardware to software* in the automotive industry according to Kuhnert et al. (2018) and further, Kryvinska et al. (2015) stated that there is an increased level of *servitisation*. Not only the industry can be analysed and its evolution, but also the business ecosystem that the firm nowadays operates within. The *Business Ecosystem* is defined as *"the community of organisations, institutions, and individuals that impact the enterprise and the enterprise's customers and supplies."* according to Teece (2007), p.1325. The battery electric car engine is an architectural innovation (Grant, 2019), which requires complete changes in the entire car design and puts up new demands for the car manufacturers to create new charging systems. This brings changes to the business models of incumbent companies.

The second part of the theoretical framework goes through the concept of Business Models and what companies can do to manage changes and innovate in order to gain competitiveness. A *business model* is a simplified portrayal of a business and how the company captures value. When an already existing product or service is redefined, it could be called *Business Model Innovation* (Grant, 2019). In order to simplify discussions and descriptions of business models, the framework *Business Model Canvas* could be used (Osterwalder et al., 2013). An organisation's capability could be described through the firm's *Resources* and *Capabilities* (Grant, 2019). To manage change the companies can for instance create strategic alliances and build key partnerships that inhibits resources and capabilities that the firm lacks. *Key Partnership* is the partners and suppliers of a firm and is viewed of high importance (Osterwalder et al., 2013). One type of partnership is *Strategic Alliances* where companies collaborate towards the same goal. *Open innovation* implies external technology sharing between firms in order to contribute to development of new technological solutions (Grant, 2019). A company can deal with industry change by redefining its role, by establishing architectural thinking and establishing a clear view of the ecosystem (Jacobides, 2011).

3

Methodology

In this chapter, the research methods used in order to answer the research question and to fulfil the purpose of the study are presented. The first section describes the research approach, followed by a description of the research process, which is divided into three parts, namely the planning phase, data collection and lastly data analysis. Thereafter, a section regarding research quality is presented and lastly, a discussion of the methodology is presented. The study was conducted in the described order, but however, the research process is seen as an iterative process, which implies that adjustments could be performed at a later stage of the research process due to new insights.

3.1 Research Approach

Patel and Davidson (2003) claims that a study should be balanced between theory and empirical studies, where an empirical study refers to when knowledge from the research is based on experience gained through observations from reality. Further, Patel and Davidson (2003) implies that researchers' work is to relate reality and theory to each other which could be performed by induction or deduction. Bryman and Bell (2014) presents that a research approach depends on which role theory takes within the study, which could be distinguished between an inductive or deductive research approach, which is aligned with Patel and Davidson (2003)'s statement. An inductive research approach refers to when new theory is created as a result of the study's data collection, which is suitable when there is lack of earlier research and data collection within the field. A deductive research approach, on the contrary, implies testing theory that already exists, which is preferable when the aim is to test a hypothesis based on existing theory (Bryman & Bell, 2014). This study aims to provide insights, which could be used as a foundation for new business model innovation for any company in the automotive industry. The insights hope to indicate what factors will have an impact on the diffusion of EVs and the future EV Business Ecosystem, in the context of Sweden, combined with exploring the role of charging infrastructure. Since the field has limited research associated with this specific case, this thesis will not test any hypothesis against established theory. Instead, this thesis will seek to develop new theory based on the analysis of collected data. Therefore, an inductive research approach is considered most suitable.

According to Bryman and Bell (2014) a study could be targeted by two different strategies, quantitative studies or qualitative studies. A quantitative research approach consists of collection and analysis of measurable and numerical data, where measurements are performed objectively, and the emphasis lies in the amount of data. A qualitative research approach, on the other hand, includes collection and analysis of non-numerical data such as pictures, actions and words, where the emphasis lies in interpretation of words seeking to interpret motives, beliefs and underlying incentives(Bryman & Bell, 2014). During the data collection phase of this thesis, a qualitative approach was used, due to the nature of its purpose. While gathering insights about the automotive industry, potential actors in a EV business ecosystem and charging infrastructure in Sweden was interviewed, hence non-numerical data, was the main source for the analysis.

3.2 Planning Phase

During the planning phase, a pre-study was conducted in order to introduce the researchers to the automotive industry, CEVT as a company and to the company's working methods and external collaborations. The first part of the pre-study was combined by meetings and interviews with employees at CEVT. The meeting time slots were used for presentations by employees, in order to give the researchers an introduction about CEVT and the automotive industry, followed by an interview session. The types of the interviews were a combination of semi- and unstructured, where the researchers had prepared questions, but were also given the opportunity to ask questions at any time during the meetings. Notes were taken during all meetings as a tool to gather the collected information. During the part where the employees gave a presentation both researchers took notes and during the section for questions one of the researchers was responsible for asking questions and the other researcher was responsible for taking notes. In the pre-study, eleven employees at CEVT were interviewed and the people the researchers got in contact with was the Senior Manager of Power Conversion, a Project Leader of Electric Vehicle Power Supply, a System Manager of High Voltage Power Supply, the Innovation Process Owner, the Senior Manager of High Voltage Energy Storage Systems, a Consumer Insight Manager, the Senior Technical Specialist of Electric Power Propulsion, the Innovation Strategy Director, the Attribute Owner of Product definition, the Technical Expert of Powertrain Software & Control and the Head of Emerging Technologies, see Table 3.1. In order to deepen the knowledge, to get an insight in current research within the field and to generate an industry analysis, literature studies was performed as a complement to the meetings.

Table 3.1: List of Pre-Study Interviews

Nr	Role of Interviewee	Company
1	Senior Manager - Power Conversion	CEVT
2	Project Leader - Electric Vehicle Power Supply	CEVT
3	System Manager - High Voltage Power Supply	CEVT
4	Innovation Process Owner	CEVT
5	Senior Manager - High Voltage Enegy Storage Systems	CEVT
6	Consumer Insight Manager	CEVT
7	Senior Technical Specialist of Electric Power Propulsion	CEVT
8	Innovation Strategy Director	CEVT
9	Attribute Owner - Product Definition	CEVT
10	Technical Expert - Powertrain Software & Control	CEVT
11	Head of Emerging Technologies	CEVT

In parallel with the pre-study, preparation for data collection was performed. Based on the different actors in Beeton and Meyer (2014)'s business ecosystem, a list consisting of interesting companies for interviews was conducted before CHARM, Chalmers Student Union's career fair. At the fair, the researchers contacted the companies and received contact information from several companies. Moreover, the researchers attended a workshop that was organised by Drive Sweden, regarding business models in relation to future sustainable transportation solutions. Participants from several industry actors attended, including potential interviewees for the study and contact information was exchanged. Furthermore, interesting actors the researchers did not get in contact with during the CHARM fair was contacted by emails, phone calls or through messages at LinkedIn. In addition, the researchers asked the potential interviewees about additional interesting actors or companies that should be included in the study. The researchers followed up on these suggestions and traced down new interviewees.

3.3 Literature Studies

As a compliment to the data collection, literature studies were performed. A meeting with a librarian was set up in order to get some guidelines and advice in how to collect and sort literature in Chalmers library system and databases. The collection was performed in Google Scholar, Chalmers Library System and Scopus where the material was collected from reports, annual reports, books, eBooks, scientific articles, databases, and relevant literature from earlier studies. Partly, frameworks, models and terms learned during earlier courses in the researcher's Bachelor and Master programs were screened. Thus, the researchers further deepened their knowledge of *Business Strategy, Corporate Strategy, Business Model Innovation, Business Model Canvas, Industrial Transformation and Technological Change and Porter's Five Forces.* Moreover, knowledge gained during the pre-study led to selection of the study's keywords which are: Electric Vehicle, Business Strategy, Charging Infrastructure, Business Model Innovation, Diffusion, Industrial Transformation and Business Ecosystem. The identified keywords were used to find further material and the selection of the material were screened by sorting the search result by publication date and publications with highest amount citations.

3.4 Data Collection

According to Bryman and Bell (2014) data collection could be divided into primary and secondary data, where primary data implies first-hand collected data in contrast to secondary data, which refers to review of existing data from earlier work. During this study, primary data was collected from interviews and attended events. In contrast to the secondary data, which will include academic theory and literature. To answer the research question, primary data was primarily used in combination with relevant literature.

Table 3.2: List of Interviews during Data Collection

NR	Stakeholder Category	Stakeholder Type	Role of Interviewee	Length of Interview
1	BE Intermediaries	Government Agency	Research Programme Manager	83 min
2	BE Intermediaries	Ministry	Deputy Director & Desk Officer	30 min
3	BE Intermediaries	Government Body	Energy and Climate Advisor	95 min
4	BE Intermediaries	Government	Regional Development Sustainable Energy and Transport & Regional Development Sutatinable Transport	75 min
5	BE Intermediaries	University	Associate Professor	80 min
6	BE Intermediaries	University	Associate Professor	90 min
7	BE Intermediaries	Research Institute	Market Intelligence Analyst	70 min
8	BE Intermediaries	Research Institute	Responsible Sustainable Mobility	68 min
9	BE Intermediaries	Research Institute	Researcher	30 min
10	BE Intermediaries	Research Institute	Senior Researcher	55 min
11	BE Intermediaries	Research Institute	Director Electromobility	90 min

12	BE Intermediaries	Industrial Assocoations	E-Mobility Expert	53 min
13	BE Intermediaries	Infrastructure Providers | Parking Company	Strategy Manager and Head of IT Department	40 min
14	BE Intermediaries	Infrastructure Providers | Real Estate Owner	Energy and Environmental Coordinator	75 min
15	BE Intermediaries	Smart Network Management Software Providers	CEO	62 min
16	BE Intermediaries	Electricity Provider	Charging Expert	66 min
17	BE Supply	EV OEM	Vice President Program Management	30 min
18	BE Supply	EV OEM	Director of Product Marketing	60 min
19	BE Supply	EV OEM	Head of Service Design Unit	60 min
20	BE Supply	EV OEM	Responsible of Aftermarket Strategies for Electrification of cars	90 min
21	BE Supply	EV OEM	Senior Project Manager	60 min
22	BE Demand	Fleet	CEO	45 min

The study includes interviews with 22 actors from the Business Network during the data collection. A compilation of actors contributing to the research through interviews is presented in Table 3.2. 16 interviewees represented the category Business

Ecosystem Intermediaries, the Business Ecosystem Supply segment was represented by 5 actors and lastly, one actor represented Business Ecosystem Demand category. In Figure 3.1, a visualisation of the interviewed actors applied to the Business Ecosystem is presented.

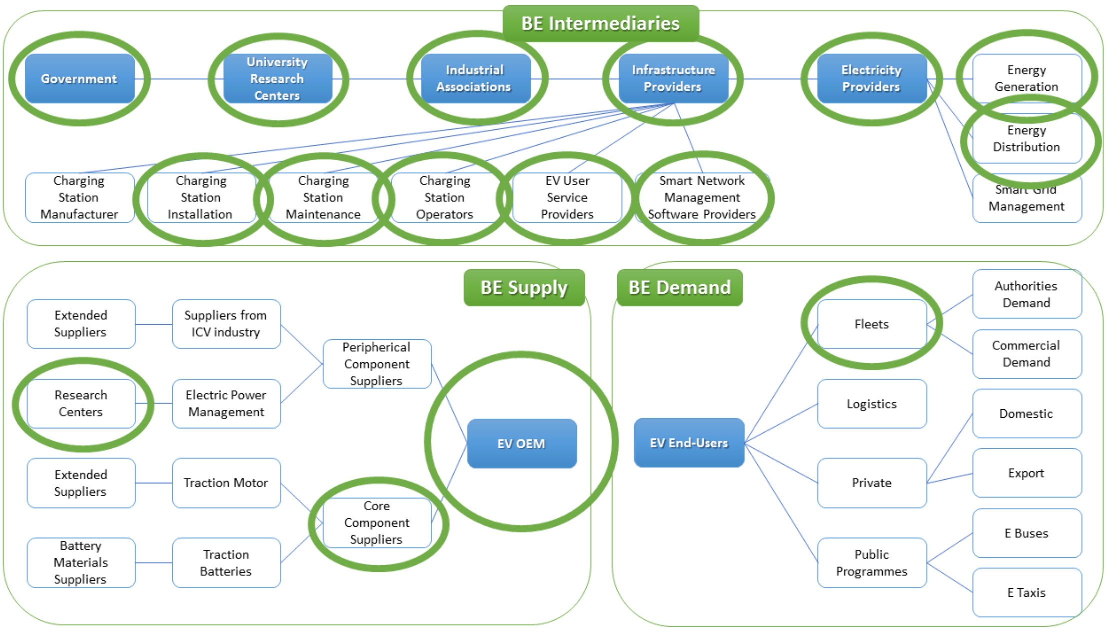

Figure 3.1: Modified version of the Business Ecosystem of Electric Vehicles with green circles around the actors that was interviewed in this research (Beeton & Meyer, 2014), p.219.

3.4.1 Interview Template

Interviews was the main method in order to collect primary data. The interviews were semi-structured, where the interviewers prepared an interview template prior to the interviews. According to Patel and Davidson (2003) it is important to clarify the purpose of the interview in order to get the interviewee to relate to its purpose and understand the importance of their participation and thereby be willing to contribute. Additionally, it is important to clarify how the interviewees contribution will be used. Therefore, the first part of the interview template includes practical questions and information. Patel and Davidson (2003) argues for the importance of the formulation and structure of the questions. An interview should start with neutral questions in order to gain knowledge regarding background variables followed by the actual questions regarding the research questions and lastly the interview should be rounded off through neutral questions and some time for the interviewee to add information that have not come up during the interview but could be important to convey to the researchers (Patel & Davidson, 2003). The interview template used in this research is structured as described above, first an introducing part where practical details are solved and a short introduction of the research project is presented. Thereafter, the questions are categorised under six sections which are the following: *Actors' Views on BEVs*, *Charging and Charging Infrastructure*, *Actors's Way of Working regarding Electromobility*, *Collaborations between Actors*, *Sustainability* and *Actor's Views on the Future.* The interview template is displayed in Appendix A1.

During the interviews, the interview template was used as a general guideline, however, the interviewees were allowed to answer questions and talk freely. According to Bryman and Bell (2014) semi-structured interviews is a suitable structure, in order to cover issues and topics of interest, while allowing flexibility during the interviews. Due to the societal changes caused by COVID-19, the interviews could not be performed as physical interviews. Therefore, the interviews were conducted as virtual interviews through voice links at the web-based tools *Skype, Teams* and *Zoom.* When performing virtual interviews by voice links, the interviewer cannot interpret the interviewees impressions and thereby, the analysis can only be based on what the interviewee announce and based on the tone of the voice (Patel & Davidson, 2003). However, by performing virtual interviews, the researchers were able to perform a higher number of interviews since the travel time to and from the interview objects was eliminated. According to Patel and Davidson (2003), a higher amount of interviews could strengthen the quality of a research.

Complimentary to the interviews, insights from events such as workshops and seminars was used as a source for collecting primary data. The researchers attended two virtual seminars where the subject areas were *Off-street Charging in Nordic Cities* organised by Swedish Energy Agency and *The revision of the EU Alternative Fuels Infrastructure Directive* which AVERE organised. AVERE is the European Association for Electromobility. During the seminars, the organiser presented information from current research at the time, followed by a time slot for questions and answers, where the attendants were able to send questions which the organiser answered.

3.5 Data Analysis

Theoretical frameworks were used during the study in order to structure thoughts, insights, as a helping tool in order to stay on track, to prepare the interview template for interviews and to analyse the collected data. As data was collected, data analysis was performed iteratively throughout the study. Theoretical frameworks were used as a tool to make valid analysis of the collected data.

In order to ensure that research was performed as unbiased as possible, thus no personal opinions affecting the result, a systematic method was used to compile the empirical results. Since the qualitative interviews was written down as notes in the interview template during the interviews, the researchers used the same themes from the interview template in the compilation. The data was therefore subcategorised in the six themes: *Actor Views on BEVs, Charging and Charging Infrastructure, Actor's Way of Working regarding Electromobility, Collaboration between Actors, Sustainability* and *Actors' Views of the Future.* Directly after each interview, the researchers wrote down key-takeaways containing highlighted areas from the notes taken during the interview as preparation for the compilation of the data. When the last interview was completed, the process to compile the results was initiated.

The process consisted of three parts, where the researchers proceeded in a systematic way of working. In the first part, each interview was sorted separately where data, quotes and key-takeaways were sorted into the themes. When that part was finished, the second step subtracted data from each interview, now sorted in the format of each theme, and merged them into tables linked to each theme. Each theme resulted in one document each, consisting of tables with sorted data. All the themes resulted in 82 pages of systematically conducted tables of quotes, who said what and how many actors that expressed the same opinions. The tables consisted of the three columns: *Factors*, *Described in the Interviews Why it is a Factor* and *Factor Described by Whom*. This step structured the data and gave an overview of which factors several actors agreed about and displayed where they disagreed. The third and last step was to write a descriptive text of the tables, which was performed to make the result more tangible. Some results were presented as tables since the table format gave a clear overview.

3.6 Research Quality

According to Patel and Davidson (2003), to ensure quality in qualitative research, validity and reliability are the two significant influencing factors. Moreover, Patel and Davidson (2003) claims that quality in context of qualitative research refers to quality throughout the research process.

In a qualitative study, validity refers to discovering phenomenon, describing perceptions and to understand and interpret reality. In the context of a qualitative study, reliability should be viewed in the light of the unique situation prevailing during the research process. Therefore, if a question captures a unique situation which falls into variation between answers, it is considered more important than always receiving identical responses. Since validity and reliability are so intertwined, the concept of validity gets a supplementary sense and further, the term validity is used. (Patel & Davidson, 2003)

As mentioned, the quality of qualitative research refers to quality during the entire research process. Therefore, validity implies the pursuit of good validity the entire research process as well. It can be expressed in the researcher's ability to use and apply their understanding throughout the research process. In terms of data collection, validity refers to if the researchers succeed in creating the basis for a credible interpretation of the study object. Furthermore, validity is linked to how the researchers manage to capture what is ambiguous and perhaps contradictory. In other words, the relationship between the typical, normal, and special. Validity could also be associated with the ability to argue for the most likely interpretation. (Patel & Davidson, 2003)

Furthermore, Patel and Davidson (2003) argues that in a qualitative research process, it is problematic to identify clear procedures, criteria or rules in order to obtain high quality research. Therefore, it is important to distinctly describe the research process. This in order to give the recipients of the study the opportunity to perceive how the study has been conducted and all the choices performed during the study. The description includes how the research problem has occurred, the rule of theoretical knowledge, the selection of the scope and its actors, the situation and context where the study was performed, the performance of data collection, analysis and how the results are presented. Patel and Davidson (2003) claims that if these parts are well written, it can strengthen the validity of a qualitative research context.

3.7 Discussion of Methodology

In this chapter, the methodology used during this study was presented. One section describes the planning phase which was the initial part of this study including a description of the pre-study where eleven employees at CEVT were interviewed, where the interviewees conveyed knowledge regarding the automotive industry, EVs and especially BEVs, but also lithium batteries, charging and charging infrastructure. Since the researchers were new within the field of electrification of the automotive industry, the pre-study has been a foundation for the study as a whole since the research further is based on decisions made through the knowledge gained during that phase. During the pre-study, the researchers invested a lot of time to analyse what actors and companies could influence the ecosystem and which actors are involved with charging infrastructure and all the selected interviewees exist in the Business Ecosystem for public charging infrastructure. The external interviews performed in this study reflect a huge part of the research and is therefore of high importance which also implies the importance of well selected interviewees.

The interview template used during the interviews is divided in different areas with related questions, this structure was used in order to ensure that the different parts were covered. During some interviews, answers to the questions overlapped, thus the same answers occurred several times per interview and an answer to a question also answered another question. The researchers chose to formulate broad questions in order to capture a wide scope, which could be a reason for overlapping answers since some actors gave broad answers. Other explanations could be that the different parts in the Business Ecosystem is deeply interconnected or also that the questions were inadequate or too similar. Since this occurred in some but not all interviews, the compatibility between the questions and the interviewee could be an influencing factor as well.

4

Empirical Findings

In this chapter, the empirical findings are presented, and the data is only from the interviews performed in this study. It is only the descriptions and citations from the interviewed actors displayed, therefore, all opinions and viewpoints derive from the actors. The results are divided into six areas which are *Actors' Views on BEVs*, *Charging and Charging Infrastructure*, *Actor's Way of Working regarding Electromobility*, *Collaboration between Actors*, *Sustainability* and *Actors' Views on the Future*. Lastly, the chapter is concluded by a *Summary of the Empirical Findings*. The different areas provided a different amount of data from the interviews, hence, some subsection in this chapter are more extensive than others.

4.1 Actors' Views on BEVs

This section entails subsections about actor views on policies, existing barriers to buy a BEV and descriptions of diffusion of electrical vehicles with both the barriers and enablers to diffusion are presented. Tesla's business model was frequently mentioned by the actors and their viewpoints are presented in the end of this section.

4.1.1 Polices on BEVs

During the interviews, the role of policies was brought up several times as an important factor to contribute to the transformation of the car industry. In contribution, car industry by both encouraging the diffusion of more electrical vehicles and the removal of traditional ICE cars.

At government top level, there are existing policies related to environmental aspects and the departments work on a more strategic level. At the authorities' level, they also work on a strategic level but closer to implementation and create many initiatives and projects to facilitate the transformation to a more sustainable society. Their wish is not to drive strict regulation to prevent development, e.g. not favouring one inferior technology over a superior technology. *Klimatklivet* gives grants for installing charging points and it is a national initiative by the government to support investments that contribute to environmentally friendly solutions. All organisations, both firms and municipalities can apply for grants from Klimatklivet, when installing both normal and fast charging stations. Individuals who want to install a charging point at their house cannot apply for grants via Klimatklivet, but instead can apply for grants via the Swedish Environmental Protection Agency (Naturvårdsverket) and receive grants to about 50% of the installations costs, but maximum 10 000 SEK.

All the three different actor groups, namely the intermediary side, the supply side, and the demand side, all agree that subsidies are needed to some extent. Some of them claim that the state should subsidise EVs more and take a stronger position in forcing ICE cars away. Other countries were frequently brought up as a positive example where the state helped with heavy subsidies to increase the diffusion of EVs, like in Norway. In Sweden, the interviewees named more uncertainty regarding the official automotive strategy and they wished that the politicians would send a clearer signal to the industry and to the automotive manufactures by subsidising EVs. Once a higher EV adoption has been accomplished, the subsides could be phased out. Legal actions are almost always required to make changes in behaviour. There are some beliefs that more legal actions are required to help the transformation to the circular economy and that they are on their way, which will force auto OEMs to take more responsibility for the batteries. Another way is to use whips to force out ICE vehicles from the market. It was mentioned that without whips to reach the climate targets, a transformation to EVs will be hard.

4.1.2 Barriers to Buy a BEV

Regarding the barriers to buy a BEV in Sweden today, the interviewees gave different but mainly similar answers. The study shows that *price* is the main barrier to buy a BEV according to 15 respondents of all the 22 actors that were asked. Other frequently mentioned barriers to buy a BEV were *range anxiety, charging anxiety model of availability* and *the availability of charging infrastructure at home* as well as an *infrastructure for public charging.* The most frequently mentioned factors are shown in Table 4.1 with a description of each.

Table 4.1: Barriers to Buy a Battery Electric Vehicle (in Sweden)

Factors	**Description of Factor**
Price	*Expensive compared to other powertrains*
Range Anxiety	*The user is worried how far the vehicle will reach before it runs out of battery capacity*
Charging Anxiety	*The user is worried about where to charge but also how to charge*
Model of Availability	*There are not enough of car models to choose from*
Lack of Public Charging Infrastructure	*If there is no or not enough public charging infrastructure, the user don't want to buy an EV*
Lack of Private Charging Infrastructure	*If there is no availability to charge at at home, the user don't want to buy an EV*

The majority of the respondents claimed *price* to be the main barrier where the switching incitements are too low. Despite a decline in price, EVs are still perceived to be in the segment of high cost and too expensive for the mass market. The financial incitements are too low to purchase an EV if you drive less than 10 000 km/year, including a purchase from the secondhand market. Also, one actor claimed that there is currently a lack of secondhand market places for BEVs. However, the counter argument from one automotive OEM is that this perception of the price being too high, will change when people understand that the total cost of ownership (TCO) is lower for an EV than for an ICE car. By time, customers will learn to evaluate the TCO, instead of just viewing the initial purchase price tag and comparing car models.

An intermediary actor claimed that the barriers to buy could be described as one table consisting of three legs, where all the three are equally important. These three legs consist of a combination of price, a sufficient number of different car models and enough charging infrastructure. The automotive industry has not raised the volume yet, but more full battery car models will be released in the fall of 2020. The amount of relevant car models is deemed too low today and the customers' needs of wanting different sizes and models of car has not yet been met.

"When Volvo releases a BEV, the Swedes will buy an EV" - Market Intelligence Analyst

Two concepts that are closely related is *range anxiety* and *charging anxiety* of the EV end user. Range anxiety is when the user is uncertain how far the vehicle will reach before it runs out of battery capacity and annoyed if this occurs before the vehicle has reached its planned end destination. Why this scenario occurs is due to the external climate affecting the status of the battery of the EV, where a fully charged BEV can drive further kilometres in the summer before discharging, while in the cold winter, the same BEV will not last as many kilometres, and this variety and uncertainty about range scares people to some degree of extent. The other concept of charging anxiety regards the uncertainty of finding an electricity source for charging the BEV. The analogy the interviewees used was that you cannot buy a car if you cannot refill it with gasoline, and applied it to the end users of EVs, you cannot buy an EV if you cannot charge it. It is an issue if the infrastructure is not built out fast enough to comfort the BEV users.

Charging infrastructure, both at home and public was for many interviewees described as a barrier to buy if there were not sufficient charging possibilities for the buyer and the access to it is a crucial part. For all the potential customers that want to buy an EV, but do not own their own parking space, e.g. people living in apartments in the city centre, it becomes too hard and difficult for them to solve the charging issue, thus charging infrastructure becomes a barrier to buy a BEV. The large mass will not buy if they cannot charge at home or work. Apartment residents are advised to charge somewhere else or on a fast charging station, and with this reasoning you will never get them to buy an EV, claims some actors. If apartment residents are not presented with a sensible solution to charging, they will not buy.

The incentives to buy an EV today seems low due to *psychological* reasons, people buying what they are used to and that there is a lack of technical knowledge regarding how to charge. The customers are experienced in refilling gasoline that does not need to be planned ahead for and feel uncomfortable with the new technology.

In spite of all the barriers mentioned above, there were also some actors arguing that the charging infrastructure is not the reason why people do not buy EVs.

4.1.3 Diffusion of EVs

Many intermediary actors believe that BEVs will gain a large market share and that there is no doubt about EVs' place in society. Many of the interviewed actors believe that the numbers of EVs will expand in the automotive market and that it will surge is a technological non-issue. One market intelligence analyst from the interviewed actors, predicted a larger market share of about 50% by 2025 in the Swedish automobile market.

4.1.3.1 Barriers to Diffusion

Several reasons are mentioned as the barriers to diffusion, and they differ according to the actors in the study. According to one professor, we are currently well into the S-curve where it is turning fast. One reason is that the process is slowed down because the organisations, who can enable a faster diffusion, cannot work faster at the moment. However, the most recurring factor that was mentioned as a hindrance for the diffusion of BEVs was the *price* of the BEV. The issue is that a BEV is more expensive than ICE vehicles and the price affects the adoption rate the most because customers do not consider the TCO. Combating this with financial incentives is needed to get the spread of EV started. The large mass waits until the cars get cheaper or perhaps waits for a secondhand market. A Research Programme Manager mentioned that new technology is expensive when it arrives and that it is not for everybody.

The two factors *range* and *charge anxiety* play an important role in EV diffusion, where the range is technically not a problem but the range is a barrier to buy. Globally, the range differs from what is promised in the brochure compared to the reality, which has created suspicion against EVs. A professor has observed two cases in her behavioural studies on new EV users. A typical behaviour of users with an ICE car are to drive until the gas is low and then search for the closest gas station and refuel the car. The group that kept this ICE *mental attitude* and treated the EV like an ICE car, experienced a stronger charge and range anxiety after switching to a BEV. However, the group that changed their mental attitude are positive about EVs. This group of users learned a new behaviour to meet the new needs of the battery and instead of waiting until it is discharged, these users charge whenever it is possible to always have sufficient levels of battery levels. To combat the insecurities from users related to the usage of EVs, a need for education is required to deliver new knowledge, but no one wants to pay for this according to a researcher.

An actor representing an EV OEM said that one cannot sell cars if there is no infrastructure. An infrastructure provider thinks it is a responsibility of the automotive industry to put focus on *charging infrastructure* and further stated that if the OEMs want to increase the number of EVs, they should install chargers and set a charger standard. A researcher points out that the challenge is to build charging infrastructure before there are any customers versus selling cars before there is a charging infrastructure in place. Another barrier to diffusion that was outlined by many actors, was the factor of *interoperability*. In the case of charging infrastructure, interoperability means how well one product or system works with other products or systems. For example, an EV user can connect itself to one system and while on a journey, the user might need to charge the BEV someplace new but encounters a new brand which is incompatible with the user's product. Interoperability is a problem and it is compared to as having money but unable to pay with them. Different BEVs have different chargers where the users need to keep track of which ones are compatible and which are not. The *standardisation* of chargers differs per continent, which increases the complexity of design for automobile OEMs. One actor within the Government category mentions that the transformation to EVs and set up of charging infrastructure will be performed in 10 years which is a shorter time than usual societal changes. For instance, gas stations and ICE-vehicles grew up during 120 years.

One researcher suggested that the business model of traditional auto OEMs is outdated. Moreover, the same researcher describes that traditional auto OEMs have *intellectual property* rights that are associated with the technologies of internal combustion engines and these OEMs want to protect them. The researcher suggested that this may be one reason why they do not install charging points and drive on the development of electrification. Two different actors from the supply side and one from the demand side, agree that traditional automotive manufacturers have, involuntarily, invested billions in huge industrial investments for the technology behind EV, which involves a combination of large investments in both factories and R&D costs. This is a burden for traditional car companies. All previous investments in factories designed for producing ICE vehicles and other large investments related to ICE, create enormous *exit costs* for automotive manufactures and this makes them more inclined to hold on to the old technology and not leave the ICE cars behind. The actor from the demand side accuses automotive manufacturers of having held back the development of BEVs, because these OEMs earn more money on ICE cars. This actor asserts that these automotive manufactures try to delay the use of fossils as long as possible. An EV OEM respondent states that the EV charging infrastructure is at the expense of the oil industry, therefore, resistance could occur.

4.1.3.2 Enablers to Diffusion

As the previous section is about barriers to diffusion, this section will describe different factors that will enable the diffusion of EVs. There are several factors which will impact the gain in diffusion, ranging from *policy pushes* to technology improvements. One actor believes in a fast diffusion because the public sector wants it to happen and due to large investments. Another determinant of diffusion is that lower battery prices will help the diffusion.

Many actors mentioned that it is the incentives from politicians and regulators that drives the electrification and in Europe, the electrification is driven by emission goals and requirements of lower emissions. The demand and supply are not generated from consumers nor voluntarily by traditional car producers but instead from regulation. Currently, there is legislation that forces car manufacturers to produce EVs, so the diffusion rate of EVs is bound to increase. One actor representing a EV OEM claimed that in order to get a diffusion of EVs, it is needed to punish ICE with taxes, tolls or petrol/diesel taxes. Auto OEMs cannot sell cars in a particular market unless the emission is lower than 95 g/km CO_2 or less. This influences automotive companies' business models because the fines are so large that it is difficult to get profitability in the business. One fleet actor on the demand side claimed that it is painful for OEMs to reduce their volumes and lose revenue, due to the increase of car sharing services. The fleet actor further argued that car manufacturers must adapt their business models to be sustainable.

In Sweden, a subsides system called *Bonus Malus*, which is Latin for good-bad, is in place for customers since 2018 and applies to new vehicles. The bonus malus system rewards vehicles with lower CO_2 emissions and penalises vehicles that emits higher levels of CO_2 with higher taxes. The effect from the Bonus Malus system and the negative incentives on ICE vehicles, is expected to result in an increase in the number of electrified vehicles in the Swedish car market.

Aside from policy pushes due to sustainability reasons, a main factor to increase the number of BEVs in Sweden will appear when the segment of *company cars* increases from ICE and PHEV to BEVs. This will have a great impact on the Swedish car market. In addition, the factor of *car pools* is described as a prerequisite for the transition to take place. In concern to the technology, the users who switched to a BEV will not go back to the old technology. Almost all big actors within the automotive industry already have a BEV platform or will soon release it.

Building charging infrastructure is seen, by some actors, as the key factor to enable the diffusion of EVs and enable electrification. Some actors view the public sector as the key actor to enable the diffusion of EVs. In the early stages, actors mention a threshold regarding the charging infrastructure and that the public sector should subsidise it in order to enable a technical shift. Thereafter the public sector should step aside and let the market solve it. In order for the car to continue being a symbol of liberty, accessibility to fast charging is a necessity. Some other actors think that OEMs should build charging infrastructure if they want to sell BEVs, especially in the introductory phase. The same actors believe that the OEMs do not consider building infrastructure as a part of their role because they do not build gasoline stations today, someone else builds them. However, to make people buy EVs, public charging infrastructure needs to be established since it is an enabler for people to take the step to use EVs. There is low interest in installing charging infrastructure in some areas, for instance in the sparsely populated areas, since it is hard to receive return on investment (ROI), which becomes a problem for the diffusion of EVs.

4.1.4 Actors' Views on Tesla's Business Model

One automotive OEM who do build their own charging infrastructure is Tesla and many of the interviewed actors frequently mentioned Tesla as a positive example. One researcher mentioned that what Tesla does regarding the infrastructure is great for their users. A market intelligence analyst praises Tesla for their way of driving their BEV sales by innovating their business model. Many actors describe the business model of Tesla as driven, innovative, and great, but difficult for other companies to copy. One opposing opinion about the difficulty to copy came from an actor from the supply side representing an EV OEM, who claims that it is not difficult to copy Tesla's business model but it is difficult to find new innovative systems. Tesla has showrooms instead of car dealers and the company can send software updates regularly. Tesla has succeeded with the positioning and price and the company is described to be at the top of the ecosystem. One interviewed automotive OEM actor said that Tesla has data on the driving behaviour of all their cars and 90% of all existing driving pattern data is from Tesla. Same actor blamed Tesla's charging infrastructure for being a very closed network.

Another OEM, Nissan, followed the Tesla way, and gave away several fast chargers in 2011 to the city of Gothenburg. These chargers were installed, but due to their poor quality and bad functionality they were later removed.

4.2 Charging and Charging Infrastructure

The charging and charging infrastructure are key parts in electromobility. This section includes the respondents' thoughts regarding responsibilities, the network, challenges, business model and the electricity grid associated with charging and charging infrastructure.

4.2.1 Responsible for Charging Infrastructure

In Table 4.2, different suggestions regarding of which actor should be responsible for installing charging infrastructure are presented. Several suggestions was proposed by the interviewees. Some actors mentioned several different alternatives and further, a few believes that it should be several actors collaborating.

Table 4.2: List of Actors Who Should Be Responsible for Charging Infrastructure According to the Interviews

Responsible	**Description**
Mix/Many Actors	*Needs to be a combination of several actors collaborating.*
State	*In order to accelerate the transformation towards EVs, the state need to help with subventions in the initial phase.*
Not the State	*It is not the government's responsibility to build petrol stations if that analogy is drawn.*
Electricity Providers	*The electricity providers are responsible for charging infrastructure. They are used to building long-term infrastructure in other situations.*
Operator of Charging Infrastructure	*Own charging infrastructure operator.*
OEMs	*OEMs are responsible for enabling charging solutions to their customers.*
Not OEMs	*An OEM does not need to offer a gas station solution to their customers, other actors will do it. It is the same regarding charging.*
Society	*Charging infrastructure has different profitability in different places. In sparsely populated places, societal responsibility should exist.*
Market	*Pure commercial activities since there is a willingness to pay.*
Public	*Public authorities have a role to get over the threshold, then comes the customer demand.*
EU	*EU must solve standardisation, it is their role.*
Cities	*Cities should take a strategic role and enable market driven business models.*
Real Estate Owners	*Real estate owners have responsibility to enable charging possibility when cars are parked for an extended period of time.*

Parking Companies	*Actors owning parking lots must ensure charging possibilities.*

4.2.2 Network of Charging Infrastructure

In the study, different actors from the Business Ecosystem, see Figure 4.1, were interviewed and the study also tried to locate new or missing actors from the network of charging infrastructure. The newly identified key actors were real estate owners, landowners, and aggregators. The figure of EV Business Ecosystem only depicts one box for Government and it was emphasised that in Sweden, the government could be divided into several subcategories, where there are several levels of government, state and municipal for instance. Aggregators, in terms of apps aggregating different actor's networks to facilitate for end users and services, as well as a tool to load balance a car park, could be parts of the network as well. In the business ecosystem, *aggregators* are placed in the EV Service Provider category. Lastly, insurance companies are worth to mention as an additional actor since lithium batteries are classified as dangerous goods.

According to one researcher, the Business Network could be viewed differently depending on from what perspective the system is viewed. A technical description of the network is separated from an economic description. Furthermore, two researchers highlighted that some actors in a potential network are more important than others. Since some actors have greater impact, they have the greatest influencing power. Understanding them corresponds to understanding how the charging infrastructure will be built. The small player within the system can almost be neglected as they have a marginal effect. Electricity providers and real estate owners are mentioned as key important actors related to the network of charging infrastructure.

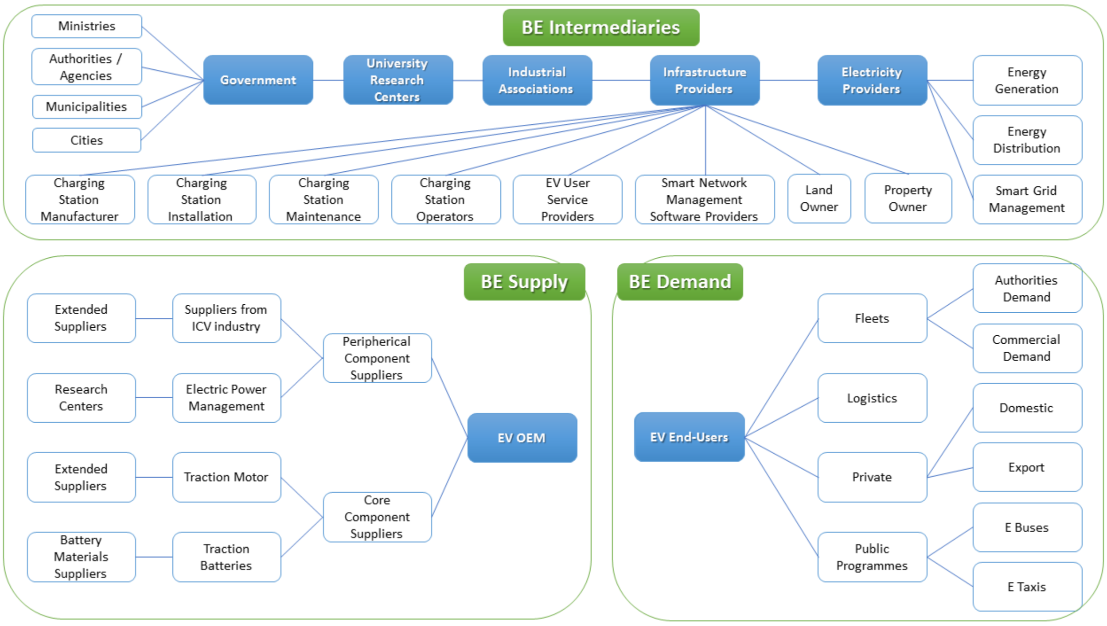

Figure 4.1: Modified version of the EV Business Ecosystem, adapted with six new actors (Beeton & Meyer, 2014), p.219.

4.2.3 Challenges with Charging Infrastructure

Some actors view charging at home or at the office, i.e. the place where the vehicles stand still for several hours, as the basic problem that needs to be solved since it is where most of the charging will be performed. Most users charge at home up to 95% of all charging occasions according to a researcher. Another interviewee mentioned the knowledge gap regarding charging infrastructure as a challenge.

That it is difficult to install charging infrastructure in cities is an opinion shared by a few actors since many parties need to collaborate, however the difficulty to install varies among different municipalities. For instance, in Gothenburg, it is not allowed to install public chargers on public street areas. People living in apartments usually do not own their parking lots but need to get approval from the landowner to set up a charging box. It is common that people living in apartments do not even have a fixed parking lot, which makes the setup of charging possibilities even more complex. One way to set up public charging stations in cities is to collaborate with the owner of parking lots since they already have access to the end users using their parking lots, who may have the need to charge their vehicles. According to one installer of charging infrastructure, it is much harder to set up charging stations at streets than compared to inside parking garages, where the electricity is drawn and outlined in an easier manner compared to the street's higher complexities underneath the ground.

Land is a critical factor and as previously mentioned, landowners are key actors for enabling charging infrastructure. It is difficult to get access to territory in the city centre in order to install charging stations. One researcher claims that fast charging is not needed since most of the charging is performed at home or at work where the vehicle is parked for several hours. Therefore, it will be possible to charge the needed battery capacity with normal charging. One respondent from an EV OEM does not agree but instead states that fast charging is needed on the roads. A joint venture of German car manufacturers created *Ionity* which enables fast charging on the highways in Europe. It is mentioned that fast charging is invested by risk venture capitalists in contrast to normal charging which instead is invested by private individuals or real estate owners. One actor from the infrastructure providers, a real estate company, states that they are willing to set up charging stations connected to their properties, but the customer demand is low.

4.2.4 Business Model of Charging

The cost of charging infrastructure is debated where one interviewee implies that building charging infrastructure is expensive, since it requires local expansion of the electricity grid to charging placements. However, two researchers argue the opposite and claim that building public charging infrastructure is not expensive compared to the cost of building cars or in comparison to the entire transport system. Additionally, several interviewees mention a *profit dilemma* related to the public charging infrastructure. It is hard to earn money on public charging infrastructure and therefore, the price for charging at a public charging station has increased. It is hard to get profitability since big investments are required in the beginning and the system is hard to plan to an optimised system since not even the customers know how it will be used. Therefore, it is seen as a riskful investment. Still, there are some *first-mover advantages* in setting up new charging infrastructure linked to the occupation of space and land. Moreover, price differentiation can be an obstacle if you are not a member of a particular charging network, where non-members pay more to charge compared to members of the club.

One actor on the supplier side, an EV OEM, suggested that there should be one public charging station per 7-8 sold EVs. The same actor emphasises the need of integrating the charging infrastructure into city planning. A researcher claims that there is too much focus on charging infrastructure, and that much research shows that the spread of EVs could be increased even though charging infrastructure is not fully developed. It is also mentioned that people living in self standing houses do not have any issues installing a charging point at home. However, an actor representing a municipality stated the opposite, it could be a fire hazard to plug in a car to power outlets in a house without knowing the features of the house electricity grid. On the same theme, one EV OEM respondent pinpoints that the situation in Sweden is different compared to other countries due to Sweden's high proportion of house owners (2,8 million households). In contrast to Shanghai or Paris for instance, where it is a social issue since individuals cannot install charging stations themselves. Another interviewee representing a carpool fleet states that they are satisfied with today's charging infrastructure and experiences no problems for themselves or for their customers.

A Market Intelligence Analyst reason about OEMs providing their own charging infrastructure but mean that they hesitate because they lack skills in how it should be executed. A few OEMs already provide charging solutions, for instance Tesla, Nissan, and Volkswagen. One interviewee within the actor group of EV OEM, claims that Tesla provides charging infrastructure in order to sell more cars. A few actors believe that the market will solve the challenges related to charging. Although there is a standard in the technology for charging, there is not a standard of the business model and the system which explains why OEMs choose quite different paths. One Electricity Provider claims that the industry has the responsibility to strive towards finding a standard and to target customer groups in the direction to create a *full cost coverage solution*. On the contrary, one actor claims that parallel charging solutions, like Ionity and chargers from Electricity Providers, are accepted from a user perspective.

It is important to follow the market since the technologies are constantly developing. Some years ago, the technology was not as mature as it is today, and therefore, the technology in chargers installed a decade ago is today outdated. Lastly, it is mentioned that there is a *balance* between *battery size* and *infrastructure expansion*, the cost moves between the vehicle and the infrastructure.

4.2.5 Electricity Grid

In general, many interviewees do not view the electricity grid as a problem for the establishment of EVs. That the electricity grid should be a threat is excessive, sometimes it could be a challenge on a local level, but EVs should be seen as a potential for the future. Other actors in the society, industries for instance, are challenging the electricity grid to a greater extent and therefore, industry actors are a bigger problem connected to the electricity grid than the EVs. It is also mentioned that due to the technology of *load balancing*, the electricity grid can handle EVs. It would be a huge problem if EVs just were plugged in without having a smart network in the ground, but in Europe load balancing is established. On the contrary, a few respondents generally view the electricity grid as a problem for the charging infrastructure. One opinion is that no matter how much load balancing and smart grids, there will still be major challenges with the electricity grid. Another respondent state charging opportunity as a way to attract customers to buy EVs, where the players are pushing for increased fast charging which in turn becomes a challenge linked to the electricity grid.

Lack of effect in the electricity grid is another problem mentioned by some of the respondents, however, it is agreed that capacity problems have nothing to do with EVs. The electricity grid needs to be updated since it is old. One respondent claimed that it is cheap to expand the electricity grid. The problem is connected to peak hours which is between 5 p.m. and 9 p.m. and therefore, it is not an energy problem but related to the *electricity effect*. One interviewee highlights the issue of who gets access to electricity if the capacity is not enough for everyone.

"If too much pressure and calculation is put on the user, it is doomed to fail. Some form of AI is required to assist the user. It's difficult to keep track of peak hours etc. for the customer herself" - Associate Professor

A challenge is to set up charging boxes since there is not enough electricity in houses, parking garages and parking lots built in recent years. Linked to this issue, one actor mentioned that the electricity connected to a parking lot is not enough to charge 20 cars at a reasonable speed in order to generate a charged car after a decent time. The actor views this as an infrastructural problem. An idea for the future is to use load balancing in a residential building by switching off the heat pump for a few hours between 7 p.m. and 9 p.m. and then promote charging of EVs to reduce the need for power without the residents being noticed. Another idea is to use the possibilities of vehicle to grid (V2G) and storage of batteries, which the electrification of the fleet of vehicles enables for the electricity grid. A few interviewees think the dilemma should be the other way around, thus, how the electricity grid should be strengthened to handle EVs.

4.3 Actor's Way of Working regarding Electromobility

In this section, actor's working ways related to electromobility are presented in three sections, namely how the actors perceive their way of enabling EVs, how the actors work and lastly, challenges linked to actor's roles in the business ecosystem.

4.3.1 Enabling EVs

The results of this study show that the actors that were interviewed worked very differently with enabling EVs in Sweden. By the nature of their car manufacturing role, some actors like the automotive OEMs, manufacture EVs and enable more EVs in that way. Whereas others, has picked up a new type of role or service by installing charging stations, both public and private charging stations. The latter is mainly the actors of Electricity Providers and Parking Companies as Infrastructure Providers. The newly discovered key actor Landowner permits access to the land where the charging stations can be installed.

On the different government levels, ranging from ministries, government agencies to city level, different actions are being taken to enable the diffusion of EVs. Some examples are investment in research and projects, creating subsidies schemes for installing new charging stations and by creating a commission, specifically just for electrification. Then other actors take it upon themselves to help others and spread knowledge to the new customers. They do this by taking part in different stakeholder networks or projects.

4.3.2 Way of Working

Some actors work actively with *open innovation* through *hackathons* and create venues with seminars, in which actors and the amount of participants vary. Other actors do not work with open innovation and a few were not familiar with the term. Regarding *design thinking*, a few actors state that the methodology is integrated in their working ways, but most actors do not include design thinking in their job. In addition, several actors mention that they do include a customer-oriented focus in their work by including the segments of private ownership of cars, fleets, and autonomous fleets. Several projects related to EVs and charging infrastructure are ongoing in the interviewee's organisations. There are opportunities for actors to co-finance research together, industry actors could be involved if there is a clear need from the industry. Three of the interviewed actors are currently offering charging solutions to end users. An infrastructure provider claims that the offering is usually not promoted but the customers can ask for it since an indication of need is wanted before installation of chargers.

4.3.3 Challenges regarding Actor Role

Some of the main challenges the actors mentioned regarding their own role was the fact that they nowadays have a *new role* due to changes that has occurred in the developing market. Traditional car manufacturers are now also EV manufacturers. Electricity Providers are also unaccustomed to work towards end users and the new tasks related to EVs. Some of the actors related to public authorities experience their role as a neutral actor as a challenge when working as a coordinator. A coordinator role is needed in order to arrange cooperation between organisations.

4.4 Collaboration between Actors

This section deals with collaboration between actors and the existing barriers for collaborations. Due to secrecy and confidentiality reasons, the interviewed actors were not allowed to fully discuss which other companies they collaborated with.

4.4.1 Obstacles for Collaboration

The collaboration scene is viewed very differently among the interviewed actors, where some claim that there are no barriers to collaboration between the different stakeholders, while some actors highlight their perceived problems with the collaborations. The most popular view is that the collaborations of today work fine but there is room for improvement. If there are any issues, they are minor. The smaller issues that were brought up by the actors range from general collaboration issues to issues regarding dealing with new types of charging infrastructure. The most frequently mentioned issue that was brought up about collaboration was the difficulties associated with when people and companies have *different agendas* and it is usually the coordinator in the middle of the collaboration who is experiencing these obstacles. By the nature of a firm, it wants to make money and focus on its core business, and hindrance occurs between the parties when their goals are not aligned. Sometimes there is a clash of two company cultures when a public company cooperates with a private company and they do not understand each other's businesses. When private companies collaborate with research institutes or universities, they have different time perspectives, where the research has a longer horizon than what the private companies are working with today. The private firm's focus is usually here and now, while the researchers have their sight set more into the future.

Collaboration issues regarding charging infrastructure are related to the number of actors that need to collaborate which makes it more difficult. It is difficult to collaborate due to new questions about financials and accessibility to land. Another obstacle in today's partnerships is that there are no clear guidelines from the authorities and that the rules of the game are unclear, especially for the manufacturers. Sometimes there is a conflict that one is both industry colleagues and competitors at the same time and compete about reaching the same customers first.

Cooperation between new parties can sometimes be less efficient, when the automotive industry collides with the electricity industry, due to both parties are used to not having or sharing the same customer focus. Automotive players are more aware of customers and their behaviour compared to electricity providers who are not working as closely to their customers. An actor from an authority works with educating electricity providers and collaborates with them to make them understand that charging infrastructure is not about trying to optimise the electricity grid, but rather instead that the cars and their users have different needs than their traditional electricity customers.

The biggest barrier to collaboration is due to *legal requirements*, where it is sometimes illegal to cooperate in different ways and these laws prohibit if one actor becomes too strong and does no longer favour the customers. There is also the legal aspect of protecting the firm's intellectual property and not leaking valuable information to other legal entities, even within the same company group. By law, different authorities and governmental companies are required to have *neutrality*. These public companies need to stay independent and cannot advise private companies about what supplier they should cooperate with, even if they do have this expertise and knowledge. This leads to the situation where meetings become less efficient because neutral actors can only have shallow discussions with other companies, and this is an obstacle for the development of charging infrastructure. Managing expectations and clarifying the agenda are two necessary things to do before having these dialogues with different actors.

There is a need for *collaboration* according to several actors and one highlighted that a *joint strategy* is needed for public charging. Regarding what is lacking from charging infrastructure today is an actor coordinating all actors collaborating. According to one researcher, the level of cooperation between electricity companies and car manufacturers is low today. Many intermediary actors mentioned that they wished that car manufactures *shared more information and data* regarding the cars and batteries. Researchers want access to data from OEMs and user survey data. An infrastructure provider wants to receive customer insights from car manufacturers in order to build a better offer who matches the needs of the car and they are interested in the input from OEMs. Another actor also wants data from big automotive corporations in order to enhance their software model, but claims it is very hard to access it because the larger the company, the harder they protect their data.

4.5 Sustainability

Sustainability was discussed during the interviews and the compiled results are presented in this section.

4.5.1 Circular Economy in Charging Infrastructure

From the interviewed actors, it is the most common to not to work actively with the *circular economy* in charging infrastructure, where the *take-make-waste culture* is still dominating. The main focus is on the impact of the car batteries and some wished to give the batteries a *second life*. One intermediary actor claim to be actively supporting the transformation towards circular economy and another intermediary actor highlights the afterlife issue of batteries. Profit is still the main focus and not circular economy.

4.5.2 17 Sustainable Development Goals

When asked about the Sustainable Development Goals (SDG) from the UN, the majority of the interviewed actors answered that they work with the SDGs more or less. The most frequently mentioned goals were number 7, 9, 11, 12 and 13 from the Sustainable Development Goals (SDG), see Figure 4.2. To put them into context for charging infrastructure and electrical vehicles, the different SDGs touch upon different areas that relate to both the industry of automotive but also electricity. SDG number 7 is about contributing to sustainable electricity and providing green electricity to the charging stations. SDG number 9 is mainly about innovation and sustainable infrastructure, some actors facilitate this by creating hackathons. SDG number 11 is to create sustainable cities, where charging infrastructure could be a part of. SDG number 12 is about ensuring sustainable consumption and production patterns, where the purchasing function focuses on sustainability aspects. SDG number 13 is more general about taking climate action and some work indirectly with this one from their work and focus on the other goals.

4.5.3 Sustainability Aspects

According to interviews, the electricity mix has a big impact on the sustainability aspect of EVs. If the electricity is generated from renewable sources in Sweden it has a better impact than imported electricity from other European countries like Germany, who mainly produce their electricity from coal. The main sustainability issue that was brought up was the car batteries.

Regarding the physical charging infrastructure itself, there was no, or little effort made to make them sustainable. Charging infrastructure consists of materials and technology and in general, both raw materials and technology parts are very cheap

Figure 4.2: The most common SDGs mentioned by interviewed actors. Modified version of the SDGs. (United Unions, 2015)

today. Meanwhile labour costs are high, and this combination of too cheap raw materials and too expensive labour creates low incitements to change the existing products. Recycling high tech is expensive, and to force companies to recycle was suggested as a solution. It would be more sustainable if the chargers had higher utilisation.

The usage of sustainability differs between the actors, where some use it as a selling point, whereas others do not include it in their sales pitch. Some actors put demands on their suppliers before purchasing charging equipment, but some say that those manufactures don not include sustainability as an option. Some have an active Environmental Management System working.

4.6 Actors' Views on the Future

The automotive industry is transforming, this section aims to gather the interviewees thoughts and beliefs on the future of mobility.

4.6.1 Cities 5 Years Ahead

Some actors agree that in five years ahead, the mobility in cities will be quite unmodified from the current situation. They believe that EVs will continue to increase but a large adoption of EVs is more than five years ahead due the conversion being slow. On the contrary, one actor believes in fast conversion since there are lots of investments related to BEVs today which according to the interviewee will speed up the transformation which will be done in five years.

Others think that the usage of cars will *decrease* in cities, since the infrastructure will be adapted into not needing cars to a greater extent while some actors believe that no cars will be allowed in city centres in five years. Speculation regarding prohibition of ICE-vehicles but allowing EVs, public transport, undergrounds and sharing pools in city centres also occurs. One ministry actor claim that there are clear goals for moving from transport with cars to public transport and the goal is to increase the proportion of travel by bicycles, public transport or walking by 20-25% in 2025.

Additionally, some actors believe in *less ownership of cars* and instead an increase in car sharing pools. It is also mentioned that there could be a difference between different cities, where at some places, transportation could be efficient and have modular mobility flows. In contrast to in cities like Gothenburg where trams are integrated in the public transport which can complicate infrastructure changes, according to one interviewee.

4.6.2 Cities 10-30 Years Ahead

Almost all actors believe in *radical mobility changes* within cities in 10-30 years ahead, but view the transformation differently. Some actors believe in less or no cars at all in cities. This stems from considering less usage of cars in total and that the city ideal goes towards removing the cars from city centres in some cities. However, one actor mentioned that how mobility will be structured in the future depends on the speed of technological development and how cities are structured basically. A few actors mention that in the future, parking on streets will not be wanted due to crowded cities where the streets will be used for something else than parking lots, thereby accessibility of a 4-seater car will be more difficult. On the contrary, one actor believes that the mobility system will be similar to how it is designed today in 20 years but with a higher amount of EVs.

Several actors assume that there will be a mix of *several versions of powertrains*, bike sharing pools and pool based vehicles, a flora, in the future. It is not just electrification that needs to be prioritised but the idea is that it should be possible to use other modes of transport than a car, but still, electrification is needed and switch to sustainable fuels and biofuels. However, some actors agree that cars will still be around in our society, due to the freedom it provides. They believe in a high amount of EVs since they assume EVs will be well established by then. A decrease in ownership of cars is assumed and a few interviewees believe ICE-cars has been eliminated. One actor describes that ICE-vehicles will *vanish* since there is no example in history where better technology, which EV-technology is perceived as, does not have superseded outdated technology, which the ICE-technology is viewed as. An EV OEM respondent believes that in 2030, ICE-vehicles will have a *negative secondary value*, ICE car owners will have to pay to get rid of them.

Some interviewees discussed the impact of autonomous vehicles (AVs) and how they could affect the society if or when they are implemented in the future. The automation should make major differences in how mobility is carried out around in the cities. Self-driving affects the planning for roads and parking lots. Some actors even claim that public transport will not be needed to a greater extent, since autonomous vehicles will replace it and the autonomous vehicle will be included in road trains. Further, an electricity provider mentioned that the charging infrastructure that is set up today is not suitable for autonomous cars and will therefore probably not be used if or when autonomous vehicles are established.

4.6.3 Future Role per Actor

In Table 4.3, some of the interviewee's thoughts on their role in the future society is presented. Several actors want to take a leading position and are open to collaborate.

Table 4.3: Thoughts on Future Role per Actor as Described in Interviews

Actor	**Thoughts on Future Role per Actor as Described in Interviews**
Research Institute	*"Wish we could work more systematically regarding our own resources and that competence could be shared."*
Fleet	*"Wish we are a leading actor when it comes to transition Sweden to a fossil-free country."*
EV OEM	*"Want a leading position regarding electrification. Tesla has a huge technological advantage, but we can be among the leaders."*
EV OEM	*"In the future, we want to be part of the ecosystem with a close relationship with the other players."*
University	*"Want to get better at working with interdisciplinary things."*
Research Institute	*"R&D partner - help to increase knowledge parts in society, so decisions are based on science rather than opinions. We take on a bigger part in debates. We can assist politicians in the debate who may need support from educated side who elucidate problems objectively."*
Research Institute	*"Same vision as the state."*

Industrial Association	*“We should focus more on the electricity grid and a new spin-off from us should be created and focus on industry questions.”*
Electricity Provider	*“Increase focus on hydrogen. Hydrogen is big in Asia, Germany and the Netherlands. We have experience in biogas. Has competence in-house about gas.”*
Government Body	*“Would be fun to act more as a consumer help. If we were more employees, we could do more."*
EV OEM	*“Changing mobility forever. No dealers, a different business model.”*
Software Provider	*“Wants to be one of the 20 in the world who understands batteries. Huge market - 300 billion SEK per year.”*
Infrastructure Provider	*“An even clearer role and not just parking of cars. More defined that we are an area where mobility stands still and awaits the next trip.”*

4.7 Summary of Empirical Findings

During the interviews, the interviewees have shared several thoughts and opinions, which in some ways were aligned with each other, but different opinions also appeared. There are a few policies enabling the diffusion of BEVs, Klimatklivet for instance. The most common barriers to buy a BEV are price, range anxiety, charging anxiety, model of availability, the lack of availability to charge at home and lack of public charging infrastructure. There are several factors influencing the diffusion of BEVs which can be divided into barriers and enablers. The public sector is seen as one key actor to enable the diffusion by subsidising charging infrastructure. Initially, to enable a technical shift, and later, by stepping aside to let the market forces solve it. Tesla’s business model was frequently mentioned by the interviewed actors, who described it as innovative and that the company’s work regarding the infrastructure is great for Tesla’s users. A few OEMs already provide charging solutions, e.g. Tesla, Nissan, and Volkswagen. A big amount of different answers was received of who should be responsible for enabling charging infrastructure, which is presented in Table 4.2. Real estate owners, landowners and aggregators are seen as additional key actors in the Business Ecosystem. To find a place to set up public charging infrastructure is seen as one challenge. Further, there is a profit dilemma related to building charging infrastructure and there is a linkage between infrastructure expansion and battery sizes, where the cost moves between the vehicle and the infrastructure. Load balancing facilitates the load of the electricity grid.

The interviewees work differently towards enabling EVs and few actors work actively with open innovation and design thinking. Moreover, handling new roles, as a result of changes in the market, is a challenging factor. Although the most popular view from all the interviewed actors was that the collaboration between them works well, some of them mentioned smaller obstacles that could be improved between them or to enhance the ecosystem of charging infrastructure. Some examples of the smaller obstacles are the need for more information, data sharing between each other and a joint strategy. Other mentioned barriers for collaboration were companies with different agendas and neutrality roles. Sustainability is integrated in the EV business ecosystem to some extent by most of the actors, but the take-make-waste culture is still dominating, which implies that it is not common to work with a circular economy. The most common SDG goals the interviewees worked actively with in relation to charging infrastructure is number 7, 9, 11, 12 and 13. Car batteries was the main sustainability aspect that was brought up. Most of the interviewees agree that cities will look different in the future with a mix of mobility solutions. EVs are expected to be well established and the mobility in cities will consist of several versions of powertrains.

5

Analysis

To understand competitive behaviour and the determinants of profitability, the external factors that impact industries shall be examined and then the analysis shall be extended with additional influencing forces, where the perspectives of business models, complements and ecosystems are included.

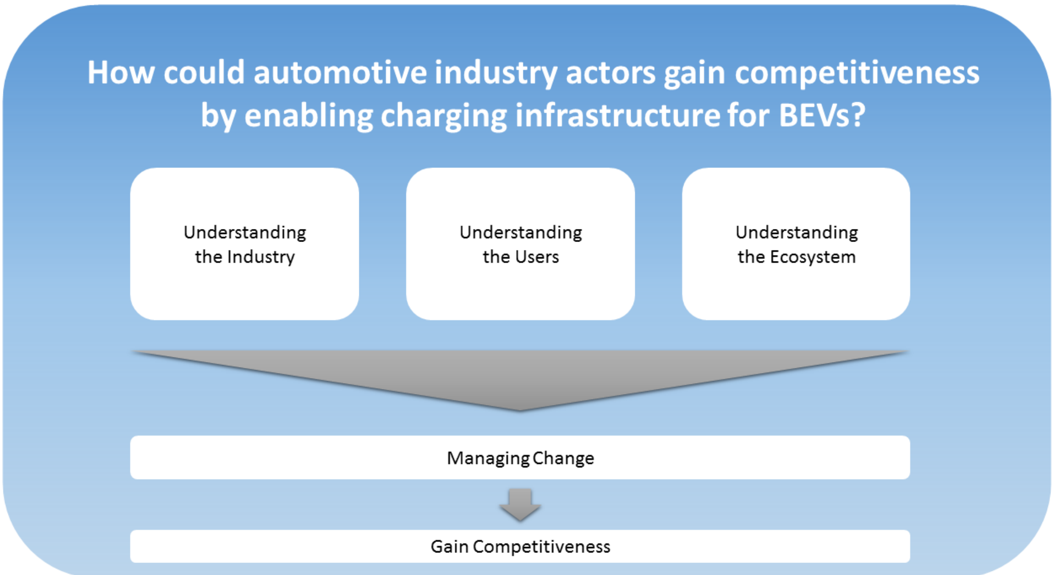

Figure 5.1: Overview of the Structure of the Analysis

It is important to understand the competitive environment, in order to create a successful strategy, according to Grant (2019). Competitive advantage is achieved when the competition is beaten. Setting the basis for strategy could be divided into four parts, see Figure 5.1, where the three first consist of basis and the fourth part consist of how to manage the changes. The first one is to *understand the* *industry* with the associated forces and legislations impacting and transforming it. The second part is to *understand the needs of the users or customers.* The third one is to *understand the Business Ecosystem, the EV infrastructure issues from a business perspective* and its business case. The fourth part is to *manage the changes* in order to meet the needs and gain competitiveness, by re-shaping the strategy and innovating the business model. In strategy analysis, it is also important to include the perspectives of complements and ecosystems, declares Teece (2007). This transformation requires a holistic system of innovative technologies, policies, and business models.

5.1 Understanding the Automotive Industry

Key trends influencing the automotive industry are *regulatory trends*, who derive from climate change, and *technology trends*, who derive from digitalisation and decreasing technology cost curves, e.g. autonomous driving, connectivity, etc. How these factors affect the automotive industry is seen by the regulation driving the electrification and increasing R&D in EV and batteries. The different technology trends drive incumbent automotive companies into making the cars into computers with wheels (Seba, 2014). The focus shifts from hardware to software where the car can be viewed as an IoT with wheels and the vehicle will be interconnected in future smart city concepts.

The quest for profitability becomes more complex and difficult in an increasingly volatile and uncertain competitive environment. Consumers and incumbent industry actors often face several restraining forces and switching costs in adjusting to new technologies or new ways of doing business.

5.1.1 Industry Analysis

Where an ICE car consists of about 2000 parts (Ernst & Young, 2017) and each part is just one part of the bigger system, the automobile manufacturer had a better position to bargain and these parts had many suppliers of each. Therefore, if one supplier refused the price, the automotive manufacturer could easily pick another supplier who is cheaper. On the contrary, the BEV consists of only 20 moving parts, according to Ernst & Young (2017) where each part is valued higher and each part is manufactured by only a scareful of suppliers. This puts the suppliers of the EV components in a higher bargaining position and hence, the bargaining power of suppliers is increasing in the automotive industry when it transforms along with EVs. The emergence of new suppliers, mainly in the software field but also battery suppliers, control the key technologies, thus, enforces their bargaining power. From the interviews, scarcity of resources for producing the components of an EV is also brought up as a factor to increase this force on the industry. To deal with this, several automotive players either partner or bought mining companies for the wanted minerals, battery materials suppliers or battery producers, according to Grant (2019). For example, Tesla and Panasonic partnered and are producing lithium ion batteries together. Another example is the Chinese company BYD, an EV OEM and a producer of lithium ion batteries, who have vertically backward integrated into lithium mining (Grant, 2019).

In Figure 5.2, a modified version of the Business Ecosystem from Beeton and Meyer (2014) is presented, where *new* actors are included. Further, Beeton and Meyer (2014) describes that there are several key actors to the left side of the EV OEM that consists of core component suppliers e.g. traction batteries and motors, but also electric power management players. In regard to charging infrastructure, key technologies are controlled by charging station manufacturers and technology providers, who produce charging boxes and equipment. New technology players are emerging and along with this, they are also enforcing their bargaining power.

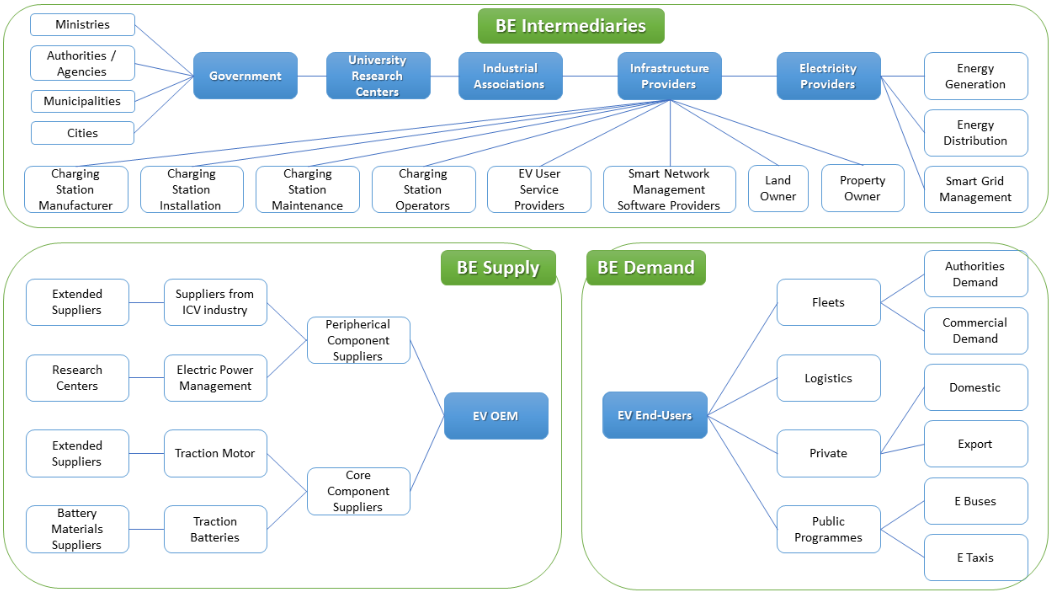

Figure 5.2: Modified version of the EV Business Ecosystem, adapted with new actors in the BE Intermediaries side (Beeton & Meyer, 2014), p.219.

The threat of substitutes to EVs are expected to increase with the emergence of new mobility solutions and other alternatives to cars, e.g. bicycles, public transport and smaller electrical pods or scooters. Environmental concerns and the desire to avoid car traffic jams will increase the substitute competition, according to Grant (2019). Interviewed actors in the EV business ecosystem agrees with this and they claim that this will impact the charging infrastructure, with the risk of it becoming obsolete or replaced by another technology.

As previously stated in Chapter 2, Grant (2019) claims that the threat of new entrants is increasing in the automotive industry. The automotive industry is going through a transformation, where the dynamics of the industry is changing, and where actors who previously were Tier 1 suppliers or Tier 2 suppliers to OEMs, now can build their own EV due to holding on to the key battery technologies and its correlated patents and intellectual property. The industry is though still demand-ing high investments in EV R&D, production, and marketing, thus requiring high capital requirements. To reach financial viability, these large investments need to be divided by a large output volume, which is hard for new entrants. To increase sales volumes, traditional OEMs can enjoy brand recognition and customer loyalty. Nevertheless, in the case of where the new entrant is an already established company who is holding a key technology, the large investments in product development and production may already have been done, and thus their barrier to enter may be lower than incumbent OEMs, who need to transition from ICE to EV development and EV factories.

Since the BEV engine is an architectural innovation (Grant, 2019) and requires architectural changes to the product, it has a high impact on the strategy of a firm and the innovation brings a strain on incumbent firms' human resources and to their employees with the skills and know-how in ICE technology. The technological change from hardware to software undermines the resources and capabilities of incumbent automotive firms and it is, thus, competence destroying, as described by Tushman and Anderson (1986). Both tangible and intangible resources are affected by the industry transformation, where all the patents and other intellectual property of the ICE becomes obsolete and the physical resources like factories need to completely be redesigned and reformed. As the Figure 2.7 from Chapter 2 depicts, all types of resources of a firm indirectly impact the strategy of a firm.

The bargaining power of buyers has traditionally been moderate and could be altered when switching to a BEV. The interviews unveiled that when the customers switch from an ICE car to a BEV, they need to consider new aspects, which result in some switching costs. First, they need to acquire new knowledge about BEVs, how and where to charge it, and they themselves, may have to invest in a charging point to install at home. BEV end-users may tend to favour car brands that come with network externalities, e.g. can enjoy the system of Tesla products, like their Supercharger network.

The rivalry among existing firms in the automotive industry is fierce, where two aspects stand out the most, competition of sales volume and high exit barriers. Grant (2019) describes that the industry is outlined by an overcapacity, where the output is higher than the car sales. The EV OEMs are currently mainly competing in a niche market and thus, the segment to reach for profit is smaller and more intense. Previous huge investments in ICE R&D, production facilities, distribution networks and marketing, makes it very difficult for the incumbent automotive companies to let go of the older technology. In conclusion, the competition in the EV market is fierce. The same amount of companies is competing for a smaller sales volume, than on the ICE market.

5.1.2 Diffusion of EVs

Although it is easier to analyse the industry life cycle of an industry in retrospect, there are some indicators that the EV industry is somewhere between the introduction phase and entering the growth phase. In general, BEV market penetration is still low and the main focus from firms is still on product innovation. However, the EV adoption is higher in some markets, e.g. Norway and China, where an increase of BEV sales has occurred.

The introduction phase has many technological alternatives before one emergent dominant design grows (Tushman & Anderson, 1986). In the automobile market, there are now many technological alternatives to the ICE vehicle with a range of different EVs emerging. By viewing the different technologies as S-curves by their performance over time, as described by Granstrand (2016), where lower S-curve represents the ICE vehicle technology and the higher S-curve represents the BEV technology. The presence of the BEV technology created a performance boost on ICE vehicles, causing the creation of PHEV. The powertrain of a PHEV is a mix of both the technologies and can be powered either by the internal combustion engine or a small battery. Since the PHEV still emits CO_2, the BEV is more favoured by governments and politicians according to the empirical findings, and the PHEV is sometimes viewed as a vehicle transition between ICE cars and BEVs, a visualisation is shown in Figure 5.3. An automotive company can make sales with the PHEV in the transition phase, but, as this phase declines, so will the PHEV sales. There is an ongoing debate about which powertrain technology will dominate the market, where the main discussions are about the dominance of BEV or FCEV technology. Hence, there is still no clear dominant vehicle design set in the automotive industry. Many interviewees believe that there might not be one dominant vehicle design in the future, as in the previously mature car market, and rather a mix of many different vehicle *powertrain* technologies. This argument was mainly driven by material and resource scarcity analysis and geopolitical analysis. Hence, time will tell which technology will become the winning design of the EV race.

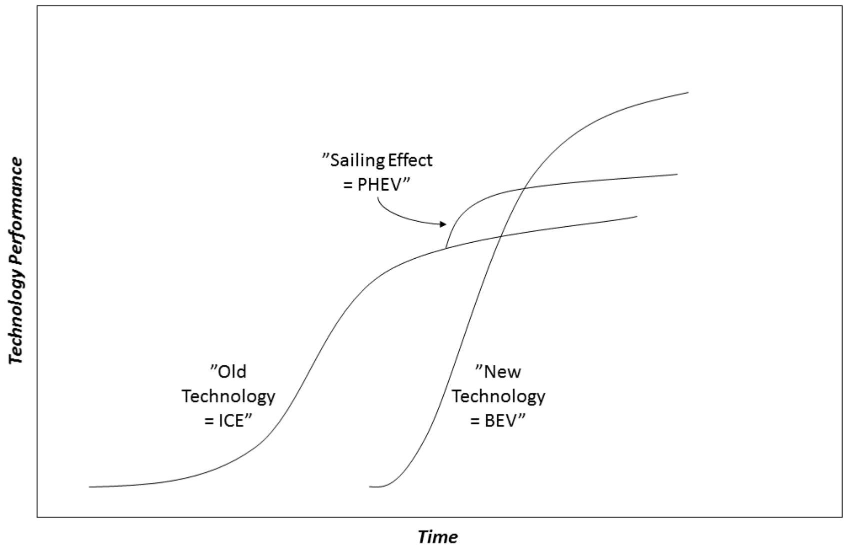

Figure 5.3: S-curves for competing technologies and the sailing effect, modified with different powertrain technologies (Granstrand, 2016), p.192.

Historically, trajectory maps with performance improvement can incline if a disruption might or might not occur, according to C. M. Christensen (2011). When the trajectory curves are parallel, there will be no disruption. When they are not parallel and the lower curve of new technology is steeper than the old technology, then there are signs of disruption. In addition, Grant (2019) claims that, both technology innovation and business model innovation can work as a disruptive force on incumbent companies. In the interviews, Tesla was described to be on top of the ecosystem, i.e. an OEM who have outperformed other EV OEMs in performance and delivering value to customers.

Alongside with improving the battery technology to make the EV commercially successful, C. M. Christensen (2011) p.245 claims that a *"Vehicle must be simple, reliable and convenient"*. These features and other attributes can evolve and grow in an emerging value network, where initially some of these might have been perceived as weaknesses and later to advance into being perceived instead as strengths in the value network. Today's barriers to buy might evolve into strengths and desirable attributes, i.e. the size of the battery as a feature that is perceived as too small for long trips today and in the future the small size will be viewed positively.

5.1.3 Charging Infrastructure

Key success factors for one company may look different for another, however, all companies need to capture value and make money. In the automotive industry, auto OEMs make their money from car sales and are dependent on customers buying cars. The problem starts to arise when customers do not buy cars in the same amount as before and the car manufacturers cannot make use of their economies of scale. Lower sales and lower production volumes hits the company hard. So, what can they do to sell more cars? This is not an easy question to reply because of the many different reasons it consists of and it is a complex problem. It is crucial to understand the customers and their needs. It is even more important to listen to what the customers do and observe their pains and adjust and improve the product or service accordingly, in order to not lose the customers to a competitor. The role of charging infrastructure stretches over the areas of the industry, the users and the EV business ecosystem. To answer the research question, the element of charging infrastructure will be explored.

Charging stations can be seen as a *complement to cars*. As stated by Teece (2007) in the Theory Framework, the presence of a complement in a system, enhances the value of the product, as ink is a complement to printers. For example, the presence of charging stations that are compatible with the product, BEV, enhances the value of that product and its product brand. Hence, it strengthens the position of the company against its competitors. The complement further strengthens the product value if the experience to use it is seamless and convenient. On a higher level, complements can also be used in business model innovation according to Osterwalder et al. (2013). An example of this is Daimler's Car2go, serving as a complement to their core business model. That Tesla provides charging infrastructure to their customers could be seen as a complement to their mobility and energy solutions.

Insights from the Empirical Findings shows that, in order for enabling *BEV diffusion, home charging is vital* and to have possibilities to charge at work is important. The key rule here is that, *where the car stands still the longest, is where it should charge.* Therefore, it is the most common that BEV users charge most of the time at home or at work and many end-users manage well with only charging at home and seldom need to charge their BEV at a fast charging station. Although the daily need for public fast charging stations is low or almost non-existent by the typical BEV user, their existence is crucial for enabling users to roam freely with their car and support the diffusion of BEVs. There are a higher number of private charging points, than the number of public charging points, but despite the fact of public fast chargers having lower utilisation and having a smaller number in size to private chargers, *public charging is crucial for increasing the BEV adoption rate.*

Regulation of environmental topics is driving the electrification forward and market forces alone will have a hard time to drive the transition to electrification, in contrast to the traditional case with technology development. Historically the firm with new technology discovered a new market segment and claimed market share with Schumpeterian rents. Lower sales volumes in the BEV market are caused by a lack of customer demand, which in turn stems from the customers' perceived feelings about the barriers to buy a BEV. The potential new customers feel that the BEV is inferior to ICE and thus more expensive. This makes it harder to create financial viability in both the BEV manufacturing and the case of charging infrastructure. Therefore, *government policies play a key role* in promoting the development and deployment of EV and charging infrastructures. In Sweden today, policy makers favour technology neutral policies and are not intending to drive a promotion of technology-specific policies, similar to what is occurring in Norway and China.

5.1.4 Differences with Charging Infrastructure and Gas Stations

Charging infrastructure has been depicted in the beginning of this research as something that will progress when EV sales rise, just like the gas stations grew in numbers along with the growing industry of ICE cars in the last century. However, the Empirical Findings expressed a *major difference to remember when using the analogue of comparing a charging station to a gasoline station with three aspects*. The *first* aspect to consider is that, to the same pace as the number of cars in society grew, almost the same pace the gasoline station could evolve together. The number of gasoline stations increased over time together with cars for about 120 years. But in the case of the commercial EV in late 2010s, and their expected expansion phase, the number of installed charging points will have to be installed at a much quicker pace than the previous gas station, due to the high number of users switching to an EV from ICE. The comparison is between 120 years of co-developing a transport system and 10-15 years of co-developing a completely new mobility system. The *second* aspect to remember is that the first system was built and supported along with the oil and gas industry while the new mobility system is mainly supported by regulators and to some extent not supported by the oil industry. A *third* major difference to remember is that the need for them is completely different. The users with an ICE car are dependent on gasoline stations to fill the tank with fuel to continue being able to use the vehicle. But in the case of an EV, the users tend to charge up the battery a little, every time it is possible when parking the car, to avoid the situation of running out of battery on the road. The behaviour can be called opportunity charging. Thus, it is a different user behaviour steering the need of these different stations.

5.2 Understanding the User

To understand EV infrastructure issues, it is important to consider the *consumer perspective*. The empirical data shows that potential BEV users experience a lack of knowledge about recharging the battery of the EV and other user behaviour related issues. There is a lot of *psychology* behind charging a BEV and how the user perceives the experience. There is a slight learning curve to get used to the new technology and it is important for OEMs to ensure that the experience of using their BEV product becomes *seamless* for the end-users, so they can associate the BEV with positive feelings. If the automotive OEM leaves this to another actor in the EV business ecosystem, the OEM cannot control the charging experience, which is so interconnected with their product. By adopting a system approach and viewing the charging as a service to their product offering, the OEMs can control, adjust, and improve the experience of their product (BEV).

As previously mentioned, BEV users tend to recharge the BEVs differently than an ICE car. Consequently, the BEV users tend to create a new type of mindset of how to use and when to charge the vehicle with a new type of driving pattern to create a more seamless experience for themselves.

By *overcoming the barriers to buy*, EV sales can grow. The top five barriers to buy, as depicted in Chapter 4, are the price of the BEV, range and charging anxiety and the availability of private charging at home and the availability of public chargers on the road, where the last three are *highly related to EV infrastructure*. One *linkage* that was identified in the study was the relation of the more severe the range anxiety is, the higher density of charging infrastructures is required.

5.2.1 Charge Anxiety

There are several *challenges* that a new BEV *end-user faces* when handling a BEV in the beginning. These uncertainties put a lot of pressure on the end-user to know how to handle the new product and its associated new technologies of managing the battery and its needs and executing charging. The customer needs to have acquired a lot of knowledge to overcome its anxieties. They need knowledge about how to charge the BEV, where to charge it and how much to pay for the charging, due to the low-price transparency of today. When locating a new charging point, the end-user faces even more uncertainties with wondering if the charging point is free and available, if the payment will work on this charging station or if the charger at the charging point is compatible with the vehicle. In Europe and in Sweden, there are many charging stations that require the user to have pre-ordered a RFID/NFC tag in order to be able to pay for the charging. These stations do not accept credit cards as a payment solution for temporary visitors, which makes it problematic for end-users on the road to pay on new charging stations. Roaming with an EV would feel more comfortable if the user could receive real time information about charge point availability and obtain more price transparency and user-friendly payment methods. Hence, interoperability is key for users and BEV adoption.

5.2.2 Range Anxiety

The external weather climate affects how much energy or fuel a car consumes, and the unpredictableness of this, especially affects the *range anxiety* of BEV users. The energy consumption for weather dependencies were often brought up in the interviews, although the same logic applies to gasoline cars, who also consume more fuel during different weather conditions. Since the total range of the cars differ, where the total range of a BEV is lower than ICE cars, this sparks more anxiety due to reaching the maximum range limit faster. The BEV users will experience a learning curve while driving in familiar areas, where the range anxiety might decline by time. However, the anxiety will still be present when roaming in new areas with the car.

Being able to charge in buildings and in city centres for apartment residents would make them more prone to switch to an EV. The auto OEM focuses on a niche market of house owners to switch to an EV and install a charging box in their home. In Sweden, a larger percent of the population lives in an own house, but on other markets and regions, it looks very different and urbanisation drives the development into the direction of more people living in the cities. The strategy of today seems to be focusing mainly on house owners and *neglecting apartment residents*, which might not be sustainable in the long term.

5.2.3 Price Concerns

One factor that was brought up by several actors was how unconvinced the customers was of the argument that the TCO for an EV is lower than for an ICE car and by forcing the customers to reflect upon the TCO, the more unconvinced the customers become into making a purchase of a new car when they released how expensive it is to own a car. This pushes the trend of lower individual ownership of cars. The customers are used to only seeing the purchase price and compare that with other models or car brands. They are intimidated when viewing the price tag for a BEV, and sceptical when the dealers or OEMs argue that it can be cheaper if they divide the cost over the entire period of time that the car is being used.

Most customers neglect to consider the TCO when purchasing a new car. This might be a consequence from the ICE business strategy of OEMs, where the business model is built upon a strong aftermarket business, i.e. low price for the initial purchase and a higher aftermarket service price. The new marketing strategy from EV OEMs is to change the customers mindset to the other way around and justify a higher initial price with lower need of aftermarket services. In order to persuade the customers that the TCO is lower for an EV than compared to its counterpart, the ICE car. The customers who consider the TCO before purchasing a new car, face several uncertainties while calculating the TCO. For apartment residents, the TCO is hard to estimate due to low price transparency in public charging stations. For villa owners, the TCO is also difficult to estimate because of the uncertainties of finding out how much it would cost to install a charging box and the costs for charging the vehicle on a daily or regular basis. All this extra work can be viewed as a switching cost for the customer.

5.2.4 Design Thinking

The users are less likely to make the switch to BEVs if they need to battle all these inconveniences and insecurities. Therefore, different actors will have to either collaborate or take it upon themselves to create a more seamless experience for the user. C. M. Christensen (2011) emphasises the importance of being able to observe the market needs instead of listening. Bertolotti et al. (2018) elaborates on observing a customer's needs and pains, is practised in the methodology Design Thinking. The process creates empathy for the end-user and thus, create products or services that are adjusted well for users and generates insights about user iteratively. To apply the Design Thinking methodology could therefore be a solution in order to make the experience of a BEV more seamless. Furthermore, Carlgren et al. (2014) states that the Design Thinking methodology could be adjusted to all areas and integrated to any organisations. The automotive industry is no exception, hence, the methodology could be viewed as an opportunity.

5.3 The Business Perspective of the EV Business Ecosystem and Charging Infrastructure

In order to answer the research question *"How could automotive industry actors gain competitiveness by enabling charging infrastructure for BEVs?"*, it is fundamental to understand the EV business ecosystem where the charging infrastructure is being embodied. It is essential to analyse the EV infrastructure issues from the business perspective. The analysis consists of the economics of charging infrastructure, the EV business ecosystem, the aspects of sustainability in the ecosystem and what actor is considered to be responsible for enabling charging infrastructure.

5.3.1 The Economics of Charging Infrastructure

To understand EV infrastructure issues, it is important to consider the business perspective. The main problem from a business perspective is to create cost effectiveness for public fast charging. It requires high investments in preparing and installing the charging infrastructure and the low user utilisation of the charging station generates low revenues. The profit margins are too low in order to make a good business case out of it. The financial aspect of charging infrastructure is highly dependent on the pricing of the service and the utilisation volume. If the utility of a charging station is low, the payback time can be very long and, in some cases, up to 15 years, see Appendix 3. If the utility of the charging station is high, the payback time is less than 5 years. All the interviewed actors described the utilisation of their chargers to be low in Sweden and that they were careful with installing too many quickly regarding that the technology is still developing. There is a risk of the technology to become outdated before the payback of the investment is reached. To reach financial stability in the charging business model, additional revenues streams should be explored, e.g. parking fees or food services. Another way to create a positive business case could be through new business models with collaboration with different stakeholders to enact more income.

In addition, the infrastructure issues are complex and interdisciplinary. The different disciplines range from car manufacturing, battery knowledge, charging point's hardware to software communication protocols, the interface between the car and the charging point, the electricity grid, to roaming platforms. A common EV infrastructure issue is when the EV needs to charge and the charging point does not understand because of different communication protocols. These protocols exist between the vehicle to charging point, from charging point to charging point and from charging point operator to roaming platform. Another dimension of complexity is to fulfil the needs of a range of different users, and not only the private consumers' needs but also the growing segment of fleet owners and for other commercial usage. This market is developing and the most active actors today that is driving this change are charging point operators, e.g. Ionity or Eon, technology providers, e.g. ABB or Siemens, electricity mobility service providers or electricity providers, like Vattenfall or Eon, and roaming platforms e.g. Hubject.

To create more cost-effective EV grid integration, smart charging technologies are being developed. By being able to adjust the rate of charging and to return electricity to the grid in case of shortages in the grid during peak hours. The main view of the interviewed actors was that the electricity grid will manage a transition to BEVs.

5.3.2 The EV Business Ecosystem

This study took a broad approach to view the different stakeholders and uncovered that they do have different standpoints and interests. Some new actors were identified to have some influence over the other actors. An example of an actor influencing others is the actor type landowners since access to land is crucial for installation of public chargers. The EV Business Ecosystem in Sweden, today lacks a clear and well-defined actor who takes the role of an aggregator. The market is still categorised with several payment options and brands for charging and the customers struggle with connecting to several charging platforms. According to an interviewee, Tesla has a closed charging network and keeps out non-members, unless they acquire a charging adapter in advance. Incharge and Ionity are perceived as more open charging networks, but the customers still face interoperability issues while on the road, where most of the charging stations require pre-ordering a payment solution. The interoperability issues could be dealt with in several ways. To reach a more user-friendly status, the charging station operators could create easier payment methods for end-users on the go or the services of a charging network could be combined and facilitate by an aggregator actor.

The results from this study show many different opinions regarding charging infrastructure and that actors have different visions. This may affect the collaboration between the actors. As Grant (2019) mentioned in Chapter 2, in order to succeed with a strategy, it is key to align the goals before implementing it.

Although some actors had a clear view of who they thought should bear the responsibility of enabling charging infrastructure, they themselves discarded their role and pointed fingers on other actors to install chargers. While being aware of the factors influencing the diffusion of EVs, they still claimed it as a task for someone else to solve. Many actors claim that Electricity Providers are responsible for installing charging stations and they, the Electricity Providers, agree to take it upon themselves to install chargers together with landowners or parking companies. However, the electricity providers claim that they lack customer insights from the end users, which the car companies are not sharing.

The interviewed actors are working either directly or indirectly with enabling a charging infrastructure and assisting the diffusion of BEVs. The indirect ways of working consist mainly of research projects or knowledge spreading. Only three actors work directly with enabling and offering charging for EVs. Due to the general knowledge of BEVs from the mainstream is still perceived as low, the indirect work could scale up to change the public awareness of BEVs and charging.

5.3.3 Sustainability in the EV Business Ecosystem

Regarding how well the sustainability aspect is established in the business ecosystem, the majority of the actors does include the environmental aspects to some extent, but there are improvements to be made to make the charging infrastructure fit into the circular economy and to improve the social sustainability, making the BEV accessible to everyone and not only house owners. The 17 SDGs are too broad to say anything about the actors' sustainability work, but they were used to get the conversation going about sustainability. The SDGs are too vague on its own to describe the work of sustainability, but their usage could indicate if the company considers the sustainability aspect or not. The interviewees were asked, among other things, if they are familiar with the 17 SDGs, if the company is officially working with them and which ones they are focusing on the most, while working with charging infrastructure for BEVs and how they aim to contribute. Most of the interviewees were aware of them and only a few were not familiar with them.

5.3.4 Responsible Actor in the EV Business Ecosystem

As the research question states, the OEM would install charging infrastructure. However, in this study, other stakeholders in the BE were pointed out as the *responsible for installing charging infrastructure*, e.g. the governmental bodies, municipalities, electricity providers, among a few others. The amount of different answers from the interviewed actors indicates that there is no obvious actor who should bear the sole responsibility of enabling and installing charging infrastructure, and it further indicates that this is a complex system where different actors and stakeholders need to cooperate to share the responsibility of enabling charging infrastructure and installing more charging stations.

Instead of OEMs taking it upon themselves to install, they could act as *leaders driving this collaboration with key partners*, due to the absence of such coordinators today. Efforts of this coordination role have been attempted by some governmental agencies on a higher level and when it comes down to the operational level, it turns insufficient, because the role of the government body feels obligated to stay neutral in its role. Some argue that it should be the government driving and coordinating such efforts due to their wishes and goals of transforming the transportation system into becoming carbon free. If OEMs instead took the role of the initiator of such collaboration or as an aggregator, there are advantages for them to harvest in such a network. The charging infrastructure could better match the vehicle technology, battery sizes and be better integrated together. By enabling *connected charging points*, the OEMs could receive data from the charging stations and of the EV users who visited the station. This mass data could be analysed by the OEM to enhance the vehicles' performances and better adjust them according to user behaviour.

The OEMs might not need to do this alone, but could create a *strategic alliance* with another company that inhibits the resources and capabilities that the OEMs today lack in the fields of high voltage power and electricity grids. The analogue that OEMs should not install charging stations because they do not own gasoline stations was brought up several times in the study. However, Volvo is one example of an automotive manufacturer who also owns a gas station, named *Tanka*, and the users can refuel their car with membership cards for a reduced price.

5.4 Managing Change

How to stay competitive in this transformation requires the companies in the industry to rethink their current strategies and re-evaluate their business models in order to find new sources of profitability. The firms need to decide if they want to be innovators or fast followers in the changing market. Different companies have different resources and prerequisites to adapt to changes, whereby this report cannot give a finished solution, but may serve as one part of the basis in the decision process when considering charging infrastructure.

By understanding the industry, the users and the business ecosystem regarding BEVs and charging infrastructure, the company can navigate the transforming environment and create new competitive advantages. In order to stay competitive, C. M. Christensen (2011) suggest that it is important to create a *plan for learning* and adapt accordingly to the market needs. But not to react to what customers say they want or what they lack, but to observe what customers do and identify arising obstacles. OEMs can design a more seamless experience by observing what the customers do not manage to do. In early markets, one should be careful with relying too much on market research reports. (C. M. Christensen, 2011) As mentioned in a previous section, the Design Thinking methodology can be used to find out the real problems of the users and help firms to understand their users.

Dealing with change or potentially disruptive technology, a firm can manage this by being more ambidextrous and if the company decides to expand into the new area, a resource allocation problem may occur. C. M. Christensen (2011) suggests that this can be solved by creating a new organisational context with an individual spin off company, letting all the resources of the new company to focus on only the new area.

Automotive industry actors could gain competitiveness by enabling charging infrastructure for BEVs by viewing charging stations as a complement to cars, innovating their existing business models and creating an organisational plan for learning and adapting to changes.

6

Discussion

This chapter begins with a discussion of the analysis, which is divided into the three parts, *Gaining Competitiveness*, *Business Model for Charging Infrastructure* and a part discussing *The Role and Position of CEVT*. Then, reasoning regarding the *Limitations of the Study* is presented and lastly a part discussing potential *Further Research*.

6.1 Gaining Competitiveness

To answer the research question, the three different areas of understanding the industry, understanding the users, and understanding the ecosystem was explored in this master thesis, see Figure 5.1. Charging infrastructure could be an additional area, but this element is integrated deeply in each part, thus, the role of charging infrastructure was analysed in each area. How automotive actors could gain competitiveness by enabling charging infrastructure is settled by a combination of all the areas mentioned above and is highly changeable in different markets and for different brands. Thus, there is no simple answer to it. Each area still contains high uncertainties, but it is certain that new mobility ecosystems will evolve, where the actors are still yet to be clearly identified.

Using the vehicle should be easy, convenient and *seamless*. If there are any existing issues related to charging the BEV, the convenience is gone. Hence, the aspect of seamless charging of BEVs should be further analysed by automotive manufacturers. When creating a business strategy for seamless charging of BEVs, there are a few things to consider that this report unveils. First, the company should acknowledge the *charging stations as a complement to BEVs*. Furthermore, by understanding and observing the BEV user, the company can discover what the customers do and how they handle the experience, which can further help the company to easier facilitate user needs and remove user pains.

Then, automotive OEMs need to make sure that the charging infrastructure is in place, either by becoming a charging station operator themselves, or making sure that another actor *fulfils the needs of charging* to the extent of what their users require. The auto OEMs can do this in several ways, and the three most frequently mentioned ways in this report were via partnerships, strategic alliances or through open innovation. OEMs can acquire new knowledge or capabilities from external sources via their key partnerships.

To outline three different directions an EV OEM can take regarding their role in charging infrastructure, three different business strategies are suggested. As mentioned above, if the needs of charging are fulfilled, the first strategy for the OEM may consider leaving enabling charging infrastructure to another actor. Whereas, the second business strategy is where the OEM is more involved with existing charging station operators to ensure that the charging needs of their users are fulfilled. As previously stated in Chapter 5, another tactic for the OEMs is to act as leaders driving the collaboration with key partners, which could be the third strategy for an automotive OEM to consider.

An idea of how OEMs can assist in how to overcome the customers' perceived issues and to boost EV sales, is to create showrooms combined with a *knowledge* *centre* for educating the mainstream users, but also offering expertise to the tech savvy enthusiasts and early adopters. In the empirical findings, it was mentioned that car dealerships had trouble answering technical questions related to the BEVs. Such a knowledge centre could offer the potential customers to try the BEV and personnel could show them how to recharge the battery on the spot. Overcoming some uncertainties regarding the usage of BEVs might help the demand to grow and the creation and diffusion of knowledge should increase industry sales.

Charging infrastructure can both enable competitive advantage and not, it has both advantages and disadvantages. For example, opportunities to manage user's needs in order to make them more comfortable with buying full electric cars and thereby increase BEV adoption, along with the opportunity to collect valuable user data, but it also carries difficulties with financial viability. Tesla has thought of the whole system that their product exists within and other companies may benefit from similar thinking to create a more seamless experience of their product and how to use it, i.e. charge it. By viewing the automotive industry more holistically, the industry can be recognised as an interrelated system of the automotive sector, energy sector and the software sector. The external forces on the industry leads to new mobility services and affects user behaviour.

6.2 Business Model for Charging Infrastructure

In the case of the OEM choosing to engage in charging infrastructure, it's essential to create a *service-oriented business model* with *financial viability*. The company must rethink the traditional business model in order to find new ways for income and business model innovation is needed. There are several ways to find new revenue streams from the charging infrastructure, e.g. *data from users*, data from charging points or additional services beyond the charging fee. The auto OEMs can build better cars with the data of the user behaviour or communicate the information to other actors. When introducing new services, collaborations may be needed. While business model innovation can facilitate greater market adoption of EVs, the area is also filled with challenges and open for continuous change.

Business models create, distribute and capture value and some considerations related to charging are unveiled in the study and they are further explored below. To start with some comments regarding the *customer segment* that is the most common today. The study shows that most of the focus is put to villa or house owners. There is a potential to include apartment residents and capture this segment group. Along with the global trend of urbanisation, there are opportunities to capture this growing customer segment.

The value proposition is simple as being able to use the EV and recharge it to continue using it. By offering charging possibilities to EV customers, the charging operator is delivering value to the customer. To nurture the *customer relationships*, the firm can create customer loyalty through loyalty programs or member clubs for charging.

Implications on *revenue streams* were discussed in Chapter 5.3.1 earlier, but to conclude, it is difficult to get profitability due to low utilisation of the charging points and not being able to charge high fees. New innovative ways must be implemented to increase the revenue streams, e.g. collecting data from EV users and either use the data internally or sell it externally. The payment could be subscription based and/or adhoc based charging, that is seamless and interoperable, to solve the EV infrastructure issues.

EV OEMs possess two main *key resources* for creating a seamless charging experience, that is customer insights and high knowledge about the EV. In the interviews, these two factors were mentioned by existing charging operators as key factors to have access to in order to build a better service offering. For the existing infrastructure providers, to handle the missing key resources that are required to operate effectively, information between the actors could be shared in partnerships. There are also key resources that EV OEMs are lacking, which instead electricity providers and infrastructure providers own. This could be managed with key partnerships and strategic alliances. Among other activities, *the key activities* would then expand to build relationships with key partners and understand the customer's charging needs. By usage of *Key Partnerships* and enter partnership with another organisation or to create an *Alliance* with firm's who own the resources and capabilities one's company do not have could be a solution to extend a company's area of expertise in a profitable way since the companies share investment and R&D costs. Moreover, knowledge sharing between companies could increase the quality of a product or service.

To deal with the *cost structure* of a charging infrastructure business model, a sharing economy was proposed by an actor. Investments could be shared with partners and reduce the cost of each company. High investments were associated especially in ground digging, installing the infrastructure and equipment. Less investments are required inside a parking garage where the electricity grid is usually outlined.

6.3 The Role and Position of CEVT

As mentioned in Chapter 1, CEVT is an R&D company innovating modular platforms to EVs. However, in this study they are categorised within the actor group of EV OEM in the EV Business Ecosystem. CEVT differentiates themselves from traditional automotive OEM's, whose main focus has been to develop and produce vehicles, in contrast to CEVT's B2B sales of platforms. But due to market changes resulting from technological development and stricter emission policies, automotive OEM's focus has started to change into a broader mission to *enable mobility* which CEVT is also a part of. If CEVT were not to be widely categorised into the group of EV OEMs, their position in the EV Business Ecosystem would more specifically be positioned between the Core Component Suppliers and the EV OEMs, see Figure 6.1. CEVT is an innovation centre that can deliver both vehicle platforms and other engineered high-tech solutions for the automotive sector.

This study has focused on investigating additional actors in the Business Ecosystem and their views, thus, it can be used as a basis for strategy decisions for the actors in the EV business network. These insights can also help CEVT, with developing strategy. But since internal data and detailed information regarding any firm's business models has not been taking into account, the following ideas and recommendations are abstract in their nature.

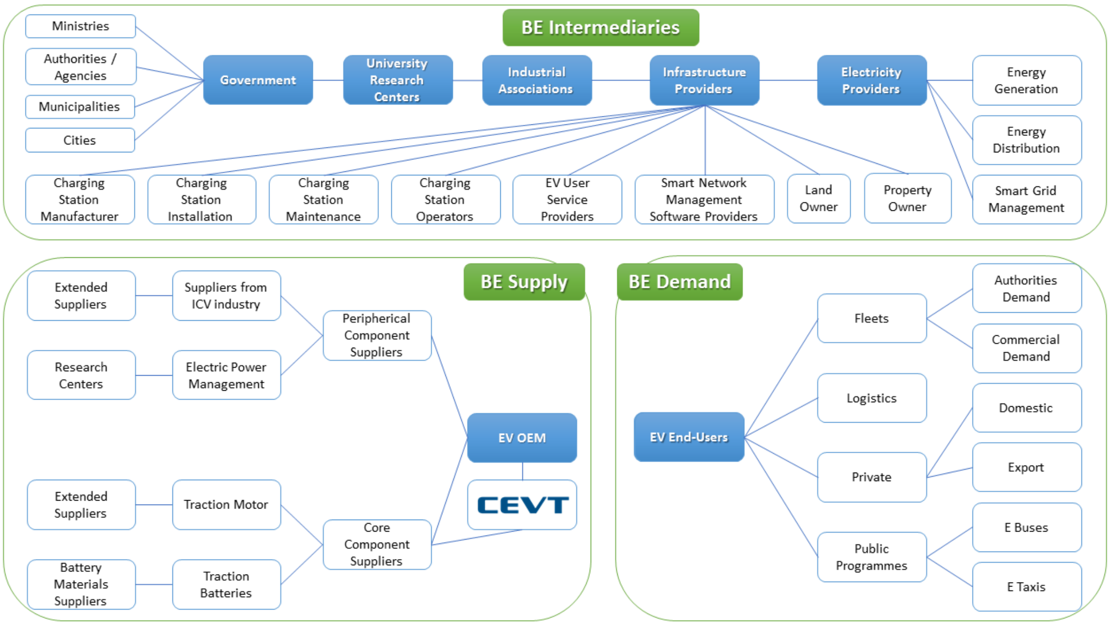

Figure 6.1: Modified version of the EV Business Ecosystem with the company CEVT added. (Beeton & Meyer, 2014), p.219.

One major difference between CEVT and automobile OEMs, is that CEVT has no or low tangible resources and investments made in production facilities. If CEVT wanted to switch, change, or leave the industry, the company would have lower exit costs and lower barriers to exit, in contrast to traditional OEMs with high physical investments and assets, such as production linked to ICE. This may serve as an advantage for CEVT and the flexibility can facilitate the company's response to industrial changes faster.

Another difference between CEVT and more traditional automotive OEMs, is that CEVT is further away from the end-users in the business ecosystem since their business is B2B related.

By being further away in the network, the collection of customer insights could be more challenging. As mentioned in Chapter 5, understanding the user is crucial to gain competitiveness, and therefore it may be important for CEVT to sustain or create collaborations with actors in the network, in order to access customer needs. Collaborations or strategic alliances could enable CEVT to get closer to the customers and thereby gaining more insights regarding customer needs. An idea could be to innovate solutions to make charging infrastructure more seamless through connectivity between the vehicle, the charger, and the electricity grid by cooperation, e.g. with electricity providers or software providers.

Furthermore, as mentioned in Chapter 5, charging infrastructure for apartment residents seems to be neglected, while house owners are prioritised. Today's market for BEVs can be described as a niche market, primarily targeting the customers with a house and a premium customer segment. In order to target the mass market later, the charging needs of apartment residents must be fulfilled. Since the apartment residents are increasing in numbers, it could be an opportunity for CEVT, or other actors, to innovate new charging solutions for EV users that live in apartments.

6.4 Limitations of the Study

The selected limitations of this study resulted in focus on BEVs, which was investigated through empirical studies. However, PHEVs as well as FCEVs are growing mobility segments and therefore, the interviewees partly touched upon EVs in general, as a complement to discussions regarding BEVs. While discussing future mobility solutions during the interviews, it was difficult to limit to BEVs only because several respondents believed in interaction between several powertrains. Therefore, both PHEVs and FCEVs are processed in the study, but the main focus is on BEVs.

This study focuses on *electrification* which is one out of four megatrends described by Cornet et al. (2019) as mentioned in Chapter 1. Moreover, *Autonomous Driving, Connectivity* and *Shared Mobility* are described as megatrends. This study partly touches upon Autonomous Driving, since several interviewees believe in autonomous vehicles as a possibility for future societies and the implementation of autonomous vehicles could change the way to charge the vehicles. Inductive charging is another aspect that could change the way to charge, since it could be perceived as more convenient and user-friendly than plug-in charging.

Further, the study is focused on private consumers of BEVs, traditionally it implies ownership of cars or company cars, but carpool fleets are included as well. However, the empirical findings mainly resulted in the private market in a traditional way, thus carpool fleets are not mentioned to a large extent. It could be a result of the method since it might not have been clear that carpool fleets were included since the market is dominated by private owned cars or company cars.

Areas outside Sweden were excluded from the study since all of the interviews were performed either at Swedish companies or linked to an international company's office located in Sweden. Furthermore, the all interviewees were based in Sweden. Therefore, the results are related to cities in Sweden and might not be applicable to cities in other countries. Two main things that differentiates Sweden from other nations, in regard to charging infrastructure, are lower density of population per area and higher proportion of house owners, which could affect the utility rates of public charging stations. Therefore, the business model behind a functioning charging infrastructure solution in Sweden might not be convertible to other regions. However, since other countries generally have higher population density it could be easier to create a profitable charging infrastructure system outside Sweden.

The researchers aimed to target as many potential actors in the Business Ecosystem as possible, which resulted in *22 interviews* in total. The research aimed to capture a wide range of actors in the EV Business Ecosystem to create an overview and to cover a wide group of different stakeholders within the Business Ecosystem, with the goal of trying to find their viewpoints. By capturing different actors' perceptions of the same ecosystem, the researchers hoped to increase the validity of the results. In 20 out of 22 interviews, the researchers interviewed one person representing their firm. In two interviews, two employees participated who together represented their organisation. This structure may have given biased results since one or two people at a large enterprise might not know everything about their organisation. Furthermore, some thoughts and opinions shared by the interviewees could be reflected by personal opinions. However, the researchers requested answers that the interviewee's organisations could support.

6.5 Further Research

This study focuses on electrification and it became a natural part to focus mainly on this megatrend when exploring today's charging infrastructure for BEVs and the EV ecosystem. The other megatrends of autonomous driving, connectivity and shared mobility was slightly touched upon, but further research could investigate more deeply how the aforementioned trends would affect the charging infrastructure and the ecosystem. The interview template was used for all interviews which implies that the same questions were asked to all interviewees since the study's focus was to map out the Business Ecosystem actors. To further investigate key actors in the network and ask each actor more specific questions could be interesting. Moreover, further investigations of different business models for charging stations, including technical aspects or focus on how to create a profitable business model for charging could be included in future research. In the study, all subcategories in the Business Ecosystem are not included since the researchers could not get in touch with a few actors, operators, and suppliers for instance. Therefore, to expand the study and include additional actors could be of interest.

7

Conclusion

In order to set a strategy for a company, it is crucial to understand the external environment that the firm operates within, which this study has further explored by analysing the automotive industry and by interviewing 22 different stakeholders in the EV business ecosystem. The purpose of this thesis was to investigate a business strategy related to the charging of BEVs, by providing insights and collecting a wide approach of factors that could influence such strategic decisions. The thesis report serves as a part of a decision process for actors who are interested in being a part of the charging infrastructure for BEVs. These different insights were provided throughout the paper and some proposals of actions for automotive actors within the business ecosystem have been discussed, thus, the purpose of the thesis has been fulfilled. The thesis has mapped different stakeholders that are connected to charging infrastructure and interviewed different actors to gain a deeper understanding of their roles, the EV industry, the end-users and the EV business ecosystem they all interact in. The thesis took a less futuristic approach and instead, focused on the challenges of today and other factors that may arise as problems later.

The EV infrastructure issues can be viewed both from the consumer and the business perspective. From a consumer perspective, there are still several barriers to buying a BEV and these barriers are highly related to EV charging infrastructure, which in turn, the end-users also experience issues with, e.g. payment hassle when trying to pay for charging on public stations. Furthermore, the strategy for charging infrastructure is influenced by the user's range anxiety and the vehicle's battery sizes. As stated in the empirical findings, the more severe the range anxiety is, the higher density of charging infrastructures is required. The density is also influenced by the sizes of the batteries of the EV, where the smaller the battery size, the higher charging point density is required. In the thesis, it is concluded that there are a lot of psychological factors shaping the BEV user experience. However, this is expected to change with time due to learning curves, leading to a shift in need for public charging infrastructure. Today's common strategy seems to neglect apartment residents, but in order to reach the mass market, companies need to empathise and recognise these residents needs too. Actors within the ecosystem could use design thinking methodology to understand the users, which is important to gain competitiveness. From a business perspective, the main issue is to create cost effectiveness for public fast chargers, but also for public normal chargers, due to the low utilisation of the public chargers. Therefore, in order to gain competitiveness by enabling charging infrastructure, business model innovation is required to build a better business case of operating a charging station.

Only three of the interviewed actors from the intermediary side of the business ecosystem offered charging solutions in Sweden today. The actors consisted of one electricity provider, one parking company and one real estate owner, where the first two are planning to continue and expand their offerings in the future. While the other 19 actors worked in various ways with enabling EVs. The study showed that there is no clear actor who should bear the sole responsibility of charging.

In short, the EV business ecosystem can be described as complex and interdisciplinary. This consolidates the focus towards the collaboration between the different actors and its importance. The interviewees describe that the current collaborative efforts within the ecosystem are working well in Sweden, where some smaller areas of improvements could be made. To conclude, it is more difficult to operate alone in the ecosystem and to collaborate could be an advantage for the individual company to benefit from the other firm's resources and capabilities.

Three different business strategies could be considered for EV OEMs. The first strategy is to leave charging infrastructure to another actor, the second strategy is where the OEM is involved with other charging actors and the third strategy is where the OEM leads a collaboration that enables charging infrastructure. If the automotive OEM leaves charging infrastructure to another actor in the EV business ecosystem, the EV OEM cannot control the charging experience, which is so interconnected with their product. By adopting a system approach and view the charging as a service to their product offering, the EV OEMs can control, adjust, and improve the experience of their product. Another way to balance the user experience is to be involved with other actors who offer charging solutions, by sharing data and information to them, to make their charging solutions fit the BEV better, thus, enhancing a more seamless experience for the end-user. Besides value creation with partners and stakeholders, EV OEMs could take one step further by acting as leaders driving a collaboration, to ensure that the charging matches the vehicle technology, to collect data and to ensure a seamless charging experience.

Charging infrastructure is a building block to the diffusion of BEVs and to the transformation into an EV fleet. Its coexistence in the new mobility system is vital. This EV transformation requires a holistic system of innovative technologies, policies, and business models. Automotive industry actors could gain competitiveness by enabling charging infrastructure for BEVs by viewing charging stations as a complement to cars, innovating their existing business models, creating a plan for learning, and adapting to industry changes.

References

Aaker, D. A., & McLoughlin, D. (2010). *Strategic Market Management – Global Perspectives* (1st ed.). Barcelona: John Wiley & Sons.

Amsterdam Round Table Foundation and McKinsey & Company. (2014). *Electric vehicles in Europe: gearing up for a new phase?* (Tech. Rep.).

Arbib, J., & Seba, T. (2017). *Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries* (Tech. Rep.). Retrieved from `www.rethinkx.com`.

Beeton, D., & Meyer, G. (2014). *Electric Vehicle Business Models Global Perspectives* (Tech. Rep.).

Bertolotti, F., Di Norcia, M., & Vignoli, M. (2018). *Service design principles for organizational well-being: Improving the employee experience through design thinking* (Tech. Rep.).

Björkdahl, J., & Holmén, M. (2013). Business model innovation – the challenges ahead. *Inderscience*, *18*.

Bryman, A., & Bell, E. (2014). *Research methodology: Business and management contexts.*

Carlgren, L., Elmquist, M., & Rauth, I. (2014). Design thinking: Exploring values and effects from an innovation capability perspective. *Design Journal*, *17*(3), 403–424.

Chen, K., Zhao, F., Hao, H., & Liu, Z. (2018). Synergistic impacts of China's subsidy policy and new energy vehicle credit regulation on the technological development of battery electric vehicles. *Energies*, *11*.

China Euro Vehicle Technology AB. (2018). *CEVT Sustainability Report 2018* (Tech. Rep.).

China Euro Vehicle Technology AB. (2019). Årsredovisning 2018 China Euro Vehicle Technology Aktiebolag.

China Euro Vehicle Technology AB. (2020). *What we do | CEVT.* Retrieved from `https://www.cevt.se/what-we-do/`

China State Council. (2012). *Industry Development Plan of Energy Saving and New Energy Vehicles 2012–2020.*

Christensen, C., Craig, T., & Hart, S. (2001). The Great Disruption. *Foreign Affairs*, *80*(2), 80–95.

Christensen, C. M. (2011). *The Innovator's Dilemma: The Revolutionary Book that Will Change the Way You Do Business. The innovator's dilemma: when new technologies cause great firms to fail.* New York: Harper Business.

Cornet, A., Deubener, H., Dhawan, R., Möller, T., Padhi, A., Schaufuss, P., & Tschiesner, A. (2019). *Race 2050 - a vision for the European automotive industry* (Tech. Rep.).

Dirks, J. (2020). *The business case for public charging infrastructure in the Netherlands* (Tech. Rep.).

Enel X. (2019). *EV Charging Connector Types.* Retrieved from `https://evcharging.enelx.com/`

Ernst & Young. (2017). *Standing up India's EV ecosystem-who will drive the charge?* (Tech. Rep.).

Ford, D., Gadde, L.-E., Håkansson, H., Lundgren, A., Snehota, I., Turnbull, P., & Wilson, D. (2011). *Managing business relationships.* Wiley.

Gao, P., Kaas, H. W., Mohr, D., & Wee, D. (2016). *Automotive revolution - perspective towards 2030: How the convergence of disruptive technology-driven trends could transform the auto industry* (Tech. Rep.).

Granstrand, O. (2016). *Industrial Innovation Economics and Intellectual Property* (6th ed.). Svenska Kulturkompaniet.

Grant, R. M. (2019). *Contemporary Strategy Analysis* (10th ed.). New Jersey: Wiley.

Hampshire, K., German, R., Pridmore, A., & Fons, J. (2018). *Electric vehicles from life cycle and circular economy perspectives : TERM 2018 : Transport and Environment Reporting Mechanism (TERM) report.*

Jacobides, M. G. (2011). Strategy Bottlenecks How TME Players can Shape and Win Control of their Industry Architecture. *Insights*.

Jacobides, M. G., & MacDuffie, J. P. (2013). How to Drive Value Your Way. *Harvard Business Review*, *91*(7), 92–100.

Kim, W. C., & Mauborgne, R. (2015). *Blue Ocean Strategy : How to Create Uncontested Market Space and Make the Competition Irrelevant - Expanded Edition.* Boston: Harvard Business Review Press.

Kryvinska, N., Strauss, C., & Greguš, M. (2015). *Servitization: transition from manufacturer to service provider* (Tech. Rep.).

Kuhnert, F., Stürmer, C., & Koster, A. (2018). *Five trends transforming the Automotive Industry* (Tech. Rep.).

Mahut, F., Daaboul, J., Bricogne, M., & Eynard, B. (2017). Product-Service Systems for servitization of the automotive industry: a literature review. *International Journal of Production Research*, *55*(7), 2102–2120.

Osterwalder, A., Pigneur, Y., Clark, T., & Sjosten, L. (2013). *Business model generation : en handbok for visionarer, banbrytare och utmanare.*

Patel, R., & Davidson, B. (2003). *Forskningsmetodikens grunder : att planera, genomföra och rapportera en undersökning.*

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

PricewaterhouseCoopers. (2019). *The road to circularity: Why a circular economy* *is becoming the new normal.* (Tech. Rep.).

Seba, T. (2014). *Clean Disruption of Energy and Transportation: How Silicon Valley Will Make Oil, Nuclear, Natural Gas, Coal, Electric Utilities and Conventional Cars Obsolete by 2030.* Silicon Valley: Clean Planet Ventures.

Teece, D. J. (2007). Explicating Dynamic Capabilities: The Nature and Microfoundations of (Sustainable) Enterprise Performance. *Strategic Management Journal*, *28*, 1319–1350.

Tesla Inc. (2019). *Annual Report on form 10-K for the year ended december 31, 2018.* (Tech. Rep.).

Tushman, M. L., & Anderson, P. (1986). Technological Discontinuities and Organizational Environments. *Administrative Science Quarterly*, *31*(3), 439–465.

United Nations. (2015a). *Adoption of the Paris agreement* (Tech. Rep.).

United Nations. (2015b). *Resolution adopted by the General Assembly on 25 September 2015* (Tech. Rep.).

United Unions. (2015). *Sustainable Development Goals - Knowledge Platform.*

Wilhelm, M., & Dolfsma, W. (2018). Managing knowledge boundaries for open innovation – lessons from the automotive industry. *International Journal of Operations and Production Management*, *38*(1), 230–248.

Zhejiang Geely Automobile Holdings Limited. (2020). *History : Geely Global.* Retrieved from `http://global.geely.com/history/`

Zhejiang Geely Holding Group Limited. (2020). *Geely History – Zhejiang Geely Holding Group.* Retrieved from `http://zgh.com/geely-history/`

A

Appendix

A.1 Interview Template

A.1.1 Introduction

- Can we record the interview?
- Can we quote you in our thesis? (In case, we will send you a draft of what we would like to write)
- Short introduction of Sara and Nicole and of our thesis
  - Industrial Engineering and Management
  - Master Thesis students at Chalmers University of Technology
  - We are collaborating with CEVT
- We think XXCompanyXX count as an XX (see figure A.1 below), do you agree?
- Is there any actor missing?

A.1.2 Actors' Views on BEVs

- What is your view on BEV in general?
- What do you think is the biggest barrier to buying EV for people in Sweden?

A.1.2.1 Charging and Charging Infrastructure

- Who do you consider (in Figure A.1 below) to be responsible for possibilities of charging in the Business Network

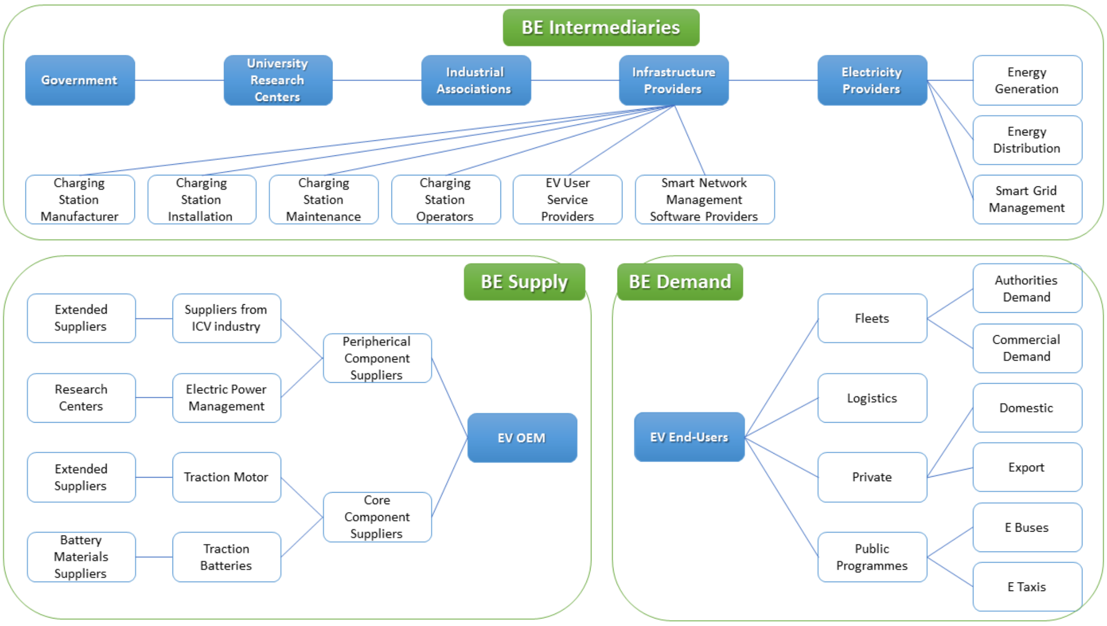

Figure A.1: Business Ecosystem of Electric Vehicles, modified version (Beeton & Meyer, 2014), p.219.

- How should charging infrastructure be or look like, according to you?
- What challenges of the electrical grid linked to EVs can you see in Sweden?
  - Today and the future?
- Do you know if it is difficult to install charging points in the city centre?
- What do you consider to be the biggest challenges today regarding the charging infrastructure for BEVs?
- What is your view on the establishment of electrical roads?
- Does XXCompanyXX work with electrical roads? How?

A.1.3 Actor's Way of Working regarding Electromobility

- How do you work today with enabling BEVs in Sweden?
- How do you work with enabling BEVs in Sweden in 10-30 years from now?

- Can you mention any current projects regarding charging infrastructure for EVs (BEvs)?
- What is your view on your role in the Business Ecosystem?
- What challenges with the role in the network do you have?
- Do you work with Open Innovation today?
  - How do you do it and how does it proceed?
  - Which other actors do you invite to collaborate in Open Innovation?
- Do you work with Design Thinking today?
- Do you work differently towards the different segments of private customers (ownership of car), fleet and self-driving fleets?
- What do you think about the business model of Tesla, regarding the charging infrastructure part?

A.1.4 Collaboration between Actors

- Which other actors do you collaborate with mainly? [See Figure A.1 again]
  - What does such collaboration look like?
- How would you like a collaboration with another car manufacturing company to look like?
- How would you wish a collaboration would look like today? Is there a more optimal way to cooperate?
- What barriers to collaboration exist today? Why do they exist? What could a solution to such a challenge be, according to the interviewee?
- Any barriers to collaboration within EV and charging infrastructure?

A.1.5 Sustainability

- How do you currently work with the 17 Sustainable Development Goals? (See Figure A.2 below)

- How can you help with contributing to make the automotive industry more sustainable from an environmental perspective?
- How do you work with making the infrastructure connected to charging of electric vehicles (BEVs) sustainable?
- Are certain charging solutions more or less sustainable?
- How do you believe the concept of circular economy could be integrated in the charging infrastructure? (Maybe making parts of the charger more modular for example)

Figure A.2: UN's 17 Sustainable Development Goals (United Unions, 2015).

A.1.6 Actors' Views on the Future

- How do they envision the future of transport in cities in 5 years?
- How do they envision the future of transport in cities 10-30 years?
- Ideal state of the future? The dream scenario?
- How do you envision the society regarding electromobility in 2030?
- Which role do you wish XXComapanyXX would have in the future?

A.2 Charging Standards in the World

Charging standards have different designs in different regions in the world, and the distinct types are presented in Figure A.3. AC-charging represents normal charging and DC-charging represents fast charging.

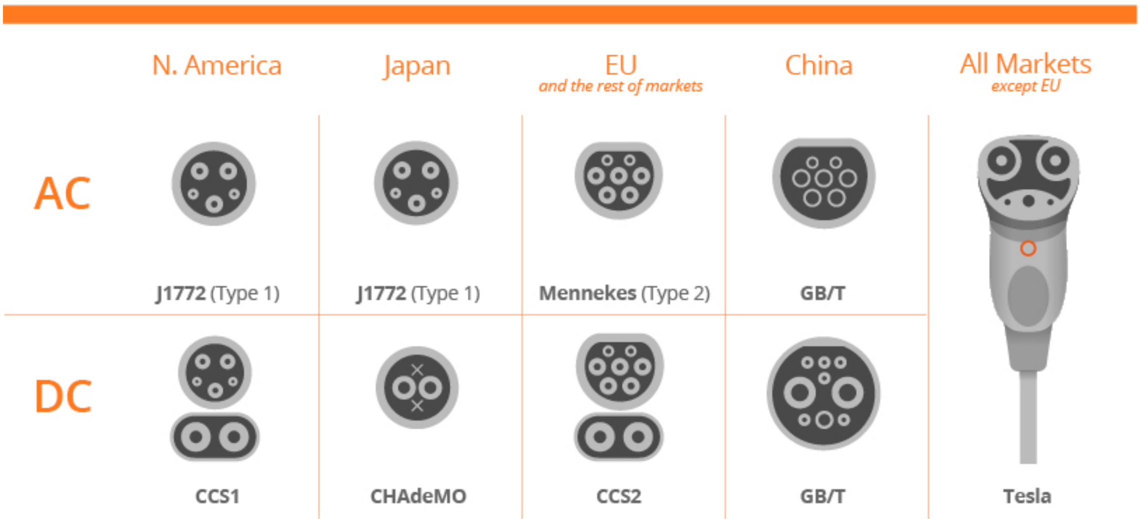

Figure A.3: Charging Standards in the World. (Enel X, 2019)

A.3 Profitability of Charging Stations

The price model used to calculate the payback time (years) and IRR (%) for charging stations. The charging station type that was used is 3x25A, see Figure A.4. (Dirks, 2020)

Revenues, as of 2020, consists of electricity sales, divided into volume and charging price. Revenues from HBE is a Dutch subsides, the amount was not stated in the source, so without this revenue stream, the table should be viewed with a less optimistic view. Volume is kw-hr and is divided into low, median, high, and average. Per each segment, charging price, in euro, is sorted into low, median, and high. (Dirks, 2020)

Costs, as of 2020, is made of one-off costs, recurrent fixed costs and recurrent variable costs that are associated with charging stations. (Dirks, 2020)

Charging Station Typologie		*Baseline*	
Volume (kw-hr/yr)	Charging Price (€/kw-hr)	Payback (yr)	IRR (%)
Low	low	>16	-20%
	median	14	-12%
	high	11	-5%
Median	low	9	3%
	median	7	12%
	high	6	20%
High	low	5	28%
	median	3	44%
	high	2	65%
Average	low	>16	-16%
	median	11	-4%
	high	8	5%

Figure A.4: Payback time and IRR of charging infrastructure in relation to utilisation of chargers and charging-price. (Dirks, 2020), p.8.

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

CHALMERS
UNIVERSITY OF TECHNOLOGY