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Digitalization and Electrification´s Transformational Impact on the Automotive Mobility Industry

A multiple case study on the Swedish automotive mobility industry facing changing business models, challenges, and future opportunities

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Abstract

The automotive mobility industry, including car manufactures, car-sharing, and ride-hailing companies, is experiencing technological change through electrification and digitalization. These two trends can potentially disrupt the whole industry through, i.e., electric vehicles and charging infrastructure, connected vehicles, IoT, big data, and autonomous driving. The industry actors have been affected by these trends to a large extent and will continue to be impacted in the future. This research aims to deepen the understanding of how the industry actors have been affected by these two trends by adopting business model and business model innovation perspectives and to identify challenges and future possibilities arising from these trends. The study is set in a Swedish context where car manufacturers, car-sharing, and ride-hailing providers were interviewed through a qualitative research strategy. The results showed that these two trends impacted all three components of the business model framework (value proposition, value creation and delivery, and value capture). Several challenges related to the two trends were identified, including regulations, competence gaps, IT security, digital environment, charging management, charging infrastructure, few resources, high costs & low supply of EVs, and electricity prices. The future opportunities that were found related to electric multimodal mobility and integrated mobility offering, autonomous vehicles, new customer segments, dynamic pricing, charging possibilities, new collaborations, and facilitated P2P car-sharing. The findings provide a foundation for industry stakeholders to identify areas to improve and evolve strategies around electrification and digitalization and future research areas to address.

Keywords: Digitalization, Electrification, Business model, Business model framework, Business model innovation, Technological Change, Industrial Change, Disruptive technology, Automotive Mobility, Automotive Industry, Mobility services, Car-sharing, Automotive manufacturers, Car-sharing providers, ride-hailing providers

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1.0 Introduction

There has been plenty of research on technological change. Perhaps the most famous one is Schumpeter's creative destruction, in which incremental and radical innovation is explained (Anderson & Tushman, 1990). Incremental innovations align with the current technological paradigm, whereas radical innovations destroy competencies to create a new paradigm (Tongur & Engwall, 2014). Anderson & Tushman (1990) presents the notion of technological discontinuities that affect the core of business processes and profits. When technological discontinuities occur, the industry typically experiences an era of technology ferments where organizations struggle to adapt to or destroy innovative technology, eventually leading to actors competing for a dominant design. When a dominant design is established, the industry stabilizes until the next technological discontinuity (Anderson & Tushman, 1990).

Dominant design marks the end of an era of technological ferments followed by incremental innovations. As one design becomes the industry standard, the ecosystem is built around this design, making it challenging to demerge (Anderson & Tushman, 1990).

In the early days of the automotive industry, a technological variation of product design shifted between battery-powered cars and the internal combustion engine (ICE) until the ICE became the industry standard. Once again, the industry experience technological shifts between the same technologies, with electric vehicles increasing in popularity. In addition, digitalization brings the Internet of Things (IoT), autonomous and connected vehicles, and big data into the automotive market, disturbing the once incrementally changing industry. The dominant design of the product and business model are challenged, and the industry is awaiting the next dominant design, most likely the electric vehicles.

Incumbent industry actors often find difficulties reacting to technological transformation (Tongur & Engwall, 2014). The firms established business models and existing customers constrain investments in innovations that do not go hand in hand with existing business models and customer segments (Chesbrough & Rosenbloom, 2002; Christensen, 2000). Furthermore, new innovations are usually not as appealing to incumbents as in terms of market share and profitability. However, business model constraints do not exist for new entrants, and they can diversify into an industry by taking advantage of new innovations (Christensen et al., 2018).

This industry dynamic can be seen in the automotive mobility industry, where Dijk et al., (2016) highlight that vehicle manufacturers have avoided costly and risky investments in

technological innovations. The (then) new entrant Tesla, started to compete in the market in 2003, using battery-powered electric vehicles through a new type of digitalized business model and now has the largest market share within the growing niche of EVs and is the highest-valued car manufacturer (Statista, 2023). In the last years, the incumbent car manufacturers have started to invest heavily in EVs as it continues to take market share from the ICE car. Zarazua de Rubens et al. (2020) found that car manufacturers are struggling with EV adoption due to a lack of a profitable business case due to inefficient production and selling strategies based on ICE vehicles' business model rather than the qualities of EVs.

Christensen et al. (2016, p. 48) point out that companies' difficulties with technological change "*is a business model problem, not a technology problem."* The business model is the key to capturing value from innovative technologies and gaining sustainable competitive advantages (H. Chesbrough, 2010). Applying the same technology or innovation with different business models will yield different outcomes. Chesbrough (2010, p. 355) highlights that "*a mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model*." Due to technological advancements od digitalization and electrification, business models and business model innovations are crucial for automotive mobility industry actors.

1.1 Background

Technological advancements and changing consumption patterns create opportunities for organizations to capitalize on new business models. At the same time, there is environmental pressure pushing companies towards sustainable practices. Technological advancements and concerns about vehicle emissions significantly impact the automotive mobility industry. The term "automotive mobility industry" will be used in this study, and it refers to the automotive and car mobility industry involving both car manufacturers and service providers (see section 3.3 for more information).

The world is becoming increasingly digitalized, which has given rise to four disruptive megatrends in the mobility industry called "CASE" - Connected, Autonomous, Shared, and Electrification. For example, connected and electric vehicles (EVs) are becoming increasingly widespread across the globe, and autonomous (self-driving) cars are believed to be available in major cities before 2035 (Mazar, 2022).

Furthermore, automotive executives predict a changing environment concerning customer relationships, revenue models, and technologies, creating a need for new business models.

(Mazar, 2022). Cars are becoming connected to the cloud, enabling software features, services, and maintenance over the air, which presents a new source of subscription revenue for car manufacturers. Over 50% of executives believe their business models must transform along with technological development (Kim et al., 2021). New entrants are developing and utilizing innovative technology and business models that threaten the incumbent original equipment manufacturers (OEMs, i.e., vehicle manufacturers). Business model innovation and a strategy regarding the CASE trends will undoubtedly be crucial for all automotive mobility providers to remain competitive.

It has historically been challenging to compete within the automotive industry with incumbents that have dominated the market. However, several entrants have taken market share from OEMs during the past decade by entering the high-growth market of electric vehicles (for example, tesla) and providing new services by taking advantage of digitalization. Further competition is expected from new entrants as nine out of ten automotive executives believe start-ups will significantly affect the automotive mobility industry (Mazar, 2022).

Furthermore, since the car has become software-reliant, industry borders have opened, enabling technological giants such as Google and Apple to enter the industry. The previously mentioned companies have started to invest in technology for manufacturing cars and autonomous driving. Both companies will likely launch their branded vehicle along with Amazon (Mazar, 2022), increasing the competition. The development of autonomous and connected vehicles allows new entrants, both tech giants and startups, to disrupt the market. Existing actors must innovate with products and business models and have a strategy regarding technological innovations to remain competitive.

Moreover, the rise of digital platforms has led to novel business models that draw on the sharing economy and access-based consumption, such as ride-hailing and car-sharing. This service enables customers to use a vehicle whenever needed and pay for the time they use it without owning a car. In a car-sharing scheme, users share the same cars, which can increase the utilization of one car by fifteen times (Shams Esfandabadi et al., 2022). Several OEMs have launched car-sharing services, including Volvo, Toyota, Daimler, BMW, and Volkswagen. Startup companies have entered the carsharing and ride-hailing market not by manufacturing new cars but by providing platforms to enable carsharing among existing vehicles. This new access-based business model affects the automobility industry through different consumption patterns and user needs by eliminating the need of traditional car sales.

EVs have a low cost of consumption compared to fossil-fueled cars, and they have proven to be especially effective in inner-city driving (Kley et al., 2011), which could explain why several car-sharing providers have introduced electric car fleets. However, there are challenges related to, for example, limited and costly access to charging stations (He et al., 2020).

Prior research suggests that it will not be enough for car manufacturers to focus purely on producing and selling electric vehicles like conventional cars; instead, companies should develop new digitalized business models for EVs (Zarazua de Rubens et al., 2020).

Overall, both OEMs and car service providers are affected by the digitalization and electrification of vehicles, leading to increased competition and a changing business environment. In order to remain competitive, business model innovation is essential, as it has proven to be a robust response in such an industry (H. Chesbrough, 2010).

This study will examine the current and future impact of digitalization and electrification on the business models of automotive mobility providers in the Swedish context.

1.2 Purpose and Research Questions

This study is necessary for its timeliness, practical relevance, and academic contribution. The automotive mobility industry is going through a period impacted by technology which has the potential to disrupt the industry and create significant challenges and opportunities. By understanding how electrification and digitalization affect automotive mobility providers' business models and innovation strategies, this study will shed light on how technological advancements affect the mobility industry in a current state and provide a future perspective. Furthermore, this study can give insights to providers in developing a sustainable business model and strategies for the future and help regulators and governments understand the challenges mobility providers face. Understanding this in one specific industry would provide valuable insights that can apply in other sectors experiencing technological shifts.

Previous studies on technology advancements and the automobility industry have focused on categorizing the automotive industry on disruptive scales (Covarrubias, 2018), or focused on automotive retail (Kim et al., 2021), or shared autonomous mobility (Merfeld et al., 2019). Some studies have focused on business models for electrification (i.e., Zarazua de Rubens et al., 2020), but rarely from the company’s perspective. Several authors argue that there has been limited research on business models regarding digitalization and electrification in the

automotive industry and highlight the need for more research on the subject (Athanasopoulou et al., 2016; Rachinger et al., 2019).

This study aims to deepen the understanding of how automotive mobility providers adapt and innovate business models for electrification and digitalization and generate strategies for industry stakeholders regarding these two trends. The two trends are relevant to examine since they capture the main technological developments of the automobility industry.

Additionally, this research focuses on automotive manufacturers and car-sharing providers. The first mentioned creates products, while the second provides services. These actors are investigated in the Swedish context because of the immense growth of EVs, the fast pace of digitalization, and both car manufacturers and car-sharing providers in the country. Furthermore, this country is the home country of the author, facilitating the execution of this study.

The research questions of this study are:

- **RQ1:** *How have digitalization and electrification impacted Swedish automotive mobility providers' business models?*

- **RQ2:** *What challenges and future opportunities do these trends bring to the industry?*

The first RQ aims to answer how digitalization and electrification have influenced business models by looking at what current challenges and advantages industry actors have experienced by these trends. The second RQ adopts a future perspective that focuses on the challenge and future opportunities digitalization and electrification brings to the industry.

The following section will present empirical literature on electrification and digitalization in the automotive mobility industry, followed by theoretical literature with an overview of business models and business model innovation. Then a section about the research method will follow. After that, the study's empirical findings, analysis, and conclusion will be presented.

2.0 Literature Review

This section will first present an empirical literature review, including previous research. The second section will include a theoretical literature review of the theories used in the study.

2.1 Empirical Literature

The empirical literature review presents what previous research has found about digitalization and electrification within the automobility industry and their effects on the business models of different industry actors. The empirical literature servers two primary purposes, to inform the reader about digitalization and electrification in the automotive mobility industry and to analyze the empirical data.

2.1.1 Digitalization in the Automotive Mobility Industry

In the following section, a definition and introduction to digitalization will be presented, followed by previous research on each component of digitalization in the Swedish context.

Introduction to Digitalization

Digitalization is based on digitization, which refers to transforming analog data into digital data sets. Digitalization can be seen as exploiting digital opportunities (Rachinger et al., 2019). The increasing significance of digitalization is highly related to the development of information and communication technologies (ICT) (Wittmann, 2017.). In the automotive/mobility industry, digitalization can be defined as "the transfer of analog data into a digital form with support by information and communication technology (ICT) inside and outside of a vehicle" (Wittmann, 2017. p.141).

The term "digital transformation" is often used by business researchers to explore how companies use digital technologies (i.e., the cloud, IoT, blockchain) to "*enable major business improvements to augment customer experiences, streamline operation, or create new business models*" (Warner & Wäger, 2019, p. 326). Digital transformation can, for example, create radically new products, services, and business models by combining different technologies (Rachinger et al., 2019).

There has been some research on digitalization in the automobility industry. The following sections divide digitalization into big data and analytics, autonomous driving, connected vehicles and could computing, and the Internet of Things.

Big Data and Analytics

Big data and analytics are highly related to customer relationship management (CRM), leading to new information about customer behavior, preferences, and needs (Wittmann, 2017). The data from car consumers can be used to develop, i.e., targeted customer offerings, new business models, and efficiency increases from analytics, presenting new opportunities for automotive players (Llopis-Albert et al., 2021). Rachinger et al. (2019) found that manufacturing companies within the automotive industry had experienced changes to their BM by using the generated data to understand customer behavior.

Rahchinger et al. (2019) research also found that business-to-business manufacturers within the automobile industry saw digitalization-driven changes to their business models due to changes in employee competencies, new technology partners, new ways of generating revenues (i.e., from customer data) and influences on customer contact and relations (i.e., social media).

Connected Vehicles, Cloud Computing, and Autonomous Vehicles

Athanasopoulou et al. (2016) highlight supplementary and complementary services/values enabled by digitalization. The authors argue that supplementary entertainment systems, tracking and tracing systems, and location-based advertisements make the car into a platform with add-on services together with complementary services such as car diagnostics, preventive maintenance, and automated emergency calls.

Furthermore, new value propositions in the industry relate to self-driving, parking and lane assist options, GPS technologies, real-time data processing, and other constantly developed technological features (Athanasopoulou et al., 2016). The car is becoming more and more software-heavy, turning into a computer on wheels, enabling new types of revenue streams that capitalize on the software services through what Bohnsack et al. (2021) call the product-based digital extension, where companies sell add-on services through a subscription or modular-based pricing model.

Connected Vehicles (CV) enables vehicles to connect wirelessly to other vehicles, passengers, traffic signals, power grids, et cetera. Today, companies use CV to increase safety, and it has the potential to improve usability by connecting autonomous vehicles, charging stations, traffic signals, and distribution grids (Das et al., 2020). CV can improve the driving experience, safety, and comfort while reducing congestion. For example, Vehicle to vehicle communication among 30% of road vehicles can reduce 20% of all traffic (Das et al., 2020). Furthermore, CV drives the development of autonomous vehicles by enabling adaptive cruise control and

automatic lane keeping, which is required for autonomous vehicles. Autonomous vehicles will most probably be commercialized through a sharing service since this is facilitated when the car can drive itself (Coppola & Morisio, 2017).

Internet of Things (IoT)

Digitalization has led to new types of services in the automotive mobility industry. The development of digital platforms to connect suppliers and demanders has transformed the industry, and companies like Uber have become significant players (Wong et al., 2020). Furthermore, digital platforms enable actors to provide Mobility-as-a-Service (MaaS) offerings, integrating different mobility providers into one platform (Wong et al., 2020). Traditional car manufacturers must adopt business models and organizations to cope with these changes (Athanasopoulou et al., 2016; Llopis-Albert et al., 2021).

Car-sharing services have been made available by advancements in smartphones and connected vehicles. Customers use their smartphones to find, unlock and lock vehicles. The service is only available digitally because consumers must have a smartphone to participate. Canzler & Knie (2016) argues that the traditionally essential features such as the number of cylinders, the volume of the engine, and power have decreased in importance, and digital capabilities, i.e., apps increased in importance, which is especially true for car-sharing systems. Instead of traditional features, the most extensive and most comfortable selection of cars enjoys a competitive advantage in car-sharing schemes. Canzler & Knie (2016) concludes that app developers will rule the automotive industry because the place where decisions are formed and made has shifted.

Llopis-Albert et al. (2021) imply that digitalization will improve the value chain by increasing efficiency, reducing costs, and enabling greater collaboration and innovation. Further, the authors argue that digitalization allows car manufacturers to shift from selling via dealerships to a direct business-to-consumer approach through e-commerce, which we have already seen taking place on the market, i.e., Tesla sells their cars through their webshop. This results in new digital ways of engaging with customers, which call for new capabilities, such as marketing, user experience, and data collection and utilization.

A dilemma with digitalization and technological advancements in vehicles is that the vehicle is designed to last for around 20 years. However, since the technologies and software services constantly develop, the car will fast be outdated in terms of technology (Athanasopoulou et al., 2016).

All in all, digitalization has a major impact on the automotive/mobility industry through the development of digital platforms, which enables new types of mobility services, improvement in supply/value chains, e-commerce b2c, which leads to new types of customer contact and relations, and requirement of new digital capabilities and technological partners. There is also a changing landscape with less mobility demand through digital working from home and an increasing role of smartphones. Those who lead in developing new services, products, and business models related to digitalization will gain significant competitive advantages.

Digitalization in the Swedish Context

Lopez-Vega & Moodysson (2023) investigated digital innovations within the automotive industry in Sweden and distinguished innovations from 1971-2017 into six areas: robotics, cloud-based and connectivity, the internet of things, electrification, and autonomous vehicles. The authors found that autonomous vehicles represented the technology with the highest number of innovations and disruption potential in Sweden and were primarily incremental innovations. In contrast to the existing literature on technological change, these incremental innovations have the potential to transform the automotive industry without disrupting it (Lopez-Vega & Moodysson, 2023). Additionally, the authors found a cross-industry integration of innovations, meaning that digital transformation may occur in other industries but affect the automotive, for example, telecommunications. Furthermore, Kanda & Kivimaa (2020) found that the automotive mobility industry will experience sustained changes due to digitalization since it enables work from home, reducing mobility needs. There is limited research on digitalization within the Swedish context, and the area needs additional research.

2.1.2 Electrification in the Automotive Mobility Industry

This section first introduces Electric Vehicles. Then opportunities and advantages of EVs from previous research will be presented, followed by vehicle electrification in the Swedish context.

Introduction to Electric Vehicles

Electric vehicles (EVs) are automobiles operating on electric or battery-driven motors rather than gasoline, diesel, or alternative fuel engines. With a focus on sustainability and reducing carbon emissions, the electrification of vehicles is rapidly increasing, driven by the availability of higher-performing and more cost-effective battery technologies, improved vehicle mileage, and greater ecological awareness among consumers and governments. This study considers two types of electric vehicles. Battery electric vehicles use 100% electric power, and plug-in hybrid electric vehicles use a combination of battery and internal combustion engines.

Furthermore, the charging infrastructure is essential to EV adoption as it must function well for large-scale EV adoption.

The electrification of vehicles has changed the automotive market for all actors. Car manufacturers have engaged in the EV market to remain competitive, and actors have been pushed to adopt EVs by governmental regulations. The European Parliament recently banned new fossil fuel cars from being sold in the European Union in 2035 (Abnett, 2023). This means that EVs, the most prominent replacement for fossil-fueled cars, will take a significant market share in the future of automobility.

The electrification of vehicles has gained much research during the past two decades regarding business management and innovation. Research on EVs has focused on different industry actors, including car dealerships (Kim et al., 2021), car manufacturers (Llopis-Albert et al., 2021), service providers (Kley et al., 2011), and suppliers (Müller et al., 2018). The empirical literature on electric vehicles will summarize previous research about its impact on automotive manufacturers and service providers.

Electrification Opportunities

Kley et al. (2011) contend that mobility actors, both service providers and manufacturers, would experience changes in their traditional business models and relations due to the introduction of electric vehicles. The authors suggest that electric cars can create advantages at greater utilization rates due to the lower consumption cost, providing possible advantages of adopting EVs in mobility services such as car-sharing, where the vehicle's usage capacity is increased. Expanding the user base for one car can lower operational costs and spread the capital costs over more people (Kley et al., 2011). Abdelkafi et al. (2013) agree that the servitization of electric vehicles is very promising, as it can increase market penetration and support the wide diffusion of electric cars. In this approach, the mobility service is the value proposition, not the product (Abdelkafi et al., 2013), which means that EVs would not drastically affect the value proposition of mobility providers. Whether EVs are optimal for a car-sharing program depends on the recharging speed, number of charging stations, and the range of the EV (Abouee-Mehrizi et al., 2021).

Electrification leads to extended utilization concepts, which can improve economic efficiency through new applications. A popular research subject regarding electric vehicles is Vehicle to Grid (V2G), which uses the vehicle's battery as temporary electric storage and a power source. This would enable the EV battery to take and feed energy to the grid depending on off-peak

and peeks periods. To charge when energy prices are low and discharging when prices are high presents a viable business case (Kley et al., 2011). Currently, V2G is rare, but further power grid digitalization could accelerate it.

Additionally, Kley et al. (2011) highlight the possibility of secondary usage of components no longer used in the vehicle, such as the battery, whose remaining capacity after EV use is assumed to be 70-80% (Kley et al., 2011). Furthermore, the connected nature of electric vehicles makes it possible for car manufacturers to track driver behavior, such as speeding and braking. This data could help companies determine drivers' risk profiles and incentivize drivers to drive carefully to obtain a lower insurance premium (*An Ecosystem Approach for EV Adoption*, n.d.).

As previously mentioned, the problem of EVs short-range could be overcome by offering a mix of EVs for shorter trips and the traditional combustion engine vehicle for the occasional longer trips (Kley et al., 2011). Alternatively, information on the nearest charging stations could be integrated into the EVs navigation system (Kley et al., 2011).

Electric automotive mobility providers operate in a business climate of high technological uncertainty and dependence on external decisions (i.e., charging infrastructure and regulations) makes it difficult for actors to generate a profitable business (Abdelkafi et al., 2013). However, Zarazua de Rubens et al., (2020) argue that EVs could be profitable for companies adopting new business models with shifts in selling methods and customer targets.

Several studies suggest the need for new value proposition, marketing, and advertising for EVs that reflects a new customer-centric approach that gives the meaning of the car that lies beyond only its environmental benefits (Abdelkafi et al., 2013; Kumar & Alok, 2020). Abdelkafi et al. (2013, p. 34) argue that "car manufacturers who first identify a real innovative meaning for the electric car will be able to get a serious advantage."

So far, several factors related to EVs that affect the industry have been presented, including the short range of EVs, dependency on charging infrastructure, lower consumption costs, higher purchasing prices, increased inner city efficiency, and secondary usage of batteries. However, researchers are not unanimous on whether vehicle electrification will affect industry business models. In contrast to other academic literature, (Athanasopoulou et al., 2019) findings from interviews with a group of experts suggest that business models across the industry would not be affected by electrification. Further research on electrification's current and future effects on the automotive mobility industry´s business models will bring more clarity.

Electrification Challenges

There is a challenging business climate for car manufacturers that compete in EVs. For instance, the driving range of EVs is much shorter than that of traditional cars, which creates "range anxiety" among consumers (Kumar & Alok, 2020)**.** Another aspect emphasizing range anxiety is EVs´ dependability on the local charging infrastructure. Since EVs still is a small minority of road transportation, most countries do not have a well-developed charging infrastructure, and public charging stations usually are scarce, which makes it difficult to drive long distances. Due to the range anxiety, EVs are easier to use in inner-city driving and are also energy efficient. Previous research concludes that EVs are superior to conventional cars in inner-city driving and that the value proposition for OEMs selling electric cars will be aimed at those who drive short distances (Kley et al., 2011).

Car-sharing programs operating around urban cities can therefore be an attractive application of EVs. A challenge for electric car-sharing operators is how to charge their fleet because of limited or costly access to the charging station (He et al., 2020). How the providers manage the charging of their fleet will be crucial. For example, charging cars when they reach 40% electricity instead of 20% could increase profitability by 15% (He et al., 2020). Also, increasing the charging power improves profitability (He et al., 2020).

(Kumar & Alok, 2020) presents additional challenges to EV adoption related to economic uncertainty. The generally high purchasing price of EVs, long payback period, and uncertainty over maintenance and repair create further consumer anxiety (Kumar & Alok, 2020)**.** Zarazua de Rubens et al. (2020) highlights that car manufacturers are producing and selling the EV based on ICE cars, making them more expensive to produce and sell, leading to higher purchase price. This is logical since many car manufacturers' organizations surround ICE cars.

Electrification in The Swedish Context

There is a growing demand for electric vehicles in Sweden. In 2022, nearly 100 000 battery electric cars were sold across the country, representing 31% of all automotive sales during the year, a relatively large proportion relative to other countries (Rask, 2023). The relatively widespread adoption of EVs in Sweden suggests that the barriers such as range anxiety and unprofitability of EVs have been overcome in the country. There is also a presence of mobility service providers who use electric cars, making Sweden an exciting country to perform this study in.

Previous studies on automotive electrification in the Swedish context have focused on EV user´s demographics and behavior and how economic and technical factors influence EV adoption (Chen et al., 2020; Haustein & Jensen, 2018; Sovacool et al., 2018), acceleration of policies related to EVs (Kotilainen et al., 2019). Haustein & Jensen´s (2018) study on barriers to EV adoption from a customer perspective in Sweden and Denmark found that EVs alone would not cover the mobility needs of people due to their shorter driving range. The authors concluded that companies should focus on pushing the "green" association with EVs and offering trials to increase the spread of EVs (Haustein & Jensen, 2018). Research shows that sustainable shared mobility services such as electric car-sharing have the potential to satisfy mobility needs in urban cities and replace the private EVs (Berg et al., 2019). However, people's everyday logistics, time affluence, effort requirement, and accessibility are barriers to the widespread adoption of these services (Berg et al., 2019; Sopjani et al., 2020).

The literature review of this study found that few researchers focused on electrification's impact on business models among Swedish automotive mobility providers. This area remains a research gap that this study aims to narrow.

2.2 Theoretical Literature

Bellow, a presentation of this study´s theoretical literature will follow. The theoretical literature will serve as the theoretical framework of this study, and it includes Business Model (BM) and Business Model Innovation (BMI)

2.2.1 Business Model

The business model area has gained increasing academic interest over the past years (Goffin & Mitchell, 2017). Scholars have defined business models in different ways, but in general, business models can be seen as a description of how a firm conducts business (Richardson, 2008). Richardson (2008) states that "*the business model provides a logical and simple structure between the firm´s theory of how to compete and its activities*" and serves to "*complete the description of the (firms) strategy*" (p. 143). Dubosson-Torbay et al. suggest "*A business model is nothing else than the architecture of a firm and its network of partners for creating, marketing and delivering value and relationship capital to one or several segments of customers to generate profitable and sustainable revenue streams*." (Dubosson-Torbay et al., 2002, p. 7). Teece (2010) highlights that a business model should inform what activities will be performed, how they should be linked and sequenced, who should perform them, and where.

This thesis has used Richardson's (2008) business model framework (Figure 1) to analyze business models. Richardson (2008) analyzed previous literature to understand which components were used in business models and build a framework out of the themes he saw. The framework aims to "*provide a comprehensive picture of the way the firm does business and at the same time orient the framework to strategy*" (Richardson, 2008, p. 137). By strategy, Richardson means the company can create superior customer value and seize more of that value than competitors (Richardson, 2008). The framework builds on three main concepts of value, which are later broken down into components.

The value proposition is why customers attach value to the firm's offerings and includes the offering (what the firm sells), the customer target, and how the firm is competitive with existing companies (Richardson, 2008). The value proposition is relative to the competition, so a firm that offers its target customers a greater value than its competitors is said to have a strong value proposition.

The value creation and delivery system provides additional details about how to compete by implementing the value proposition (Richardson, 2008), including the value network, the

firm’s resources, capabilities, organizational activities, and structure. The larger value network of which the firm is a part, including, for example, suppliers, complementors, partners, and distributors, is a key aspect of the value creation and delivery system (Richardson, 2008). Resources and capabilities include raw materials, employees, knowledge, patents, and other tangible and intangible assets. The organizational activities and structure must align with the value proposition. It considers the companies' value chains, activity systems, and business processes. These describe the product/service design process to customer delivery in terms of activities the firm must conduct to deliver the product or service (Porter, 1985). For example, the value chain of an automobile manufacturer can consist of design, inputs, assembly, marketing, and distribution & sales. The business processes and activity systems are part of the value chain divided into smaller tasks. Furthermore, the value proposition brings strategic consideration to the value creation and delivery system (Richardson, 2008). For example, if a firm wants to compete on value through low cost, decisions about resources, suppliers, and business activities must consider this to create and deliver this value.

The third component of this framework is value capture which refers to the firm’s ability to generate money. This includes the revenue and economic models (Richardson, 2008). The revenue model describes the source of revenue and the different ways revenue can be generated (Richardson, 2008). An example of changing revenue models can be seen in various industries where firms transition from a selling product to recurring subscription revenues, such as the leasing and car-sharing business models in the automotive industry or the case of streaming services in the entertainment industry. The economic model also considers the cost structure (Richardson, 2008).

Finally, one should remember that the business model framework provides a static view of how a company conducts business. However, the business models of companies are not static. They evolve. In this study, the framework is used to analyze how the business models of the automotive industry have evolved. The business model framework provides a logical structure and visualization of how firms conduct businesses, making it a suitable tool for analyzing this study´s findings.

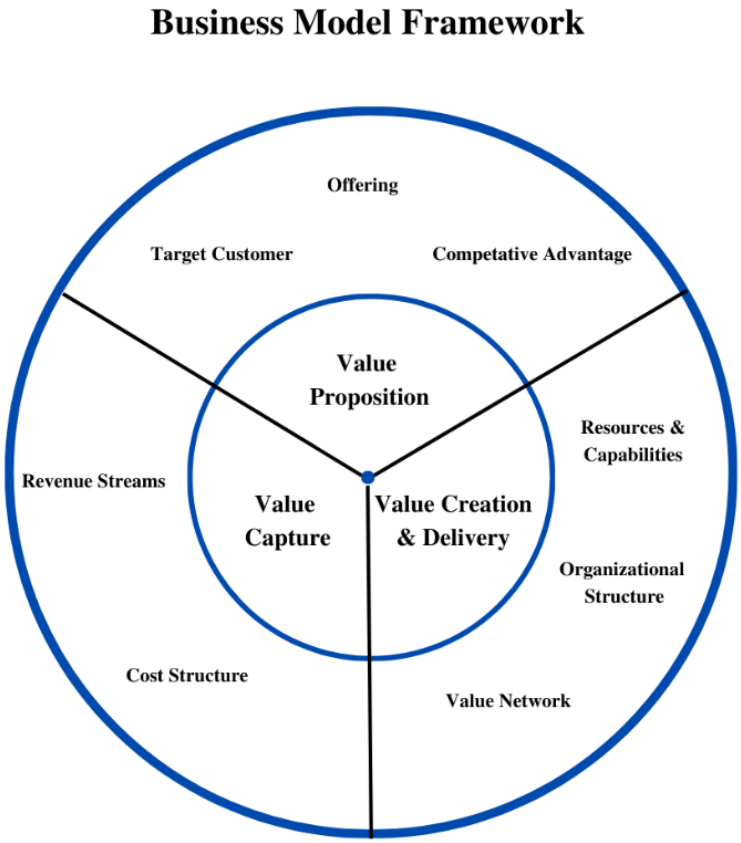

Figure 1: Business Model Framework

Source: Produced by the author based on Richardson's Business model framework

2.2.2 Business Model Innovation

Prior research has shown that companies who innovate with their business models yield increased revenue growth and a sustainable competitive advantage (Mitchell & Coles, 2004). New innovations and technologies will likely require new business models, drastically impacting how much value the technology or innovation will create (H. Chesbrough, 2010). Chesbrough (2010, p. 355) stated, "*It is probably true that a mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model*." Furthermore, when a firm is too locked in its existing business model, it can hinder investments in new promising innovation, just like Chesbrough & Rosenbloom illustrated when studying

‘the innovation selection process of Xerox (H. Chesbrough & Rosenbloom, 2002). Therefore, business model innovation becomes essential, especially for companies operating within a changing technological and business environment.

D. Mitchell & Coles (2003) defines business model improvements, replacement, and innovations. The authors state that changes in one business model element that improve the company performance regarding competition in sales, profits, and cashflows is a business model improvement. When an improvement is made on more than one of the business model elements, it is referred to as a business model replacement. Business model innovation is “*business model replacement that provides product or service offerings to customers and end users that were not previously available*”(Mitchell & Coles, 2003, p. 16). Moreover, the process of developing business model replacements is business model innovation. Mitchell & Coles do not refer to the same business model framework used in this thesis.

Business model innovation has proven to be a way to outperform competitors and create a sustained competitive advantage (D. Mitchell & Coles, 2003). By altering and improving the business model elements, the company can pivot when, for example, technology evolves and take advantage of new opportunities. Achieving sustainable competitive advantage through BMI is typically done by adding sales-expanding benefits without increasing prices, adjusting prices to gain more purchases, and lowering the operating costs within the firm or for the firm’s customers or end users (D. W. Mitchell & Bruckner Coles, 2004a). If competitors cannot duplicate these actions, it will lead to sustained competitive advantage (D. W. Mitchell & Bruckner Coles, 2004a).

D.W. Mitchell & Bruckner Coles (2004) found that companies can achieve a sustainable competitive advantage through successful business model innovation by adding complementary products or services that build on existing offerings, often aimed at the same customer target the company already has an established relationship with. The authors also suggest that companies should watch and understand what is important for their customers to base their offerings on this (D. W. Mitchell & Bruckner Coles, 2004a). Furthermore, the authors highlight that successful BMI can be done through changes in the pricing model, offering lower prices the more one purchases to increase volume, and lowering operating costs in innovative ways, i.e., crowdsourcing, to name a few breakthrough moves (D. W. Mitchell & Bruckner Coles, 2004a). Furthermore, the authors suggest that companies should look at

innovations and business models outside their industry to generate ideas for business model innovation (D. W. Mitchell & Bruckner Coles, 2004a).

Furthermore, to successfully achieve BMI, companies must have a process in place (D. W. Mitchell & Bruckner Coles, 2004a). When companies put business model innovation into a regular ongoing practice, it is called continuing business model innovation (Mitchell & Coles, 2003). Continuing Business model innovation is a process that offers the potential to regularly take advantage of opportunities to create a sustainable competitive advantage (D. W. Mitchell & Bruckner Coles, 2004b). It is essential to constantly look for ways to improve the business model by experimenting rapidly and inexpensively since it requires significant trial and error (H. Chesbrough, 2010; D. W. Mitchell & Bruckner Coles, 2004b). Experimenting with business models will gain important data and accumulated learning, probably from a series of failures, before discovering a successful business model (Chesbrough, 2010).

Moreover, Innovation has historically been characterized as an internal process among the company's R&D expenditure, with closed business models and innovation processes, meaning no or little cooperation, outsourcing, insourcing, or inter-organizational activity (H. W. Chesbrough, 2006). However, the innovation process has become more expensive with longer R&D cycles and shorter product life in the market (H. W. Chesbrough, 2006). H. W. Chesbrough presented the idea of open innovation in 2003, arguing for companies to open the boundaries of the business model, using inflows and outflows of knowledge and external ideas in innovation processes. (H. W. Chesbrough et al., 2006). Adding to this, Teece (2018) highlights that assets considered outside the firm that are complementary to the company's product or service can deliver additional value to the customers with positive outcomes for both parties. Keeping an open business model and innovation perspective will make it easier to take advantage of complementary products or services. Furthermore, Open innovation creates a free flow of innovative ideas within and between organizations, increasing the firm’s performance and positively influencing business model innovation (Huang et al., 2013).

Previous research has demonstrated the benefits of business model innovation, including increased revenue growth and a sustainable competitive advantage (Mitchell & Coles, 2004; Chesbrough, 2010). Chesbrough (2010) emphasizes that a great business model can enhance the value of a mediocre technology. Locked-in business models can hinder investments in innovations (Chesbrough & Rosenbloom, 2002), making business model innovation crucial in a changing business and technological environment.

Mitchell and Coles (2003) define business model improvements, replacements, and innovations. Business model improvement refers to changes in one element that enhance company performance. When improvements occur in multiple elements, it becomes a business model replacement. Business model innovation involves providing new offerings to customers and end users that were not previously available. Mitchell and Coles (2003) highlight the significance of business model innovation in outperforming competitors and achieving sustained competitive advantage.

Successful business model innovation can be achieved by adding complementary products or services, adjusting prices, and lowering operating costs (Mitchell & Coles, 2004). Companies should understand customer needs and explore innovations outside their industry for new ideas. Having a process in place, such as continuing business model innovation, is essential for success (Mitchell & Coles, 2003). Experimentation and learning from failures are crucial aspects of the process (Chesbrough, 2010).

The concept of open innovation, introduced by Chesbrough (2003), suggests that companies should open their business models to external knowledge and ideas. Embracing open innovation facilitates the incorporation of complementary assets and enhances customer value (Teece, 2018). Open innovation promotes the flow of ideas, improves performance, and positively influences business model innovation (Huang et al., 2013).

3.0 Methodology

This chapter describes the research methodology, including research strategy, design, data collection, analysis, and quality.

3.1 Research Strategy

The research strategy refers to the overall approach guiding the theses in formulating research questions and designing the research (Bell et al., 2019). In this study, the chosen research strategy was a qualitative approach. Qualitative research was particularly suitable for this study as it allowed for an in-depth examination of people's experiences and perspectives without the researcher's influence or data collection purposes (Bell et al., 2019). This study had an epistemological position which Bell et al. (2019) describe as interpretivism, meaning that the research aims to understand the social world by examining its participant´s interpretation of that world. Qualitative research methods such as interviews and document analysis enable the researcher to gather rich, detailed information emphasizing words rather than quantification (Bell et al., 2019).

This study aimed to clarify a situation with insufficient information, which means the study was exploratory and is best investigated through a qualitative research strategy (Quintão et al., 2020). Qualitative research provides more flexibility than a quantitative approach in research design, data collection, and analysis, enabling the researcher to ask general rather than specific research questions (Bell et al., 2019). This approach is appropriate for this study which has rather general research questions with open-ended questions in the interview guide. Furthermore, the qualitative approach is practical when collecting data from multiple sources in real-world settings. It allows the researcher to interpret data to reach deeper meaning in the respondent’s answers which is helpful for this study.

Qualitative research generally emphasizes the inductive approach, where the theory is the outcome of the data collection and analysis (Bell et al., 2019). Although less common, qualitative research can also adopt a deductive approach, starting with theories that are later tested (Bell et al., 2019). This research has a foundation in the business model, business model innovation theories, and an empirical context. However, the findings have brought additional insights into these theories and the research field. Therefore, this study adopts an abductive approach between theory and research. The abductive approach often starts with a puzzle and then seeks to explain it (Bell et al., 2019). The puzzle arises when researchers identify an empirical phenomenon that the literature cannot fully explain (Bell et al., 2019).

Furthermore, the abductive approach is an iterative process that goes back and forth between real-world empirical sources and literature (Bell et al., 2019). This approach helps overcome the limitations of the deduction's strict reliance on theories and induction's incapability of theory building (Bell et al., 2019). This study linked the empirical and theoretical literature, bridging the gap between the two through an iterative process.

There has been some critique of qualitative research where skepticism is pointed to difficulties in replicating studies, problems of generalization, and transparency. This will be addressed in the following section.

3.2 Research design

The research design for this study was a case study with a comparative design. A case study differs from other research designs because it emphasizes a single case (Bell et al., 2019). According to the previous reference, a case can be an organization, a location, a person, or a single event. The comparative design implies that we can better understand the studied phenomenon by investigating two or more contrasting cases (Bell et al., 2019). When the comparative design is used with the qualitative strategy, it becomes a multiple-case study (Bell et al., 2019). A multiple case study is an extension of the case study design where the researcher investigates more than one case jointly (Bell et al., 2019). This study used the multiple case study approach because it allowed for examining complex, real-life phenomena in their natural setting and comparing the investigated cases to present an industry perspective of digitalization and electrification's impact on business models, challenges, and future opportunities.

While some researchers argue that multiple case studies increase the generalizability of the findings since it allows the researcher to evaluate external validity, others argue that it is almost impossible to provide generalizable results regardless of the case study design (Gustafsson, 2022, slide 20). However, this study aims not to arrive at a generalizable conclusion for a population. It serves as starting point where companies can find inspiration in adapting, addressing challenges, and identifying future opportunities.

When selecting cases, it is vital to know the trade-off between the number of cases and the depth of the research (Gustafsson, 2022, slide 20). More cases give insights from more companies, which could enhance the analysis by comparing more answers. The downside is that less attention will be paid to each case, risking missing out on unique critical insights

(Gustafsson, 2022, slide 20). Since it would not be possible to deep-dive into many cases due to the study's time limit and prioritization of getting multiple perspectives, one respondent per company was interviewed.

Moreover, the sampling followed grounded theory, meaning theoretical sampling continued until theoretical saturation was achieved (Bell et al., 2019). In other words, interviews were conducted until the basis of a category was formed. Once this is achieved, grounded theory suggests stopping data gathering and generating hypotheses out of that category (Bell et al., 2019). According to grounded theory, this is what the researcher did. This approach is iterative, where the researcher moves back and forward between sampling and theoretical reflection.

3.3 Data Collection

This section is divided into three parts. Firstly, the data collection method will be presented, followed by a motivation for the selection of cases. Lastly, there will be a description of the selected cases.

3.3.1 Data Collection Method

The data collection methods used in this study are semi-structured interviews. When conducting semi-structured interviews, the interviewee has an interview guide with prepared questions (Gustafsson, 2022). The semi-structured interview guide includes open-ended questions related to the research question (Appendix 1). The advantage of conducting a semi-structured interview is that it provides structure and leaves room to be flexible by asking follow-up questions or questions that might arise during the interview. This approach enabled a more nuanced understanding of electrification and digitalization's impact on business models, challenges, and opportunities since it allowed the respondent to speak freely about the subjects and what aspects they found important without the influence of the interviewee.

Furthermore, the interviews were held online because some respondents were located relatively far from the interviewee, and the respondents preferred it. Online interviews imply cost and time saving since the interviewee does not have to travel to perform the interviews. It is more flexible and convenient, which might encourage more people to agree to be interviewed (Bell et al., 2019). Bell et al. (2019) argue that there are some limitations with online video interviews, like technological problems and fluctuations in the connection, which can damage the flow of the interview and make it difficult to transcribe later, and that it is more likely for the respondents to not show up to the interview. However, all the respondents showed up. There

was only one time during the six interviews when the connection was lagging, and the researcher asked the respondent to repeat the disrupted meaning. All the respondents were used to having online video meetings, contributing to a good flow of the interviews. Furthermore, online video meetings allow for seeing one another's faces, enabling the interviewee to analyze facial expressions and body language and make eye contact during the interview.

Furthermore, all the respondents agreed to be recorded during the interview. Directly after each interview, the interview was transcribed. By transcribing the interview, taking notes during the interviews was not crucial, which enabled the interviewee to be fully aware of the respondents' answers and ask relevant follow-up questions. Additionally, it was helpful to look at the transcriptions for coding the interviews and pick up on what the respondents said that was overlooked or missed during the interviews.

3.3.2 Selection of Cases and Respondents

The selection of cases followed a purposive sampling technique based on industry, business model, and geographic location. This study is limited to the automotive mobility industry in Sweden, and the selected cases operate in this industry. The industry was chosen because it has been affected by electrification and digitalization to a large extent. Therefore, it was relevant to investigate how the two trends impact the automotive mobility industry actor's business models, challenges, and future opportunities. The automotive mobility industry combines and limits two industries, namely the automotive industry and the mobility industry. The automotive industry encompasses many car production, wholesaling, retailing, and maintenance companies. However, this study focuses on automotive manufacturers such as Volvo and Toyota. The mobility industry encompasses various forms of transportation, including buses, bikes, scooters, and segways. In this study, the primary emphasis is on personal cars rather than other types of vehicles, hence the term "automotive mobility industry." Therefore, the automotive mobility industry includes car manufacturers and car-sharing companies, with the latter encompassing ride-hailing providers. An option was to exclude traditional car manufacturers in the study but to capture the industry´s spectrum of a more traditional (selling cars) approach on one end to the more recent mobility service offerings (where you do not own the car) on the other end. The researcher chooses to include an automotive manufacturer in the study.

Consequently, the cases chosen are a traditional car manufacturer, two car-sharing services, one ride-hailing service that is also about to launch a car-sharing service, one mobility provider that offers car-sharing, leasing, selling, and subscription, and one industry expert. The industry expert was included to broaden the perspective of someone not bound to a company competing in the industry and to access knowledge from an expert on the topics. Furthermore, there are different business models among the selected cases, which was a criterion as this study aims to investigate how different business models are affected by electrification and digitalization. Additionally, the geographical area was a criterion since the study is limited to the Swedish context, meaning companies that operate in Sweden. More information on the selected cases will be presented in section 3.3.2.

Finding respondents among the cases who could answer questions about the company´s business model was important. The researcher looked for people involved in the firm´s strategy development to find the right people. LinkedIn was used to search and find people. On LinkedIn, the person's job titles were shown, and based on that, people were contacted on LinkedIn. Furthermore, two respondents were found through a mutual contact with the researcher. In the table below, the respondents of this study are presented. Respondent R2 and R3 are the same person who was interviewed twice. This is because this person is a former employee of Toyota Sweden and is now a part of Toyota´s new mobility provider Kinto, so the person knew both companies well and was able to provide answers from both perspectives.

Respondent	Role	Company	Date	Duration	Medium
R1	Public Policy Director	Bolt	2023-04-04	00:38:13	Zoom
R2	Previous CFO	Toyota Sweden	2023-04-13	00:31:15	Zoom
R3	Head of Nordics	Kinto	2023-04-13	00:34:21	Zoom
R4	Head of Offer & Pricing	Lync&Co	2023-04-21	00:50:14	Teams
R5	Director of Strategy & Business Development	Volvo Mobility	2023-04-26	01:00:53	Zoom

R6	Senior Project Manager	Lindholmen Sience Park	2023-05-03	00:57:12	Zoom

Table 1: List of Respondents

3.3.3 Description of Cases

This section describes the case companies and respondents of this study. By getting an introduction to this, the reader will more easily make sense of this study's results, analysis, and conclusion.

3.3.3.1 Bolt & R1

Bolt provides a mobility platform and operates in several European countries, such as Germany, Austria, Switzerland, Norway, Denmark, Sweden, Finland, and the Baltic states. The company offers a range of services, including ride-hailing, food delivery, and micro-mobility (e-bikes, e-scooters), and is about to launch a car-sharing service in Stockholm. The focus of the interview was primarily on their ride-hailing and car-sharing services. However, micro-mobility was discussed since the respondent saw potential in integrated mobility as a service that not only includes the car. The respondent highlights that Bolt's business model is based on the sharing economy and aims to connect demand and supply through a digital platform.

The respondent has been working at Bolt for almost three years, and he is the Director of Public Policy in the Nordic and Baltic regions and Germany. The person oversees the company's relations with government officials, policymakers, and regulatory bodies. As a policy expert, the respondent ensures that the company's business practices align with local laws and regulations. The respondent oversees a team of about ten members who handle the company's operations in the region while he focuses on strategy and management.

3.3.3.2 Toyota Sweden & R2

As the name implies, Toyota Sweden focuses on the Japanese automotive manufacturer Toyotas business in Sweden. Toyota manufactures and sells cars under the brands Toyota and Lexus. Toyota is the world’s largest automotive manufacturer, as seen by the number of vehicles sold globally (Misoyannis, 2023). Toyota differentiates from the competition by being close to the customer, having local customer knowledge, and being cost-efficient.

The respondent has worked in the automotive industry for many years. The respondent started at Toyota four years ago as a business controller and became the CFO of Toyota Sweden.

3.3.3.3 Kinto & R3

For the past two years, R3 has been working solely with Kinto, where he is the Head of Nordic, responsible for establishing Kinto in the Nordics. The respondent explains that Toyota owns Kinto to a hundred percent and that it is their approach to the car-sharing business model. R3 explains that the business model of Kinto is to deliver the use of a car as a service where the company remains the owner of the car instead of having to buy and finance a car traditionally. The service covers the need for a car for an hour up to several years. Kinto is a station-based car-sharing service operating in Stockholm, Gothenburg, and Malmö. They have stations in these cities with dedicated parking spaces where the customer collects and returns the car. Further, the respondent states that the long-term goal with Kinto is to look beyond the car and offer other service solutions that help the customer transport from one location to another. Today Kinto offers Toyota and Lexus cars, but the respondent explains that they are not bound to work with only these brands.

3.3.3.4 Lync&Co & R4

Lync&Co is a Gothenburg-based automotive mobility company. The company traditionally sells cars, but the respondent explained that they do not want to be a traditional car company and differ because of their subscription and car-sharing offerings. In the subscription offering, everything is included, such as insurance and service. The service is very flexible, and customers can start and stop subscribing to the car they are using with very short notice. It is a subscription service because Lync&Co owns the car, and the customer pays a monthly fee to use it. Customers who subscribe to a car or buy their own from Lync&Co can rent out the car when they are not using it, which is Lync&Co´s car-sharing service. Here, the renter of the car will pick it up and drop it off at a predetermined location by the lender, so-called Peer-to-Peeer (P2P) car-sharing.

Furthermore, the respondent highlighted that the company works a lot with connectivity, launching new car applications every two months. For example, he explained that they were the first to integrate Microsoft Teams into the car. Lync&Co currently has one car, which is a hybrid, and their next will be a fully electric one.

R4 has worked for Lync&Co for over a year as Head of Offer and Pricing. The respondent is responsible for presenting and packaging the cash offering (when the customer purchases the car traditionally) but primarily focuses on Lync&Co´s subscription service. The respondent is also involved in the company's future roadmap, including what to launch in the future and how to package the future offerings. Previously, the respondent has worked with marketing, sales, and business development at companies such as Adidas and Mondelez.

3.3.3.5 Volvo Car Mobility & R5

Volvo Car Mobility offers a station-based car-sharing service called Volvo on Demand. They are connected to Volvo Cars and use their cars for the service. With this service, they cover car demands from an hour to longer periods. The company also offers a subscription service, much like Lync&Co, which is very flexible compared to traditional leasing. The respondent explained that the customer could pick up the car in an hour and use it for as many mounts as they like. He also said that the company is looking at Peer to Peer (P2P) solutions which means that instead of a company providing the cars, people lend out their cars to others. The company would mediate this exchange through a digital platform.

R5 has worked for Volvo Car Mobility for over a year as Director of Strategy & Business Development. The respondent focuses on the strategy regarding future activities and aligns Volvo Car Mobility strategy and values with the parent company Volvo Cars. Before the respondent´s career at Volvo Car Mobility, R5 worked within bank and finance and the development of mobile and mobility services. For example, he played a part in developing Swish. Furthermore, the respondent has worked at Smart Group with brands like Elskling.

3.3.3.6 Industry Expert R6

R6 has worked for Lindholmen Science Park for nine months, where he is the project manager for four different projects within electronics and mobility. Before his time at Lindholmen, R6 worked for Business Region Gothenburg, where he was responsible for a group working towards the vehicles and mobility industries. He has also been involved with electrification plans for Gothenburg city and innovation projects within the energy field.

3.4 Data Analysis

Thematic analysis was used to analyze the data. This approach and grounded theory are most famous for analyzing qualitative data (Bell et al., 2019). In thematic analysis, the researcher identifies themes in the data. A theme is a category that builds on codes identified in the data. When identifying themes, Bell et al. (2019) suggest that there should be an emphasis on repetition in the data. However, the authors stress that repetitions are an insufficient basis for a theme. The theme should also be relevant to the research questions.

The first step in the thematic analysis is to break down the gathered data in the codes. This process is referred to as open coding or first-order themes. These are very close to the original data. By analyzing similarities and repetitions of the first-order themes, the researcher can finally derive second-order themes to produce an aggregate dimension of themes.

When conducting the thematic analysis, the author used the interview transcriptions to obtain first-order themes close to the empirical data plotted in a Microsoft Excel file. The first-order themes were color-coded and assigned the same color if they related. In this way, second-order themes were derived. Four main categories were formed by grouping the second-order themes, which serve as the aggregate dimension. In addition to the four aggregate dimensions, an additional category called “Other” was formed since they did not relate to other second-order themes. However, most “Other” themes were irrelevant to the research questions and, therefore, not included in the data presented. For more information on the thematic analysis, see Appendix B.

To summarize, this study has adopted a qualitative research strategy, a multiple case study research design with semi-structured interviews for data collection, and thematic analysis as the data analysis method. This combination of research strategy, design, methods, and data analysis methods has allowed the researcher to examine the topic thoroughly and made it possible to answer the research questions of how digitalization and electrification affect business models and creates challenges and opportunities for companies in the automotive mobility industry.

3.4 Research Quality

While reliability and validity are essential criteria for ensuring and assessing the quality of the research, they have not been adapted to suit the characteristics of qualitative research (Bell et al., 2019). Lincoln & Guba, (1985) proposed alternative criteria for reliability and validity for evaluating the research quality for qualitative research. The authors proposed trustworthiness as a criterion for ensuring research quality. Trustworthiness has four criteria: credibility, transferability, dependability, and confirmability. Each of these criteria will be discussed in this chapter.

3.4.1 Credibility

The consideration of different perspectives of social reality is relevant when assessing the credibility of the research. If there are multiple possible explanations for a social phenomenon, the acceptability of a researcher's interpretation depends on how believable it is. To establish credibility, researchers need to follow good research practices and seek confirmation from the people being studied to ensure they have understood their social world correctly Lincoln & Guba, (1985). To address this aspect, the citations used in this study were sent to the respondents to ensure that the researcher and respondent had similar perspectives of the social world.

Credibility is also important for ensuring the research´s reliability Lincoln & Guba, (1985). Quintão et al. (2020) highlight triangulation's importance in increasing reliability. The authors explain that triangulation refers to using different data sources by conducting interviews with multiple participants, involving different evaluators, using multiple perspectives of the same data set, and adopting different complementary methods. By adopting a multiple case study approach, the respondents' answers could be compared and analyzed together, which offers some degree of triangulation.

3.4.2 Transferability

Transferability refers to how the findings can be transferred from one context to another (Bell et al., 2019). To address this, the authors stress the importance of a detailed description of how the research has been conducted. The author published the interview guide, thoroughly described how the interviews were conducted, and was transparent about what companies and respondents participated in the study.

3.4.3 Dependability

Dependability is about a logical and traceable research process (Bell et al., 2019). To ensure the dependability of the research, it is essential to have kept all the phases accessible (Bell et al., 2019). Chapter three of this research has described how the selection of respondents, cases, et cetera have been made, and the interview guide and table of thematic analysis are accessible to ensure dependability.

3.4.4 Confirmability

Confirmability ensures that the researcher has acted in good faith, not letting personal values or other aspects influence the research. According to Lincoln & Guba (1985), confirmability is attained when the three criteria above are met.

4.0 Empirical Findings

In this section, the study's findings will be presented. The findings are divided into five main themes with corresponding subthemes from the thematic analysis. The five main themes are "Digitalization Opportunities," "Digitalization Challenges," "Electrification Opportunities," and "Electrification Challenges." In the Analysis section, the result will be discussed from a business model and business model innovation perspective relating to the empirical literature.

4.1 Digitalization Advantages and Opportunities

Several advantages and opportunities rooted in digitalization could be derived from the interviews. This chapter will address these.

4.1.1 Improved Offering

Respondents expressed an improved offering thanks to digitalization. R1 highlighted that their offering is built on efficiency, which improves their service through availability and lower price.

> *"You can also build a business model that utilizes digital technology. By doing so, you can skip further old manual steps, which results in efficiency. This efficiency can be translated into an improved service with increased availability and proximity to the customer. But, most importantly, it can also translate into reduced costs, which in turn is reflected in the final price."* – R1.

R1 pointed out that one aspect of the increased efficiency is that payment and the connection between supply and demand occur digitally in the app.

R3 and R4 explained that they could deliver a car-sharing service thanks to digitalization. This service makes car mobility available to a broader crowd, not only those who have purchased a car.

They also expressed that the companies they work for have experienced an improved offering thanks to the connected car, which is a result of digitalization. It was clear that the connected car delivers additional value and comfort to the customer since it enables car users to, for example, unlock the car with a phone, pre-heat the car on a cold winter day, connect other services to the car (example Spotify), monitor, track and measure fuel and electricity stats on the phone, automated parking functions, and self-driving functions.

When addressing digitalization possibilities in a future scenario, R4 expressed their vision to make automotive mobility "hustle-free" for the customer. They are currently looking at digitalizing the charging of electric vehicles making payments and charging more convenient for the customer. He also mentioned that they are experimenting with AI and suggested that AI could "open a new world." For example, the car would choose the most efficient route by itself.

Both R2, R5, and R4 had some vision for autonomous cars. R2 stated that Toyota is one of the companies within the industry that invests most in this technology. He claimed that autonomous cars would increase accessibility and lower the price of mobility.

> *"Then we can have, in some cities, self-driving taxis which keep the price down and increases accessibility. At the same time, it is very safe, and sometimes you have an app, and you book a trip with a car that picks you up for SEK 20 that drives across town and it is still a business that can make money from it."* – R2.

R5 explains that Volvo has an autonomous concept car in Gothenburg that visualizes how the autonomous vehicle could expand the concept of a car.

> *"You should be able to decide to meet on a street corner in Gothenburg with some colleagues and then you could jump into the car and then the car is a conference room for the next few hours while you might be on your way to Malmö and the car drives itself and you sit comfortably, like at a round table basically in the car. Later, you might go back by yourself to Gothenburg in the evening, and then the car's interior can change, so you can lie down and sleep until you arrive."* – R5.

To summarize, digitalization improves mobility companies' offerings by lowering costs, increasing mobility availability, and embedding software features to enhance customer experience.

4.1.2 Additional Revenue Streams & Partners

Many respondents highlighted increased software features in the car that entails new possibilities. Both R2 and R4 drew similarities between the car and the iPhone.

> *"It (a digitalization possibility) is obviously the connectivity in the car. It's like if you think about an iPhone, the metal itself isn't that important, but it's the content that's important."* – R4.

According to R2, a similarity between the iPhone and the automobile is that users can download apps on the iPhone and will be able to do so in the car as well.

> *"We are well aware that we buy apps in the App Store today, and it is not unthinkable that car companies and Toyota will be one of those who sell apps to their customers through the car in the future."* – R2.

Both R2, R4, and R6 expressed that the distribution of apps or software services brings additional revenue streams for car distributors in terms of after-sales. When the traditional customer journey ends with a car purchase, connectivity enables companies to generate additional sales by offering over-the-air upgrades of the vehicles.

> *"...you can of course cash the car and then you are out directly from our books. But we still have things that we can sell to the customer through connectivity, such as different packages and so on, so we still have the opportunity to sell things to that customer."* – R4.

R6 states that apps often enable car users to charge their car and other types of functions on which they can make money. Furthermore, the respondent explained that car manufacturers are starting to sell software subscription services to their customers through apps where the customers can pay a monthly fee to access features.

> *"The automotive industry is starting to get into this. For example, you want electrically heated seats or an electrically heated steering wheel, so you get to subscribe to it. Or if you want more power and more effect in your electric motor, you can unlock it when you want."* - R6.

The modern connected car also entails new collaboration partners. R6 highlighted that it used to be unthinkable for automotive companies to collaborate with companies from other industries, such as telecommunication. Today, it is evident that companies across these

industries collaborate since the car has multiple sim cards. Furthermore, R6 explained that companies like Apple and Google are also involved in the automobile industry because they provide digital platforms to the car's infotainment systems. The respondent argues that although cross-industry collaborations might be complex, automotive companies can make cars more user-friendly and attractive and save much money.

To summarize, digitalization enables mobility companies to sell software services and apps, bringing additional revenue sources.

4.1.3 Customer Relationships and Behavior

R2 and R3 explained that connectivity is not only an opportunity to generate additional revenues on software but also a chance to establish closer contact with the customer. R2 said:

> *"Connected services provide an opportunity to be very relevant for the customer and to understand them better than when they only meet us once in the car dealership, so of course, connected services entail many new opportunities to have closer contact with customers."* – R2.

Furthermore, R2 highlighted that digitalization has more frequently contributed to customer purchasing mobility, leading to more frequent and closer contact with the customer.

> *."..it is more like buying mobility from us several times when the need arises, per hour, a month at a time, or a year at a time. And that means we have much closer contact with customers, more opportunity to ask if they need anything else, and it is a new opportunity for us to get closer to our customers."* – R2.

R5 described that a vision for Volvo Car Mobility is to offer mobility services in all phases of life, making the customer relationship start before the purchase, subscription, or leasing of a car. For example, younger people who live in urban areas might not afford or need to own a car; in that case, car-sharing might be an alternative. If a more long-term mobility need arises, the customer already has experience with Volvo and might want to continue using Volvos cars.

Furthermore, R4 underlined the importance of collecting and using data to understand customer behavior since this information can help improve the offering. He said it is essential to know what the data means and, for example, understand if a particular customer behavior is temporary or regular.

To conclude, the respondents experienced that digitalization creates closer contact and creates earlier customer relationships with their customers and allows them to understand them better.

4.1.4 Shared Multimodal Mobility

Respondents said that digitalization has dramatically facilitated shared services, making it available through a digital platform and possible to unlock the car digitally. For example, R3 explained:

> *"Digitalization has made it easier to consume a car as a service. There are many opportunities to distribute services digitally … such as a digital key. This means that we can provide a car that is used by many different users, thanks to the key becoming a part of an app. This is an effect of digitalization that has created a new type of business model, and that is what we call car-sharing."* – R3.

The respondents believed that car-sharing and shared mobility would become even more relevant. It was also clear that mobility providers want to engage in shared mobility offerings besides the car, such as electric bicycles, scooters, and other types of micro-mobility.

> *"We will probably see an increased adoption rate when it comes to shared infrastructure or shared mobility. And I also think it becomes more relevant with more types of vehicles."* – R1.

R3 shared the same view as R1 and explained that:

> *"We call it contact mobility when we look at other types of solutions that can be very relevant for our customers in the future in urban environments, and of course, it is bicycles, scooters, different types of smaller mobility vehicles that can be a part of the future, which are very adapted for city life, electric, take up less space, still safe, and can transport several people. We are looking at such areas, and if we can deliver it through a digital platform as a service."* – R3.

R1 and R3 expressed that digital applications enable the integration of different mobility offerings into one platform. An example of how this could work is that the customer enters an app and then receive a suggestion to take a vehicle to a location where there is a carpool with a car to use. Then leave the car at another location where the customer is suggested to take the

tram and take an electric bike home. This is referred to as mobility as a service (MaaS) offering, which both R1 and R3 believed would shape the future of urban transportation.

> *"There is also an increased benefit of multimodality, and within that lies not only the provision of several types of transportation but also the building of bridges between them. And it is that type of more holistic or comprehensive solutions that will really be able to make a difference."* - R1.

R6 also highlighted how digitalization provides combined or multimodal mobility possibilities in cities. He explained that people can get personalized transportation suggestions depending on preferences, how and when they move, what weather it is, et cetera, and integrating information about traffic to the service.

> *"It (digitalization) is a possibility to offer mobility as a comprehensive service and sort of even learn from my daily behavior. For example, I am getting up today, it is going to rain so you might want to take a bus ticket instead of cycling to work … suggest you a bus ticket 20, 30 minutes later to avoid traffic congestion."* – R6.

According to R1, cities' sustainability transformation is another aspect of shared multimodal mobility.

> *"All cities must make a transformation to a sustainable future, and this type of mobility actually replaces private cars. And the transition then from individually owned infrastructure to shared infrastructure, be it taxis, electric bikes or scooters, or carpools for that matter too. It is probably an absolutely crucial component for urban transformation"* – R1.

R3 also lifted the sustainability aspect:

> *"That is what we believe, that if we can share the resources, we can, with the same amount of cars produced, provide even more mobility than we previously have done."* – R3.

Furthermore, R5 explained that a goal is to reduce the number of cars from a city planning perspective, which car-sharing results in, and that the sharing economy is likely to increase.

> *"Historically, the car is seen as something very personal. And it is not so sure that it can perhaps be seen that way in all future contexts. So, it will maybe be more like a commodity."* – R5.

To summarize, digitalization has made car-sharing and other shared mobility offers possible, including MaaS which is seen as an emerging phenomenon in urban cities, and it open ups opportunities for companies to provide vehicles other than just the car. It also contributes to sustainability by replacing and reducing the number of private cars.

4.1.5 Facilitated Expansion

R3 mentioned that digitalization facilitates an expansion to other mobility areas, such as electric bicycles, electric scooters, and other vehicles suited for urban transport, to become more relevant in the mobility industry.

> *"Thanks to digitalization, there is an opportunity to further develop our offering for customers ... and offer other mobility services ... and it will be an opportunity to develop the business further and become more relevant in the mobility field."* – R3.

R1 also found that digitalization makes expansion easier and pointed out the geographical aspect.

> *"Since the service is digital, it is not tied to a certain location, and this also makes it possible to work across borders at a reasonable cost. If we had had to back up 45 data centers or 45 taxi exchanges, it would not have been possible to compete in the way we do now, so yes, that also makes it scalable."* – R1.

R5 also explained that a digital platform is scalable, making it easier to enter new markets.

> *"It does not matter if you are in two countries if you are in 32 countries. The platform can handle it regardless, so there are no problems entering new markets in that regard."* – R5.

However, some challenges are associated with geographical expansions, which will be further explained in Chapter 4.4.1.

To conclude, three respondents experienced that digitalization facilitates expansion. One mentioned expansion to other mobility areas, and the other mentioned geographical expansion.

4.1.6 Other

R5 argued that there are possibilities for targeting specific customer segments through different pricing models. Students were mentioned as an attractive target group since they usually do not own a car and have a more flexible schedule than people working. Some discounts or lower prices through dynamic pricing could make the service more appealing to students, who often have a tight budget. Furthermore, R5 explained that incorporating dynamic pricing into the car-sharing service can increase demand during off-peak periods.

Additionally, R5 highlighted an initiative among several competing car manufacturers aiming to establish a standard for a digital key, which would facilitate car-sharing, especially P2P. Further, he explained that this technology has the potential to revolutionize the way people use and own cars, reducing barriers to sharing cars and increasing opportunities for alternative modes of transportation. Without a standard, creating individual solutions can be expensive, complicated, and ultimately ineffective, said R5.

> *"It is an interesting future technology that can surely change car usage and ownership. It could significantly lower the barriers to sharing a car with others."* – R5.

4.2 Digitalization Challenges

There were three main challenges that companies faced related to digitalization. These were regulation & resistance, competence gap & organizational adaptation, and IT security risk.

4.2.1 Regulations & Resistance

R1 and R4 expressed concerns regarding regulations that can hinder or hurt the new business models of car-sharing and multimodal mobility business models. According to R1, regulation was the largest risk to their business. R1 mentioned that governments have already imposed "premature regulation," meaning regulations are put in too early without considering damages to the companies affected. R1 exemplified this with electric scooters in Denmark.

> *"In Denmark, they have chosen to try to regulate the accidents by demanding helmet requirements for full-face helmets there and not for electric bicycles and not for bicycles. And it has made the use of electric scooters very, very low."* – R1.

R1 highlights another example of how regulation has challenged their taxi business.

> *"Regarding the taxis, in the German city of Düsseldorf … we cannot lower our prices as much as we would like. We have to keep them at an artificially high level, on the same level as the old taxi companies."* - R1.

R4 explains that different car-sharing regulations in different countries make it challenging to operate internationally. Furthermore, R4 said that Lync&Co are trying to promote car-sharing but that people need to get used to someone else driving their car. R1 points out that there is resistance toward digital business models in the industry. Traditional taxi, bus, and car rental companies do not want to see themselves overtaken.

When looking into the future, R4 explains that the technology for autonomous vehicles more or less is there but that regulations and lobbying are making the implementation extremely slow. R6 agreed that regulations could put sticks in the wheel for further advancements in digitalization, such as autonomous vehicles.

> *"Technology beats legislation in speed every time"* – R6.

To summarize, regulations are posing a threat to multimodal mobility, car-sharing, and digital taxi services. The digital transformation is happening faster than some actors want, i.e.

traditional mobility companies and the wider population might not be ready to share their vehicles.

4.2.2 Competence Gap & Organizational Adaptation

Two respondents mentioned that introducing a digital business model demands different competencies that the organizations must acquire. Both R2 and R4 mentioned that there is a competence gap in the company to some degree.

> *"For Toyota, the challenge is competence. We have had the competence and processes to build cars and sell cars. But when we move to start delivering services that are driven by a lot of digitization, there is quite a large competence gap"* – R2.

R2 further explains that the new arena for meeting the customer has moved mainly from traditional physical dealerships to online and that this transformation is challenging for an automotive company like Toyota. Kinto, Lync&Co, and Bolt are much newer companies, partly created due to digitalization, and respondents representing those companies did not express the organizational transformation as equally challenging. However, both R3 and R4 shared the picture that there are some competence gaps in their companies (Kinto & Lync&Co).

R4 described that it has been challenging to launch a business model that has not existed before. They had to walk a pretty unknown road where they had:

> *"Tripped over many landmines, in the systems world, so to speak, especially when launching a new business model that did not exist before."* – R4.

Furthermore, all respondents believed that shared mobility continues to grow and replace private cars to a greater extent than we see today. R2 highlighted this as a challenge for a car manufacturer like Toyota since fewer cars will be needed in the future. R2 also pointed out that autonomous vehicles will change the whole business model of car manufacturers. He believes they will not sell cars, but supply mobility services, including shared autonomous vehicles. R2 said that Kinto might play a part in this vision.

R2 found it difficult for the organization (Toyota) to adapt to the online customer meeting point, new digital service offerings, and fewer cars needed. The other respondents did not bring this up. There was a challenging competence gap for Lync&Co and Kinto, as well as Toyota.

4.2.3 IT Security Risk

R2 highlighted that a significant risk and challenge is IT security. Since the car has become and continues to become more and more software heavy and connected, there is now a risk of being hacked. Protecting the customer's integrity becomes more important since they are exposed to getting their vehicle´s software features breached. R3 exemplified this risk by explaining that if the digital key becomes hacked, others can access your vehicles, and if a server is down, people cannot access their cars.

> *"If a server gets hacked and is down. Then no one can access their cars in the morning when they have to open it with the digital key. And that is why IT security, and everything here is very critical for Kinto and Toyota."* – R3.

To summarize, since the car has many software features like a digital key, IT security breaches have become a significant risk and challenge.

4.3 Electrification Advantages & Opportunities

There were four main advantages and opportunities identified from the empirical data. These are a competitive advantage, electric alternatives, sustainability, charging network & infrastructure, and other advantages and opportunities.

4.3.1 Competitive Advantage

All the respondents believe that EVs entail competitive advantages. R2 explained that self-charging hybrids, which generate energy when the user breaks, have been Kinto´s electrification strategy. Now they also offer 100% electric cars. When Kinto started to offer self-charging hybrids, many other competitors in the car-sharing business were only offering traditional petrol cars, which gave Kinto a competitive advantage, R2 explained. The self-charging hybrids also entail much lower operational costs due to a lower millage emission than competitors.

> *"To us, the hybrid is much more effective. It makes our operational costs for delivering this kind of service much lower than our competitors … and the customer likes the hybrids too."* - R2.

R4 described that Lync&Co currently have one car, which is a hybrid, and that their next car will be 100% electric. Their current hybrid can go a relatively long distance on electricity which R4 explained is quite rare for a car of that size. He highlighted that the high performance of their car had given them attention and strengthened their brand image.

> *"It's clear that right now there are not many (hybrid) cars of our size that can go 70 km in one charge, so it is a competitive advantage, getting attention because of that."* – R4.

To conclude, actors can gain a competitive advantage by performing well in the EV segment.

4.3.2 Electric Alternatives

Electrification has brought forward more alternative vehicles and types of fuel. For example, companies such as Bolt offers electric vehicles such as electric bikes and scooters in many urban cities. R1 highlights that scooters without an electric motor are not as attractive as a scooter with one and that electrification makes the offer appealing to customers.

The electrification of vehicles has created fully electric cars, self-charing hybrids, and plug-in hybrids. The plug-in hybrids use both a conventional and an electric motor. R2 highlighted that plug-in hybrids often is more convenient than a fully electric car since the limited range does not become a problem. Still, there is a significant decrease in emissions.

> *"With plug-in hybrids, you do not need a huge battery. A smaller battery can still make a car run entirely on electricity without emissions for a number of miles and when you as a driver sometimes drive very far, you have reserve power in the form of a petrol engine, but you can still radically reduce your emissions because you mostly run on electricity. And besides, we can build many more cars."* - R2.

R4 explained that the customer can travel far with hybrid cars, usually to and from the office. In this way, the hybrids cover a majority of everyday trips, and when the occasional need to drive longer distances arises, the petrol engine kicks in.

R2 also highlighted that batteries take up many resources (more on this in chapter 4.4) and that it is necessary to look at different electric alternatives, such as cars driven by hydrogen gas and fuel cell, to produce enough electric cars.

> *"Thanks to the fact that it is possible to make different solutions, we believe that the electric car is an opportunity to reduce emissions, continue to produce cars as well as have the free movement that the car brings."* – R2.

However, R6 pointed out that much time and money have been invested in the battery infrastructure already, and hydrogen gas requires safety systems and other aspects, which entails a new ecosystem to invest in. Therefore, R6 believes battery EVs to be the most prominent electrification solution.

To summarize, some respondents highlight that electrification has facilitated multimodal mobility with electric bikes and scooters and that alternatives like the plug-in hybrid, hydrogen and fuel cells are necessary for producing enough EVs.

4.3.3 Sustainability

An obvious advantage of electrification is the sustainability aspect which has already been touched upon. All the respondents mentioned that they see electrification as an opportunity to become more environmentally friendly and that they strive towards this. For example, R1

highlighted the usage of EVs to create a "greener" city, and R2, R3, and R6 mentioned that electrification offers excellent potential to reduce the car's emissions. The respondent also stressed the importance of using different electric alternatives, such as hybrids and hydrogen cars, to achieve sustainability, as highlighted in the chapter above.

> *"We have seen that electrification is possible and brings great potential in that it can be very convenient and flexible for customers, but not least that it also deals with sustainability, to reduce the emissions of all cars."* – R3.

Moreover, R6 underlined that in Sweden, actors had gotten far when it came to designing circular batteries. This means it becomes possible to reuse and recycle as much as possible of the batteries, said R6.

4.3.4 Charing Network & Infrastructure

Three respondents mentioned possibilities for companies related to charging networks and infrastructure. R2 described that electrification opens new opportunities for car manufacturers who, for example, can manage their charging network like Tesla is doing and selling the charging. He believed this would bring new partnerships and business models to the industry.

> *"It opens new opportunities, like Tesla, for example, running its own charging network and selling the charging … It is a whole new kind of business model for a car manufacturer, and it is something that I think the car manufacturers must take a stand on already. It will create a lot of different partnerships and new models."* - R2.

As a step towards providing a hustle-free experience, Lync&Co is working on facilitating the charging for customers. According to R4, there is potential to make the charging and payment process easier. He points out that it can be tedious for EV users who, for example, live in apartments and cannot charge at home and that it is vital to facilitate the process.

> *"We want to be a hustle-free experience in a way, so we work with very flexible solutions that should make it easier if you compare it to how you fill up a normal car today with gasoline or some other fuel. So, we are looking at making the payment and the handling process itself easier."* - R4.

Furthermore, R1 highlighted that the charging network would likely move to urban areas, facilitating electric vehicles and multimodality and integrating public and private transport. R1

believes that “mobility hubs” will arise in cities where different mobility alternatives are available in one place. For example, there will be electric scooters, bicycles, dedicated parking for taxis, and shared cars at a tram stop, with local charging networks making electrification possible.

> *“I think we will see how the charging function moves out into urban life and thus makes multimodality significantly more efficient and groundbreaking. I think it is coming pretty soon.”* - R1.

To summarize, some of the respondents see possibilities with charging infrastructure. The ones mentioned were building their charging networks, selling charging, facilitating charging, and mobility hubs supporting electrification and multimodality.

4.3.5 Other

R5 saw two main possibilities with electrification. Firstly, he believed that the battery in EVs would evolve, and he linked it with the evolution of the battery of a mobile phone, which at first weighed about 15 kilograms. Ha states that if the battery of EVs continues to evolve, the cars will become cheaper and the charging faster, and the range of the car will become less critical.

> *“And it will surely be the same in this case, that batteries are expensive today, but will likely become significantly cheaper and affect the industry quite a bit.”* - R5.

Another opportunity that R5 highlighted was that electrification has enabled charging the car at home, making the user its own electricity producer. He explains that this will make it easier to provide peer-to-peer (P2P) car-sharing services (see Chapter 3.3.3.5 for more info on P2P). According to the respondent, we are not bound to many small car-sharing actors. We can easily borrow the neighbor’s car, and the host can handle the vehicle's charging.

> *“All in the car-sharing industry are looking at peer to peer, more or less, and here, electrification in itself offers great opportunities, given that It will actually be possible to charge the car at home where it is parked.”* – R5.

Furthermore, R6 highlighted that just as digitalization brings inter-organizational collaborations, electricity/energy providers are involved in charging infrastructures and other

companies for producing chargers for home charging. Therefore, creating and maintaining good relations with these types of companies becomes essential.

R6 explained that he currently works on a vehicle-to-grid (V2G) project with Volvo Cars. This means that the vehicle can transfer energy to the grid when prices are high and charge when prices are low. In this way, the car contributes to balancing the grid load. The respondent stated that they will test this on a work-related parking station where the car stands still connected to a plug-in charger during working hours. The respondent said that V2G might also be tested on some car-sharing stations in Sweden. Moreover, R6 talked about how the vehicle to everything (V2X) can be an opportunity for car-sharing providers. This would enable the cars to transfer batteries among each other.

> *"… In V2X set-ups, you could see solutions that balance the energy between the cars. Then the cars have to be connected to their charging boxes, and there would probably be some kind of wireless intelligence that controls this"* – R6.

To conclude, one respondent highlighted that batteries will likely become cheaper and faster to charge. The respondent also explained that electrification provided favorable conditions for P2P car-sharing services. Another respondent stated that electrification leads to cross-industry collaboration and that V2G and V2X will provide possibilities for the industry.

4.4 Electrification Challenges

A few main challenges related to electrification were identified. These are charging infrastructure and capacity, a lack of resources, low supply, and too expensive.

4.4.1 Charging Infrastructure and Capacity

All of the respondents mentioned charging infrastructure as a challenge. The main aspects highlighted by respondents were a lack of charging stations and not enough charging capacity. R1 pointed out that charging stations is restraining the transformation to an electrified taxi fleet.

> *"A restraining factor to an electrified taxi fleet is the lack of charging stations ... It is perhaps the case that we must have exclusive charging stations for taxi operations?"* - R1.

R3 explained that it is not possible to charge the car in some cities where they operate, making the transition to EVs difficult. Furthermore, the respondent said that using a car-sharing service makes it uncomfortable for the customers, who sometimes must find a charging station before they take off. R3 also mentioned that they have charging stations at their parking spots, and the charging capacity is not enough during times of high demand.

> *"There is a low charging capacity on these charging posts, which means that if there are a lot of people renting the car, the car never really has time to charge up"* – R3.

R1 did also mention capacity issues with EVs. He explained that taxi cars are constantly driving and that it becomes difficult to take an hour to charge the vehicle, given that the driver could have used that hour productively if charging was not required. Also, he saw a problem with setting aside time for charging for car-sharing.

> *"So far, we have not really found the capacity that makes it possible to have an electric fleet .... How do you create gaps in the utility that make it possible to set aside an hour to charge a car?"* - R1.

Furthermore, R4 and R5 highlighted that a challenge is to compete with EVs in many countries outside of Sweden that do not have a developed charging infrastructure. R4 explains that this leads to Lync&Co not wanting to limit itself to only delivering fully electric cars.

> *"There are not any countries that are very developed yet, and there are many markets which are very difficult, like if you look at Southern Europe and so*

> *on, they do not have the same coverage for electricity poles, so there it becomes a challenge"* – R4.

R5 mentioned that it could be challenging to expand internationally, partly because many countries have not gotten as Sweden regarding a charging infrastructure but also because of different structures regarding parking spaces where you might need to talk to many different actors. This also makes it more challenging to have discussions regarding charging stations.

R4 and R6 highlighted the charging infrastructure for people at home as a problem. It will be difficult for people living in an apartment in an urban city who does not have a charger at home to have an EV. R6 explained that most EVs charge on private parking spaces on the driveway, and the challenge in Sweden is that a relatively large portion of people lives in apartments. This is why R5 believed that car-sharing with dedicated cars and parking stations with apartment chargers could be a solution.

Furthermore, R4 believed that people might not use EVs because they are unsure how they will work for longer distances, although it is not much more difficult than using a classic car. To address this challenge, R4 said educating people about EVs is important.

To summarize, respondents found insufficient charging infrastructure, primarily outside of Sweden, making it difficult to expand internationally. They also found that charging posts has not had enough capacity to charge shared cars when demands are high and that there is challenging to have an EV for people living in apartments and who do not have access to a charger at home.

4.4.2 Lack of Resources, Low Supply, and Too Expensive

The respondents highlighted that there is a lack of resources, a low supply, and high costs for EVs as well as unstable electricity prices. One respondent pointed out that battery cars are not a sustainable solution for all vehicles today due to scares resources.

> *"We notice that many say that everyone should sell battery cars, but we think that people have not really done the homework on the shortage of earth metals and the inputs that are needed, and the challenge in the future is that the price will increase so much that it will no longer be available"* – R2.

As previously mentioned, R2 stated that we need different electric options for electrifying vehicles.

> *"It will not work to only build fully electric cars, but we believe that we need a range of various electrified options"* - R2.

Both R1 and R5 said that they would love to have fully electric car fleets, but it is too low in supply and expensive.

> *"We would like to have only electric cars, but it is hard to get hold of it right now. It is both too expensive and a too low supply"* – R1.

R5 highlighted the high electricity prices and believed that a more stable price is necessary for electrification. On the same line, R4 mentioned the electricity shortage as a problem with vehicle electrification.

> *"We already have an electricity shortage today, so it is like what happens if all of a sudden everyone has an electric car? It is clear that it will be a problem"* – R4.

To conclude, a lack of resources, low supply, high costs for EVs, and unstable electricity prices are all seen as challenging.

4.4.3 Other

Another challenge unrelated to those mentioned so far was an organizational change from a car manufacturer's perspective. R2 explained that electrification means a new architecture for building the car based on battery and charging for a car manufacturer like Toyota.

> *"These are completely new areas that car manufacturers must address, which requires huge investments and changes the entire value chain because you must build large battery factories"* – R2.

5.0 Data Analysis

This chapter will provide an analysis of the empirical finding. First, a comparison of this study´s findings and previous research will be analyzed. Then, to address this study's first research question, the advantages, and challenges of electrification and digitalization will be linked to the business model framework presented in Chapter 2.2. Future opportunities and challenges will be presented and connected to the business model innovation theory linking to the second research question.

5.1 Impact on Business Model

The empirical findings imply that most improvements could be related to the value proposition but that all three business model components improved through either digitalization or electrification. Furthermore, the trends have brought new types of products and services that were not previously available. According to D. Mitchell & Coles (2003), an improvement to more than one business model element, which provides previously unavailable offerings, is a business model innovation. Consequently, digitalization and electrification have entailed BMI among the industry actors. The following section will analyze how the three components of offering, value capture and delivery, and value capture of the business model framework have been affected by digitalization and electrification in more detail.

5.1.1 Value Proposition

The empirical findings suggest that all three elements, customer target, offering, and competitive advantage of industry actors, have been impacted by either electrification or digitalization.

Offering

The findings of this study highlight that the significant shift in the offering, from an industry perspective, is from offering a product to offering a service. According to Richardson's (2015) business model framework, the offering is a part of the value proposition and describes what the firm is selling. The more recent service business models result from digitalization, including car-sharing, ride-hailing, and subscriptions. This has allowed traditional car manufacturers to offer their cars through an entirely new business model, expanding the traditional product offering to include new services. By adding complementary services that build on the existing offering (in this case, providing cars), Mitchell & Bruckner Coles (2004a) argues that it can lead to a sustained competitive advantage. However, the barriers for a car manufacturer to enter

the car-sharing market is low, which makes it difficult to conclude that it leads to a sustained competitive advantage. Furthermore, the findings imply that these new digital business models were experienced as making improvements to the offering compared to more traditional business models such as taxi and car rental companies by increased availability, efficiency/speed, and lower service price.

Moreover, to innovate business models, Mitchell & Bruckner Coles (2004a) highlight that companies should look for how they can improve the offering by bringing sales expanding benefits without increasing prices or lowering the operating price for the customer. An example of this can be seen in the findings where one company offers a digital platform where customers can rent out their cars they bought or subscribed to. In this way, the company can gain additional sales without increasing costs through the digital platform while their customers can earn money. This type of business model innovation can lead to sustained competitive advantage (Mitchell & Bruckner Coles, 2004a).

Besides the technology-enabled car-sharing services, it became evident that the offering was improved by connecting the vehicle to the mobile phone and the internet. Features such as navigation with real-time traffic data, pre-heating the car, its seat, or driving wheel, and integrating Spotify and other applications, make the car more user-friendly. Hence, industry actors' offering and value proposition has shifted from a more traditional focus on personal transportation to a greater emphasis on software features, entertainment, and comfort. This can also be seen in previous literature where Canzler & Knie (2016) highlight the increased importance of apps in a car and even argue that app developers will rule the industry. The increasing importance of apps was present in the empirical data where for example, a traditional car manufacturer expressed interest in becoming an app distributor.

Additionally, the findings suggest that digitalization and electrification have made it easier for industry actors to offer complementing services, expanding their offering to more than just car services, for instance, by operating electric bikes, scooters, and other micro-mobility sharing services through the same digital platform as their existing offering. In this way, the company are leveraging its existing resources to expand its offering and deliver more value to the customers. This finding relates to D. W. Mitchell & Bruckner Coles' (2004a) argument about adding complementary services that build on existing resources. In line with D. W. Mitchell & Bruckner Coles' (2004a) business model innovation theory, the empirical data suggests this can lead to a sustainable competitive advantage since a broader range of mobility offerings

integrated into one single platform were believed to offer greater value than having all these solutions fragmented on different platforms.

Target Customer

As highlighted by Richardson (2015), the target customer plays a crucial role in shaping the value proposition and determining to whom the firm is selling its offering. Regarding services like car-sharing and ride-hailing, the target customer has shifted towards people living in urban cities. This shift focuses strategically on an urban population who may not have the means or desire to own a car outright. By targeting this segment, industry actors can tap into a growing market of individuals seeking convenient, cost-effective transportation solutions.

However, it is important to recognize the challenges associated with this shift. One significant challenge is the limited ability of individuals living in apartments to charge electric vehicles (EVs) at home. This limitation poses a potential obstacle as car manufacturers increasingly produce and market EVs as their primary offering. The lack of charging infrastructure in urban areas may dampen the appeal of EVs for this customer group, potentially hindering the success of traditional ownership models.

Nevertheless, by entering the car-sharing segment, industry actors can address these challenges and target the urban living customer segment with an alternative offer. Car-sharing services provide access to EVs without the need for individual ownership or reliance on personal charging infrastructure. This alternative offer expands the customer base and aligns with the growing demand for sustainable, flexible mobility solutions. This targeting of new customer groups reflects a strategic adaptation of the value proposition (Richardson, 2008), which is in line with what Kley et al. (2011) argued about the value proposition of EVs will be aimed at those driving shorter distances. By identifying and addressing the specific needs of individuals who do not want to own a car, industry actors are innovating their business models to provide alternative mobility solutions and capture new target groups, which could increase the success and profitability of the EV (Zarazua de Rubens et al., 2020). Previous research also shows that EV car-sharing satisfies mobility needs in urban cities and could replace private EVs (Berg et al., 2019), making this an interesting niche for the EV offering.

Furthermore, the empirical findings imply that expanding to other geographical areas was also made more accessible when providing services through a digital platform. This means it is easier for companies to target customers in other countries. However, when offering electric

vehicles, industry actors experienced restraints on where to expand geographically, depending on the countries charging infrastructure. This limits where to target the value proposition.

Competitive Advantage

Findings implied that car-sharing and subscription services could increase competitive advantage over competitors not involved in this offering. Richardson (2008) states that the firm's ability to compete is one of the three components of the value proposition. Firstly, customers become exposed to the car brand much earlier than when buying a car, creating early customer relationships. Findings suggested this improves the chances of the customer buying, leasing, or subscribing to a car of the same model later in life if or when a more long-lasting need for a vehicle occurs.

Secondly, the findings indicated that the service offering had created more frequent and closer customer relationships than traditional car purchases since the customer often buys mobility and interacts directly with the company through digital platforms.

Thirdly, integrating technology and connectivity fosters more robust customer engagement and relationships. The ability to customize car settings, access personalized information, and seamlessly connect with external applications not only enhances the overall user experience as highlighted in the "offering" section above, but increases customer engagement, strengthens customer loyalty, and provides valuable insights for industry actors.

In this way, car manufacturers such as Toyota and Volvo, who offer car-sharing services, can experience competitive advantages over competitors who do not. However, since these circumstances affect the whole industry, it is questionable to what extent it is a sustained competitive advantage. Therefore, creating more frequent, closer, and earlier customer relations is not in itself a competitive advantage. The advantage lies in how the company can capitalize on them. For example, understanding customer needs will be a competitive advantage when the firm can develop an offering closer to customer needs than competitors.

Electrification has generated a competitive advantage for many companies in this study. EVs compete on driving range and charging speed rather than traditional values. Existing literature has also found that traditional values decrease in importance as the car becomes more electric and connected (Canzler & Knie, 2016). The findings suggest that performing well in these new domains brings attention and can strengthen the company´s brand image. Additionally, the electrification of vehicles has also created a "first mover advantage" by offering electric cars

before competitors. Customers who want to use EVs have no choice but to go to the company that offers them, leading to a competitive advantage. Although this has led to competitive advantages for some of the companies in this study, previous literature highlights that competitive advantages can be achieved by identifying a new innovative EV meaning (Abdelkafi et al., 2013). The findings imply that one new innovative use of EVs is through the digital car-sharing offering. The generally high purchasing price of EVs and challenges with charging could be managed by adopting this new business model since the customers will not have to purchase the car or be responsible for charging and service.

5.1.2 Value Creation and Delivery

According to the empirical findings, all three elements of value capture and delivery, value network, resources and capabilities, and organizational structure, were impacted by digitalization or electrification.

Value Network

In Richardson's (2008) business model framework, the value network comprises key external actors who play a crucial role in creating and delivering value to the customer. The value network of automotive mobility providers has been impacted by digitalization and electrification through cross-industry collaborations with new complementors, suppliers, partners, and distributors, which are the main components of the value network (Richardson, 2008).

Regarding electrification, which has brought a whole new infrastructure around the car, the findings highlight the charging infrastructure as a critical aspect of the company's EV offering. Therefore, electricity companies, governments, and other actors influencing public and private charging infrastructure have become important partners and complementors.

Regarding digitalization, the software-reliant connected car entails new suppliers and partnerships that were previously not considered. Companies like Apple and Google impact the car's infotainment systems, making these companies' products complementary to the cars. Furthermore, telecommunication companies provide cars with, for example, sim cards essential for the connected car. Hence these types of companies have become important suppliers and partners coherent with Rahchinger et al. (2019) findings. In line with Athanasopoulou et al. (2016), these cross-industry collaborations lead to complementary assets, i.e., the sim card,

which creates new value for end users. i.e., the connected car is a value-creating from collaboration (Teece, 2018).

Additionally, the findings suggest traditional dealerships are more rarely used because of digitalization, as highlighted by Llopis-Albert et al. (2021) in the literature review. Instead, the car manufacturer has more direct contact with customers, leading to further data collection opportunities (Llopis-Albert et al., 2021). Regarding sharing services, car dealerships are removed from the value network. Instead, real estate companies who rent out parking spaces and city planning actors have become important to the value network of car-sharing providers.

These cross-industry collaborations embody the principles of open innovation theory proposed by H. W. Chesbrough et al. (2006), which emphasizes inter-organizational collaboration and acquiring knowledge from outside the firm to drive innovation. This shift towards open innovation has been instrumental in leveraging the expertise and resources of external partners to enhance their value network. By opening the business model to engaging with complementors, suppliers, partners, and distributors from various industries, these providers can obtain diverse capabilities, technologies, and market insights beyond their traditional boundaries. For example, by working on fast charger solutions with electricity companies or the development of connected cars with software and telecommunications companies, exchanging knowledge and technology can lower innovation costs and increase revenue (H. W. Chesbrough, 2006). It became evident that innovations from other industries are affecting the car and business models coherent with (Lopez-Vega & Moodysson, 2023) findings. The telecommunication industry was highlighted as an example from the empirical data that directly affect the car's connectivity, which has given the car new functions and made car-sharing business models possible.

Resources & Capabilities

The findings suggest that resources and capabilities, the second element of the value creation and delivery system (Richardson, 2008), have been affected by electrification and digitalization requiring new raw materials and competencies. The production of EVs requires batteries, and batteries require different raw materials compared to traditional ICE. This shift in resource requirements has led to a reconfiguration of the supply chain and procurement processes. Companies now need to secure access to necessary materials for battery production. This poses challenges and opportunities for EV providers as they strive to ensure a stable supply of these raw materials while managing the associated costs and sustainability considerations.

In addition to the shift in raw material requirements, the digital platform has become a vital resource, especially for different types of car-sharing providers, since the service is delivered through this platform. The digital platform is used directly by customers for ordering and reserving cars, unlocking them, paying, and much more, heavily impacting the user experience. This means that car-sharing providers are competing on features directly related to the car and through the digital platform. It can be argued that the digital platform can lead to a more comfortable selection of cars. This aligns with Canzler & Knie's (2016) findings suggesting that providers with the largest and most comfortable selection of cars can achieve a competitive advantage.

Moreover, the advent of digitalization has also impacted the required competencies within the industry. The findings imply that the customer meeting point is shifting to a digital arena, where car manufacturers can sell directly to the customer through e-commerce. This leads to new types of customer interactions, which require new capabilities and resources related to digital marketing, user experience, and data collection (Llopis-Albert et al., 2021). Rahchinger et al. (2019) found that many companies in the industry are experiencing a competence gap which also can be found in the empirical data where most respondents experienced challenges in acquiring digital skills, such as software developers.

Organization

The empirical data implies several organizational changes for car manufacturers and sharing providers, including adopting the value chain, activity systems, and business processes (Richardson, 2008).

The value chain of car manufacturers has been restructured to align with the production of EVs. Significant investments, particularly in battery production sites, have been made to meet the increased demand for electric vehicles. The production of batteries has emerged as a distinct business process within the overall activity system of vehicle assembly. Integrating battery production into the value chain is a strategic move to ensure the incorporation of EV-specific components. Moreover, according to the empirical data, charging EVs within car-sharing schemes has become an important business activity for car-sharing providers. The findings suggest this process can be challenging due to low charging capacity and limited and costly access to chargers, which is supported in previous literature (He et al., 2020).

Furthermore, integrating software and hardware components is crucial for cars to enable advanced connectivity features such as internet connection, GPS, sensors, and over-the-air

updates. This integration is part of the broader activity system involved in assembling the vehicle. By incorporating these digital features into the activity system, car manufacturers enhance the value proposition of their EVs, providing customers with a connected and technologically advanced driving experience.

In addition to the production process, digitalization has significantly impacted data analytics within the value creation and delivery system. The availability of vast amounts of data generated by vehicles, customers, and operations has opened new opportunities for analysis. Car manufacturers and providers can now leverage data analytics to gain insights for decision-making, predictive maintenance, and customer behavior analysis. By understanding customer preferences and behavior through data analytics, they can continuously refine their offerings, anticipate customer needs, and create a competitive advantage (Mitchell & Bruckner Coles 2004a). These insights support Wittmann's (2017) findings that data analytics can increase understanding of customer behaviors, preferences, and needs. With this information, companies can create new targeted offerings and business models (Llopis-Albert et al., 2021) to strengthen the value proposition (Mitchell & Bruckner Coles, 2004a).

Additionally, new business processes have emerged as a result of digitalization. One notable example from the empirical data is the adoption of digital payment systems, which streamline transaction processes within the value chain. Car manufacturers and service providers enhance the customer experience by offering digital payment options, enabling seamless and secure transactions. These digital payment processes contribute to the overall efficiency and effectiveness of the value creation and delivery system.

Moreover, the digital customer meeting point has become a key focus area within the value creation and delivery system. Car-sharing and ride-hailing providers leverage mobile applications as the digital interface to deliver their services. The findings suggest that car manufacturers face the challenge of establishing a digital customer meeting point through apps and e-commerce. This transition necessitates restructuring the value delivery process to accommodate the digital landscape and provide customers with a seamless and integrated experience.

5.1.3 Value Capture

Value Capture includes how the firm captures the value it has proposed and created and consists of revenue streams and costs (Richardson, 2008).

Revenue Streams

Adopting new digitalized sharing services has led to a shift in revenue models, with a greater emphasis on subscription and pay-per-use models. This transformation is significant as it alters the revenue composition within the industry, moving away from predominantly one-time purchases to recurring revenues. The findings also suggest that the subscription revenue model has been adopted by car manufacturers who started to digitally distribute software features to cars, much like iPhone users buy apps. To gain the app's features, the customers pay a monthly subscription fee, enabling companies to generate continuous revenue streams throughout the customer lifecycle. This can be linked to Bohnsack et al´s (2021) product-based digital extension where companies can benefit from subscription revenues through the connected car.

These strategic introductions of new revenue models reflect the industry's response to digitalization and align with Mitchell & Bruckner Coles' (2004a) suggested approaches for successful BMI. By diversifying revenue streams and exploring new sources of revenue generation, companies can enhance their competitive position without relying solely on price increases. This approach ensures the business model's sustainability and opens avenues for creating a sustainable competitive advantage in the dynamic and evolving market landscape.

Costs

The findings show that digitalization and electrification have impacted companies' cost structure. Digitalization has resulted in more efficiency, less administration, and fewer manual tasks through, for example, the digitalization of payment through the digital platform of many sharing services. This, in turn, has led to cost savings. Furthermore, some respondents frequently described EVs as expensive, increasing the company's costs. This could be linked to the additional expenses and investments of car manufacturers producing batteries, expressed in the empirical data. Previous research has found that EV production and selling are based on ICE cars, making it more complicated for car manufacturers to produce EVs, which could be another reason for the increasing costs related to EVs (Zarazua de Rubens et al., 2020).

However, when having a pay-per-use revenue model, which car-sharing providers have, the evidence suggests that they can lower operating costs since the cost of using the vehicle

declines for an electric fleet compared to a fleet of ICE cars. This is because the price of electricity is far lower than the price of fossil fuel. Also, in a car-sharing scheme, the number of users per EV increases, which lowers the provider's operational costs, and the capital costs are shared by several users (Kley et al., 2011), making it more available and affordable.

Companies can achieve a sustained competitive advantage by lowering operational costs within the firm (Mitchell & Bruckner Coles 2004a). While one respondent explained that this had been a competitive advantage for their car-sharing scheme, it is unlikely that it would lead to a sustained competitive advantage today since EVs are no longer a unique resource and challenging to copy, which is a requirement for sustained competitive advantage (Mitchell & Bruckner Coles 2004a).

Summary of Findings & Analysis from 5.1

		Digitalization	Electrification
Value Proposition	Offering	• From product to service • Increasing availability & efficiency • Lower price • Enhancing customer experience • Easier to offer complementary services	• Enabeling complementary services, i.e. micro-mobility
	Target Customer	• More focus on the urban population • Scaleble platform facilitates geographical expansion	• Limited geographical targeting
	Competative Advantage	• Earlier, more frequent, and closer customer relationships	• Gaining a first-mover advantage • Competing with new attributes such as range and charging speed
Value Creation & Delivery	Value Network	• New partners, suppliers & complimentors from telecommunication and mobile operating systems • Distribution occurs more inhouse, creating less use of car dealerships	• New partners & complimentors regarding charing infrastructure
	Resources & Capabilities	• The digital platform has become an area to compete in • Competences regarding software and IT has become important	• EVs require different resources than traditional cars
	Organization	• Integration of software-related components into production • Data analytics has become a critical business process for i.e., createing new offerings • Shift from physical to digital customer meeting point	• Restructured production process for EVs • Investments in battery production sites
Value Capture	Revenue Streams	• Increasing amount of subscription revenues • Increased after-sales revenues • Pay-per-use revenue models	
	Costs	• Cost savings through the digitalization of manual tasks	• Investments in batteries • Lower operational costs for sharing providers • Increasing investment/costs to electrify the fleet of cars

Table 2: Summary of digitalization's and electrification´s impact on industry actor's business models

5.2 Challenges and Future Opportunities

While the previous section analyzed the impact digitalization and electrification have had on the business model, this section adopts a forward-looking perspective where challenges and future opportunities are analyzed regarding the business model and business model innovation.

5.2.1 Challenges

The findings indicate that the main challenges of digitalization and electrification are competence gaps, IT security, adaption to the digital environment, regulations, charging infrastructure, charging management, few resources, high costs & low supply of EVs, and electricity prices.

Competence gaps, IT security, & Adaption to the digital environment

There are some challenges caused by digitalization. Several respondents experienced changes in competence gaps concerning IT, a finding also in Rahchinger et al. (2019) study. This change was experienced as challenging because it has caused competence gaps among several companies in this study. Finding competencies within the digital landscape was also experienced as challenging when looking ahead.

Additionally, IT security has become an increasingly important area because of the car's connected nature, such as wireless unlocking. For example, if a server gets hacked, people might be unable to access their cars. This challenge becomes more crucial as the car becomes more connected, which it most likely will be in the future. This challenge was not found in previous literature. Moreover, for one car manufacturing company in this study, the organizational adaption to the digital environment, i.e., the digital customer meeting point, was difficult.

Regulations

Another challenge brought up was regulations that affect the ability to compete. For example, the ride-hailing provider Bolt experienced minimum price regulation in Germany. This is a competitive disadvantage which, in turn, weakens the company's value proposition (Richardson, 2008). However, in the Swedish context, current regulations were not perceived as a challenge, but they could be a future threat to the industry actors. Future regulatory policies will be crucial for dealing with new technologies and business models, for example, related to autonomous vehicles.

Charging infrastructure

As mentioned in the previous chapter, several respondents in this study described the charging infrastructure as a challenge. On the one hand, it was experienced as relatively well-developed in Sweden, but still not enough to reduce consumer anxiety about EVs (Kumar & Alok, 2020). When looking outside of Sweden, the charging infrastructure is often far less developed, making it difficult for companies to expand their EV offering to certain countries. This finding was not showcased in previous literature.

Charging management

Additionally, car-sharing companies have been challenged by electrification. When demand is high, the vehicles do not have enough time to charge between usage, negatively affecting the customer experience. In coherence with the empirical data, He et al. (2020) found that limited access to and costly charging is a big challenge for car-sharing providers. Adding to these challenges, the empirical data implied that the charging capacity at car-sharing stations is too slow. When car-sharing providers offer an electric fleet, how they manage to charge will directly impact the customer experience and profitability (He et al., 2020), making this an area where potential competitive advantages can be gained. These will be highlighted in the section below called "*Capitalizing on charging."*

Few resources, high costs & low supply of EVs

Furthermore, electric vehicles are often relatively expensive cars with more uncertainty than traditional cars regarding maintenance, repair, charging, et cetera., creating consumer anxiety (Kumar & Alok, 2020). This is a more significant challenge for car manufacturers than car-sharing providers since the customers who buy EVs from car manufacturers must be responsible for the abovementioned aspects. For car-sharing users, these challenges do not create as much anxiety since the customer does not own the car. However, the empirical data suggest that EVs are experienced as expensive by the service providers, which might hinder them from operating an electric fleet. Additionally, the low supply of EVs and scarce resources were seen as challenges in the empirical data. It became evident that electric battery requires resources that are of limited supply. Because of this, battery EVs will become more expensive as the resources diminish. This will increase consumer anxiety about EVs (Kumar & Alok, 2020) and pressure automotive mobility companies dealing with EVs.

Electricity prices.

Moreover, insecurities about future electricity prices could be derived from empirical data. Electricity prices have already fluctuated and increased during the last year in Sweden. If everyone would drive an electric vehicle, the electricity demand would drastically increase, increasing the price. This challenge was not highlighted in previous literature.

5.2.2 Future Opportunities

The main future opportunities derived from the findings are electric multimodal mobility and integrated mobility offering, autonomous vehicles, new customer segments, dynamic pricing, capitalizing on charging, inter-organizational & cross-industrial collaborations, and facilitated P2P car-sharing.

Electric multimodal mobility

The empirical findings imply future opportunities to develop electric mobility solutions for urban cities. This can be referred to as micro-mobility, which is how one of the respondents expressed it. Electrification creates possibilities to develop attractive micro-mobility solutions since many of these vehicles (i.e., bikes and scooters) will deliver a greater value to the customers if they are powered by electricity than they would otherwise. Digitalization makes it easier to commercialize the micro-mobility offering since it can be added directly to the existing digital platform through which the company offers its current services and already has a user base. Furthermore. by engaging in micro-mobility, companies move away from the automobile as a means of transportation into vehicles more adapted to urban cities where there usually are struggles with parking spaces and limited movement with a car. The respondents also saw micro-mobility as a shared offering, like the car-sharing service. Although companies found it attractive to offer micro-mobility vehicles in urban cities, the car will still be crucial, especially during longer trips or when transporting groceries and other goods.

Integrated mobility offering

The findings imply the possibility of integrating different means of transportation into a single user interface through an application, commonly referred to as Mobility as a Service (MaaS). This application would calculate effective mobility solutions depending on specific needs, distance, weather, and many other factors and provide mobility suggestions combining different vehicles. Automotive mobility companies must provide the platform or collaborate with different actors to join the MaaS solution. Adopting an open innovation and business

model approach to the MaaS idea could foster external and internal knowledge sharing and collaborations and drive innovation since many different actors will be involved in this project (H. W. Chesbrough et al., 2006).

One respondent in this study who believed in the MaaS concept suggested that mobility hubs would facilitate urban transportation. The mobility hubs would be like big stations where car-sharing, taxi spots, micro-mobility vehicles, and public transport are available, with charging possibilities. The integrated chargers to the mobility hubs would address the charging infrastructure challenge in urban cities. Mobility hubs could promote the use of EVs and provide opportunities for further shared mobility solutions.

Autonomous vehicles

The empirical data highlighted the introduction of autonomous vehicles as having a significant impact on the business model within the industry. A business model based on service instead of products with Increased accessibility, lower price of mobility, and enhanced customer experience was expressed as potential result of autonomous vehicles. Since the price decreases and availability increases, the need to own a vehicle will likely decrease with the introduction of autonomous vehicles. Business models based on service concepts like car-sharing or ride hailing were expressed as prominent alternatives for the autonomous car. The value this technology can bring will be determined by which type of business model it will be offered through (H. Chesbrough, 2010), leading to many business model possibilities. By continually updating, improving, and experimenting with business models, companies will have good conditions for capitalizing on autonomous vehicles (H. Chesbrough, 2010; D. W. Mitchell & Bruckner Coles, 2004b).

Furthermore, the empirical data suggested that the car's value proposition would be altered with autonomous vehicles. When the car drives itself, the interior of the car could be modified based on user needs. For example, when there is a long trip at night, the car will be a sleeping place; when it is a business trip, the car will be a conference room. The value proposition of this type of car would have a different meaning than a traditional one, with more focus on personalized experience, convenience, comfort, and productivity.

New customer segments & Dynamic pricing

Besides form the customer segment of urban living people in apartments, for car-sharing providers, a new target customer group the respondents expressed interest in was students. This

group was seen as attractive for car-sharing companies since they usually can not afford to buy a car, and they do not work the traditional eight to five hours, which means this group might balance the demand during usual off-peak hours. Car-sharing companies can target this more price-sensitive group by adopting specific pricing models or discounts. Furthermore, dynamic pricing can be an option to create more demand at off-peak periods. This could lead to better utilization rates and increased revenue from car-sharing providers.

Capitalizing on charging

The charging of electric vehicles has been chiefly expressed as challenging so far in this study. However, it also provides opportunities for automotive mobility providers that were impossible before. The empirical data highlighted selling charging as an opportunity to gain additional revenue sources. One possibility is for the companies to develop a charging network for their car, like Tesla, and make the charging station compatible with their own car. This creates incentives to drive a car of that brand because of better charging possibilities than other companies. However, this contrasts with the principles of the sharing economy. If the charging station were universally compatible, it would be easier to charge the EV regardless of the car brand. This might provide the greatest value for the whole society. The companies could make this into a business model where other companies subscribe on their charging stations, or mutual sharing among the companies of all the separately operated charging stations. There are many opportunities to capitalize of the charging, and it is important for industry actors to take a stance on this. It will create new business models with new partnerships and previously impossible revenue streams.

The charging and low range of the EVs have been experienced as a hustle for customers (source). The evidence suggests possibilities for digitalizing the charging process, such as automated payment functions, stable electricity prices, and faster charging. In this way, charging the EV could be easier than fueling an ICE car, making EVs more convenient for customers. Continuously looking for charging opportunities to create a better service than competitors is in line with Mitchell & Coles (2003) continuous business model innovation, and it can provide sustained advantages over competition.

Another future possibility of charging can be seen in vehicle-to-grid (V2G) and vehicle-to-everything (V2X) solutions. This implies that cars are connected to the electricity grid, enabling them to charge when prices are low and transfer electricity back to the grid when usage and prices are high. This could lead to another source of revenue for automotive mobility providers

managing their charging, which is coherent with Kley et al. (2011) findings. For example, a fleet of car-sharing cars parked and connected to a charger can buy and sell electricity via the grid. Customers owning a car can draw advantage of this and earn money while not using the car. In this way, automobile companies lower the operating costs for their customer, a business model innovation strategy highlighted by D. W. Mitchell & Bruckner Coles (2004a) to reach sustained competitive advantages.

Furthermore, V2X would drastically improve the charging of car-sharing providers because it would enable cars to transfer electricity directly to each other wirelessly. This will decrease the chances of a customer waiting a long time to drive a car and could lead to better utilization of EVs.

Inter-organizational & cross-industrial collaborations

As the previous chapter shows, many actors within the automotive mobility industry are part of a cross-industry value network that has expanded because of digitalization and electrification. The expanding value network leads to more collaborations, which has increased the value of the product or service for the end customer. (D. W. Mitchell & Bruckner Coles, 2004a) highlight that companies should look outside their company and industry to reach new innovative business models. By taking inspiration from other industries and forming new partnerships, companies can find innovative ideas and complementary innovations that can create even more value for customers.

An example of a cross-industry collaboration was highlighted in the empirical data, which addresses the inconvenience of owning a car for many people living in an apartment. By collaborating with apartment houses, automotive mobility providers can offer a certain number of cars, the apartment inhabitants can share. For real estate companies, which often cannot provide parking space to many inhabitants, this would be a great feature to offer and a selling point for the apartments. Similar deals can be made by companies offering car-sharing services for their employee's daily traveling. By looking for other utilization areas of the service in other industries and potential complementary products, the services can potentially create more value for the customer (Teece, 2018).

Facilitated P2P car-sharing

The empirical evidence suggests that automobile companies want to develop a universal standard for the digital key. This would enormously facilitate Peer-to-Peer (P2P) car-sharing

because providing access to other persons to a private vehicle would be very easy. Furthermore, the EV provides additional possibilities for P2P car-sharing. Since the EV makes it possible to charge at home, the vehicle host can be responsible for charging the vehicle whenever the car is not rented out. This can extend the utilization of the car by ensuring that it is fully charged before use. The possibilities for P2P car-sharing could mean a shift to a business model where the companies serve as a mediator of demand and supply rather than offering a mobility service.

Summary of Findings & Analysis from 5.2

	Digitalization	Electrification
Challenges	• Competence gaps • IT security risks • Adaptation to digital environment • Regulations	• Charging management • Charging infrastructure • Limited resources • High costs of EVs • Low supply of EVs • Higher electricity prices
Future Opportunities	• Electric multimodal mobility • Integrated mobility offernigs (MaaS) • New customer segments • Dynamic pricing • New Collaborations • Facilitated P2P car-sharing • Autonomous vehicles	• Electric mulitmodal mobility • Capitalizing on charging • Facilitated P2P car sharing

Table 3: Summary of challenges and future opportunities regarding digitalization and electrification

6.0 Conclusion

The conclusion will answer the two research questions of this study, suggest managerial and theoretical implications, and highlight limitations and future research areas.

6.1 Answering the Research Questions

This research aimed to deepen the understanding of how automotive mobility providers adapt and innovate business models and generate strategies regarding electrification and digitalization. The findings of this study have shed light on how the two trends have affected companies and how they have adapted and innovated their business models to capitalize on these trends. Furthermore, the findings have provided challenges and future opportunities regarding digitalization and electrification, which can serve as a basis for developing business strategies around these trends. The following text will answer the two research questions of this study.

6.1.1 *How have digitalization and electrification impacted Swedish automotive mobility providers' business models?*

Introducing car-sharing services has altered the traditional value proposition within the automotive mobility industry where station-based car-sharing services, ride hailing, and subscribing to a car are becoming attractive options to owning or leasing a car. Digitalization has made these new services possible through the digital platform, which creates a user-friendly interface, lowers prices, and automates payment processes. The car's connectivity makes it possible to unlock the vehicles, drastically facilitating car-sharing digitally. The connectivity also enables connection to the phone and internet, which has shifted the value proposition of the automobile to be more centered around digital applications and software features enhancing the comfort and entertainment of the drivers.

The connected nature of the vehicle and the digitally enabled car-sharing and subscription services offer companies a competitive advantage by creating early customer relationships, fostering frequent and closer customer interactions, and leveraging technology for enhanced customer engagement. Furthermore, electrification has made expanding offerings within the industry easier by including complementary services like electric bikes, scooters, and other micro-mobility sharing services. Companies can leverage their existing digital platform to introduce these services. By introducing car-sharing services, the target customer segment has expanded towards urban populations who may not want to own a car outright but seek

convenient, cost-effective transportation solutions. Furthermore, the target customer becomes limited for industry actors offering EVs since they are dependable on the charging infrastructure.

Looking at the value creation and delivery system, cross-industry collaborations with new complementors, suppliers, partners, and distributors related to the connectivity of the car and charging infrastructure have become crucial for creating and delivering value to customers. Additionally, the shift towards digitalized business models has reduced the reliance on traditional dealerships. Moreover, there has been a shift in raw material requirements due the production of EVs, batteries, and a connected car, necessitating a reconfiguration of the supply and value chain. Need to secure access to raw materials crucial for battery production. The digital platform has become an essential resource for automotive mobility providers, enabling better user experience and service delivery. Regarding capabilities, the industry has experienced a shift in competencies regarding IT.

In terms of value creation, the main implication of digitalization is the emergence of subscriptions and other recurring revenues. Firstly, the digitally enabled car-sharing and subscription offering utilizes pay-per-use and subscription revenue models. Secondly, the connected car enables car manufacturers to sell additional functions to the vehicles, commonly priced through a subscription model. This led to after-sale revenue increases. Additionally, electrification has made the production of vehicles more expensive. However, for car-sharing operators, the operational costs have decreased since electricity is cheaper than fuel.

To conclude, digitalization and electrification impacted all three business model components. Understanding this impact can facilitate identifying the challenges and opportunities the future holds.

6.1.2 *What challenges and future opportunities do these trends bring to the industry?*

This study´s findings present several challenges and opportunities emerging from digitalization and electrification's current and perceived future impact on the automotive mobility industry. The challenges revolved around regulations, limited charging infrastructure, IT competence gaps, IT security, adaptation to the digital environment, limited resources in producing batteries for EVs, high costs & low supply of EVs, and increasing electricity prices. In addition, car-sharing providers found it challenging to manage charging for their fleet of EVs.

On the other hand, the two trends bring several opportunities for industry actors. Developing electric mobility solutions for urban cities, such as electricity-powered micro-mobility, presents an attractive opportunity for companies. Integrating different transportation modes through Mobility as a Service (MaaS) platforms allow for effective mobility solutions and the potential for collaboration with various actors, increasing the value for citizens and industry actors.

Furthermore, autonomous vehicles emerge as a transformative opportunity, with potential business models based on service concepts. The value proposition of autonomous vehicles is expected to shift towards personalized experiences, convenience, comfort, and productivity, which opens new avenues for innovation. By engaging in strategic collaborations and novel business models, companies can capitalize on this technology. At the same time, customers receive lower prices and more efficient transportation.

New customer segments, for example, students, present an attractive target group for car-sharing providers, and dynamic pricing models can be employed to cater to their needs and increase utilization rates during off-peak periods. Charging infrastructure, although challenging, offers opportunities for revenue generation through selling charging services, developing charging networks, and embracing V2G and V2X solutions. The last mentioned could facilitate the managing of charging for car-sharing providers.

Lastly, facilitated P2P car-sharing, supported by the development of a universal standard for digital keys and the advantages of EVs for home charging, can transform the business model by focusing on mediating demand and supply rather than solely providing a mobility service.

6.2 Managerial Implication

By understanding what changes digitalization and electrification have brought to the automotive mobility industry, stakeholders gain insight into the market dynamics and can adapt their strategies and business models to stay competitive in a changing landscape. It can also be necessary for identifying impacted areas with optimization potential. In addition, it could be valuable insight to compare these changes to other industries affected by one or both trends.

Another insight from this study was the increased cross-industrial nature of the automotive mobility industry. Managers should look inside and outside industry borders for strategic alliances to foster innovation and capitalize on digitalization and electrification.

The challenges discovered in this study can be used by managers to proactively minimize the risk to the business when digitalizing or electrifying the business. For example, acquire sufficient employee competencies and strategic partnerships. The identified opportunities could guide managers in strategic planning and innovate and differentiate offerings.

6.3 Theoretical Implications

This study contributes to academic research by identifying challenges and opportunities not mentioned in the existing literature. New challenges include a lack of resources to produce EVs, insecurities about electricity prices, difficulties owning an EV for people living in apartments, regulations, and IT security risks. New opportunities are related to capitalizing of charging, facilitated P2P car-sharing, earlier customer relationships through connected vehicles and car-sharing and subscription services, and extended mobility services beyond the car.

6.4 Research Limitation

Although this study provides managers with valuable insights, it has limitations. Firstly, this study investigated the automotive mobility industry, capturing multiple actors, including car manufacturers, car-sharing services, and ride-hailing services. The findings of this study provide an overall picture of the industry, and all changes in the business model, challenges, and opportunities might not apply to a specific company within the industry. Secondly, the study was conducted in the Swedish context, which might differ from other geographical areas. Finally, the study was conducted within a restricted time, limiting the number of interviews conducted. Therefore, the findings of this study cannot be generalized to apply to the whole industry.

6.5 Future Research

Firstly, future research could focus on conducting similar studies in different geographical contexts and compare how the findings match with this study´s findings. This would provide valuable insight into how changes in business models, challenges, and opportunities are related to geographical context. Secondly, future research could investigate how companies can overcome challenges identified in this study or seize the future opportunities generated from this study. Thirdly, since this research has adopted an industry perspective, future research could focus on one industry actor to generate more specific findings about one type of company. Finally, future research might address only one of the two trends investigated in this study or be directed toward one specific field within a trend, such as connectivity, autonomous vehicles, big data, IoT, charging infrastructure, or electric vehicles.

7.0 References

Abdelkafi, N., Makhotin, S., & Posselt, T. (2013). Business model innovations for electric mobility-what can be learned from existing business model patterns? *International Journal of Innovation Management*, *17*(1). https://doi.org/10.1142/S1363919613400033

Abouee-Mehrizi, H., Baron, O., Berman, O., & Chen, D. (2021). Adoption of Electric Vehicles in Car Sharing Market. *Production and Operations Management*, *30*(1), 190–209. https://doi.org/10.1111/poms.13262

Anderson, P., & Tushman, M. L. (1990). Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change. *Administrative Science Quarterly*, *35*(4), 604–633. https://doi.org/10.2307/2393511

Athanasopoulou, A., Bouwman, H., Nikayin, F., & de Reuver, M. (2016). The disruptive impact of digitalization on the automotive ecosystem: A research agenda on business models, platforms and consumer issues. *29th Bled EConference: Digital Economy, BLED 2016*, 597–604.

Athanasopoulou, A., de Reuver, M., Nikou, S., & Bouwman, H. (2019). What technology enabled services impact business models in the automotive industry? An exploratory study. *Futures*, *109*, 73–83. https://doi.org/10.1016/j.futures.2019.04.001

Bell, E., Alan Bryman, & Bill Harley. (2019). *Business research methods* (Fifth edition).

Berg, J., Henriksson, M., & Ihlström, J. (2019). Comfort first! vehicle-sharing systems in urban residential areas: The importance for everyday mobility and reduction of car use among pilot users. *Sustainability (Switzerland)*, *11*(9). https://doi.org/10.3390/su11092521

Bohnsack, R., Kurtz, H., & Hanelt, A. (2021). Re-examining path dependence in the digital age: The evolution of connected car business models. *Research Policy*, *50*(9), 104328. https://doi.org/10.1016/j.respol.2021.104328

Canzler, W., & Knie, A. (2016). Mobility in the age of digital modernity: why the private car is losing its significance, intermodal transport is winning and why

digitalisation is the key. *Applied Mobilities*, *1*(1), 56–67. https://doi.org/10.1080/23800127.2016.1147781

Chen, C.-F., Zarazua de Rubens, G., Noel, L., Kester, J., & Sovacool, B. K. (2020). Assessing the socio-demographic, technical, economic and behavioral factors of Nordic electric vehicle adoption and the influence of vehicle-to-grid preferences. *Renewable and Sustainable Energy Reviews*, *121*. https://doi.org/10.1016/j.rser.2019.109692

Chesbrough, H. (2010). Business Model Innovation: Opportunities and Barriers. *Long Range Planning*, *43*(2), 354–363. https://doi.org/10.1016/j.lrp.2009.07.010

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, *11*(3), 529–555. https://doi.org/10.1093/icc/11.3.529

Chesbrough, H. W. (2006). *Open business models : how to thrive in the new innovation landscape*. Boston, Mass. : Harvard Business School Press.

Chesbrough, H. W., Vanhaverbeke, W., & West, J. (2006). *Open innovation researching a new paradigm*. Oxford : Oxford University Press.

Christensen, C. M. (2000). *The innovator's dilemma* ([Rev., updated ed.]). New York : HarperBusiness.

Christensen, C. M., Bartman, T., & Van Bever, D. (2016). The hard truth about business model innovation. *MIT Sloan Management Review*, *58*(1), 31.

Christensen, C. M., McDonald, R., Altman, E. J., & Palmer, J. E. (2018). Disruptive Innovation: An Intellectual History and Directions for Future Research. *Journal of Management Studies*, *55*(7), 1043–1078. https://doi.org/10.1111/joms.12349

Coppola, R., & Morisio, M. (2017). Connected Car: Technologies, Issues, Future Trends. *ACM Computing Surveys*, *49*(3), 1–36. https://doi.org/10.1145/2971482

Covarrubias, A. (2018). When disruptors converge: The last automobile revolution. *International Journal of Automotive Technology and Management*, *18*(2), 81–104. https://doi.org/10.1504/IJATM.2018.092184

Das, H. S., Rahman, M. M., Li, S., & Tan, C. W. (2020). Electric vehicles standards, charging infrastructure, and impact on grid integration: A technological review. *Renewable and Sustainable Energy Reviews*, *120*. https://doi.org/10.1016/j.rser.2019.109618

Dijk, M., Wells, P., & Kemp, R. (2016). Will the momentum of the electric car last? Testing an hypothesis on disruptive innovation. *Technological Forecasting and Social Change*, *105*, 77–88. https://doi.org/10.1016/J.TECHFORE.2016.01.013

Dubosson-Torbay, M., Osterwalder, A., & Pigneur, Y. (2002). E-business model design, classification, and measurements. *Thunderbird International Business Review*, *44*(1), 5. https://doi.org/10.1002/tie.1036

Haustein, S., & Jensen, A. F. (2018). Factors of electric vehicle adoption: A comparison of conventional and electric car users based on an extended theory of planned behavior. *International Journal of Sustainable Transportation*, *12*(7), 484–496. https://doi.org/10.1080/15568318.2017.1398790

He, L., Ma, G., Wei, Q., & Xin, W. (2020). Charging an Electric Vehicle-Sharing Fleet. *Manufacturing & Service Operations Management*, *23*(2), 471–487.

Huang, H.-C., Lai, M.-C., Lin, L.-H., & Chen, C.-T. (2013). Overcoming organizational inertia to strengthen business model innovation: An open innovation perspective. *Journal of Organizational Change Management*, *26*(6), 977–1002.

Kanda, W., & Kivimaa, P. (2020). What opportunities could the COVID-19 outbreak offer for sustainability transitions research on electricity and mobility? *Energy Research and Social Science*, *68*. https://doi.org/10.1016/j.erss.2020.101666

Kim, S., Connerton, T. P., & Park, C. (2021). Exploring the impact of technological disruptions in the automotive retail: A futures studies and systems thinking approach based on causal layered analysis and causal loop diagram. *Technological Forecasting and Social Change*, *172*, 121024. https://doi.org/10.1016/J.TECHFORE.2021.121024

Kley, F., Lerch, C., & Dallinger, D. (2011). New business models for electric cars-A holistic approach. *Energy Policy*, *39*(6), 3392–3403. https://doi.org/10.1016/j.enpol.2011.03.036

Kotilainen, K., Aalto, P., Valta, J., Rautiainen, A., Kojo, M., & Sovacool, B. K. (2019). From path dependence to policy mixes for Nordic electric mobility: Lessons for accelerating future transport transitions. *Policy Sciences*, *52*(4), 573–600. https://doi.org/10.1007/s11077-019-09361-3

Kumar, R. R., & Alok, K. (2020). Adoption of electric vehicle: A literature review and prospects for sustainability. *Journal of Cleaner Production*, *253*. https://doi.org/10.1016/j.jclepro.2019.119911

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*.

Llopis-Albert, C., Rubio, F., & Valero, F. (2021). Impact of digital transformation on the automotive industry. *Technological Forecasting and Social Change*, *162*. https://doi.org/10.1016/j.techfore.2020.120343

Lopez-Vega, H., & Moodysson, J. (2023). Digital Transformation of the Automotive Industry: An Integrating Framework to Analyse Technological Novelty and Breadth. *Industry and Innovation*, *30*(1), 67–102. https://doi.org/10.1080/13662716.2022.2151873

Merfeld, K., Wilhelms, M. P., Henkel, S., & Kreutzer, K. (2019). Carsharing with shared autonomous vehicles: Uncovering drivers, barriers and future developments – A four-stage Delphi study. *Technological Forecasting and Social Change*, *144*, 66–81. https://doi.org/10.1016/J.TECHFORE.2019.03.012

Mitchell, D., & Coles, C. (2003). The ultimate competitive advantage of continuing business model innovation. *The Journal of Business Strategy*, *24*(5), 15–21. https://doi.org/10.1108/02756660310504924

Mitchell, D. W., & Bruckner Coles, C. (2004a). Business model innovation breakthrough moves. *The Journal of Business Strategy*, *25*(1), 16–26. https://doi.org/10.1108/02756660410515976

Mitchell, D. W., & Bruckner Coles, C. (2004b). Establishing a continuing business model innovation process. *The Journal of Business Strategy*, *25*(3), 39–49. https://doi.org/10.1108/02756660410536991

Müller, J. M., Buliga, O., & Voigt, K.-I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological*

Forecasting and Social Change, *132*, 2–17. https://doi.org/10.1016/j.techfore.2017.12.019

Porter, M. E. (1985). *Competitive advantage : creating and sustaining superior performance*.

Rachinger, M., Rauter, R., Müller, C., Vorraber, W., & Schirgi, E. (2019). Digitalization and its influence on business model innovation. *Journal of Manufacturing Technology Management*, *30*(8), 1143–1160. https://doi.org/10.1108/JMTM-01-2018-0020

Richardson, J. (2008). *The Business Model: An Integrative Framework for Strategy Execution The Business Model: An Integrative Framework for Strategy Execution The Business Model: An Integrative Framework for Strategy Execution*. http://ssrn.com/abstract=932998Electroniccopyavailableat:https://ssrn.com/abstract=932998Electroniccopyavailableat:http://ssrn.com/abstract=932998https://ssrn.com/abstract=932998

Shams Esfandabadi, Z., Diana, M., & Zanetti, M. C. (2022). Carsharing services in sustainable urban transport: An inclusive science map of the field. *Journal of Cleaner Production*, *357*. https://doi.org/10.1016/j.jclepro.2022.131981

Sopjani, L., Stier, J. J., Hesselgren, M., & Ritzén, S. (2020). Shared mobility services versus private car: Implications of changes in everyday life. *Journal of Cleaner Production*, *259*. https://doi.org/10.1016/j.jclepro.2020.120845

Sovacool, B. K., Kester, J., Noel, L., & de Rubens, G. Z. (2018). The demographics of decarbonizing transport: The influence of gender, education, occupation, age, and household size on electric mobility preferences in the Nordic region. *Global Environmental Change*, *52*, 86–100. https://doi.org/10.1016/j.gloenvcha.2018.06.008

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Teece, D. J. (2018). Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. *Research Policy*, *47*(8), 1367–1387.

Tongur, S., & Engwall, M. (2014). The business model dilemma of technology shifts. *Technovation*, *34*(9), 525–535. https://doi.org/10.1016/j.technovation.2014.02.006

Warner, K. S. R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, *52*(3), 326–349. https://doi.org/10.1016/j.lrp.2018.12.001

Wittmann, J. (n.d.). *Electrification and Digitalization as Disruptive Trends: New Perspectives for the Automotive Industry?* (pp. 137–159). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-44468-0_9

Wong, Y. Z., Hensher, D. A., & Mulley, C. (2020). Mobility as a service (MaaS): Charting a future context. *Transportation Research Part A: Policy and Practice*, *131*, 5–19. https://doi.org/10.1016/J.TRA.2019.09.030

Zarazua de Rubens, G., Noel, L., Kester, J., & Sovacool, B. K. (2020). The market case for electric mobility: Investigating electric vehicle business models for mass adoption. *Energy (Oxford)*, *194*, 116841. https://doi.org/10.1016/j.energy.2019.116841

Books, Documents, Reports, and Web pages

Abnett, K. (2023, February 14). EU lawmakers approve effective 2035 ban on new fossil fuel cars. Reuters. https://www.reuters.com/business/autos-transportation/eu-lawmakers-approve-effective-2035-ban-new-fossil-fuel-cars-2023-02-14/

An ecosystem approach for EV adoption. (n.d.).

Gustafsson, E. (2022). qualitative research_part 1 [PowerPoint slides] retrieved from: https://canvas.gu.se/courses/61775/files/6561739?module_item_id=770040

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*.

Misoyannis, A. (2023, January 30). Toyota remained world's biggest car maker in 2022. drive. https://www.drive.com.au/news/toyota-remains-worlds-biggest-car-maker-in-2022/

Statista. (2023, March 20). Global market capitalization of carmakers by market cap 2023. https://www.statista.com/statistics/1130533/global-market-value-of-carmakers-by-market-cap/#:~:text=global%20market%20capitalization%20of%20carmakers%20by%20market%20

cap%202023&text=tesla%20was%20the%20most%20valuable,over%20569.95%20billion%20u.s.%20dollars

Mazar, G. (2022, December 21). global automotive executive survey 2022. KPMG. https://kpmg.com/de/en/home/insights/2022/12/global-automotive-executive-survey-2022.html

Rask, K. (2023, January 2). Årets statistik: 2022 fick Sverige nästan 100 000 nya elbilar – motsvarande 31%. Allt Om Elbil. https://alltomelbil.se/arets-statistik-2022-fick-sverige-nastan-100-000-nya-elbilar-motsvarande-31/

Goffin, K., & Mitchell, R. (2017). Innovation Management : Effective strategy and implementation (Third ed.).

Appendix

Appendix A. Interview Guide

Introduction

- How long have you been working for the company?
- Which position do you have in the company, and what are your responsibilities?
- Have you had any previous positions in the company?

Business model

- Can you provide a brief description of the company's business model?
    - What value do you deliver to the customer?
    - How do you create and deliver the value?
    - How do customers pay for the offering?
    - What is the company´s competitive advantage?

Digitalization and business model

- What challenges has digitalization brought to your company?
    - Please give an example
- What opportunities has digitalization brought to your company?
    - Please give an example
- Can you describe how digitalization has affected the company´s business model?
    - Please give an example
- What opportunities do you see digitalization will bring to your company looking ahead?
    - Please give an example
- What challenges do you see digitalization will bring to your company looking ahead?
    - Please give an example

Electrification and business model

- What challenges has electrification brought to your company?
    - Please give an example
- What opportunities has electrification brought to your company?
    - Please give an example
- Can you describe how electrification has affected the company´s business model?
    - Please give an example
- What opportunities do you see electrification will bring to your company looking ahead?
    - Please give an example
- What challenges do you see electrification will bring to your company looking ahead?
    - Please give an example

Business model innovation

- Do you believe the current business model must change or that other business models must be introduced to remain competitive as the industry changes?
    - In what way?
- What processes does the company have for making changes to the business model?

Other

- Is there anything you would like to add to what we discussed today?

Appendix B. Table of Thematic Analysis

First-order Themes	Second Order Themes	Aggregatets
Easy to pay Pay through app Digital key Order direct online Online platform Cheaper and effective rides Freer movement	Customer Benefit	Digitalization Advantages & Opportunities
Connected services Selling software services Sell functions trough apps Self-driving Parking Car like a phone	Connectivity	
Close to customer Create early customer relations More frequent mobility purchases Understand the customer Prolonged customer relationship Analyzing data	Customer Relationship	
Replaces private car Multimodality Other mobility solutions than car New sharing business models Car as a Service Become relevant in other areas Micro/contact mobility	Shared Multimodal Mobility	

New customer targets New products New relations Autonomous cabs customer can earn money on the car	Novelty	
Fewer costs Prerequisite Easy to expand Optimal pricing	Other	
Self-charging hybrids Lower operating costs First mover advantage Customer enjoys electric offering Compete on range Attention for good performance	Competitive Advantage	Electrification Advantages and Opportunities
More inner-city chargers Make charging easier Automated charging Facilitating payment for charging Earn money on charging	Charging Network	
More Eco friendly Sustainability Reduce car emissions	Sustainability	
E-bikes E-scooters Plug-in hybrids Different electrical alternatives Hydrogen cars Fuel cell cars	Electric Alternatives	
Multimodality Mobilityhubbs	Collaboration & Integration	

Connected/integrated mobility Increased Collaboration		
Resistance from car rentals Resistance from taxi Price regulations Autonomous vehicle regulations Regulations for carsharing Premature regulations Regulations to multimodality	Regulations & Resitance	Digitalization Challenges
New digital BMs Online customer meeting point Online transformation Competence gap	Organizational Adaptation	
Consumer integrity IT security risk Hacking Customer integrity	Integrity & Security	
Not enough resources Find alternative ways to sustainability Too expensive cars Lack of electricity	Lack of resources	Electrification Challenges
Lack of charging capacity Too slow chargers Urban charging Difficult to expand geographically	Charging Infrastructure	
Need to adapt EVs Need to change BM Need to change products Difficult to know how Large investments in battery parks	Organizational Change	
Takes more from customer Finding charging stations Complicated for customer	Customer Inconvenience	

Executive Summary

1.0 Introduction

Scholars have long studied technological change, including the interplay between incremental and radical innovations (Anderson & Tushman, 1990). Disruptive technological shifts, like the rise of electric vehicles and digitalization, are challenging established business models in the automotive industry. Incumbents face constraints in adapting, while new entrants leverage innovative technologies to disrupt the market, like Tesla, who has capitalized on electric vehicles and innovative business models to disrupt the market successfully.

To navigate this landscape effectively, industry actors must recognize that the challenge lies in technological advancements and underlying business models. Developing effective business models depends on capturing value from innovative technologies and attaining sustainable competitive advantages (H. Chesbrough, 2010). In the automotive mobility industry, aligning technology and innovation with suitable business models becomes crucial for success.

Electric and digital vehicles and business models have already witnessed widespread adoption and will likely increase over the coming years. The two trends present several challenges and opportunities for industry actors, including car manufacturers and service providers. For example, autonomous vehicles are expected to enter major cities by 2035, which will significantly impact the industry (Mazar, 2022). In response to these trends, automotive executives recognize the importance of evolving their business models to adapt to changing customer relationships, revenue models, and technologies (Mazar, 2022).

The rise of digital platforms has spurred the emergence of business models centered around the sharing economy and access-based consumption. Car-sharing and ride-hailing services have changed traditional car ownership patterns, enabling users to access vehicles on-demand and pay for their usage rather than owning a car. This shift in consumption patterns has further propelled the need for innovative business models that cater to these emerging trends.

Overall, both OEMs and car service providers are affected by the digitalization and electrification of vehicles, leading to increased competition and a changing business environment. To remain competitive, business model innovation is essential, as it has proven to be a robust response in such an industry (H. Chesbrough, 2010). This study will examine the current and future impact of digitalization and electrification on the business models of

automotive mobility providers in the Swedish context. Automotive mobility providers refer to the automotive and the car mobility industry, involving both car manufacturers and service providers (more on this in Chapter 3).

1.1 Purpose and Research Questions

Previous studies on technology advancements and the automobility industry have focused on categorizing the automotive industry on disruptive scales (Covarrubias, 2018), or focused on automotive retail (Kim et al., 2021), or shared autonomous mobility (Merfeld et al., 2019). Some studies have focused on business models for electrification (i.e., Zarazua de Rubens et al., 2020), but rarely from the company's perspective. Several authors argue that there has been limited research on business models regarding digitalization and electrification in the automotive industry and highlight the need for more research on the subject (Athanasopoulou et al., 2016; Rachinger et al., 2019). With this theoretical point of departure, this study seeks to generate additional aspects of how the technology has impacted and can potentially impact the industry.

This study aims to deepen the understanding of how digitalization and electrification have changed the industry and can influence the industry looking ahead. To reach this aim, this study focuses on how automotive mobility providers adapt and innovate business models regarding these two trends and what challenges and opportunities have arisen. By understanding this industry, stakeholders can generate strategies for capitalizing on these trends. Digitalization and electrifications are relevant to examine since they capture the main technological developments of the automotive mobility industry.

Additionally, this research focuses on automotive manufacturers, car-sharing, and ride-hailing providers. These actors will be investigated in the Swedish context because of the immense growth of EVs, the fast pace of digitalization, and both car manufacturers and car-sharing providers operating in the country. Furthermore, this country is the home country of the author, facilitating the execution of this study.

The research questions of this study are:

- **RQ1:** *How have digitalization and electrification impacted Swedish automotive mobility providers' business models?*

- **RQ2:** *What challenges and future opportunities do these trends bring to the industry?*

The first RQ aims to answer how business models have been influenced by digitalization and electrification by looking at what challenges and advantages industry actors have experienced by these trends. The second RQ adopts a future perspective on the challenges and opportunities digitalization and electrification bring to the industry.

The following section will present empirical literature on electrification and digitalization in the automotive mobility industry, followed by theoretical literature with an overview of business models and business model innovation. Then a section about the research method will follow. After that, the study's empirical findings, analysis, and conclusion will be presented.

2.0 Literature Review

This section will first present an empirical literature review, including previous research. The second section will include a theoretical literature review of the theories used in the study.

2.1 Empirical literature

Previous research on digitalization within the automotive mobility industry has focused on big data, Connectivity, and the Internet of Things (IoT). Big data and analytics provide valuable insights into customer behavior, leading to targeted customer offerings and new business models in the automotive industry (Wittmann, 2017; Llopis-Albert et al., 2021; Rachinger et al., 2019).

Connected vehicles (CV) leverage wireless connectivity to enhance safety, usability, and comfort while paving the way for autonomous vehicles. CV facilitates vehicle-to-vehicle communication and enables adaptive cruise control and automatic lane-keeping (Athanasopoulou et al., 2016; Das et al., 2020; Coppola & Morisio, 2017). The increasing software orientation of vehicles transforms them into "computers on wheels," opening new revenue streams through software-based services (Athanasopoulou et al., 2016; Bohnsack et al., 2021).

The Internet of Things (IoT) has revolutionized the industry by creating digital platforms that connect suppliers and customers, enabling services like car-sharing and mobility-as-a-service (Wong et al., 2020; Athanasopoulou et al., 2016; Llopis-Albert et al., 2021).

These digital transformations require traditional car manufacturers to adapt their business models and organizations (Athanasopoulou et al., 2016; Llopis-Albert et al., 2021). However, the rapid pace of technological advancements poses challenges regarding vehicle longevity

and staying up-to-date (Athanasopoulou et al., 2016). Digitalization in the automotive industry improves the value chain, increases efficiency, and calls for new capabilities such as marketing, user experience, and data utilization (Llopis-Albert et al., 2021).

Electrification within the automotive mobility industry refers to electric vehicles (EVs) and charging infrastructure. EVs offer advantages such as reduced carbon emissions, lower consumption costs, and improved mileage and affect various industry actors, including car dealerships, manufacturers, service providers, and suppliers (Kim et al., 2021; Llopis-Albert et al., 2021; Kley et al., 2011; Müller et al., 2018).

EVs open up opportunities for mobility services like car-sharing and vehicle-to-grid integration (Kley et al., 2011; Abdelkafi et al., 2013). A secondary usage of EV components, tracking driver behavior, and integrating charging station information are potential benefits (Kley et al., 2011; An Ecosystem Approach for EV Adoption, n.d.). However, challenges include range anxiety, dependence on charging infrastructure, higher purchasing prices, and economic uncertainties (Kumar & Alok, 2020; Zarazua de Rubens et al., 2020).

The previous research on digitalization and electrification, with a few exceptions, has not primarily focused on the business model. This study will address this research gap.

2.2 Theoretical Literature

Theoretical literature includes business model and business model innovation theories. The literature on business models has gained increasing interest in recent years (Goffin & Mitchell, 2017). Business models can be seen as a description of how a firm conducts business (Richardson, 2008). Osterwalder and Pigneur (2002) define business models as the conceptual and architectural implementation of a business strategy and the foundation for business processes. Teece (2010) emphasizes that a business model should inform activities, their linkage and sequencing, responsible parties, and locations.

This thesis adopts Richardson's (2008) business model framework, which comprehensively explains how a firm does business and its strategic orientation. The framework comprises three main concepts: value proposition, value creation, delivery system, and value capture.

The value proposition encompasses the firm's offerings, target customers, and competitiveness relative to competitors. It represents the reason why customers attach value to the firm's offerings.

The value creation and delivery system details how the firm implements the value proposition and competes. It includes the value network, resources and capabilities, organizational activities, and structure. The larger value network, which includes suppliers, complementors, partners, and distributors, plays a crucial role in value creation and delivery.

The value capture component focuses on the firm's ability to generate revenue. It involves the revenue model, describing the sources of revenue and different ways it can be generated, and the economic model, considering the cost structure.

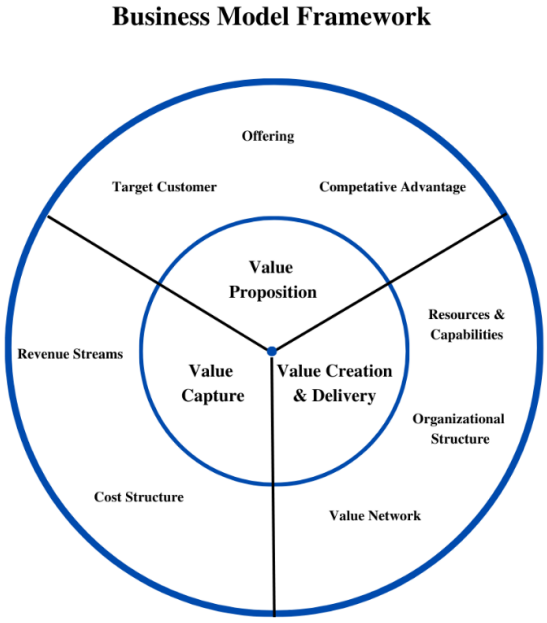

Figure 1: Business Model Framework

Source: Produced by the author based on Richardson's Business model framework

Previous research has demonstrated the benefits of business model innovation, including increased revenue growth and a sustainable competitive advantage (Mitchell & Coles, 2004; Chesbrough, 2010). Business model innovation involves providing new offerings to customers and end users previously unavailable (Mitchell and Coles, 2003). Mitchell and Coles (2003) highlight the significance of business model innovation in outperforming competitors and achieving sustained competitive advantage.

Successful business model innovation can be achieved by adding complementary products or services, adjusting prices, and lowering operating costs (Mitchell & Coles, 2004). Companies should understand customer needs and explore innovations outside their industry for new

ideas. Having a process in place, such as continuing business model innovation, is essential for success (Mitchell & Coles, 2003). Experimentation and learning from failures are crucial aspects of the process (Chesbrough, 2010).

The concept of open innovation, introduced by Chesbrough (2003), suggests that companies should open their business models and engage in inter-organizational and cross-industry collaborations to gain external knowledge and ideas. Embracing open innovation facilitates the incorporation of complementary assets and enhances customer value (Teece, 2018). Open innovation promotes the flow of ideas, improves performance, and positively influences business model innovation (Huang et al., 2013).

3.0 Methodology

This study employed a qualitative research strategy, which allowed for an in-depth examination of participants' experiences and perspectives (Bell et al., 2019). The chosen epistemological position was interpretivism, aiming to understand the social world through participant interpretations (Bell et al., 2019).

The research design for this study was a multiple-case study with a comparative design, focusing on digitalization and electrification's impact on business models, challenges, and future opportunities (Bell et al., 2019). The multiple-case study approach facilitated the exploration of complex, real-life phenomena in their natural setting and enabled comparisons between cases (Bell et al., 2019). The sampling followed grounded theory principles until theoretical saturation was achieved, and interviews were conducted to form meaningful categories (Bell et al., 2019).

For data collection, semi-structured interviews were conducted using an interview guide with prepared questions. This approach provided structure while allowing flexibility for follow-up questions and free discussion by the respondents. The interviews were held online, saving time and cost, although there were some limitations with technological issues (Bell et al., 2019). All respondents agreed to be recorded, and transcriptions were made immediately after each interview, eliminating the need for notetaking and facilitating analysis.

Additionally, purposive sampling was used based on industry, business model, and geographic location within the automotive mobility industry in Sweden. The automotive mobility industry refers to car manufacturers, car-sharing providers, and ride-hailing providers. The chosen cases included a traditional car manufacturer, car-sharing services, a

ride-hailing service with a car-sharing component, a multi-service mobility provider, and an industry expert. Different business models were considered, reflecting the impact of electrification and digitalization (Bell et al., 2019).

Respondent	Role	Company	Date	Duration	Medium
R1	Public Policy Director	Bolt	2023-04-04	00:38:13	Zoom
R2	Previous CFO	Toyota Sweden	2023-04-13	00:31:15	Zoom
R3	Head of Nordics	Kinto	2023-04-13	00:34:21	Zoom
R4	Head of Offer & Pricing	Lync&Co	2023-04-21	00:50:14	Teams
R5	Director of Strategy & Business Development	Volvo Mobility	2023-04-26	01:00:53	Zoom
R6	Senior Project Manager	Lindholmen Sience Park	2023-05-03	00:57:12	Zoom

Table 1: List of Respondents

For analyzing the data, thematic analysis was used. Themes were identified based on codes and repetition in the data, emphasizing relevance to the research questions (Bell et al., 2019). The analysis involved open coding, deriving first-order themes, and analyzing similarities to derive second-order themes, ultimately forming four main categories (Bell et al., 2019).

Research quality, reliability, and validity were not applied to qualitative research. Instead, trustworthiness was considered, which includes four criteria: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). All these criteria were taken into consideration during the study.

4.0 Empirical Findings & Data Analysis

Digitalization and electrification have affected all three business model elements: value proposition, value capture & delivery, and value creation. The two trends have also generated several challenges and future opportunities.

Value proposition

Starting with the value proposition, the findings highlight a shift from product to service offerings in the industry (Richardson, 2008). Car-sharing, ride-hailing, and subscriptions are examples of digitalized service models. Traditional car manufacturers have expanded their

offerings by adding complementary services based on existing resources, such as car-sharing services, a strategy that can lead to sustained competitive advantage (Michell & Buckner Coles, 2004a). However, entering the car-sharing market does not guarantee a sustained competitive advantage due to relatively low entry barriers for car manufacturers. Additionally, the findings imply that these new digital business models were experienced as improving the offering compared to more traditional business models, such as taxi and car rental companies, by increased availability, efficiency/speed, and lower service prices.

Furthermore, the findings imply that car-sharing and ride-hailing providers can leverage their digital platform to offer new electric micro-mobility services, such as e-bikes and scooters, which could lead to sustained competitive advantage in line with Michell & Buckner Coles (2004a). This is because a wider range of mobility offerings integrated into one single platform was believed to offer a greater value than having all these solutions fragmented on different platforms.

Besides the technology-enabled car-sharing services, it became evident that the offering was improved by connecting the vehicle to the mobile phone and the internet. Features such as navigation with real-time data of traffic, pre-heating the car, its seat or driving wheel, and integrating Spotify and other applications make the car more user-friendly. Hence, industry actors' offering and value proposition has shifted from a more traditional focus on personal transportation to a greater emphasis on software features, entertainment, and comfort. This can also be seen in previous literature (Canzler & Knie, 2016).

Regarding services like car-sharing and ride-hailing, the target customer has shifted towards people living in urban cities. By targeting the urban population who seek convenient transportation solutions rather than owning a car, actors can tap into a growing market of individuals seeking convenient, cost-effective transportation solutions. EVs were also found suitable for a car-sharing business model aimed at urban dwellers who live in apartments since they often do not have accessible charging possibilities.

The findings implied that competitive advantage is achieved by establishing early customer relationships, fostering closer interactions, and integrating technology, resulting from digitally enabled car-sharing, subscription services, and vehicle connectivity. Electrification has offered some actors a first-mover advantage, i.e., offering electric hybrids before competitors. The focus of EVs is on driving range and charging speed, instead of more traditional values, in line with Canzler & Knie (2016), which has made competing on these

new attributes possible. Capitalizing on customer needs and innovative uses of electric vehicles, such as digital car-sharing, is essential for sustained competitive advantage (Abdelkafi et al., 2013).

Value Creation and Delivery

According to the empirical findings, digitalization and electrification have impacted the automotive industry's value network, resources and capabilities, and organizational structure. The findings suggest that the value network, consisting of external actors involved in creating and delivering value (Richardson, 2008), has been affected by cross-industry collaborations with new complementors, suppliers, partners, and distributors (Richardson, 2008). These collaborations involve electricity companies, governments, software companies like Apple and Google, and telecommunication companies. The increased cross-industry nature of the automotive mobility industry can also be seen in previous literature (Rahchinger et al., 2019; Athanasopoulou et al., 2016). Traditional dealerships are less commonly used, and real estate companies and city planning actors have become important in the value network of car-sharing providers.

Resources and capabilities have also been influenced by electrification and digitalization. The production of electric vehicles requires different raw materials, leading to supply chain reconfigurations and procurement process changes. Additionally, the digital platform has become a vital resource, especially for car-sharing providers, impacting the user experience and competition (Canzler & Knie, 2016). The required competencies within the industry have shifted towards IT, digital marketing, user experience, and data collection, a finding also present in Llopis-Albert et al. (2021) study. In accordance with Rahchinger et al. (2019), the empirical data found that several companies experience a competence gap related to IT.

Organizational changes have occurred in car manufacturers and sharing providers, including restructuring the value chain, integrating battery production, incorporating software and hardware components, and adapting the digital platform. Data analytics plays a significant role in leveraging the vast amounts of data generated by vehicles, customers, and operations for decision-making and refining offerings that can strengthen companies' value proposition (Mitchell & Bruckner Coles, 2004a). Digital payment systems and mobile applications have emerged as new business processes to enhance efficiency and provide a seamless customer experience.

Value Capture

Digitalized sharing services have shifted revenue models towards subscription and pay-per-use models, moving from one-time purchases to recurring revenues. Car manufacturers have adopted subscription models for digitally distributed software features, generating continuous revenue streams throughout the customer lifecycle, supported by Bohnsack et al. (2021) findings. This strategic shift diversifies revenue streams and aligns with Mitchell & Bruckner Coles' (2004a) approach for successful business model innovation, potentially creating a sustainable competitive advantage.

Digitalization and electrification have impacted cost structures. Digitalization has improved efficiency and reduced manual tasks, resulting in cost savings, for example, through digitalizing payment processes. However, EV production costs and investments have increased for car manufacturers due to battery production requirements and the complexity of transitioning from ICE cars to EVs, which aligns with Zarazua de Rubens et al. (2020) findings. Car-sharing providers with a pay-per-use model can lower operating costs using electric fleets, benefiting from lower electricity prices than fossil fuel and enjoying shared capital costs (Kley et al., 2011). Lowering operational costs can lead to a sustained competitive advantage (Mitchell & Bruckner Coles, 2004a).

To see a summary of these findings and analysis, see Table 2 on page 60.

Challenges

Digitalization has led to competence gaps in IT, and IT security has become increasingly critical as cars become more connected, highlighting the need for robust cybersecurity measures. Additionally, organizational adaptation to the digital environment poses a challenge, particularly in establishing effective digital customer interactions. Regulations like minimum price regulations can hinder competition and weaken companies' value propositions. Although not currently posing a challenge in the Swedish context, it was experienced as a threat.

Electrification has been challenging for expanding electric vehicle offerings to other geographical areas with a less developed charging infrastructure—furthermore, consumer anxiety, the availability of EVs, and the development of charging infrastructure present challenges. Electric vehicles' higher costs and uncertainties regarding maintenance, repair, and charging contribute to consumer anxiety. Insecurities about future electricity prices,

driven by increased demand from widespread electric vehicle adoption, create uncertainties for the industry. Finally, limited access to and costly charging options pose significant challenges for car-sharing providers in managing their electric fleets, as He et al. (2021) indicated.

Future Opportunities

Multimodal mobility and integrated mobility offerings present future opportunities for developing electric mobility solutions in urban cities, particularly in the form of micro-mobility powered by electricity. This can be facilitated through digitalization and added to existing digital platforms, catering to users' needs and providing alternatives to car-centric transportation.

Integrating different transportation modes into a single user interface, Mobility as a Service (MaaS) offers effective mobility solutions tailored to individual requirements. Automotive mobility companies must provide their own MaaS platform or collaborate with various stakeholders to participate in this evolving concept. Adopting an open innovation and business model approach to the MaaS idea could foster external and internal knowledge sharing and collaborations and drive innovation since many different actors will be involved in this project (H. W. Chesbrough et al., 2006).

Introducing autonomous vehicles can revolutionize business models, shifting the focus towards service-based concepts like car-sharing and ride-hailing. Collaboration with tech companies developing self-driving technologies may be crucial for automotive mobility providers to stay competitive and reshape their value networks.

Car-sharing providers can target new customer segments, such as students, through pricing models and dynamic pricing strategies. Capitalizing on charging infrastructure also presents opportunities for revenue generation and innovative business models, including developing universal charging networks and exploring vehicle-to-grid solutions.

Cross-industry collaborations enable automotive mobility companies to discover innovative ideas and complementary innovations and create enhanced value for customers. Examples include partnerships with real estate companies to offer shared car services to apartment dwellers or provide car-sharing services for employees' daily commuting.

Facilitated peer-to-peer (P2P) car-sharing, aided by universal digital key standards, simplifies access to private vehicles. With the possibility of home charging, electric vehicles extend the

potential utilization of P2P shared cars, allowing hosts to ensure vehicles are fully charged before each use. This shift towards a mediator role in demand and supply can reshape the business model of automotive mobility providers.

To see a summary of these findings and analysis, see Table 3 on page 67.

6.0 Conclusion

This research aimed to deepen the understanding of how automotive mobility providers adapt and innovate business models and generate strategies regarding electrification and digitalization. The findings of this study have shed light on how the two trends have affected companies and how they have adapted and innovated their business models to capitalize of these trends. Furthermore, the findings have provided challenges and future opportunities regarding digitalization and electrification, which can serve as a basis on developing business strategies around these trends. The following text will answer the two research questions of this study.

RQ1: How have digitalization and electrification impacted Swedish automotive mobility providers' business models?

Digitalization has enabled the introduction of car-sharing services, which has altered the traditional value proposition within the automotive mobility industry where station-based car-sharing services, ride-hailing, and subscribing to a car are becoming attractive options for owning or leasing a car.

The connectivity also enables connection to the phone and internet, which has shifted the value proposition of the automobile to be more centered around digital applications and software features enhancing the comfort and entertainment of the drivers. The connected nature of the vehicle and the digitally enabled car-sharing and subscription services offer companies a potential competitive advantage by creating early customer relationships, fostering frequent and closer customer interactions, and leveraging technology for enhanced customer engagement.

Furthermore, electrification has made expanding offerings within the industry easier by including complementary services like electric bikes, scooters, and other micro-mobility sharing services. By introducing car-sharing services, the target customer segment has expanded towards urban populations who may not want to own a car outright but seek convenient, cost-effective transportation solutions.

Looking at the value creation and delivery system, cross-industry collaborations with new complementors, suppliers, partners, and distributors related to the connectivity of the car and charging infrastructure have become crucial for creating and delivering value to customers. Additionally, the shift towards digitalized business models has reduced the reliance on traditional dealerships. Moreover, there has been a shift in raw material requirements due the production of EVs, batteries, and a connected car, necessitating a reconfiguration of the supply and value chain. Need to secure access to raw materials crucial for battery production. The digital platform has become an essential resource for automotive mobility providers, enabling better user experience and service delivery. Regarding capabilities, the industry has experienced a shift in competencies regarding IT.

In terms of value creation, the main implication of digitalization is the emergence of subscriptions and other recurring revenues. The digitally enabled car-sharing and subscription offering utilizes pay-per-use and subscription, revenue models. The connected car enables car manufacturers to sell additional functions to the vehicles commonly priced through a subscription model. This led to after-sale revenue increases. Additionally, electrification has made the production of vehicles more expensive. However, for car-sharing operators, the operational costs have decreased since electricity is cheaper than fuel.

RQ2: What current challenges and future opportunities do these trends bring to the industry?

This study´s findings present several challenges and opportunities emerging from digitalization and electrification's current and perceived future impact on the automotive mobility industry. The challenges revolved around regulations, limited charging infrastructure, IT competence gaps, IT security, adaptation to the digital environment, limited resources in producing batteries for EVs, high costs & low supply of EVs, and increasing electricity prices. In addition, car-sharing providers found it challenging to manage charging for their fleet of EVs.

On the other hand, the two trends bring several opportunities for industry actors. The development of electric mobility solutions aimed at urban cities, such as micro-mobility powered by electricity, presents an attractive opportunity for companies that could be capitalized through an integrated MaaS offering.

Furthermore, autonomous vehicles emerge as a transformative opportunity, with potential business models based on service concepts. The value proposition of autonomous vehicles is expected to shift towards personalized experiences, convenience, comfort, and productivity, which opens new avenues for innovation.

New customer segments, for example, students, present an attractive target group for car-sharing providers, and dynamic pricing models can be employed to cater to their needs and increase utilization rates during off-peak periods. Charging infrastructure, although challenging, offers opportunities for revenue generation through selling charging services, developing charging networks, and embracing V2G and V2X solutions. The last mentioned could facilitate the managing of charging for car-sharing providers.

Lastly, facilitated P2P car-sharing, supported by the development of a universal standard for digital keys and the advantages of EVs for home charging, can transform the business model by focusing on mediating demand and supply rather than solely providing a mobility service.

6.1 Managerial Implication

By understanding what changes digitalization and electrification have brought to the automotive mobility industry, stakeholders gain insight into the market dynamics and can adapt their strategies and business models to stay competitive in a changing landscape. It can also be important for identifying impacted areas with optimization potential. In addition, it could be valuable insight to compare these changes to other industries affected by one or both trends.

Another insight from this study was the increased cross-industrial nature of the automotive mobility industry. Managers should look inside and outside industry borders for strategic alliances to foster innovation and capitalize on digitalization and electrification.

The challenges discovered in this study can be used by managers to proactively minimize the risk to the business when digitalizing or electrifying the business. For example, acquire sufficient employee competencies and strategic partnerships. The identified opportunities could guide managers in strategic planning and innovate and differentiate offerings.

6.2 Research Limitation

Although this study provides managers with valuable insights, it has limitations. Firstly, this study investigated the automotive mobility industry, capturing multiple actors, including car manufacturers, car-sharing services, and ride-hailing services. The findings of this study provide an overall picture of the industry and all changes in the business model, challenges, and opportunities that might not apply to a specific company within the industry. Secondly, the study was conducted in the Swedish context, which might differ from other geographical areas. Finally, the study was conducted within a restricted time, limiting the number of interviews

conducted. Therefore, the findings of this study cannot be generalized to apply to the whole industry.