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Francisco Santos Alonso Lastras

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Francisco Santos Alonso Lastras. A holistic approach for Business Model Innovation in the EV ecosystem : a role-based approach for analyzing BMI. Statistical Finance [q-fin.ST]. Université Paris-Saclay, 2023. English. NNT : 2023UPAST228 . tel-04506554

HAL Id: tel-04506554

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A holistic approach for Business Model Innovation in the EV ecosystem: a role-based approach for analyzing BMI

Approche holistique pour l'innovation des modèles d'affaires dans l'écosystème des véhicules électriques: une approche basée sur les rôles pour l'analyse de l'innovation des modèles d'affaires

Thèse de doctorat de l'université Paris-Saclay

École doctorale n° 573, Approches interdisciplinaires, fondements, applications et innovation
(Interfaces)

Spécialité de doctorat: Génie Industriel

Graduate School: Sciences de l'ingénierie et des systèmes. Référent: CentraleSupélec

Thèse préparée dans l'unité de recherche **Laboratoire Génie Industriel** (Université Paris-Saclay, CentraleSupélec), sous la direction d'**Isabelle Nicolai**, professeure.

Thèse soutenue à Paris-Saclay, le 15 décembre 2023, par

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Titre : Approche holistique pour l'innovation des modèles d'affaires dans l'écosystème des véhicules électriques : une approche basée sur les rôles pour l'analyse de l'innovation des modèles d'affaires.

Mots clés : Véhicules Électriques, Innovation de Modèle d'Affaires, Écosystèmes d'affaires.

Résumé : L'industrie automobile mondiale subit une transformation profonde avec l'adoption rapide des véhicules électriques. Les véhicules électriques représentent la durabilité et l'avancée technologique, remodelant le secteur automobile et réduisant les émissions de carbone. Cette transition dépasse les véhicules eux-mêmes, englobant l'ensemble de l'écosystème des véhicules électriques. Les modèles d'affaires traditionnels conçus pour les moteurs à combustion interne sont inadaptés aux véhicules électriques, nécessitant de nouveaux modèles. Cette thèse explore le dynamisme de l'écosystème des véhicules électriques et le besoin pressant d'Innovation de Modèle d'Affaires dans le secteur automobile. Cependant, l'écosystème des véhicules électriques est

Title : A holistic approach for Business Model Innovation in the EV ecosystem: a role-based approach for analyzing BMI.

Keywords : Electric Vehicles (EVs), Business Model Innovation (BMI), Business Ecosystems.

Abstract : The global automotive industry is undergoing a profound transformation with the rapid adoption of Electric Vehicles (EVs). EVs represent sustainability and technological advancement, reshaping the automotive landscape and reducing carbon emissions. This shift extends beyond the vehicles themselves, encompassing the entire EV ecosystem. Traditional business models designed for internal combustion engines are inadequate for EVs, necessitating new models. This thesis explores the dynamic landscape of the EV ecosystem and the pressing need for Business Model Innovation (BMI) in the automotive sector. However, the EV ecosystem is

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Acknowledgments

As I finalize this fulfilling and challenging journey, I want to express my gratitude to all the people who have directly or indirectly helped me get here.

First, I would like to thank the members of the jury, for agreeing to evaluate this thesis and for their valuable comments and contributions.

I extend my gratitude to CONACYT and the French Government for the scholarship that supported my doctoral studies.

I would like to thank my colleagues at CentraleSupélec, who provided me with their support all the way. Special thanks go to all the doctoral candidates with whom I've shared many great moments at LGI.

I would like to give a special acknowledgment to Isabelle for her unconditional support and guidance throughout this entire process, and for consistently pushing me to do my best.

Finally, all my gratitude to my mom, my sisters, my family, and my friends, whose encouragement and support have been my greatest source of strength.

Summary

The global automotive industry is undergoing a profound transformation driven by the rapid adoption of Electric Vehicles (EVs). This revolution is not limited to the vehicles themselves but extends to the entire ecosystem around them. In this thesis, we set out to understand the dynamic landscape of the EV ecosystem, the compelling need for new business models, and the rationale for exploring the concept of Business Model Innovation (BMI) within the automobile sector.

The EV ecosystem represents a significant shift in the automotive paradigm. It is marked by a complex network of stakeholders, including EV manufacturers, charging infrastructure providers, battery suppliers, regulatory authorities, environmentally conscious consumers, among others. Within this ecosystem, EVs are not merely vehicles but symbols of sustainability, technological advancement, and the catalysts for redefining mobility. The stakes involved are huge – from reducing carbon emissions to reshaping the competitive landscape of the automotive industry, the EV ecosystem stands as a central driver of transformation.

In this context, the traditional business models that have long supported the automotive industry are facing challenges in adapting to the transformative forces at play. The need for new business models in the EV ecosystem is, therefore, not a choice but a critical requirement. This necessity arises from the disruptive nature of EV technology, the shift in consumer preferences towards sustainability, and the convergence of the automotive and technology sectors. The existing BMs, designed around internal combustion engines, are not well-suited to meet the unique demands and opportunities presented by EVs.

At this point, it is essential to examine the rationale behind this study's focus on Business Model Innovation within the automobile sector. BMI can be understood from a dual perspective: firstly, as the development of innovative BMs within established enterprises, as articulated by Markides (2006); and secondly, as the exploration of novel business logics that facilitate the creation and capture of value for all stakeholders, a perspective highlighted by Casadesus-Masanell and Zhu (2013). This research is driven by the pursuit of new avenues for value creation and innovative approaches to effectively capture this value within the EV ecosystem.

The EV ecosystem is not a single entity, but a dynamic network of multiple stakeholders interconnected through three distinct value chains. These value chains, which cover

manufacturing, infrastructure development, and user experience, serve as the foundation of the ecosystem. Therefore, BMI requires a comprehensive exploration extending beyond typologies like the one proposed by Massa et Tucci (2013) that distinguish between business model design (BMD) and business model redesign (BMR). This thesis explores the space between BMD and BMR and goes further by acknowledging the multifaceted nature of BMI within the EV ecosystem.

Understanding BMI in this context requires a threefold perspective that considers the role and function assigned to the firm within the ecosystem. Drawing upon insights from entrepreneurship, innovation, technology management, and corporate strategy, we employ a role-based framework to provide an overview of the current field of BMI.

In this thesis, we answer the question: **how can BMI be a means of designing a product-service platform for an EV ecosystem?** This question serves as our guiding principle, driving us to investigate the intersections between EVs, business models, and innovation in three different perspectives following Spieth and alii (2014). We identify three roles for BM: explaining the business; running the business; and developing the business.

The subsequent chapters of this thesis are structured to provide a holistic response to our research question by setting three sub-questions:

RQ1: how can BMI explain the profitability dynamics within the EV ecosystem, considering both new entrants and incumbent players?

In chapter 3, we explore BMI through the lens of how businesses operate. We begin by providing a clear definition of BMI, distinguishing it as either a new business model within an existing framework or a novel logic for creating and capturing value. Our narrative proceeds to explore the ecosystem's evolving trends, highlighting the emergence of new businesses operating within established models and innovative value creation logics. This analysis not only helps us identify the driving forces behind value networks but also sheds light on the transformative potential of BMI within the EV ecosystem. By proposing a structured framework for BMI characteristics, we delve into the innovations shaping the creation of value, using the example of public street charging. In the final section, we present BMI as a fundamental means of explaining business in this context and introduce a framework for conceptualizing BMI, applying these insights to a case study on Tesla. This chapter prepares the groundwork for the second perspective on BMI,

focusing on the role of guiding the management of business operations within the disruptive EV ecosystem.

RQ2: how does BMI influence the processes and linkages among all stakeholders in the EV ecosystem?

In chapter 4, our objective is to understand the transition modes that ensure a balance between the performance of a BM and its real-world development. In the case of a disruptive EV ecosystem, BMI serves as the guidance for managing firm operations, representing the second function of BMI. We employ the MLP Framework as our methodology, exploring various configurations of the EV ecosystem, where BMI addresses operational aspects of running the business. This includes describing various possible BMs and their application to diverse business cases. One key takeaway is that such a dynamic organizational approach will lead to the promotion of innovative value propositions. Consequently, we propose exploring the third perspective in the role or function of BMI: the development of business strategies based on data network effects.

RQ3: how does BMI guide the definition and development of firm strategies, particularly in relation to the role of data?

Chapter 5 explains BMI from the standpoint of an organization's role in strategy development. BMI serves as the foundation for supporting the strategic growth of firms within the EV ecosystem. We commence by explaining the increasing significance of data in the EV ecosystem. We subsequently analyse the role of data within the ecosystem's BM, presenting a comprehensive framework for the structured collection and exchange of data. Our exploration concludes in the integration of data network effects into the business model of established players. To exemplify the practical application of this framework, we offer a case study centered around Renault.

Through these three distinct chapters, our thesis provides a comprehensive understanding of BMI's multifaceted role within the EV ecosystem, encompassing profit generation, operational management, and strategic development. The proposed research aims to provide a valuable contribution to the dynamic field of Business Model Innovation, transcending the boundaries of the automotive sector and extending its impact to comparable industrial domains.

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Chapter 1: General introduction

1.1 Global outlook on EV ecosystem

In the last two decades, the automotive industry has witnessed increasing attention to alternative propulsion systems. The dominant Internal Combustion Engine (ICE) technology has been challenged by the development of battery electric vehicles (BEVs) and other sustainable technologies such as hybrid electric vehicles (HEVs) or fuel cell vehicles (FCVs). However, since the re-introduction of EVs in 1996, incumbent car manufacturers have responded by further investments in sustaining innovations based on eco-friendly versions of ICEVs, stabilizing the regime around this technology. Today, stronger concerns about climate change and the geopolitical problems related to fossil fuels, have seen the reemergence of battery-electric vehicles. At this point, EVs are key for the decarbonization targets of the transportation sector and electromobility plays an important role in the politically and socially desired shift towards a more sustainable economy.

The EV market is experiencing rapid growth, representing the early stages of the electric mobility revolution. To have a statistical perspective on the EV market, we use the French market as an example. From 2015 to 2022, the French EV market saw significant growth, with a notable acceleration in 2020 despite challenges such as high prices, limited charging infrastructure, and public readiness. New EV registrations in France increased from 185,499 in 2020 to 459,212 in 2022, capturing 22% of the market share. Furthermore, 40% of French car buyers expressed their intentions to purchase electric or plug-in hybrid vehicles by the end of 2023, indicating strong consumer interest and momentum in the EV sector, driven by government initiatives and supportive organizations like Avere France. These initiatives aim to multiply EV sales by five and expand charging infrastructure by the end of 2023.

The regulatory framework in France, Europe, and worldwide is pushing for electric mobility, with a focus on achieving carbon neutrality by 2050. The European Union has set a target to ban the sale of internal combustion engine vehicles by 2035. Additionally, the proliferation of Low Emission Zones (ZFE) and financial incentives for clean vehicles, including rebates for individuals and businesses, has created a favorable environment for EV adoption. Globally, the EV market is growing exponentially, with China leading the way, followed by Europe and the United States. In 2022, more than 10 million electric and plug-in hybrid vehicles were sold worldwide, and this

number is expected to reach 14 million in 2023. The adoption of EVs is accelerating beyond expectations, and a transition to cleaner transportation is underway. The electrification of various modes of transportation, from electric scooters to electric buses and trucks, is transforming the landscape of mobility.

Charging infrastructure is a critical component of the EV market's growth. The concept of "smart charging" is revolutionizing the way vehicles are charged, with real-time energy allocation and innovations like vehicle-to-grid (V2G) technology. The expansion of charging infrastructure is essential to support the increasing number of EVs on the road. Predictions for 2030 and beyond suggest that the EV market will continue to grow, with estimates ranging from 145 to 230 million EVs in circulation by 2030. Long-term projections indicate that up to 670 million EVs could be on the road by 2050, with variations in adoption rates between OECD countries and emerging economies. Europe is poised to play a leading role in the global transition to electric mobility, with ambitious goals to have 14 million EVs on its roads by 2025 and between 33 to 40 million by 2030.

As such, mobility systems are experiencing a transformation challenged by social and technical innovations. We observe the development of two unfolding trajectories: the established traditional automotive regime and an electric mobility niche ecosystem. This has created a new phase of momentum around full electric mobility that could potentially jeopardize the historical architectural advantage of car manufacturers, whose BMs have captured most of the economic value in the automotive industry for years (Jacobides & MacDuffie, 2013). On the one hand, this has attracted new players with innovative BMs that aspire to be dominant actors. On the other, it has revealed the need for incumbent car manufacturers to innovate their Business Models (BM) in order to maintain their dominant position.

The re-emergence of electric vehicles (EVs) has radically transformed the traditional BMs of car manufacturers. BMs describe the activities dedicated to creating, delivering, and capturing value (Foss and Saebi, 2018; Teece, 2010). Faced with uncertainty, as well as with innovative, digital, and environmental challenges, car companies rely on alliance and cooperation strategies to secure a competitive advantage in the new electromobility ecosystem. These cooperative interactions allow firms to access the complementary capabilities of other firms in their network. In this context, the business model (BM) approach fits well with the study of new ways of configuring value creation and capture in a business ecosystem. Digitalization and increased servitization have brought about new forms of businesses and value innovations that defy

traditional theories, opening the way for Business Model Innovation (BMI) (Kley et al., 2014; Parida et al., 2019; Porter & Heppelmann, 2014).

In the car manufacturing industry, hardware-based closed systems are evolving into software-based platform ecosystems, where differentiation is achieved through service offerings. EVs are embedded in a large ecosystem, with combustion engine technology becoming less important (Huth, Wittek, & Spengler, 2013), and new components such as batteries and the public charging infrastructure emerging as critical limitations (Kley et al., 2011; Weiller & Neely, 2014). Furthermore, EVs integrate an array of new electronic systems that bring connectivity and produce data, making better electromobility services possible. In this sense, data is at the center of value creation and network effects are considered a main competitive advantage.

The automotive industry is a complex system with several interrelated elements and requires an in-depth conceptualization of multi-level factors. Recent research in innovation has mainly emphasized technical factors, while the interaction of technology with other important social, behavioral, and environmental factors has been neglected (Zhang and Qin, 2018). In addition, the emergence of the EV ecosystem has seen several start-ups enter the market with new BMs. For example, companies like Tesla have managed to gain an advantage with an innovative organization and strategy, addressing the main issues of batteries and range anxiety in a vertical integrated ecosystem. While some digital business models such as platforms, MaaS, or car sharing have been studied to some extent in the automotive industry, the way incumbent car manufacturers have adapted their BMs in response to changes, such as competition from a new BM (Teece, 2010), deserves further exploration. Thus, there is a real need for the development of a more holistic approach to the EV ecosystem, which includes a new architecture and the development of competitive and cooperative strategies.

This chapter explains the complexity and the interconnected nature of the EV market, characterized by complex inter-organizational and cross-industry collaborations among stakeholders.

1.2 EV and impacts on the automotive value-chain

The advent of electric vehicles is anticipated to revolutionize the traditional automotive supply chain, prompting OEMs, raw material providers, and component suppliers to alter their established stakeholder relationships, which have been in place for over a century during the

dominance of ICEVs. Figure 1 presents the value chain involved in manufacturing an ICE vehicle, along with an approximation of the major stakeholders' contributions to the value added. As shown, raw material providers generally contribute between 10% to 15% of the total value added to a new vehicle, with primary materials like steel, aluminum, copper, and plastic alloys being commonly used. Component suppliers who process most of the raw materials to make components account for about 50-55% of the cost, while OEM assembly plants contribute 30-35% to the value added in the production of a new car.

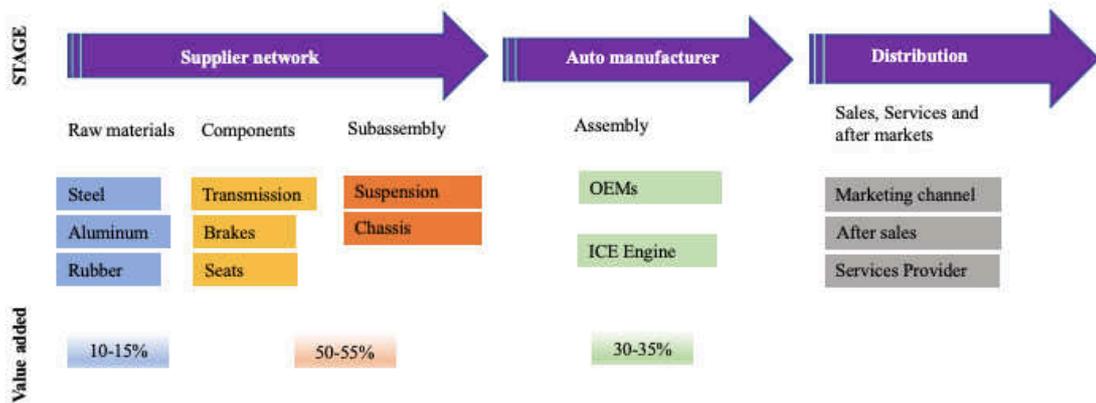


Figure 1: Automotive sector value chain.

EVs disrupt this value chain configuration, as batteries, electric motors, and a whole range of other electronic components, like the control unit, the battery management system, and the thermal management system, are replacing the classic powertrain of ICEVs. The materials and components are changing, and the share of added value for each stakeholder will also change. There is an increase in the use of materials such as copper, carbon fiber, semiconductors, and rare earth metals (lithium, cobalt). In this new EV design, it is estimated that raw materials will account for 15-20% of the vehicle's value. The use of steel, which constitutes a large part of the raw materials for vehicles, should change little, while the use of aluminum should increase to compensate for the extra weight due to the integration of batteries. Advanced and expensive lightweight materials, such as carbon fiber, are also expected to be used more. Copper, whose use is expected to increase by 75 to 80 percent for the electric motor is also a highly sought-after material. Finally, active battery materials (lithium, cobalt, graphite) will account for 7-8% of the new EV raw material mix.

The emergence of EV production has resulted in the evolution of equipment manufacturers' roles. The traditional automotive supplier's contribution to value added is limited to the vehicle's chassis, bodywork, and assembly. However, if these companies do not invest in and expand their

capabilities to include battery and electric motor production, their share of value added will decline significantly. The manufacture of batteries and cells requires new business skills, which OEMs could substantially develop, favored by their existing assembly line production capabilities and their potential to make substantial investments. Additionally, this will enable OEMs to enhance their understanding of batteries, making them more efficient in line with their vehicles and customers' usage patterns, and improve their understanding of battery cost structures. The entry of new players who specialize in producing lithium-ion batteries or other EV powertrain components also threatens the traditional OEMs' distribution of value added.

Figure 2 shows how the automotive components segment's value chain will be impacted. To retain their dominant position in value-added, OEMs will need to adjust their processes, acquire new skills, and potentially alter their industrial activities.

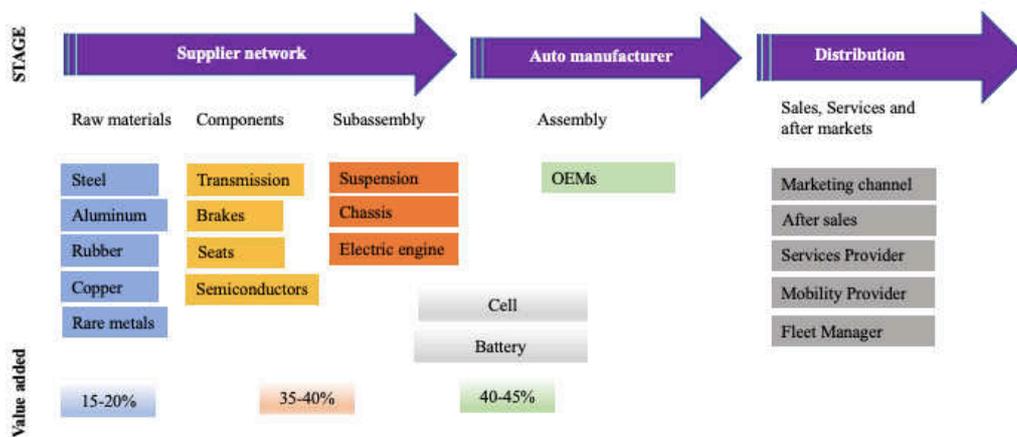


Figure 2: Automotive sector value chain with Electric Vehicle.

It is evident that manufacturers of ICE engines and transmission components will gradually phase out as EVs become the norm. EVs are much simpler to produce mechanically, which reduces the traditional suppliers' value-added share to battery and electronics manufacturers. However, the impact of EV introduction on different players in the value chain will vary. For instance, castings and forging suppliers, particularly those working with aluminum, may transition to manufacturing engine housings, chassis lighting, or suspension parts that will remain the same in electric vehicles. Powertrain pump manufacturers, many of whom have already switched to electric pumps due to hybrid vehicles and fuel efficiency measures, could potentially find opportunities in battery and engine cooling systems. They possess expertise in embedded electronic controllers that are valuable in producing battery cooling systems for

electric cars. Manufacturers of precision powertrain components and fuel injection equipment have expertise in precision manufacturing, such as submicron machining, which can be leveraged to produce electric drive modules.

Other stakeholders who will be affected by the shift to EVs are electrical component manufacturers, as there will be a greater demand for electronic components such as battery management systems, onboard chargers, and inverters. Companies that specialize in manufacturing heat exchangers or radiators for cooling systems could also have an advantage in the development of cooling systems for batteries and motors in EVs, as maintaining proper operating temperatures is crucial for battery performance. Plastic fuel tank manufacturers may also be able to utilize their expertise in producing heat and impact-resistant plastics to develop tanks for holding coolant in the battery cooling system, given their ability to create tanks in different shapes to fit within the limited space available. Furthermore, manufacturers of heating, ventilation, and air conditioning (HVAC) systems will benefit from the need for thermal management in EVs, as conventional heaters may require upgrading since the internal combustion engine is no longer a significant heat source. The functionality of air conditioning is expected to remain largely unchanged.

Finally, changes and adaptations will also be necessary on the upstream part of the value chain. For example, the maintenance modalities of a vehicle with an internal combustion engine or an electric motor are very different. Over five years, 40 to 42 percent of an ICE car customer's periodic maintenance expenses are spent on engine-related parts and consumables. Another 40 to 42 percent is spent on maintenance labor. When servicing an EV, auto parts decrease dramatically, and engine-related consumables such as filters, oils, and lubricants no longer exist. Maintenance procedures are much lighter and less expensive. The transformation of the mechanics' network will also have to be undertaken to requalify their personnel towards the overhaul and replace batteries and electronic components. New activities will have to be promoted, such as managing the end-of-life of batteries (whose life span is currently 5 to 6 years for vehicles) or the organization of a second life circuit.

1.3 EVs: a paradigm in evolution

The automotive market is currently undergoing a transition from internal combustion engines to electric power, which is expected to occur over the next 15 years. Deloitte (2020) predicts that revenue growth from car sales will stagnate during this transition, and growth will come

exclusively from mobility and financial services, accounting for a quarter of the industry's total revenue. However, the automotive market is not only evolving towards electric power; it is also experiencing numerous innovations to meet the demands of the industry. Adler et al. (2018) discuss mobility innovations related to the main macro-trends in the industry, known as ACES trends: autonomous driving, connected cars, electrification, and smart mobility.

The impact of digital technology, a major innovation factor of the 21st century, can be observed in various aspects of the automotive market. According to the OECD (2019), the automotive industry is being reshaped by the rapid development of digital technologies as follows:

- a. *Vehicle innovations* (with the development of connected and even autonomous vehicles). We note the development of wireless V2X (Vehicle-to-Everything) technologies (expected to go to 30%) that allow vehicles to communicate with other systems (V2V for Vehicle-to-Vehicle; V2I for Vehicle-to-infrastructure, or V2P for Vehicle-to-pedestrian) and with their V2G (vehicle-to-grid) environment. It is projected that by 2025, there will be over 400 million connected cars in operation, up from some 237 million in 2021 (Statista 2021b). In Europe, countries such as Germany, the United Kingdom, and France are expected to reach nearly 100% connected car penetration by 2020 (Counterpoint Research, 2018). Advances in robotics, artificial intelligence, and connectivity accelerate developments in autonomous driving. All new car models offer driver assistance systems. From a technical perspective, the current technology for highly automated driving in controlled environments is quite mature (Guo and Zhang, 2022).
- b. *Production innovations* (with smart factories 4.0). Component suppliers use machine learning and data analytics to predict and prevent breakdowns, significantly reducing unplanned downtime costs. BMW has set a goal of knowing the real-time status of all machines producing components from all their suppliers using IoT applications (Ezell, 2016). Audi and Daimler are using automated guided vehicles to transport materials between production lines and increase the efficiency of warehouse operations, and robotics are widely used to perform repetitive tasks (Kern and Wolff, 2019).
- c. *New business models*. Automotive companies are developing a service economy with new services (e.g., predictive maintenance, software updates), alternatives to car ownership (e.g., car rental services or battery renting), and on-demand services, including a reliance on the sharing economy by offering to carpool and carsharing

services accessible through mobile apps. Finally, OEMs can develop new activities such as fleet management.

- d. *The increasing role of data.* The automotive sector experiences a data-driven transformation, as the integration of digital technologies becomes increasingly central to its operations. Data analytics and artificial intelligence are leveraged for various purposes, enabling new services such as predictive maintenance, enhancing the efficiency of warehouse operations, battery and energy management, and personalized user experience. The surge in connected vehicles and the implementation of Vehicle-to-Everything (V2X) technologies foster data collection and exchange, enabling vehicles to interact with infrastructure, other vehicles, and even pedestrians. These digital advancements set the stage for innovative BMs and the growth of a data-centric ecosystem that profoundly influences the automotive industry's future.

These innovations will redefine the automotive landscape bringing together three previously independent value chains into the same ecosystem: energy (from electricity production to charging services), vehicles (from AV software development to assembly) and services (from financing to fleet management).

For traditional value chain stakeholders as well as for new players participating in this new ecosystem, the challenge consists in managing the distribution of value between the three value chains of the ecosystem and along the different points of its evolution. The objective is to position itself on the "pockets of added value" available to develop sustainable business models and to be the partner of choice for other players in the ecosystem (Deloitte, 2020). This new context will mean a new multidimensional synergy, where competitors may become allies and where interaction must evolve from traditional vertical models to hybrid ones to take competitive advantage and take a stand within a still very uncertain ecosystem, and whoever gets the right formula could win big, positioning themselves on the forefront of the mobility revolution.

1.3.1 EV market: a business ecosystem description

With the emergence of the internet, the world became increasingly connected, transforming the way we live and do business. The Internet of Things (IoT) is empowering digitalization, where the flows of information about products and services changed the perspective on value and supported by cloud computing and big data, boosted the rise of trends such as the sharing

economy and servitization (Foss & Saebi, 2018). Industry 4.0 also emerged as a result of IoT technologies, and its integration to the industrial value allowed companies to manage an entirely digital, connected, and smart value chain (Kiel et al., 2017). This has allowed companies to shorten technology and innovation cycles, increase customizations and enhance demand volatility, strengthening their future global competitiveness (Arnold et al., 2016).

Digital transition is challenging established industries, the traditional theories, and their dominating business practices, with great potential for new value creation mostly through entrepreneurial start-ups and corporate ventures (Amit & Zott, 2001). Therefore, the linear conception of traditional theories of value creation and capture such as: value chains (Porter, 1985), the resource-based view of the firm (Barney, 1991), strategic network theory (Dyer & Singh, 1991), and transaction costs economics (Williamson, 1975), among others, seem inadequate for highly competitive interconnected markets. The term "value" now refers to the total value created by business transactions, regardless of who appropriates that value (Amit & Zott, 2001), and we will observe how this evolution is reflected in the automotive sector.

Moore (1996) proposed a novel approach to confronting the "end of the industry" by introducing a new type of creative leadership and business revitalization. This approach involved utilizing the concept of a "business ecosystem" to refer to an entire "industry." Essentially, a business ecosystem refers to an economic community composed of interdependent organizations and individuals who rely on each other for survival and effectiveness (Iansity & Levien, 2004). This ecosystem approach emphasizes the value of cooperation and highlights that companies cannot succeed alone (Power and Jerjian, 2001). Additionally, Adner & Kapoor (2010) suggested that innovative companies tend to prosper when their third-party counterparts succeed.

This search for a meaningful unit of analysis beyond the focal firm has made researchers explore and propose concepts to develop an overall vision of the dynamics of collective innovation (Chesbrough et al., 2018). Open innovation, as coined by Chesbrough (2003), has become a prominent trend in the field of innovation. Meanwhile, the concept of an ecosystem, has also emerged as a noteworthy trend in the fields of technology management and innovation (Tsujiimoto et al., 2018). Work on business ecosystems and open innovation has developed independently of each other; however, they both refer, to different degrees, to innovation as a mechanism for value creation and a driver for competitiveness (G. Koenig, 2012).

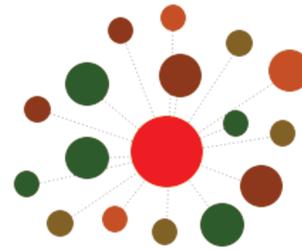
Open Innovation emphasizes the exploitation of knowledge and skills available in an ecosystem as a way to improve efficiency of the innovation processes and the exploration of new markets (G. Koenig, 2012); nevertheless research on open innovation has mainly focused on “collaborative inventing” (Chesbrough et al., 2018). In contrast, business ecosystems highlight the modification of industrial structures that now take the form of networks, where products and services result from the collaboration between heterogeneous players with complementary skills, mobilized in a collective innovation process and orchestrated by a pivotal firm. The ecosystem concept proves to be a useful analytical framework allowing a better understanding of the Open Innovation phenomenon and a helpful tool for companies to set “integrative” strategies (Hafsi & Martinet, 2007).

The ecosystem concept emphasizes that innovation cannot be achieved solely by an individual company, but rather, by creating a gravitational force that attracts other members of the ecosystem. The ecosystem approach involves more than just a few dominant players, with the goal being to create an environment that encourages others to participate and form a collaborative force. Within an ecosystem, value creation is achieved through the pursuit of common goals, with companies committing to joint initiatives. The focus is on capturing value at the inter-company level, where knowledge, stakeholder networks, new products, new customers, and financial benefits can be shared among members (Radziwon et al., 2017). Figure 3 illustrates these value creation and capture modalities, either at the firm level centered on its business model, or at the ecosystem level based on its relationships with stakeholders. The value within the ecosystem is co-created among its members and captured collectively, and it is this common value proposition what creates a competitive advantage for the entire ecosystem (Iivari & Hurmelinna-Laukkanen, 2016).

Each circle in the ecosystem diagram represents a distinct company, with the red color indicating the specific focus of analysis for various approaches. The business model approach examines the internal structure of the company to identify avenues for value creation. Coopetition and open innovation represent a more systematic approach that extends beyond company boundaries to foster value creation, but the mechanisms for value capture still prioritize the advantages of the focal firm.



Business Model approach



Company-centered ecosystem approach

Figure 3. Narrow scope for ecosystems. Source: prepared by the authors

The aforementioned approaches highlight that in a context where company boundaries are becoming less defined, innovation needs to extend beyond the firm to take advantage of external sources of value. The business model is thus viewed as a "boundary-crossing" unit of analysis that links the relationships between the company and its external stakeholders. However, this understanding of the business model fails to consider the importance of the ecosystem and how the success of the firm is intertwined with the success of its shared business ecosystem. Therefore, expanding the scope of analysis is necessary to design innovative business models that configure mechanisms for value co-creation and capture, as well as manage relationships between ecosystem stakeholders.

The design of the business model plays a critical role for entrepreneurs launching a new venture and for established company managers tasked with rethinking their BM strategy to prepare for the future. Considering the high stakes involved in the EV ecosystem and the various modes of value creation and capture discussed in the previous paragraph, it is crucial to examine the key features of a business model tailored for this type of business ecosystem. Additionally, understanding how the value chain evolves over time can shed light on how relevant stakeholders are preparing to revise their business models to pursue co-innovations.

As depicted in Figure 4, we argue that prior research on business model design has predominantly focused on analyzing a single company's perspective. However, given the current trend of shared value chains, the unit of analysis must shift from a company-centered ecosystem to a business ecosystem. In this context, various business model designs are collaboratively configured with ecosystem participants to establish a value ecosystem where all companies play a role in creating and capturing value. Hence, this study proposes that even though each

company may have distinct goals and strategies, a value ecosystem can be leveraged when diverse business model propositions are formulated to align with a shared entity.

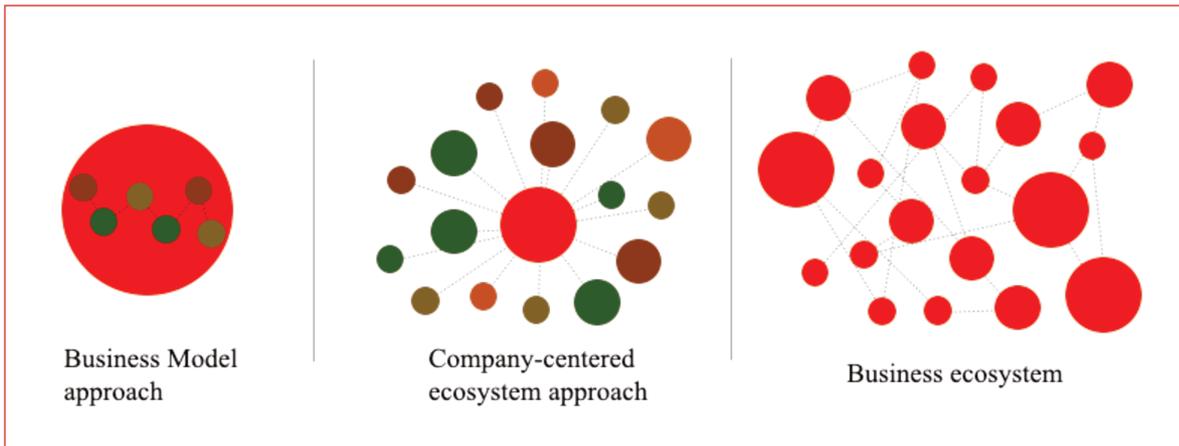


Figure 4 Toward business ecosystem approach. Source: prepared by the authors

- Due to the EV sector's configuration as an ecosystem where stakeholders have interdependent and evolving relationships, it is crucial to investigate the methods of value creation and capture within this ecosystem.

1.3.2 Three value chains into one ecosystem

Considering the macro-trends already mentioned and the evolution of the automotive market, it is evident that the electric mobility ecosystem is complex and relies on different drivers.

First, technological innovation can be structured around five trends:

- The systematic use of data is made possible by deploying the Internet of Things (IoT);
- Services are at the center of innovation.
- Innovation cycles are accelerating.
- Innovation processes are more collaborative with open innovation initiatives.
- OEMs are investing in new organizational capabilities to support digital innovation better.

The data generated by smart and connected devices transform research and development processes, enable new business models, and ultimately drive process enhancement. The systematic use of data enables process optimization, predictive diagnostics, and, at a more advanced stage, autonomous operation of products, as would be the case for autonomous cars. In the automotive sector, for example, smart sensors are used to monitor the operation and use

of the product and the external environment. The software integrated into the product allows the user experience to be personalized. Algorithms exploit the data collected to improve the performance of the autonomous vehicle and enable predictive diagnostics. The management of this data allows optimizing the relationships between stakeholders within the automotive ecosystem; user integration, vehicles system, infrastructure integration, value added services, and mobility transaction platforms.

Second, drivers with a direct or indirect impact on the future development of the automotive ecosystem are numerous and of varied origin. We organize these factors that have a direct or indirect impact on the future development of the automotive value chain according to the typology proposed by Deloitte (2018). The drivers were evaluated according to their degree of uncertainty and their impact on the OEM's activities throughout the value chain. Different nature of drivers have been identified (Figure 5): technological, environmental, social, political, and economic.

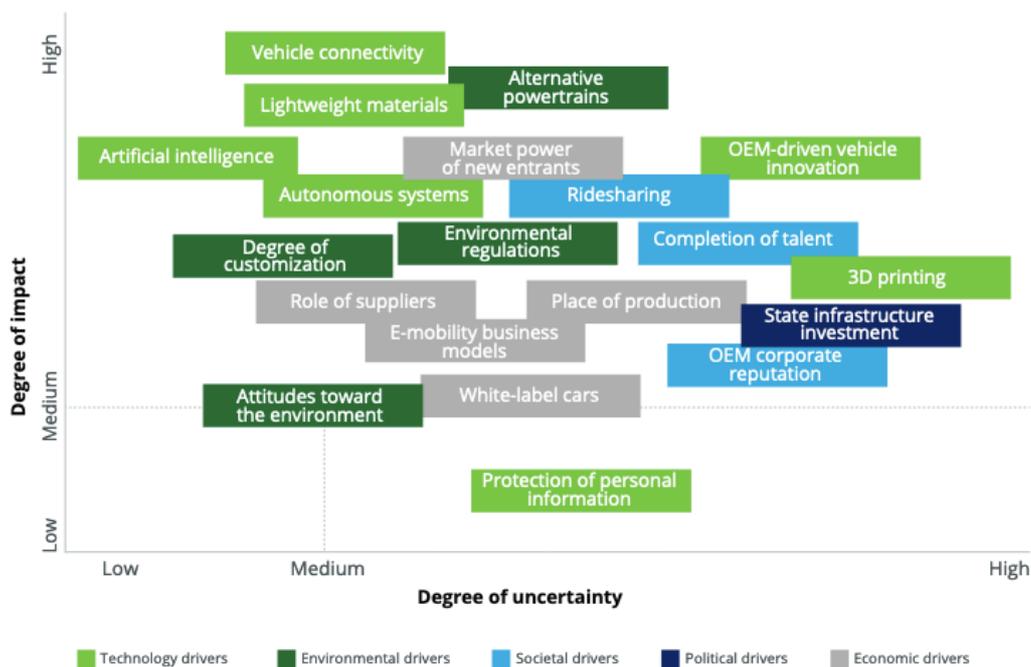


Figure 5: High-impact, High uncertainty automotive innovations drivers. Source: Deloitte analysis.

Third, three value chains are interrelated in one ecosystem. Renewable energy production and management of smart charging are the new critical links of the energy value chain. EVs significantly impact automotive manufacturing, where OEMs face the challenge of accessing critical raw materials and are confronted with an increase in the value represented by batteries. The electric vehicle value chain is being built around new players positioning themselves at different value chain stages. Thus, the stages of the electric value chain are more concentrated

upstream of the vehicle distribution phase (with powertrain-car components as well as OEMs) to develop more stages downstream on the specific issues of energy production (with the problems of renewable energy), energy distribution, energy management (and batteries in particular), recharging infrastructures and finally the stage of services related to smart mobility/charging.

All these stages are characterized by the emergence of new players in an ecosystem undergoing strategic reconfiguration requiring new skills. For example, Stellantis created a joint venture with Total-Saft in 2020, Automotive Cells Company (ACC), to produce batteries at its thermal engine production site in Douvrin (Pas de Calais). Renault has launched the same initiative with the Chinese group Automotive Energy Supply Corporation (AESC)-Envision to produce batteries for its electric vehicles. Moreover, a reversal of roles and relationships can also take place; Tesla has merged its decentralized power grid provider operations with its OEM business. Finally, EVs co-exist at the intersection of four different markets: energy, mobility, infrastructure, and IT, with a renewal of the actors, their operational stakes, and strategic objectives.

Digital transformation is pushing automotive companies to change their product design processes and have started to design cars with new features and services, following consumer demands and new trends: autonomous vehicle (AV), Connected vehicle (V2X), increased use of manufacturing robots, predictive maintenance. With the digitalization of the automotive ecosystem, we note the emergence of new players, notable producers of sensors for advanced driving assistance systems (and eventually autonomous driving), and manufacturers of software for connectivity management systems and vehicle-integrated services. The chasm in technical capabilities that exists between OEMs and Autonomous Vehicle (AV) software providers is enormous. The production of high-performance AVs requires effective integration of AV software within the vehicle platform. However, the additional skills required to integrate software development within the vehicle platform differ from those already possessed by OEMs.

Undoubtedly, the production of autonomous vehicles requires the acquisition of proficiency in software development, specifically artificial intelligence (AI); the capacity to efficiently manage a Software as a Service (SaaS) model; the ability to attract and retain a digitally skilled workforce amidst competition from software startups with distinct cultures, remuneration, and incentive structures; and expertise in collecting and analyzing vast databases essential for training AI algorithms. OEMs need to move downstream in the value chain by forming joint ventures with AV software providers or developing in-house skills. Both growth strategies have advantages

and disadvantages, and the choice will depend on the size of the OEMs and their investment capacity. The stakes are high for OEMs to capture more value within the autonomous vehicle value chain: leading the development of AV software, rather than buying it from a supplier, can allow OEMs to determine the characteristics of AV software and integrate it into vehicles at the design stage to meet market expectations better. OEMs can position themselves as integrated mobility providers, controlling everything from developing AV software to providing robot-taxi services to users.

Ultimately, services related to electric vehicles (EVs) are becoming increasingly critical, including financing options to address the upward trend in EV prices and leasing services. Other essential services include servitization, fleet management services to optimize battery usage, electric charging, and storage services (V2G), mobility services (MaaS), and battery end-of-life management. In this scenario, OEMs seek to move up the value chain by promoting a business model based on the service and sharing economy. In this way, OEMs could provide mobility as a service (MaaS) directly to customers through the creation of fleet management and/or transit companies, ensuring their continued dominance in the industry.

The digitalization of the economy has facilitated the servitization of the automotive sector. This has enabled service personalization (e.g., integration and analysis of customer information, the anticipation of specific needs, user-centric innovation analysis) as well as business process transformation (e.g., shift from make-to-stock to make-to-order, mass customization). However, the challenges are high, as additional services offered by OEMs, such as AV fleet management, require a massive network of maintenance facilities; today, dealers who could provide such a function are independent. OEMs also need asset management expertise to ensure that an adequate number of vehicles are operational and adequately located to meet consumer demand, a nationwide network of parking lots. This type of digital platform, like MaaS (Mobility as a Service), needed to connect customers and vehicles is well beyond the current expertise of OEMs.

The conditions of value creation and capture within the EV ecosystem will depend on the modalities of value proposition within the three following value chains, each with its own logic of value creation and capture: electricity production and charging infrastructure; autonomous and connected vehicle manufacturing and software development; and product and service development for mobility. The production and use of EVs are significantly changing the existing structures within the automotive industry. The evolution of business models is underway,

shifting from the traditional supply of components and modules to the production and marketing of vehicles, to a more comprehensive approach that includes supplying energy and additional services. The new value proposition is based on the development of a complex system of interdependent actors and components that exploit new sources of value. Therefore, stakeholders around the electric vehicle market, are reconfiguring and must now be addressed in an ecosystemic logic. From this perspective, it is no longer value chains that companies will analyze and evaluate, but rather value ecosystems.

The introduction of EVs into the passenger car market brings significant transformations within the automotive ecosystem, thereby influencing the mechanisms of value generation and extraction across the value chain. In chapter 2, we will explore the impact of these market developments, with particular attention to the restructuring of value creation and capture methods.

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Chapter 2: Research questions and methodology

Chapter 1 provided an overview of the evolution of the electric vehicle market. This evolution is marked by the desire to design and disseminate product and process innovations within a renewed business ecosystem. The way to create, deliver, and capture value is changing, leading us to question the new business models that the players in the ecosystem will have to adopt. It is all about creating new sources of revenue in an ever-changing market through business models. This thesis will question how to create more value for the players in the value chain and determine how to deliver this value, whether in processes, resources, the value chain, or partnerships.

2.1 Research questions

The main research question that this thesis aims to answer is: **how can Business Model Innovation (BMI) be a means of designing a product-service platform for an EV ecosystem?** Business model innovation can be defined as ‘the search for new business logics of the firm and new ways to create and capture value for its stakeholders’ (Casadesus-Masanell and Zhu).

The attention paid by management practitioners and scholars alike to business model innovation has increased sharply in recent years. While business models are traditionally concerned with the creation and capture of value at the corporate level, business model innovation also raises questions about the novelty of the customer value proposition, how this value is captured and delivered between stakeholders in the business ecosystem, and the structural reconfigurations of players. Within this framework, three research questions are addressed as we identify three roles and functions of business model innovation from the perspectives of explaining, managing, and developing the enterprise:

2.1.1 How can BMI explain the profitability dynamics within the EV ecosystem, considering both new entrants and incumbents?

Building upon our hypothesis that a comprehensive understanding of BMI within the EV ecosystem necessitates a threefold perspective, wherein the role and function attributed to firms are considered, our first research question seeks to clarify the nature of the BM in an ecosystem. We explain how firms in the EV ecosystem can create and capture new value,

thereby enabling us to conceptualize the characteristics of BMI architecture. This conceptual framework is exemplified using a real-world scenario: the establishment of a new EV ecosystem, specifically in the context of public street charging.

2.1.2 How does BMI influence the processes and linkages among all stakeholders in the EV ecosystem?

Addressing environmental problems necessitates fundamental changes in systems, often referred to as socio technical. The MLP is one approach within social transformations for sustainability, that focus on transitions in systems that provide societal functions or end-use services. We apply this analytical framework to the context of the EV ecosystem, recognizing that fulfilling societal functions involves not only technologies but also encompasses consumer practices, cultural meanings, public policies, and notably, business models. In our exploration of the second research question, we investigate the case of a disruptive EV ecosystem where BMI serves as the guiding principle for managing firm operations and addressing various aspects of running the business.

2.1.3 How does BMI guide the definition and development of firm strategies, particularly in relation to the role of data?

The two previous questions have focused on the first two dimensions of BMI, explaining how to explain, and run the business. This third research question deals with the formulation of business strategies. Leveraging the growing significance of data in the provision of new services, we examine the role of data within the ecosystem's BM. This exploration enables us to investigate the integration of data network effects into the business models of established players.

2.2 Research methodology

2.2.1 Research framework

Figure 6 presents the main steps in our methodology according to the research questions. This methodology consists of an exploratory interpretive research approach (McAlloone, 1998; Quinlan, 2017) that aims to determine how BMI can be a means of designing a product-service platform for an EV ecosystem. We divide data collection and data analysis into primary and

secondary research methods, situating meaning-making practices at the center of scientific exploration (Arnett, 2007).

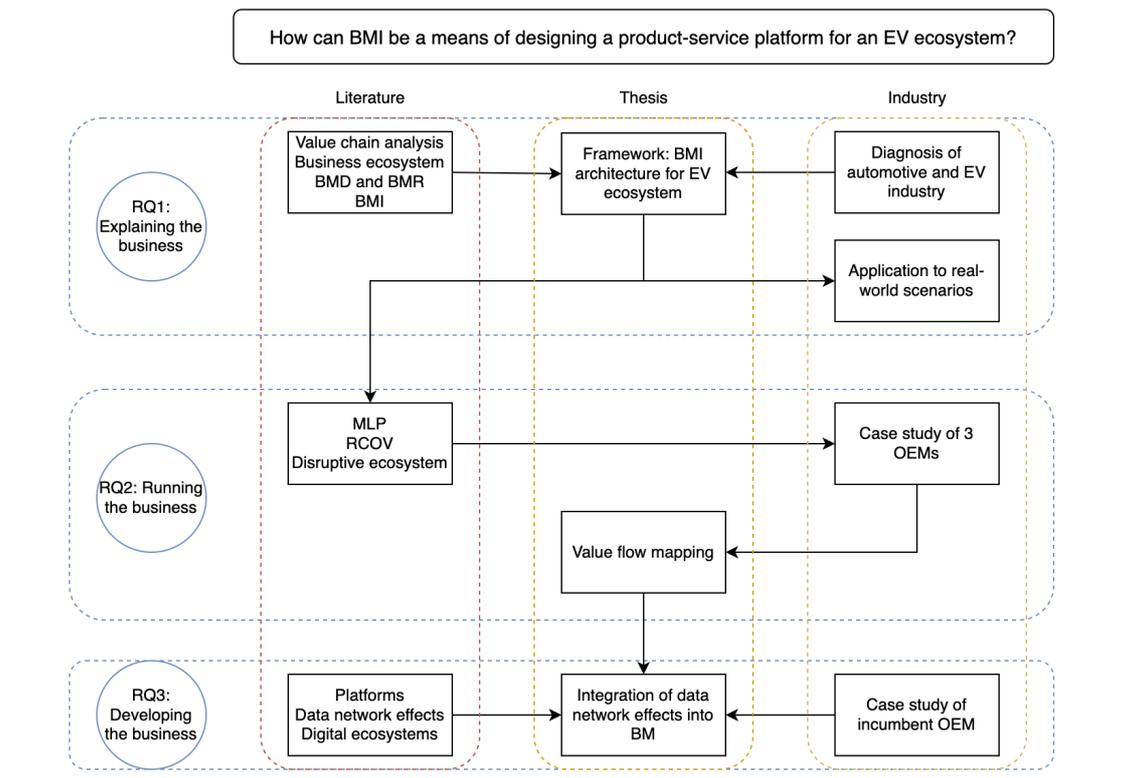


Figure 6: Research framework. Source: prepared by the authors.

Due to the novelty of the emerging EV industry, we conduct an exploratory approach to identify our research problem and establish the main research question. In this line, we delve into the literature on the global EV outlook to understand the complexity and the interconnected nature of the EV market, as well as the impacts on the actual automotive value chain. Based on this analysis of the EV paradigm in an ecosystem perspective, we formulate a hypothesis based on a role-based framework to provide an overview of the current field of BMI. We define three dimensions for BMI and apply them to the EV ecosystem: explaining the business, running the business, and developing the business (Spieth et al., 2014).

First, to understand the role of BMI to explain the profitability dynamics within the EV ecosystem, we define the avenues for value creation and capture. Based on existing literature, we explore the space between proposing new products and services and the proposition of a value network for stakeholders in the ecosystem. This allows us to conceptualize the BMI architecture and introduce a framework that we apply to real-world scenarios. The novelty of

this proposed conceptual framework is that it considers four key ideas characterizing innovations in the EV business ecosystem and its temporal evolution to explain the dynamics of BMs and BMI.

Secondly, our focus shifts to examining how BMI influences the processes and relationships among stakeholders involved in operating within the EV ecosystem. We apply the Multi-Level Perspective (MLP) framework to understand socio-technical transitions and consider the boundaries of the business ecosystem. This framework proves valuable in explaining how stable systems, often referred to as socio-technical regimes, such as the automotive industry—where innovation typically follows incremental and path-dependent patterns due to various lock-in mechanisms—can undergo transitions. These transitions occur when a radical innovation, like the emergence of the EV ecosystem in small niches at the periphery of the existing automotive system, deviates from the established regime in technical, social, business model, or infrastructural dimensions. Such deviations are often driven by pioneering activities of entrepreneurs, start-ups, activists, and other stakeholders.

In this context, we conduct a case study involving three car manufacturers, each representing different BM configurations in alignment with the RCOV model (Lecocq et al., 2008). These three scenarios account for the dynamics between technology (resources and competencies, RC), organization (set of routines, O), and value creation (V). Finally, we develop a graphical model based on the mapping of the various flows of value among players in different EV ecosystem configurations. This characterization of the BMs within the context of a socio-technical transition enables us to describe the interactions among stakeholders in the ecosystem.

Finally, we explore the third perspective in the role of BMI: the development of business strategies based on data. We analyse the role of data within the ecosystem's BM, presenting a comprehensive framework for the structured collection and exchange of data. To exemplify the practical application of this framework, we offer a case study centered around Renault. Our exploration concludes in the integration of data network effects into the business model of established players.

This research provides valuable insights into the role of BMI within the EV ecosystem and sets the stage for future exploration in this dynamic field. As we navigate the evolving landscape of EVs and their interconnected data-driven systems, we propose future research directions for a

deeper understanding of data's role in shaping the future of business models, extending beyond electromobility to encompass broader, complex ecosystems.

2.2.2 Research positioning

Our research situates at the intersection of various industrial and academic disciplines. On one hand, it operates within the industrial framework of the automotive sector, particularly within the domain of Electromobility. On the other hand, it draws upon the knowledge and methodologies derived from two crucial research domains: Industrial Engineering and Business Strategy.

Industrial Engineering focuses on the optimization of complex processes, systems, or organizations. It involves the design, improvement, and implementation of integrated systems, encompassing people, materials, information, equipment, and energy to enhance efficiency and productivity while minimizing waste and cost. While Industrial Engineering primarily directs its focus towards improving organizational processes, Business Strategy, in the context of Business Model Innovation, is more aligned with developing innovative approaches to creating and capturing value within an industry. Business strategy encompasses the establishment of long-term goals, plans, and actions that an organization employs to secure a competitive advantage and deliver value to its stakeholders. This process involves the strategic allocation of resources, competitive positioning, and decision-making to fulfill its goals (Thompson et al., 2020). In Figure 7, we illustrate the principal theories and themes encompassed in this thesis.

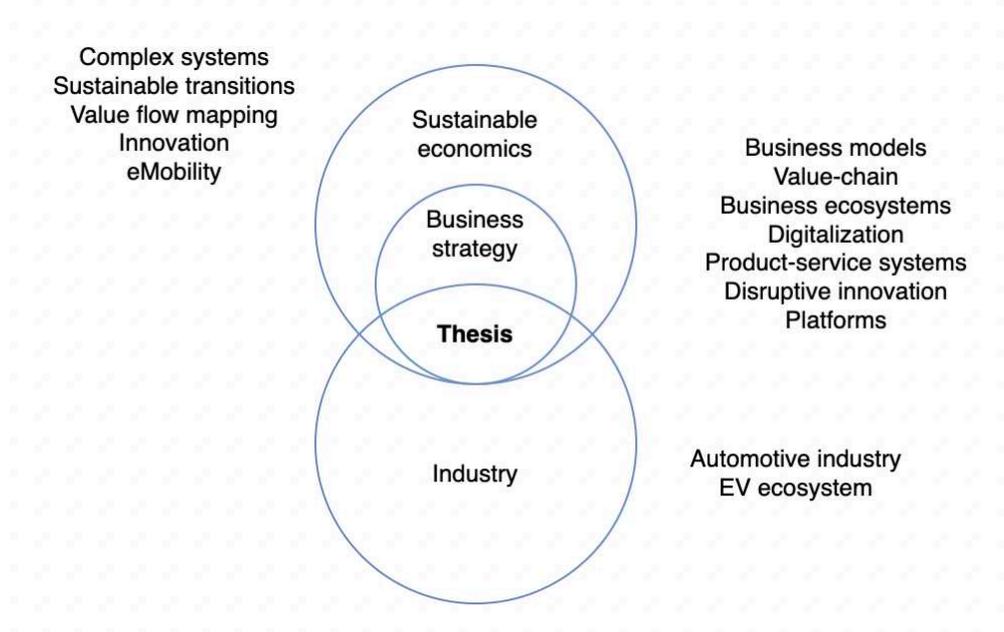


Figure 7: Research positioning. Source: prepared by the authors.

The theories and themes presented in Figure 7 serve as how we address our research questions, as depicted in Figure 8.

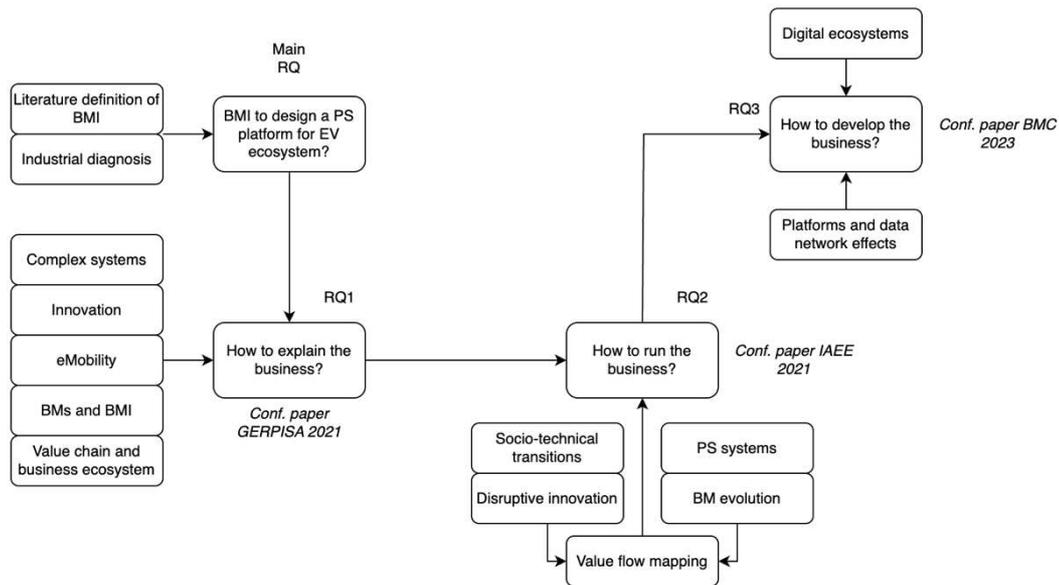


Figure 8: Mobilized knowledge to answer the research questions. Source: prepared by the authors.

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Chapter 3: Holistic approach for BMI in the EV ecosystem: transforming value chain analysis to a business ecosystem analysis.

This chapter explores Business Model Innovation (BMI) and its important role in explaining business dynamics within the rapidly evolving EV ecosystem. Our focus is to comprehend how BMI can effectively explain profitability dynamics within this ecosystem, for both emerging and established industry players. We begin by providing a practical definition of BMI, differentiating it as both an innovative approach to value creation and a transformative business model within the existing framework. This chapter sets the stage for addressing our main research question.

We analyze the ongoing trends and shifts within the EV ecosystem, with a particular emphasis on the emergence of new businesses operating within established models, introducing innovative strategies for value creation. This analysis not only helps in recognizing the driving forces shaping value networks but also highlights the potential for transformative change within the EV industry. We introduce a structured framework outlining key BMI characteristics, with a specific focus on innovations shaping value creation. The application of these insights is demonstrated through a case study of Tesla.

By the end of the chapter, we establish BMI as a crucial tool for explaining business within the dynamic landscape of the EV ecosystem. The framework we introduce enables practical application to real-world scenarios, bridging theory and practice, and facilitating a deeper understanding of how BMI influences business operations in the EV industry. This chapter sets a starting point for the subsequent exploration of BMI's role in guiding and managing business operations within the disruptive EV ecosystem.

3.1 Business Model design for a business ecosystem

The emergence of business model thinking, represents a significant departure from traditional strategic management approaches, following a more pragmatic perspective. Within this framework, scholars consider the business model as a dynamic orchestrator that shapes an organization's ecosystem within the broader environment (Demil et al., 2018). This view holds crucial implications: first, it emphasizes that the business environment varies for each organization, demanding post-business model considerations of traditional strategic concepts.

Second, the effectiveness of a business model depends on skillful negotiations and interactions with selected stakeholders. Lastly, business models and ecosystems are not static but co-evolve, offering opportunities for the evolution of business models in response to evolving ecosystems.

This perspective highlights the dynamic interplay between business models, ecosystems, and the organizational environment in strategic management. We aim to identify the distinctions between traditional approaches and the business ecosystem approach, to contribute to BM definition and design. The proposed framework offers companies a new approach to understand their place and their role within the EV ecosystem. It can provide managers with an experimental tool to understand how an ecosystemic perspective can have a positive impact on the development of the business ecosystem. This enhanced understanding could drive the establishment of successful strategies with other companies in the ecosystem and how to manage these valuable collaborations, hence contributing to strategic management. The current drawbacks of electric cars, such as lack of infrastructure, sustainability objectives, high battery costs, and short-range capacity, could actually provide opportunities to introduce an in-depth reflection on business model design (Ziegler & Abdelkafi, 2022).

3.1.1 Business model (BM) theoretical background

Business models are widely cited as being the architecture of the firm's collection of interconnected and interdependent activities executed to meet the perceived needs of the firm's internal and external stakeholders. The essential components proposed and acknowledged by various authors are the "architecture" of activities underlying the firm's creation, delivery, and appropriation of value (Santos et al., 2009; Teece, 2010; Zott and Amit, 2010; Foss and Saebi, 2017) as: value proposition, value creation, value delivery, and value capture. Every established firm employs a particular business model that describes the ability to successfully move into a new business model is a source of competitive advantage for organizations (Geissdoerfer et al., 2018). Value determined in BMs principally refers to business benefits (e.g., revenue, reputation, market access) and the exchange with customer benefits (e.g. functionality, health and safety, convenience). This activity system goes beyond the firm's boundaries to create value with other stakeholders, but the strategy remains firm-centric to capture his share of the value created collectively (Zott & Amit, 2010).

Moreover, the innovation factor in BMs is crucially vital to business viability, accomplishment, and as a source of business competitive advantage (Baden-Fuller & Haefliger, 2013). One of the

first dedicated studies, Chesbrough & Rosenbloom (2002) stressed the role of the BM as a moderator variable in the economic decision to invest. The study suggests that a new idea or technology may have no value unless it is commercialized by a BM, as mentioned by (Chesbrough, 2010, 1): “a mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model”. Thus, the choice of business model allows to capture the latent value of the technology and commercialize it by choosing the right mixes of *value proposition, market segment, cost structure, profit potential, value chain and value network* (Chesbrough and Rosenbloom, 2002); an early demonstration of the importance of complementarities in thinking about the nature of BM's.

Also, by considering other prominent framework proposed by Richardson (2008), the study bridges the *strategy* implementation in the formulation to enlighten how the activities work together to execute the strategy by which the innovating firm will gain and hold a competitive advantage. In fact, failing to align the value creation and value capture activities within the firm's new practices, might fall short in obtaining the desired results (Saebi and Foss, 2015). These observations make us consider new elements in characterizing the link between innovation and value creation. Therefore, all innovations linked to new production modes over the life cycle (service economy, product service system, circular economy, digitalization) and consumer trends (collaborative economy, sharing economy, second-hand use) must be integrated into the BM.

For example, car manufacturers face the challenge of creating additional benefits for clients, especially to offset the higher initial investment in EVs compared to Internal Combustion Engine Vehicles. As the EV industry is not yet commercially viable, EVs could enable better mobility solutions for companies (Lerch et al., 2010) as they move from product-based to service-based business models (Kindström & Kowalkowski, 2015) or become more sustainable (Jiao & Evans, 2016). EVs could serve as energy storage in decentralized energy systems (V2X) (Thompson & Perez, 2020), generate new revenue streams from battery leasing (Jiao & Evans, 2016), or take advantage of the large amount of data available around EVs to create new services (Llopis-Albert et al., 2020). Although these changes are new to firms, they are formulated as a response to a change in the industry structure. These changes affect several interconnected parts of firms, so a more holistic perspective is necessary to grasp major architectural changes.

In this perspective, some scholars argue that value should go beyond that and should be for all stakeholders within the value network (Zott, Amit, & Massa, 2011). This viewpoint is becoming

more prevalent, since the growing importance and complexity of supply chains have increased the recognition that the value system involves multiple stakeholders. To address a more rigorous modelling approach and to facilitate the process of design, some authors additionally define what are the elements that shape the business model. This business ecosystem perspective enlarges the level of analysis for collective creation and capture of value for BM, where the delivery of the value proposition depends on the ability to align strategies among stakeholders. Considering the evolution of the business ecosystem could provide insight into how the boundaries of the BM shift as the interdependences within the ecosystem evolve. This way of thinking allows for flexibility and creativity, to “assemble disparate business elements into new economic wholes, from which new businesses, new rules of competition, and new industries may emerge”. (Singer, 2009, 687).

The BM construct for EV ecosystem will not elaborate on an internal business model of a focal firm, but instead focuses on an open system business model (Berglund & Sandström, 2013) which evolves at ecosystem level. This implies the consideration of not only how firms create and capture value internally, but also how the development of their ecosystem could serve as an important platform of value creation and capture across organizations (Adner & Kapoor 2010; Chesbrough & Bogers 2014; Rong et al. 2013). In this perspective, two characteristic elements of the EV business ecosystem are evolving and must be taken into account in the BM construct.

3.2 Elements that shape EV business model

3.2.1 The challenge of incumbents to adapt their business models

The emergence of new players employing innovative business models represents a threat for incumbent companies, because of their need to adapt their existing BM's rather than just establishing one from scratch. This complex process of adaptation can represent the failure of an incumbent firm if it is not executed properly. Typical reasons that impede a profound modification of existing BM's are: dependence upon mainstream customers, rigidity of existing activities and competences, demand uncertainty, organizational tensions and reliance on established value networks (Cozzolino et al., 2018). Nevertheless, the emergence of disruptive technologies offers new opportunities, favoring firms to experiment with new forms of value creation and capture. In consequence, incumbents tend to respond in a defensive manner through “alliances and acquisitions”, accelerating the process of adaptation.

Also, opposite to the more traditional idea of closed BMs, in which companies commercialize their own internal knowledge through proprietary complementary assets along a vertically integrated firm value chain (Teece, 1986), incumbents can increase access to external knowledge by opening their business models, to gain access to larger markets, reduce costs and increase innovation. The process of adaptation is not linear, and often companies rely in *mixed closed-open* BMs to limit tensions and failures. Value creation occurs from balancing internal and external knowledge, old and new models, and value capture results from the development of platforms and the control of user's data (Cozzolino et al., 2018).

3.2.2 Service-Dominant Logic as a driver for the design of Business Models

The role of companies in the traditional value chain that produce and sell products, is becoming less profitable (Wise and Baumgartner 1999), challenging the traditional linear production model, deep-rooted at the heart of our economy, that follows a Goods-Dominant logic (GD). Consequently, companies are pushing to change from a product-based to a service-based mindset (Fleisch et al., 2014; livari et al., 2016; Ibarra et al., 2018). For example, EVs face the challenge of creating additional customer benefits to compensate for the higher initial investment costs compared to conventional cars (Kley et al., 2011). For instance, EV's can create additional customer benefits through enabling integral mobility solutions. The shift to outcome-based service, the most advanced form of service provision, represents a high-gain as well as a high-risk business model innovation strategy (Fang, Palmatier, and Steenkamp, 2008; Jacob and Ulaga, 2008; Kohtamäki, Parida, Oghazi, Gebauer, and Baines, 2019). Hence, this form of business model innovation requires an understanding on the changes involved in how value is created, delivered, and captured (Sjödín et al., 2020)

Based on these conditions, we identify two main drivers that impact the BM design: innovations and value chain configuration.

In open innovation, as developed in business ecosystem, the BM defines the structure of the firm's value chain, in order to position the firm within a value network to formulate a "competitive strategy by which the innovating firm will gain and hold advantage over rivals" (Chesbrough, 2003, 65). It suggests a context where interactions among stakeholders can be cooperative and competitive enabled by the interconnectedness of the system (Chesbrough, 2003). Changing customer expectations and technological advancement are the two dominant enablers that encourage the discovery of new BMs. According to Iansiti and Lakhani (2014), a

practice-oriented approach endorses the determining role of the revolutionary process in engendering innovative BMs. The innovation constituents are reflected in the value proposition, value delivery, value creation, and value capture.

Value creation could mean the concoction or re-engineering of assets and skills to generate a usage value, which is subjectively meaningful for potential users (Lepak, Smith, & Taylor, 2007). Value proposition could mean a value to be delivered to a chosen target customer segment or producing Product-Service System (PSS). Value capture could mean the firm's capacity to capture a value, corporeal and incorporeal, received in exchange for a usage value created for potential users (Dubosson-Torbay, Osterwalder, & Pigneur, 2002).

Although American and European scholars have varied perspectives on the concept of business models, with some linking it to open innovation while others associate it with causal modeling and design (Haaker, Bouwman, Janssen, & de Reuver, 2017), the essence of BMs is to demonstrate how companies conduct business: create, distribute, and capture value in a systematic manner. This approach offers a comprehensive view of the business activities (Spieth, Schneckenberg, & Ricart, 2014). BMs are comprehended as part of intellectual property (Teece, 2010), an instrument and a subject to adapt commercializing technological innovations. Therefore, the design of BMs enables the reengineering of business competencies to adapt the changing environments.

Adopting a Service-Dominant logic (Turetken et al., 2019), the traditional approach of viewing value creation and capture as either provider-centric or customer-centric processes needs to be replaced by a collaborative process that incorporates an actor-to-actor network, also known as the "value network" (Chesbrough, 2003). This approach facilitates value co-creation and co-capture, where the design of the entire network provides an integrated solution that meets the customer's needs (Lusch and Nambisan 2015). This new analysis of BM enhances the concept of the "value network," which influences the roles that suppliers, customers, and third parties play in value creation and capture. As a result, new actors emerge, and the role of existing ones undergoes change.

3.3 Dominant value drivers for value network

To be better aligned with the customer value proposition, firms must expand their understanding of their customers and work within an ecosystem that extends beyond individual

chains. The value network can increase the supply of complementary goods and services for value creation and enhance the network effects among users. Effective alignment of value creation and value capture aspects within the value network can amplify the value of the offering, while a lack of alignment can diminish the potential value (Chesbrough and Rosenbloom, 2002).

Amit & Zott (2001) identify four interdependent dimensions that explain the dominant value drivers in modern companies to understand business model configuration in business ecosystem: novelty, lock-in, complementarities, and efficiency. Novelty aims at adopting new activities, new ways of linking these activities, or of governing the activities; lock-in design searches to attract and keep other players willing to embrace the BM, it is achieved through switching costs or by network externalities. Complementarities occur when the bundling of activities within stakeholders promote synergies among them; efficiency targets the linking of activities in a cost-reducing manner (Zott & Amit, 2010).

Amit & Zott (2015) took their analysis of business model design a step further to identify four antecedents from design literature that drive the outcomes of these key aspects: goals to create and capture value, templates of incumbents, stakeholders' activities, and environmental constraints. They explain what influences the configuration of the different business model innovation design "themes". Figure 9 shows how antecedents are linked to the proposed design themes.

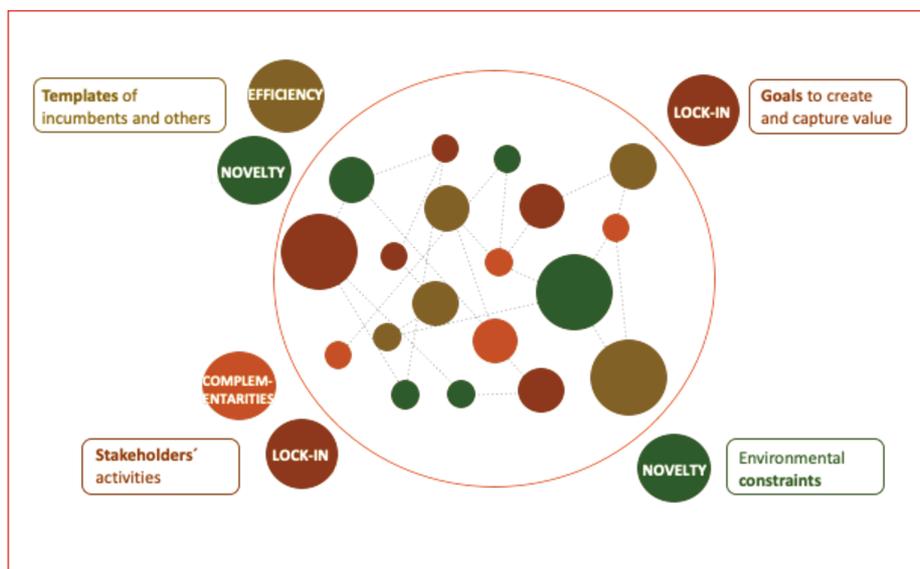


Figure 9 - Antecedents of BM for ecosystem. Adapted from the framework by Zott & Amit (2010)

The analysis suggests that the design of complex activities systems must consider these four antecedents, and that each of them must be given equal importance to avoid cognitive biases that could lead to suboptimal BM designs. The characteristics and considerations of the identified antecedents are discussed next.

3.3.1 Goals to create and capture value

Every design problem must start with a desired goal, that should be open-ended rather than specific (Boland and Collopy, 2004), to allow the design to search beyond default solutions and to consider the creation of value for all participating stakeholders. Making this the main goal prevents the migration of customers and strategic partners and enhances the commitment of business model stakeholders resulting in lock-in. Balancing the goals of value creation for all stakeholders creates trust and mutual knowledge, and encourages other stakeholders to participate in the business model (Amit & Zott, 2001).

The goal of value creation may also be achieved through network externalities among stakeholders (Amit & Zott, 2001). The idea of network externalities is closely related to the concepts of “two-sided markets” (Rochet and Tirole, 2006) and “platform markets” (Zhu and Iansiti, 2012). Externalities occur when a product or service gains value as more users benefit from it, which attracts more participants to increase its value even more (Parker, Van Alstyne, Choudary, 2016). This antecedent may be related to all four BM design themes, but according to Amit & Zott (2015), it has a stronger link with lock-in, as the more stakeholders are willing to embrace the BM, hence higher the switching costs, not only for customers but for all participant stakeholders.

3.3.2 Templates of incumbents and others

Templates mean the recycling of ideas from other firms that can bring inspiration to the design (Amit & Zott, 2015). They can reduce uncertainty but are usually the least effective. In other words, they foster efficiency at the expense of novelty, thus it is important to search beyond them for a higher pay-off (Boland and Collopy, 2004). Dominant BM designs provide valuable information about the efficient deployment of resources and capabilities, mainly in a cost-reducing manner; this enhances efficiency. However, to prevent a lack of novelty, designers must be aware of what is being borrowed, must recognize the positive and negative aspects, and must be capable of adjusting. This may lead to the consideration of different alternatives

and/or the rejections of undesired options, thus improving the process of exploration to achieve novelty (Amit & Zott, 2015).

3.3.3 Stakeholder's activities

Stakeholder activities are rooted in the concept of collaboration in two ways: as a characteristic of the configuration of the BM design, and as in cooperation of partners during the design process (Amit & Zott, 2015). "Without collaboration across boundaries of disciplines, organizations and perspectives, a design project has limited possibilities for invention of new solutions." (Boland and Collopy, 2004, 269). The arrangements involving stakeholders' activities involve two things: complementarities, the fact whether activities add value to each other with respect to some expected outcome (Amit and Schoemaker, 1993), and governance, meaning who and how should perform the activities (Amit & Zott, 2015).

The success of complementarities among stakeholders' activities requires the cooperation and coordination of related stakeholders and alignment of interests, where a good stakeholder management is key (Amit & Zott, 2015). The presence of positive network externalities also gives strength to the lock-in feature, however, for new entrants it is necessary to rely on highly reputable partners to attract new less-committed partners (Aldrich and Fiol, 1994).

3.3.4 External constraints

Every design has constraints, which are the elements of challenge in a situation. External constraints refer to the conditions embedded in an ecosystem that affect the range of design alternatives into consideration such as: environmental, economic, legal, sociopolitical, regulatory, cultural, among others (Amit and Schoemaker, 1993). They give a stimulus for creation and creativity, and when the constraints are identified, it is possible to define the problem (Boland and Collopy, 2004). The key is to become fashion setters of BM design. This attitude makes novelty-centered BMs more likely to occur in start-ups than in corporate ventures or in established companies (Amit & Zott, 2015).

The BM components must be coherent and internally aligned (Ritter, 2014) concerning innovation and value. Thus, the critical point of business model innovation is not only designing the value creation and value capture processes but ensuring they are adapted and aligned to each other (Foss and Saebi, 2018; Ritter and Lettl, 2018). Business models with a congruent

design in value creation, delivery, and capture will ultimately lead to better results (Kranich and Wald, 2018). Hence, it is necessary to gain a deeper understanding of how value-creation and value-capture activities can be aligned in the context of business ecosystems. This alignment should also take into account the evolution of the value network, as the alignment must be sustained as conditions change. This provides insight into how the boundaries of the business model are rearranged as relationships with other firms evolve, leading to the redefinition or readaptation of sources of value creation and capture. The framework of analysis proposed by the concept of Business Model Innovation enables us to address these issues.

3.4 Business model innovation (BMI) design

Analyzing the BMI of a business ecosystem requires thinking not only about the processes of value creation and capture but also ensuring that they are aligned with and adapted to each other (Ritter & Lettl, 2017). A discussion of alignment issues addresses both the state of the process configuration and its dynamics within a business ecosystem.

The potential for business model innovation lies in the design of the business ecosystem. The proposed framework is based on the antecedents of business model design (Zott & Amit, 2010), that are linked with the innovative configurations of business models (Amit & Zott, 2001). Business model innovation (BMI) involves holistic alterations to the architecture of firms' boundary-spanning activity systems for creating, delivering, and capturing value (Hock-Doepgen et al. 2020). Therefore, we propose that ecosystems can be used as a foundation for which innovative BMs are tested and implemented. This alignment also means the consideration of the evolution of the value network; as conditions change, this alignment must be maintained. Redefining or readapting the sources of value creation and capture can thus provide insight into how the boundaries of the business model rearrange as the relationships with other firms evolve (Bouncken and Fredrich, 2016). This is what we propose to study in the context of a business model innovation analysis.

3.4.1 Innovations and value creation

Rather than the creation of new technology or brand-new markets, business model innovation (BMI) aims to deliver sustainable competitive advantages for firms through enhancing the rarity and value of existing products that are produced by existing technologies to existing markets (Evans et al., 2017). The three main activity systems of BMI that enable executives to establish and discover novel and existing markets are: content innovation (an addition of new activities

to a system), structure innovation (new linkages of activities), and governance innovation (changing individual activity performance). Business model innovation is summarised as a process of creating and developing new and unique value chain architectures to improve firm performance (Amit & Zott, 2012). However, a BM may transition a firm to a completely new competitive landscape or lead to radical modifications of the firm's existing business processes (Gunzel & Holm, 2013). Thus, to attain such a differentiator in a digital arena, it is vital to incorporate BMI for viable performance and customer value delivery, as well as for successful domestic and international operations (Chesbrough, 2010). The motives of BMI are twofold: fulfilment of previously unmet needs of current customers through value creation and the desire for a new customer base through new value creation and the capture of mechanisms and activities.

Technological advancement can also have an impact on BM innovation (Baden-Fuller & Haefliger, 2013). With different technology applications, different BMs yield different market outcomes. Therefore, it is critical for firms to develop capabilities to innovate BMs. The development of a new BM might conflict with the existing prevailing BM (Amit & Zott, 2012) and, to many firms, it is not clear what the most appropriate BM should be (Chesbrough, 2010). Recent studies show that BM innovation promotes business sustainability more powerfully compared to technology innovation alone (Girotra & Netessine, 2013). A rising tendency towards IoT-oriented BM research takes an ecosystem perspective, which focuses on the perplexity of the business environment for digital technologies, underscoring contextual issues, such as interdependencies, interactions, and partnerships that evolve in the same innovation ecosystem (Metallo et al., 2018).

BM research has moved from classifying and categorising BMs to more advanced tooling for BM design, experimentation, and testing. One example of tooling is the use of so-called design patterns. The construction was introduced by a well-known architect and has been adapted for other disciplines, notably software engineering and, more recently, BMs (Gassmann, Frankenberger, & Csik, 2014). Some authors have derived patterns for BMs for specific industries or sectors, for example, Sprenger and Mettler (2016) provide and analyse e-health BM patterns.

Like design patterns, there is a design approach known as morphological analysis. With morphological analysis, a problem is framed within a specific framework or structure and solutions are described as a combination of solutions for each element of the framework. Morphological analysis is a method for identifying, structuring, and investigating the total set of

possible solutions for a given multidimensional problem. Morphological analysis can be used in conjunction with a descriptive method like the Business Model Canvas (Osterwalder & Pigneur, 2010). BM canvas for firm-centric analysis, is containing nine building blocks, namely value proposition, customer segments, customer relationships, channels, key partners, key activities, key resources, cost structure, and revenue streams. Taking this as the foundation of a BM, a generic framework is suggested consisting of four elements: value proposition (the value embedded in the products/services offered by the firm); supply chain (the relationships with suppliers); customer interface (the relationships with customers); financial model (costs and benefits and their distribution among stakeholders). For each BM dimension in the descriptive format, the morphological analysis provides possible design options (Seidenstricker, Scheuerle, & Linder, 2014). In this paragraph we follow Lüdeke-Freund, Gold, and Bocken (2019) and use the following four generic business dimensions and subcategories: value proposition (product and service), value delivery (target customer and delivery processes), value creation (partners, stakeholders, and value creation processes), and value capture (revenue and costs) to develop a morphological analysis of IOT-BM.

3.4.2 Business Model Innovation (BMI) framework

Even though research on CBMI builds upon conventional BMI research, some authors tend to highlight the differentiation from traditional streams, positioning themselves as niches (Nußholz, 2017; Pieroni et al., 2019a). Integration of the fields will avoid the risk of becoming academic silos and will maximize practical impact (Lüdeke-Freund and Dembek, 2017). The emerging CBMI field might borrow and merge elements from traditional fields, feeding back its results and contributing to synergistic developments.

Business Model Innovation (BMI) refers to “designed, novel, and nontrivial changes to the key elements of a firm's BM and/or the architecture linking these elements” (Foss and Saebi, 2016, p. 17). A BMI can be the creation of a new BM as a start-up, the transformation of a current BM, the diversification into an additional BM or the acquisition of an existing BM (Geissdoerfer et al., 2018b).

3.4.2.1 BMI framework: theoretical background

Foss & Saebi (2017) define BMI as "constellations" that have experienced innovation designed to bring about changes in the key elements of the architecture linking these elements. As a configuration of components, BMI involves interdependent strategic decisions whose

effectiveness depends on the quality of the interactions between these components and stakeholders' relationships (Maier et al., 2001; Morris et al., 2005).

BMI is not defined as a subfield of BMs but rather as having its own specific framework of elements and dimensions (Wirtz & Daiser, 2017). It is characterized as a process by which companies modify how they perform their internal and external activities (Aspara et al., 2010; Desyllas & Sako, 2013; Pedersen et al., 2018). Within this framework, BMI allows firms to enhance organizational and strategic flexibility (Bock et al., 2011), strengthen a competitive advantage (Boons & Lüdeke-Freund, 2013; Casadesus-Masanell & Zhu, 2013) and boost financial performance (Chesbrough & Rosenbloom, 2002).

As a theoretical concept, BMI is dimensionalized in terms of scope (architectural vs. modular change) and novelty (new to firm vs. new to the industry), which is helpful in the examination of the antecedents, moderators, and consequences of BM (Foss & Saebi, 2016). As BMI involves changes in multiple components and the eventual outcomes depend on the interactions between all components involved (Gunther McGrath, 2010), BMI poses many challenges to decision-makers because the interactions between the components (networks of agents and multiple activities) are complex and difficult to anticipate (Aversa et al., 2017; Baden-Fuller & Haefliger, 2013). These internal linkages and the connections with the external environment impose feedback and circular causality on the BM (Al-Debei & Avison, 2010; Cavalcante et al., 2011).

In this context, we define BMI as a system that emerges and changes in an evolutionary way (Demil & Lecocq, 2010; Sosna et al., 2010). Following this evolutionary perspective, the analysis focuses on the organizational factors that do or do not promote a change in BM (Berends et al., 2016; Gunther McGrath, 2010). In line with Foss & Saebi (2017a, p. 217), we state that "[BMI] involves changes in the overall business model that are new to the firm, but not necessarily new to the industry." Innovations that sustain firm performance focus either on how companies create and capture value (Lüdeke-Freund, 2020), on the strategic organization of complementary activities (Schneider & Spieth, 2013), or on the relationship between agents involved in the management of activities through the value chain (Sanchez-Miralles et al., 2014). The proposed frame represents service-dominant business models depicting the way that a network of organizations, the ecosystem, co-creates and co-captures value, through a solution-oriented value proposition that generates revenue and benefits for all the players participating in the ecosystem.

Starting with a value proposition (value proposition innovation), the ecosystem then seeks to identify the activities needed and the set of actors that interact (value creation and delivery innovation) for the proposition to materialize (value capture innovation). The strategic alignment looks for a mutual agreement among all members regarding their position and the flows of value; it entails recognizing gaps and creating the conditions to close these gaps. Because the different actors may have different perspectives and objectives, the analysis must not account only for interests in notions of competition and value capture, but also in perspectives of value creation and value distribution.

The framework is presented as a canvas (Table 1) and considers the following elements:

- a) **Value proposition innovation:** the interdependent value created for users by the offering. Definition of the perceived needs that can be satisfied, and in what form a customer may use it.
- b) **Value creation and delivery (the value network) innovation:** Identification of the value creation opportunities and the design of the value offering within the stakeholders' network, including the customer segment to whom the proposition will be appealing.
 - **Activities:** discrete actions needed for the value proposition to materialize.
 - **Actors:** entities that undertake the activities. They include the user, suppliers, manufacturers, complementors, and competitors. A single actor may undertake multiple activities, and multiple actors may undertake a single activity.
 - **Position:** location of the actors within the flow of activities across the ecosystem, characterizing who hands off to whom.
- c) **Value capture innovation:** agreement on value distribution and choice of profit formula.
 - **Links:** transfers across actors that might not have any direct connection to the focal actor. Financial and non-financial content such as: materials, information, influence, funds, data, usage, etc. These transfers must consider the value provided (cost) and the value captured (revenues).
 - **Strategy:** the way a focal firm approaches the alignment of partners and secures its role in the competitive ecosystem.

Table 2 Elements of the BMI framework. Source: prepared by the authors.

a. Value Proposition:	d. Positions	e. Links	f. Strategy
<i>What perceived needs can be satisfied?</i>	<i>What are the governance arrangements across the ecosystem?</i>	<i>What is the value</i>	<i>How can the focal</i>

		Actor 1	Transaction/ Interaction	Actor 2	<i>unit of each transfer?</i>	<i>firm align the partners?</i>
b. Activities: <i>What are the actions needed to satisfy these perceived needs?</i>	c. Actors: <i>Who should perform each activity?</i>					

A successful business ecosystem is one that satisfies all the participants, that achieves to have a joint value creation effort as the general goal and where participants can appropriate part of the value they helped create. We use the business ecosystem to conceptualize the collection of actors that interact with each other to reach the shared value proposition; specially the interactions that are not directly linked with the focal firm. This common value proposition will create the boundaries of the business ecosystem, and in turn the boundaries of the given ecosystem will determine the boundaries of the ecosystem strategy.

3.4.2.2 BMI: barriers and opportunities

We can thus see that the development of business models integrated with ecosystems is a process of experimentation in which learning about relationships and interdependencies is permanent and guarantees the creation of value. Following McDonald and Eisenhardt (2020), BMI is a result of a trial-and-error process and focus on the role of learning and experimentation. However, firms face serious barriers to business model experimentation. The design of an innovative business model may conflict with the configurations of a firm's assets (Chesbrough, 2010). In this regard, the concept of disruptive innovation (Christensen, 1995), influenced a new way of innovation-driven success that raised similar barriers to business model innovation. Disruption occurs when a small company with limited resources is able to successfully challenge an established incumbent (Christensen, 2015). In this case, what disrupts incumbents is that following a "dominant logic" fails to consider potential value that does not fit with the current BM proposition. This can create a cognitive barrier where the suitable business model is often biased or is not even clear. (Chesbrough, 2010). In some cases, the search for a new business

models may imply the co-existence between current and new business models, and “knowing when to shift resources towards the latter is a delicate balancing act”. (Chesbrough, 2010, 9)

The only foreseeable solution points towards adopting an experimental attitude. This calls for companies to undertake active tests in emerging markets with new potential BM configurations. These tests must provide high fidelity as quickly and cheaply as possible. A practical approach is the construction of business models maps (Ex. “the business model canvas”), to collect data and generate knowledge for further opportunities (Chesbrough, 2010). Open innovation also suggests the use of test beds that search to offer access to physical facilities, capabilities and services required for companies and users for the development of shared innovation (European Commission, 2017).

The paragraph precisely intends to propose an experimental version to contribute to the works on business model innovation. This experimental version will be developed in two steps: a description of the innovations impacting the creation of value for the business ecosystem and a proposal for modeling the existing interrelationships between stakeholders following the integration of the couple innovation/value network in the business model.

3.5 BMI framework for EV business ecosystem

This study undertakes a qualitative systematic review with a qualitative and exploratory research type (Booth et al., 2013b). This type of systemic review integrates and compares findings from qualitative studies and looks for ‘themes’ or ‘constructs’ across individual studies (Booth et al., 2012). The data collection contains a variety of sources, including electronic databases, web resources and other sources of grey literature. In addition, hand-searching of key journals and the checking of the reference lists of relevant papers was carried out. (Booth et al., 2012). The objective is to propose a framework for interpreting the relationships between all stakeholders in the EV ecosystem.

3.5.1 Innovations and EV value ecosystem

EV’s have the potential to change the nature of the vehicle manufacturing industry and the ecosystem around ICE vehicles (cf. Petrie 2012). EV’s integrate an array of new electronic systems that bring connectivity and produce data, making possible better mobility services and, eventually, cars that are fully autonomous. This transition will lead to fundamental changes in the current mobility ecosystem. First, combustion engine technology will become less important

in the long-term (Huth, Wittek, & Spengler, 2013), while new components such as the battery and the charging infrastructure will become critical limitations because of its high cost and because of the changes involved in driving behavior (Kley et al., 2011; Weiller & Neely, 2014). Then, the different utilizations of EVs will create new services such as energy storage in ‘smart energy’ systems (Kley et al., 2011); the leasing or re-using of the battery (Christensen et al., 2012, Neubauer and Pesaran, 2011); or mobility services such as car-sharing and connective services (Fournier, 2012). This will redefine the automotive landscape bringing together previously independent value chains into one shared ecosystem: vehicles, energy, and services.

EV’s represent a different systemic innovation, distinct from the dominant design of ICEV’s. EV’s have a great impact in the automotive manufacturing, where OEM’s face the challenge of supplying critical raw materials and are confronted with an increase in value represented by batteries and software for connectivity management systems and vehicle integrated services, thus causing the detriment of motorization, redefining the meaning of performance. Renewable energy production and management of smart grids are meant to be the new key links of the energy value chain with the new EV charging infrastructure. Further, services associated with EVs become essential, such as: fleet management services for optimization of battery usage; services for electricity loads and storage (V2G); mobility services (MaaS); and the management of the end life of batteries (Deloitte, 2020).

As a result, the current EV value ecosystem focuses on three main elements: the battery and the vehicle; the infrastructure enabling grid connection; and the data and energy services for the user. (Kley et al., 2011; San Román et al., 2009; Anderson et al., 2009). Considering this, the following ecosystem map (figure 10) is a generic representation of the main actors within the new EV ecosystem and the innovation interface for potential services that EV’s represent. The main actors and potential services are described next:

- *Battery manufacturing:* battery manufacturers, component suppliers, raw material suppliers, battery recycling, and related R&D.
- *Vehicle manufacturing:* OEM’s, component suppliers and peripheral services providers (e. g. selling, financing, maintenance).
- *Energy and utilities:* power network providers/operators, electricity producers.
- *Charging infrastructure:* infrastructure developers, suppliers, charging points operators.

- *EV's complementors/aggregators*: complement the offer for the final solution to customers. Can be one of the existing players, an entirely new one or a combination of both (e. g. a joint venture).
- *EV users*: end consumers of EV's. Consumers, corporate customers, and public sector.
- *Regulators and external actors*: Policy makers, government regulators, academic research and development.
- *Services*:
 - *Telematics and data management*: vehicle performance and diagnosis, in-vehicle charging infrastructure, fleet management tools, CRM.
 - *Physical charging infrastructure management*: retail, installation, and maintenance services.
 - *Charging station network operator*: fast charging, public charging, home charging.
 - *Customer service network management*: Smart grid interface, smart charging, network management software, billing, and metering.
 - *Grid integration*: smart grid management, energy distribution, consumption billing management.
 - *Mobility services*: car-sharing, ridesharing, MaaS.
 - *Battery recycling*

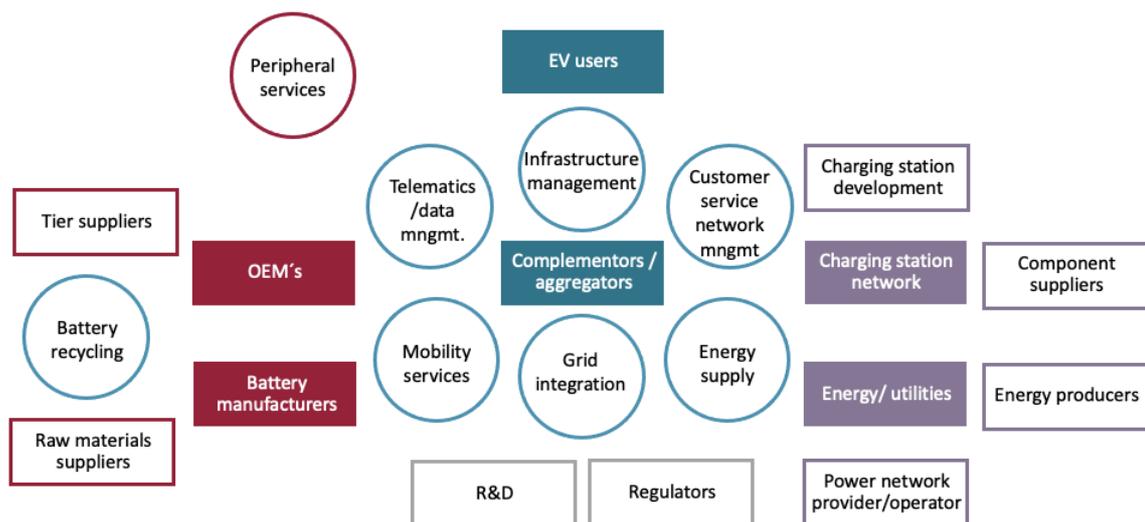


Figure 10 Generic representation of the EV value ecosystem. Source: prepared by the authors (Ernst Young, 2011; Zulkarnain et al., 2014; San Roman, 2011)

The EV ecosystem emerges with a number of different players from different industries and an array of services for the definition of innovative configurations of business models. The main

players involved in the EV ecosystem are indicated in a rectangular form, depicting the vehicle with the battery (red), the charging infrastructure to enable grid connection (purple), the data and energy management services for users (green), and other external actors (gray). The new potential services that emerge at the innovation interface are indicated in a blue circle. The EV ecosystem is at an early stage of development, where business model innovation is necessary to address the challenges for EV market penetration, to create an efficient configuration of the value network, and to define strategies that explore new ways of value creation and capture.

One of the main problems for the massive adoption of EV's is range anxiety. EV's rely on complementary charging infrastructures to charge the battery, making these two elements the fundamental challenges constraining the growth of the ecosystem. Nonetheless, technology development has experienced considerable progress, particularly with the industrialization of the lithium-ion battery technology, that has shown a decrease in prices and has improved the performance of previous batteries. Furthermore, new battery technologies (i.e. lithium-sulfur) have shown to provide promising increases in energy density to up to 400Wh/kg. In the case of the charging infrastructure, government incentives and firms' efforts have strongly supported initial investments to develop the charging network (Dijk et al., 2013), however, these first endeavors have not been enough for the vast amount of infrastructure that is needed and for the exponential acceleration in demand for the years to come. Although the deployment of the charging infrastructure represents a market opportunity, the problem still remains in who owns the value created by the EV ecosystem strategy and how to capture part of this created value.

As electric mobility continues to gain momentum as part of the transition to a low carbon economy; policies, programs, and processes relevant to the deployment of the charging infrastructure are of particular interest. The current pace of infrastructure roll-out could become a limiting factor affecting EV adoption in upcoming years. For instance, in Los Angeles, city leader in EV adoption, the current availability of public charging infrastructure is low, despite the outstanding efforts to increase deployment. In effect, EV users rely on private charging points, mainly installed at home or with exclusive access in their workplace. One of the biggest challenges of deploying new charging infrastructure is establishing how it will be funded, to some extent because private companies are not able to find business models that support the massive deployment that is needed (Pereira, 2019).

3.5.2 Innovations and value network for EV business ecosystem

BMI process facilitates its transformation into value opportunities that create new value. In the EV ecosystem, we characterize value opportunities as new forms of value for existing stakeholders or new forms of value for new stakeholders (Bocken et al., 2013). For example, additional value can be created from: the digitization of electric vehicles combining new forms of value and new stakeholders (Madina et al., 2016; Vervaeke & Calabrese, 2015); the offer of digital services at charging stations from other ecosystem players for advertising purposes; and an advanced navigation system capable of handling complex charging scenarios (Madina et al., 2016). Four key ideas characterizing innovations in the EV business ecosystem, explain business model dynamics.

First key idea: Many product and service innovations are identified in the value propositions of the automotive industry; here, we focus on four: vehicle with the battery, service-dominant design, V2X, and differentiation of market segments.

- **The vehicle together with the battery.** Due to new propulsion technology, business models now have to consider both the battery and the vehicle. This way, value capture can address the kind of revenue that will be received (selling price for equipment, leasing, or pay for use), the value opportunities created with the product (e.g., the electric drive train generates electricity during the braking process, thus creating a new source of value for the user), after-sale services (annual maintenance, software updates, battery management), as well as second use of batteries (Andersen et al., 2009).
- **Product-service system and service-dominant design.** Companies are pushing to change from a product-based to a service-based mindset (Ibarra et al., 2018; Iivari, 2016), which challenges the traditional linear production model. Also, they are invested in designing product and service systems (Annarelli et al., 2016; Manzini et al., 2001). For instance, EVs can create additional customer benefits by enabling integral mobility solutions. The shift to outcome-based service, the most advanced form of service provision, represents a high-gain as well as a high-risk BMI strategy (Jacob & Ulaga, 2008; Kohtamäki et al., 2019). Hence, this form of BMI requires an understanding of the changes involved in how value is created, delivered, and captured (Sjodin et al., 2020). Business practices inspired by this service-dominant design should be re-engineered to cope with the challenges of considering the value proposition of stakeholders, the co-production activity of the actors, and actor

costs/revenues (Turetken & Grefen, 2017). A value network implies the consideration of new actors that arise in the value chain and the changing roles of existing ones (Cherubini et al., 2015). The value network increases the supply of complementary goods and services for value creation and can increase the network effects among users (Chesbrough & Rosenbloom, 2002).

- **V2X: integrating EVs into the energy system.** Vehicle-to-Anything (V2X) is a set of standards aiming to make new vehicles interoperable and cyber-secure by providing them with the capacity to interact with their environments in various ways. The number of participants for supplying systems services is variable: from one participant (e.g., V2H where the individual needs an electric vehicle, a charging/discharging cable, and suitable software applications) to more than one, as with V2I or V2G. V2G is a type of vehicular communication system that provides EV battery usage data for energy services and derives additional value from the battery asset during times of non-use (Thompson & Perez, 2020). For V2X, the car-sharing provider can earn an additional income stream as long as all stakeholders increase road safety, traffic efficiency, and better road management, illustrating the above-mentioned value network. All these innovations impact value capture, value destroyed (Tesla is not affordable for everyone), value missed (batteries for vehicles are only used for a limited time), and create value opportunities (additional incomes).
- **Target segment (customer differentiation):** Bohnsack et al. (2014) identified two kinds of segments: luxury vs. economic segment and single-purpose vs. multi-purpose. The luxury segment targets consumers looking for premium vehicles with high comfort performance, technological amenities, and physical features. However, the performance of EVs is analyzed with other complementary criteria. For example, high software integration is the interpretation of a premium version for Tesla, and high performance is equated with greater driving range, greater maximum speed, shorter recharging times, and lower cost of recharging batteries (Chéron & Zins, 1997). These differentiation criteria can be used for single-purpose use or developed for multiple purposes in a complementary and integrated manner.

Second key idea: BMs for OEMs electric vehicles cannot be developed without considering the deployment of charging infrastructure.

The "chicken and egg" problem limits the economic model for EVs. A critical mass of EVs is required to compensate for the high investments needed for the installation of charging infrastructure, but to increase the demand for electric vehicles, the charging infrastructure must be available to drivers (T. Yang et al., 2018). Therefore, the increase in the number of electric vehicles must be accompanied by an increase in charging infrastructure to encourage EV adoption. Car manufacturers must change their mindset and consider that value is created at the mobility system level and not only at the product level. The BM for vehicle marketing and charging infrastructure are thus dependent on one another. The value creation of the mobility ecosystem, combining electric vehicle BM and infrastructure BM, must be analyzed considering the value network framework and complementary assets. This requires the development of a business model in which value capture results from the integrated combination of the value chains for electricity production, charging infrastructure, and automotive production.

Third key idea: Moving from Porter's value chain towards a business ecosystem value configuration.

We identify various drivers from different dimensions that can impact the future development of the EV ecosystem value configuration. Although EVs do not yet have a fully developed global value chain, radical changes will have to be made by eliminating some activities from the system (e.g., combustion engine production) and adding new ones (e.g., installation of charging infrastructure). Technological drivers for value chain configuration include the impact of artificial intelligence, telecommunication grids, or connected cars that could facilitate the entry of new players into the EV business ecosystem. For example, mobile energy storage can be integrated into the power system by the system battery manufacturer or during the deployment of the charging infrastructure; also, players with alternative powertrain proposals, driven by environmental factors, are beginning to enter the automotive market.

Economic drivers such as data monetization, infrastructure spending, market control by new players, servitization, and financing options can positively and negatively impact value chain configuration. The strength of IP laws, state of public transport infrastructure, data storage, ridesharing, future standing of driving, and urbanization are all examples of political and social drivers that determine how players can participate in this new business ecosystem value chain configuration. For instance, Government and local institutions could also impose new rules on how value is created and shared. In order to provide a more comprehensive perspective of the e-mobility value chain, we propose a holistic analysis that describes the electric mobility

ecosystem as an interactions model between technologies, actors (including manufacturers, suppliers, users, service providers, government, and substitutes), and infrastructure for urban development (Abdelkafi et al., 2013; Richter et al., 2020) with a sustainable perspective (Taeuscher & Abdelkafi, 2016).

Fourth key idea: A typology of value exchange forms for a range of stakeholders as part of generating revenue in the business model.

We define value capture as securing profits from value creation and delivering those profits to participating actors in the EV ecosystem (Dyer et al., 2018). Accordingly, successful value capture requires appropriate governance mechanisms to ensure value creation is greater than the cost of generating that value and that the surplus value is distributed equitably among partners (Chesbrough et al., 2018). Given the characteristics of the EV ecosystem mentioned above, a new interpretation of value mapping must be considered. Following Sjödin et al. (2020), we introduce an external perspective into value mapping to take into account the interactions between all stakeholders in the EV business ecosystem. In this way, rather than the traditional view of value creation and capture as user-centric processes, we identify a new process centered on the goal of creating value opportunities (Dyer et al., 2018).

Using M. Yang et al. (2017) definitions, we use their four forms of uncaptured value for the EV ecosystem. This potential value that could be captured but has not yet been captured by the ecosystem can take the following forms: Value destroyed as a value with negative consequences of innovation (e.g., environmental or social impacts, see Kumar & Anbanandam (2018) for social performance evaluation issues); Value missed as a value that is not fully exploited (e.g., the battery); Value creation and Value communication as the way firms establish interactions with the ecosystem to deliver a value proposition (e.g., value coming from vertical integration strategy).

3.6 BMI application in the EV ecosystem: public street charging

Charging infrastructure in public areas with public access imply multiple agents with complex interrelations involved. The deployment of the infrastructure costs are not negligible and therefore significant public and private funds are at stake, thus requiring a suitable roll out plan designed by public authorities. In this scenario (San Román et al., 2011), we consider the local DSO as the actor installing the charging points in a public parking site for public use of EV owners.

The infrastructure is assumed part of the distribution network, to lower costs and for standardization of chargers. All charging points should be accessible to any EV supply aggregator (EVSA), that in turn would pay the regulated charges to the DSO to compensate for infrastructure installation costs and a fee for the usage of the connection points. EV owners would pay their corresponding EVSAs for the charging services, that will benefit from aggregation and other economies of scale. Ideally, EV owners would have the right to charge at any EV public charging spot and pay end user tariffs according to market conditions. The BMI framework is applied to the proposed scenario in Table 2.

Table 2 Public Street charging BM. Source: prepared by the author.

a. Value Proposition: <i>What perceived needs can be satisfied?</i>		d. Positions <i>What are the governance arrangements across the ecosystem?</i>			e. Links <i>What is the value unit of each transfer?</i>
Public street charging: Charging infrastructure in public areas with public access.		Actor 1	Transaction/ Interaction	Actor2	
		b. Activities: <i>What are the actions needed to satisfy these perceived needs?</i>	c. Actors: <i>Who should perform each activity?</i>	Infrastructure development	
<ul style="list-style-type: none"> • Infrastructure development • Network charges and distribution services. • Charging services for EV owners. • Change on regulations. 	<ul style="list-style-type: none"> • DSO (EVM + C.P.) • EVSA • EV owner • Public authorities 	DSO + C.P.	→ → ← ↔	EVSA	Utilization Energy Money Data
		EVSA	→ → ← ↔	EV owner	Service Energy Money Data
		Public authorities	→ →	C.P.	Regulations Money
		EVSA	→ ↔	Energy market	Money Data
		Energy market	→	DSO	Energy
		OEM	→ ←	EV owner	Product Money

The following ecosystem map (figure 11) is a simplified version, only for the purpose of demonstration, of the business ecosystem resulting from the proposed scenario, in order to represent and understand the relationships and interdependences between the different actors and to illustrate the different transactions and the value unit of each interaction.

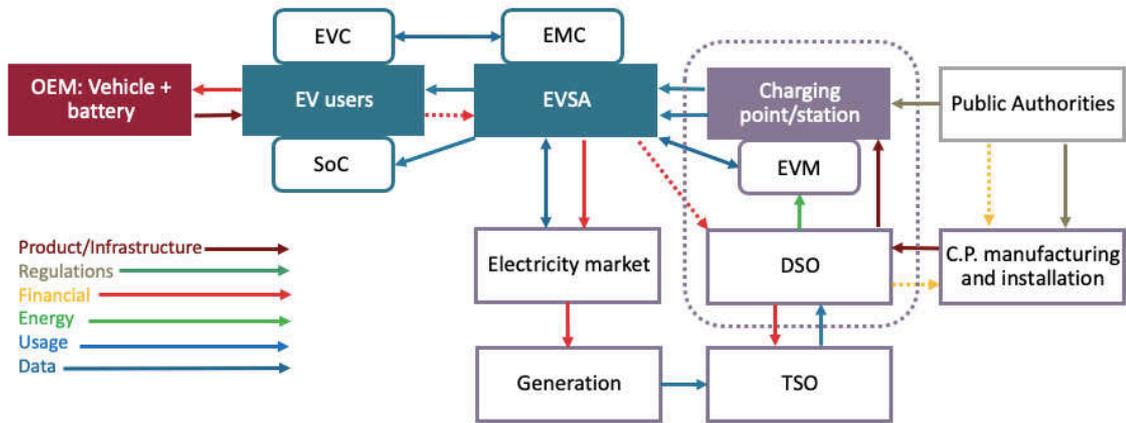


Figure 11 Business Ecosystem for the proposed scenario. Source: prepared by the authors.

For this scenario, there is a new actor that emerges in form of the EVSA. Taking the perspective of automakers, it could be interesting to bundle EV's plus the charging infrastructure (Freitas Gomes et al., 2020). This way, OEM's could expand their business models and explore the configurations that could arise from taking the position of the EVSA in the business ecosystem (figure 12), and consequently seek for new ways to create and capture value and take advantage of the positive externalities in the form of EV sales, the way Tesla is doing with the development of the Superchargers. Further, this capability could extend for the future V2G services. Finally, car makers will need to set their ecosystem strategy for the alignment of the relationships between the different actors and for the consideration of the evolution of the ecosystem.

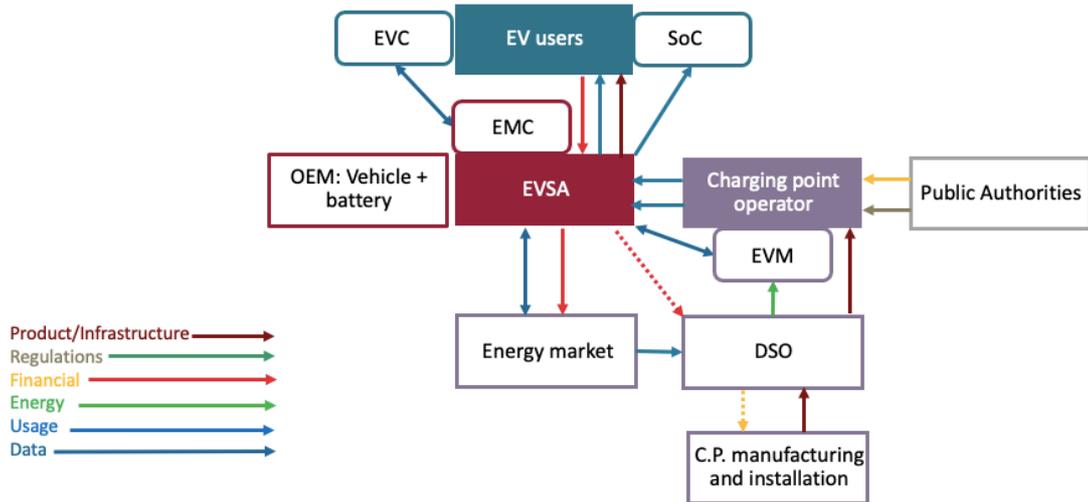


Figure 12 Bundling of EV + charging services. Source: prepared by the author.

3.7 Conceptualization of BMI architecture

Despite a growing amount of research papers recognizing that business models are ecosystem embedded (Frishammar and Parida, 2019), studies investigating the driving factors of BMI with an ecosystem optics have been scarce. The main objective of Foss and Saebi (2017) was to identify and fill gaps in the field of BMI research, not to illustrate its foundations. Our proposal is to contribute to this body of research. In the former paragraph we proposed to experiment with a BMI for an EV business ecosystem. We wish to deepen this initiative and move towards a proposal for a BMI architecture to illustrate the different transactions between stakeholders that will occur when they innovate and change their relationships and interdependencies.

3.7.1 BMI architecture characteristics

Firms increasingly rely on the business ecosystem to collaborate with other stakeholders and to synergize resources held by these stakeholders to jointly create and capture value (Wei et al., 2014). The choice of BM allows the capturing of the latent technology value and the commercialization of that technology by choosing the right mixes of value proposition, market segment, cost structure, profit potential, value chain, and value network (Bohnsack et al., 2014). To model the architecture of the activities developed by a company, we propose to characterize the modalities of value creation, capture, and delivery for a company, based on the activities following Abdelfkafi et al. (2013) and inspired by previous literature (Figure 13).

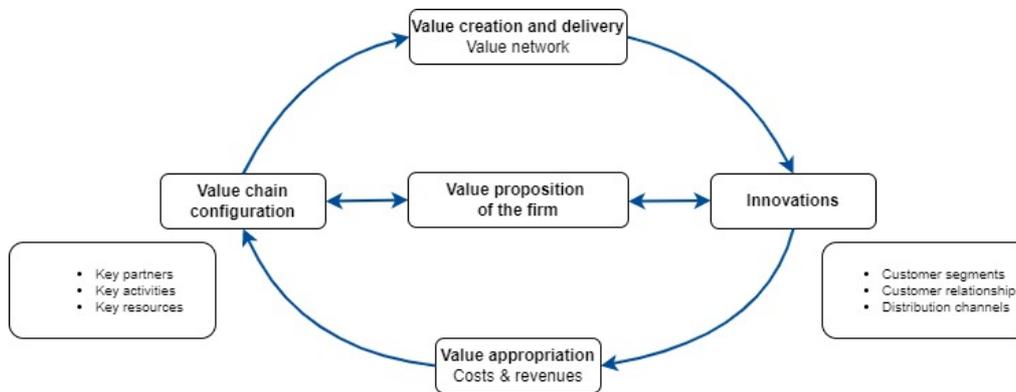


Figure 13 BM framework for a firm. Adapted from the framework by (Abdelkafi et al. 2013)

However, innovative practices in EV sector will expand to consider the life cycle of a product in their implementation with its environmental and social impacts, digital transformation, the logic of circular economy with the reduction of consumption of materials and energy, their reuse, the collaborative economy, and sharing trends (M. Ritter & Schanz, 2018). This change in the pool of activities will result in actors exiting or entering the business ecosystem while the system of activities is reconfigured. Consequently, actors could potentially rely on different types of competencies and resources than they had previously done (Yi et al., 2022).

Organizational characteristics, resources and their associated services (Penrose, 1959), and competencies are cited in the literature as facilitators of BMI (Berends et al., 2016; Berglund & Sandström, 2013; Demil & Lecocq, 2010). However, some typical reasons could impede a profound modification of existing BMs: dependence upon mainstream customers, the rigidity of existing activities and competencies, demand uncertainty, organizational tensions, and reliance on established value networks (Cozzolino et al., 2018).

Nevertheless, the emergence of disruptive technologies offers new opportunities, allowing firms in the business ecosystem willing to experiment with the "value network". The ways in which value is created and captured are very variable and sometimes incompatible with each other during the innovation process. Value creation occurs from balancing internal and external knowledge, as well as old and new models, while value capture results from the development of platforms and the control of user data. In an ecosystem context, we also explore the idea of dual value appropriation, "an inter-firm learning process where the main objective is to generate new knowledge that entails a different, unique value proposition and a different set of current and potential benefits for the alliance firms" (Pérez & Fierro, 2018, p. 558).

Finally, the current revenue/cost model based on the pricing strategy of products is expanded with the integration of new types of revenues from implemented innovations (Yang et al., 2017): the positive and negative components of value in a network of stakeholders (value destroyed); identification of conflicting values between stakeholders (value missed); identification of additional income from opportunities for BM redesign (value opportunity); and establishment of the interactions within the ecosystem that ensure the delivery of the value proposition (value communication). Contrary to value co-creation, which suggests a win-win scenario, value co-capture implies what is known as a *zero-sum game*, where the gain of one actor is equivalent to the loss of another (Wagner et al., 2010).

The BMI framework that describes these evolutions is shown in Figure 14.

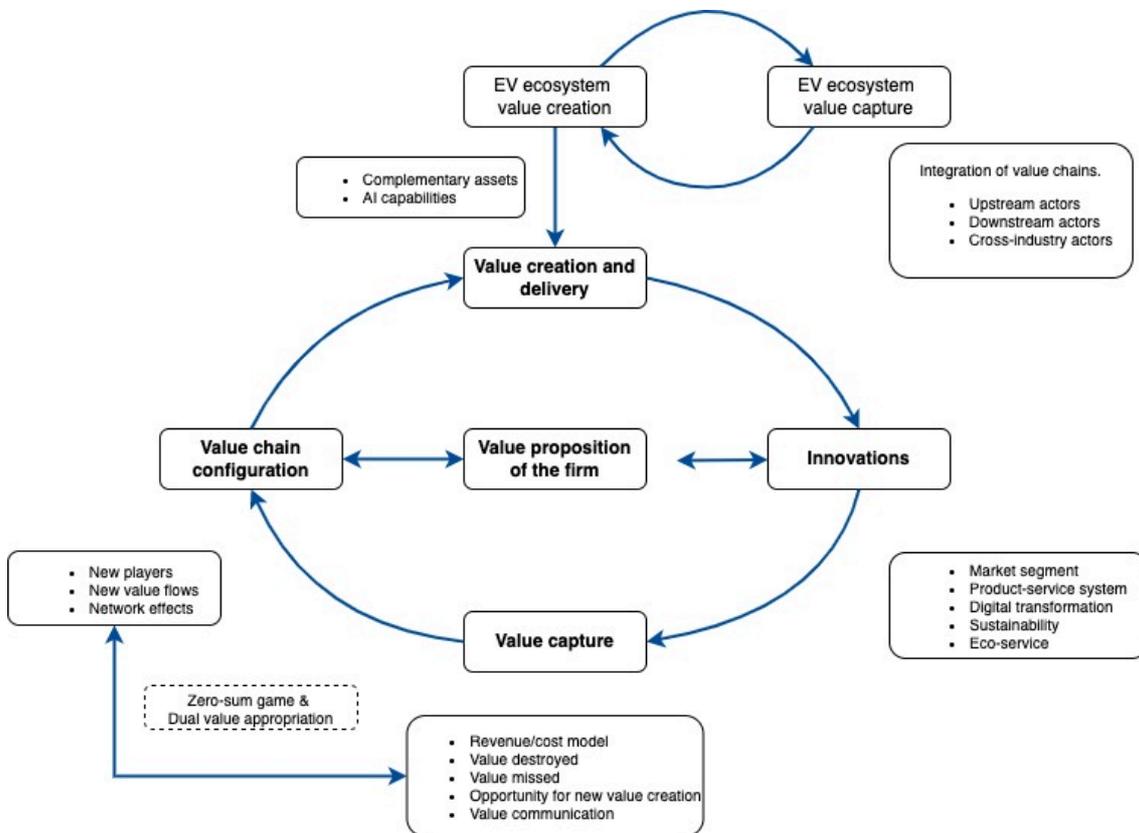


Figure 14 BMI architecture framework for a business ecosystem. Source: prepared by the authors.

Based on this framework, we now explore an experimentation of this architecture framework. We test it on the Tesla case study, because as a new entrant the determinants and stakes to create value with its ecosystem were easier to consider.

3.8 BMI architecture: Tesla case study

We chose Tesla for two main reasons. First, as a new entrant, the strategy of the company is dedicated entirely to the manufacturing of battery electric vehicles. The company has developed an innovative organization and strategy addressing the main issues of batteries and range anxiety, tailored into a larger ecosystem that comprises different actors from different contexts. Second, Tesla has managed to gain a foothold in the emerging EV ecosystem. As of July 2022, Tesla has a market capitalization of USD \$722.79 billion, making it the 6th most valuable company in the world; being worth as much as the next ten most valuable carmakers combined. Tesla is also the leader in worldwide all-electric car sales, with 21% of the market in 2021 (InsideEVs, 2022).

The data collected for this monography is based primarily on secondary qualitative data, which is highly available for the case of Tesla. The sources of data were the official website and the annual reports of Tesla, as well as the "Tesla blog," where different high-range members of the company, including Elon Musk himself, post regularly. Additionally, we searched for reports from industry associations and magazines such as Automotive News, InsideEVs, AutoWorld, and business press coverage such as Bloomberg and Business Wire. In addition, we also analyzed academic case studies by Chen (2018), Chen & Perez (2018), and Donada & Lepoutre (2016). We analyzed the data based on the elements of our BMI framework. We use our model to set a baseline to identify the main elements related to the "constellations" of activities that create, deliver and capture value (Foss & Saebi, 2016). Then, we highlight the players involved, including their assets, and identify the flows of value happening among them.

3.8.1 Tesla Master Plan: three steps in the BM evolution.

In 2003, Martin Eberhard and Marc Tarpinning, two Silicon Valley engineers, founded Tesla Motors. Their mission was to contribute to the transition from a hydrocarbon economy toward a sustainable CO₂-free economy. "Critical to making that happen is an electric car without compromises" (Musk, 2006:1). In 2004, and after a USD \$6.35 million investment, Elon Musk became the largest shareholder of the company, as well as the chairman and a top-level consultant on the technology and product design. In August 2006, Musk wrote what he called "The Secret Tesla Motors Master Plan." The vision of Tesla was to create an entirely electric vehicle technology-centric company, focusing on the evolution of batteries, proprietary motor, and computer software integration. The master plan revealed the future strategy of the company: enter the high-end market with a sports car; use that money to build an affordable

car; use that money to build an even more affordable car; and, in the meantime, also provide zero emission electric power generation (Musk, 2006).

3.8.2 A supply-chain platform: the Roadster (2008-2010)

In 2008, Musk stepped up as CEO of Tesla, and the company started the production of its first pure BEV - the Roadster - a high-performance, low-volume sports car. The first challenge was to reduce the complexities of system integration and car manufacturing capabilities. As a start-up, Tesla had limited resources and knowledge in the design and manufacturing of vehicles. Tesla partnered with the automaker Lotus, licensing the chassis technology of their model Elise, mainly related to structure and safety. Tesla's engineering team designed and adapted the existing chassis to make it compatible with the new Roadster. They modify it for installation with the Tesla-developed battery technology and AC propulsion drive train, among other technological and structural adaptations. Tesla innovated the battery system, with the Roadster being the first car to be powered with Lithium-ion (Li-ion) batteries, giving an approximate 240 miles range and reducing range anxiety. The price tag of the Roadster was around USD \$100,000 and it qualified for government incentives in several countries; for example, in the USA, incentives could cut 10% of the total cost. The Roadster was sold directly to customers, either online, in showrooms, or at the Tesla Stores, a dissimilitude with the traditional distribution channels, that cut out the car dealerships. In terms of recharging, the Roadster needs between 24 and 48 hours to recharge using the standard home outlet. Tesla assumed that the high living standards of Roadster owners could make it easy for them to install home charging.

The Roadster served as a first experiment to reposition EVs, gain legitimacy as a car manufacturer, understand the technicalities of production, and estimate the response of its target market. However, modifying the platform of an internal combustion engine vehicle to fit an EV, was not easy, and only 7% of the refitted Roadsters had parts in common with the Lotus Elise, raising the expected production costs (Siry, 2008). Two years after the initially planned delivery date, Tesla delivered 2,450 Roadsters between 2008 and 2012 (Tesla Motors, 2012).

Thus, Tesla created its initial supply-chain platform based on a collaborative strategy with other traditional car manufacturers, high investment in battery R&D, and a niche product sold directly to the customers. Following a business model canvas architecture, the company opted for a BM based on new battery technology as strategic assets, direct access to consumers, and product differentiation based on fairly traditional parameters such as luxury.

3.8.3. The nascent EV ecosystem: Model S, autonomous driving, Superchargers (2010-2016)

Production problems of the Roadster and the cost of its research and development brought financial problems that led Tesla to the verge of bankruptcy. However, in 2009, Musk initiated a series of changes to save the company. First, with the expertise gained in electrical power trains, Tesla formed a strategic partnership with Daimler, who acquired an equity stake of nearly 10%, to cooperate in the innovation of the battery systems, electric drive systems, and new vehicle projects. Then, Tesla received a USD \$465 million low-interest loan from the US Department of Energy to support the development of a new power train factory and accelerate the production of its electric vehicles. Tesla also received a USD \$40 million financing commitment to accelerate the manufacturing of the Roadster and expand the powertrain supply business. In 2009, a major milestone for the company was the acquisition of a Toyota factory in Fremont, California, for USD \$42 million, allowing the production of 450,000 cars per year. In 2010, Tesla entered the NASDAQ stock exchange and used the USD \$226 million of capital raised to become a mass market car manufacturer. The same year, they formed a battery partnership with Panasonic, raising another USD \$30 million (Tesla Motors, 2010). Finally, in 2011 Tesla received tax breaks and incentives from the California Alternative Energy and Advanced Transportation Financing Authority totaling USD \$31 million, and in 2011 and 2012, Tesla raised a further USD \$360 million via secondary offerings.

In April 2010, Tesla unveiled the Model S, the first mass-produced highway-capable EV. In contrast to its approach with the Roadster, Tesla hired a team of engineers from leading automotive companies, alongside engineers with backgrounds in Silicon Valley firms. For the Model S, the company made a radical strategic choice, building a new purpose-designed EV with an idiosyncratic architecture focused on battery technology and the elimination of range anxiety. The Model S included a battery with a higher capacity (60-100kWh) mounted on a large flat floor (Dyer & Furr, 2016) that enabled it to run up to 300 miles on a single charge. Additionally, they designed an onboard charger, that made a fast charge possible. The company focused on four main components for the power train based on core intellectual property: the battery pack, power electronics module, high-efficiency motor, and electronic software (Tesla Motors, 2011). After four years of working on its design, Tesla launched the Model S in 2012, and discontinued the production of the Roadster to focus on its new models. Tesla managed to lower the price of the Model S to up to USD \$50,000 (after a federal tax credit of USD \$7,500), becoming the most awarded auto of 2013 (Evanson, 2013).

The design of this new EV architecture allowed Tesla to build an adaptable platform to cost-effectively launch new EV models (Dyer & Furr, 2016) such as the Model X. It also incorporated a significant amount of IT innovation that allowed upgrades via software and added features such as auto parking and autopilot. While the initial activities were focused exclusively on the manufacturing of EVs, Tesla started to move into different activities other than just selling cars. In 2013, Tesla announced the Giga Factory, the largest battery factory in the world, becoming a supplier to other EV manufacturers, as well as adding an additional supply side for domestic energy storage applications - the power wall. In terms of charging infrastructure, in 2012, Tesla went further by building its own network of fast-charging stations, called Superchargers (Tesla Motors, 2011). In 2013, as the company continued to expand, Tesla launched its app, which provided Tesla drivers with information about the car and remotely carry out different actions on the car. Finally, in 2015, the company launched a new line of solar energy products using rechargeable batteries.

In Figure 15 we identify the key elements that make up the business model of the Model S. It represents the business model innovation of a mass market car manufacturer in the heart of an EV business ecosystem.

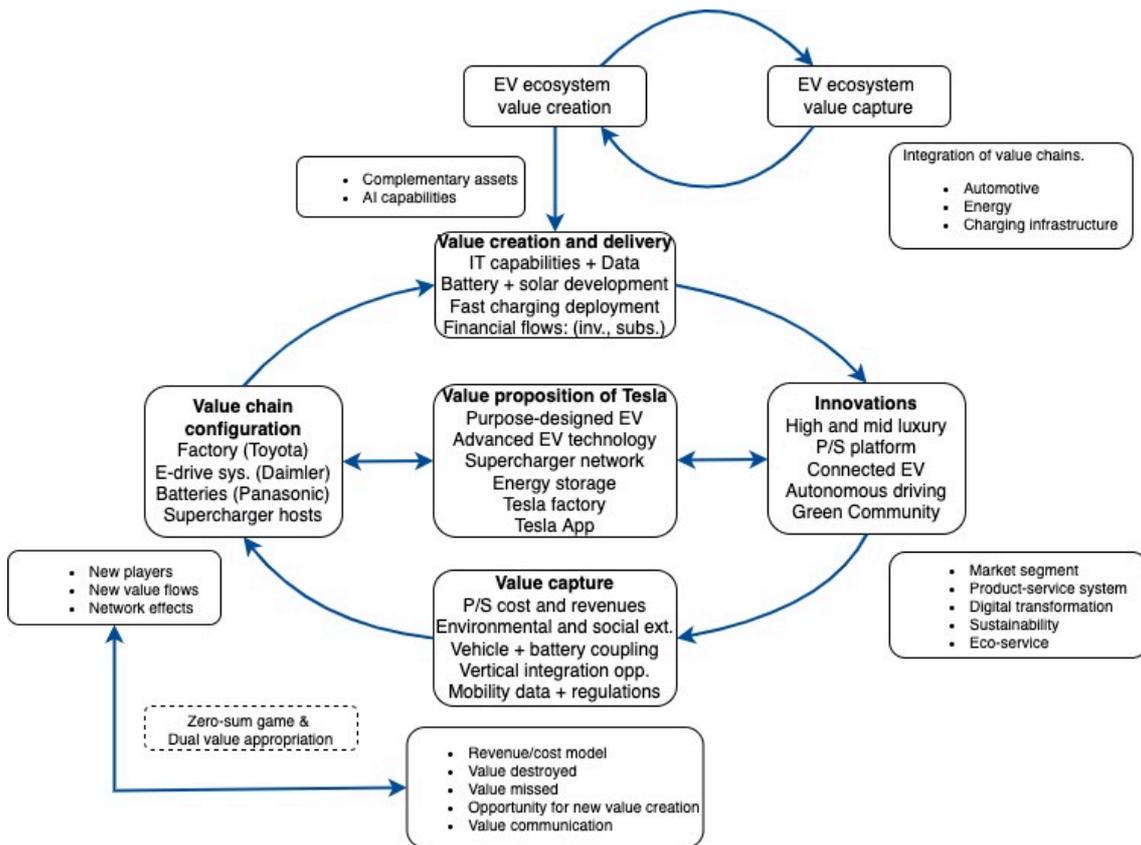


Figure 15 The Tesla Model S BMI framework. Source: prepared by the authors.

Tesla adopted a degree of vertical integration larger than any other car manufacturer. The core elements of its strategy were: proprietary electric power train, vertical integration from development through production and sales, incorporation of IT capabilities, battery innovation, and the deployment of the Supercharger network. This integral approach in the design, along with a high degree of vertical integration, demanded the alignment of interests of various stakeholders. Tesla proactively used alliances with established actors or new players from other industrial sectors to establish its competitive advantage (Donada & Lepoutre, 2016). The full captured and uncaptured value is modeled for Tesla taking into account various elements. In addition to the current revenue/cost modeling with service integration (e.g., additional data revenue, leasing, and mileage charge sales), we consider government incentives and subsidies.

Many studies highlight the importance of government subsidies in ensuring the development of the EV industry (Li et al., 2022). While these incentives can stimulate ecosystem growth, they cannot be sustained, and business models will need to be independent of them in the long run (Wang et al., 2018). In the case of coupling vehicle and battery, Tesla still under-utilizes some co-products. Although the electric powertrain can produce electricity during the braking process and generate additional value, this aspect is currently not sufficiently addressed. From a sustainability perspective, Tesla needs to integrate the assessment of the environmental and social impacts of the production and sale of vehicles and batteries. Equipping infrastructure with electrical and electronic equipment has negative environmental impacts in terms of consumption of natural resources, pollution, and production of energy that is not necessarily green. Finally, extracting personal mobility data to inform stakeholder expectations represents a real opportunity for value communication and should be treated in the mapping. However, regulations may reduce this opportunity for value capture.

3.8.4 Ecosystem scale-up: Model 3 and Master Plan Part Deux (2016-2020)

The third phase of the initial Master Plan was launched in 2017 with the delivery of the Model 3, the high-anticipated low-cost EV. The long-range version can deliver up to 350 miles and carries full self-driving software. Starting at \$35,000, the Model 3 was the best-selling EV, with a record of 500,000 worldwide sales in 2021. Tesla succeeded in the implementation of its initial plan to build a sustainable and affordable EV. After the success of Model 3, the company launched other mass-market models such as the Model X, Semi Truck, and the Model Y SUV. Tesla has also focused on the deployment and growth of its Supercharger network, as they realized that product uptake would be limited without proper fast charging options. In 2006,

Musk published the Master Plan Part Deux, which modified the original company mission statement. The new mission is to accelerate the world transition to sustainable energy (Musk, 2016), a much broader statement that encompasses: creating stunning solar roofs with seamlessly integrated battery storage; expanding the electric vehicle product line to address all major segments; developing a self-driving capability that is 10X safer than manual via massive fleet learning; and enabling your car to make money for you when you are not using it.

The BMI emphasizes the interrelationships between business ecosystem stakeholders, creating shared value (Porter & Kramer, 2011). This takes the form of the integration of concerns in the society (sustainability of transport) and a desire to create new opportunities to create value for the entire ecosystem (dual value appropriation).

3.9 Conclusions

Few tools exist to analyze firm strategies in business ecosystems; therefore, ecosystem value mapping can be used as a visual tool to understand the relationships and interdependencies between the different firms that make up the ecosystem. The observations made in designing BMI for the EV ecosystem led to the problem of the complementary assets that the stakeholders will have to develop either internally or in the form of a partnership. This organization and management issue of these skills leads us to reinterpret the works of Penrose (1959) in the case of an innovation born in an ecosystem. Moreover, a central insight derived from our analysis is the transformative role of BMI within the broader business ecosystem context. This paradigm shift implies significant transformations in the configuration of the value chain, the modalities of value creation and capture for all ecosystem participants. In the upcoming chapter, we will delve into a comprehensive description of BMI, highlighting its underlying motivations for driving business strategies within the ever-evolving EV ecosystem.

Limited tools currently exist for the analysis of firm strategies within the complex landscape of business ecosystems. We have applied the concept of ecosystem value mapping to offer a valuable visual tool to present the web of relationships and interdependencies among the diverse firms within these ecosystems. Our exploration and definition of Business Model Innovation serve as a framework to clarify the multifaceted strategies at play within this context. Our study of BMI has revealed significant changes affecting the value chain configuration and the intricate processes of value creation and capture within the broader business ecosystem.

This transformation, guided by BMI, has brought us to a critical point: the recognition of complementary assets that stakeholders need to develop, either internally or through strategic partnerships. This distinct organizational and management challenge highlights the importance of revisiting Penrose's seminal work (1959), especially concerning innovations arising from these dynamic ecosystems.

As we move forward, it becomes evident that the management of stakeholder relationships, particularly in terms of these complementary assets, requires comprehensive modeling and a careful assessment of their individual and collective importance. In the upcoming chapter, we will provide a more detailed description of BMI, positioning it as the driving force behind the strategies that guide businesses in the continuously evolving EV ecosystem. Our goal is to offer a thorough understanding of how BMI functions as a central element in this transformative landscape, elucidating the motivations that drive businesses forward.

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Chapter 4: Understanding complex transitions as experienced by the EV ecosystem.

Chapter 4 delves into the world of the EV ecosystem to understand the complex transitions occurring within it. This chapter primarily focuses on the role of Business Model Innovation (BMI) in guiding the operational aspects of companies within this fast-evolving landscape. Our central question revolves around how BMI impacts the processes and connections among all stakeholders in the EV ecosystem. To conduct this study, we utilize the MLP Framework to explore various configurations of the EV ecosystem. Our specific emphasis lies in how BMI addresses the operational aspects of running a business. We examine different business models and their application in real-world scenarios. A notable insight gained from this exploration is that this dynamic organizational approach lays the groundwork for promoting innovative value propositions. Consequently, the findings in this chapter set the foundation for further investigation into the third perspective of BMI: the development of business strategies rooted in the influence of data network effects. This chapter's insights contribute to a more comprehensive understanding of the multifaceted role of BMI in the continuously evolving EV ecosystem.

4.1 The revolution of EVs in the automotive industry

The challenge of designing BMs for an innovative business ecosystem is to study how established companies transform their current BM (Berends et al., 2016; Sosna et al., 2010). The EV represents a systemic innovation, distinct from the dominant design of internal combustion vehicles, which requires an analysis of the associated BM transformation. The innovations related to the implementation of the EV ecosystem are varied and interdependent, as demonstrated in Chapter 3. These innovations encompass technological, economic, commercial, social, and environmental dimensions.

The design process of a BMI is defined as "*designed, novel, and non-trivial changes to the key elements of a firm's business model and/or the architecture linking these elements*" (Foss and Saebi, 2017, p. 201). It is, therefore, a transitional process that involves the implementation of emerging business models in response to multiple innovations and their analysis of the changes brought about for organizations (Palo et al., 2019). Transition is a process of co-evolution

(Nelson, 1994) that changes sociotechnical configurations and leads to interactions between stakeholders in the value chain. In the context of the EV ecosystem, it is a question of transitioning from an ICE-focused to an EV automotive regime by linking the BMI and the induced organizational changes.

Chapter 3 identified the conditions that the EV ecosystem stakeholders should consider in deploying a BMI (role 1 as “explaining the business”). The objective of this chapter 4 is to understand the possible transition modes that ensure a balance between the performance of a BM and the reality of its development (role 3 as “developing the business”). From this perspective, we present ideas for defining and organizing stakeholder interactions that help explain the design of the EV business ecosystem BM (role 2 as “running the business”).

We have shown that the dynamics of technology in an EV ecosystem are based on different characteristics. Technology malleability refers to the ability of technology to be shaped and modified to suit different contexts and uses. In the context of EVs, technology malleability plays an essential role in developing and adopting EVs within the ecosystem. An example of technological malleability is the ability to improve battery technology. Technological advances have improved battery range, performance, and cost, making EVs more competitive with combustion engine vehicles. Another example of the malleability of technology developed within the EV ecosystem is the ability to develop new charging infrastructure that influences the convenience and feasibility of using an EV. The development of fast charging, wireless charging, or Plug and Charge has made it possible to charge EVs faster and easier, making them more convenient.

However, it should be noted that the trajectory of the technology is complex, and that technological malleability is not the only determinant to be considered in developing innovation within the EV ecosystem. Chapter 3 highlighted other determinants: the interactions between users and producers, the radical or disruptive dimension of EV innovations, technical complementarities, and networks with multiple actors, cumulatively of technical progress, interrelations between technological paradigms, irreversibility, uncertainty, service economy, and sharing economy. All these constraints linked to the dynamics of innovation show the limits of the malleability of technology and the importance of taking into account the issue of co-evolution (Rip and Kemp, 1998).

From this perspective of the complex trajectory of technology, we position ourselves in the evolutionary stream to explain technical change and its link with the firm's innovation behavior (Nelson and Winter, 1982). The EV ecosystem consists of a community of interdependent actors with complementarities in the production and consumption of products and services. We demonstrate that innovation ecosystems allow for the exploration of a shared value proposition and the evaluation of the impact of time on BMs and their components. Incumbent companies face different opportunities and challenges as the resources accumulated over their history determine their idiosyncratic bundle of capabilities (Kor & Mahoney, 2002). Also, as incumbents and new entrants compete for market leadership, they develop different strategies that are influenced by the socio-technical conditions of their different contexts. These capabilities establish how a firm will grow and how these capabilities themselves will evolve.

Penrose (1959) considers technology the locus for organizing change through a bundle of skills and resources to generate revenue for the organization. According to Dosi et al. (1988), firms have heuristic searches constituted by routines in the selection and adaptation environment. Nelson and Winter (1982), propose that these actions and rules organized as routines are not isolated individual actions but are instead integral parts of a broader organizational structure. These routines constitute a finite set that is historically determined at a specific point in time, with the possibility of evolution over time due to random processes. Rip and Kemp (1998) suggest a conceptualization of technology as a configuration of tangible things and skills that evolve and recombine over time as a function of individual actions and the organizational context to generate revenue.

Within this scope, Attour and Barbaroux (2016) delve into the birth phase of a platform-ecosystem's life cycle, shedding light on how the development of architectural knowledge significantly influences the early configuration of the business ecosystem's organizational structure. Their study establishes that the birth of a business ecosystem depends on a collaborative exploration process, rather than the strategic initiatives of a single keystone organization. This sequential process is key in shaping the various tangible and intangible assets embedded in the architectural knowledge, which, in turn, defines the organizational structure of the business ecosystem. The distinct components of knowledge embedded within these assets serve as the fundamental building blocks of architectural knowledge that underpin the birth of a business ecosystem. Notably, this research demonstrates that the dominant design in this context revolves around the technological platform itself, stemming not from radical innovation but from the accumulation of existing knowledge and capabilities. In line with

Henderson and Clark's (1990) framework for architectural knowledge evolution, their findings reveal that the birth of a business ecosystem is marked by phases of extensive experimentation, followed by the acceptance of a dominant design.

In this perspective, to understand the evolution of the business model of the EV ecosystem, we propose to follow the RCOV model (Lecocq et al. 2008) to account for the dynamics between technology (place to organize change through resources and competencies, RC), organization (set of routines, O) and value creation (V). An organization's intentional choices regarding its BM components are an essential source of its dynamics, as each choice leads to further changes in this or other components. For instance, between components of RCOV, the development of resources and skills (such as battery production) may lead to changes in the organizational system, with partnerships signed with companies from other sectors. Conversely, changes in the value chain (such as battery integration) will lead to changes in the resources and skills available, such as energy storage skills. Another example is the integration of vehicle-to-grid (V2G) technology, where electric vehicles become active contributors to grid stability, reshaping the value proposition for EV owners and the energy sector. This shift prompts companies to adapt routines, developing processes to manage the interaction between EVs, energy grids, and markets. Simultaneously, organizations acquire new competencies in energy market operations and grid management, leading to adjustments in their set of resources and skills. Alternatively, this adoption alters resource allocation, emphasizing software development, energy forecasting, and grid optimization expertise.

Similarly, the dynamics of the BM of an EV ecosystem may come from changes within its core components. For example, one value proposition may create abundant opportunities for other value propositions because changes in the network of internal and external links may directly impact other parts of the organizational system. For example, a decision about developing a service economy involves disrupting practices and their organizational elements, such as the need for new business skills and developing a management service for these rental services. The emerging business model of the product-service system (PSS) can evolve to become dominant, stabilizing a set of new practices before further disruption and new interdependent relationships between stakeholders in the EV ecosystem. Bohnsack (2013) shows that the emergence of new entrants into the mobility ecosystem has been built on collaboration with incumbents rather than direct competition. For example, Better Place, by introducing a smartphone integrated payment method for electric cars, sought to address range, and charging issues.

However, the conceptualization of technology must be analyzed within a systemic logic of dynamics of sociotechnical change with some characteristics: technology is shaped by social, economic, and political forces; in the same process, technologies shape human relations and societies. For example, Rip and Kemp (1998, pp.335) described the motorcar as "(...) not an isolated artifact, but the label for part of our sociotechnical landscape, made up of steel and plastic, concrete (the roads), law (traffic rules), and culture (the value and meaning of personal mobility)." Innovations that entail changes in multiple dimensions, such as infrastructure, industrial networks, business models, policy, and mobility behavior, can be studied through the lens of sociotechnical transitions (Fagnant and Kockelman, 2015; Geels, 2019). Thus, the adaptation process is integrated into a market logic in which the selection environment is socially constructed. This defines a sociotechnical system that develops between the technology and the preferences and practices of users, business models, regulations, and institutions (Rip and Kemp, 1998; Geels, 2002).

Understanding the transition to an innovative EV ecosystem means proposing an analytical framework that provides an overall view of the multi-dimensional complexity of changes in sociotechnical systems. In this context, we draw on the multilevel perspective (MLP) of sociotechnical transitions (Geels, 2002; Geels and Schot, 2007) and particularly a recent extension that integrates an ecosystem perspective with how innovations are diffused (Adner, 2017). In this chapter, we present insights from a case study of three car manufacturers representing different BM configurations and discuss the potential of the EV ecosystem strategies to disrupt the trajectory of the automotive regime dominated by internal combustion engine vehicles (ICEVs). Based on the Multi-level Perspective (MLP) of socio-technical transitions, we develop an understanding of the recent developments unraveling in the EV ecosystems and explore the drivers and antecedents of the automotive market evolution. Then, we create a graphical model based on the mapping of the different flows of value occurring among players in the different EV ecosystem configurations. It is the characterization of the BMs in a context of a socio-technical transition that allows us to describe the interactions between stakeholders in the ecosystem.

In this study, we delve into the intricate dynamics of value within the context of an EV ecosystem. Central to our investigation is the exploration of how actors can be delineated and orchestrated to drive diverse forms of value. First, we try to explain the intricate transitions that define the EV ecosystem. We adopt an Evolutionism and RCOV (Resources, Competencies,

Organization, Value) model framework, whereby socio-technical change fuels our analysis. Then, we deploy a multi-level process coupled with socio-technical analysis to analyze the niches that structure BMI. This involves understanding the strategic models that form the foundation of these transformative processes. Our attention deepens with a comparative examination of ecosystem strategies, delving into the foundations of strategic interactions. A critical anchor is Figure 14 from Chapter 3, serving as our reference framework for the representation of values within a BMI. Our study extends to discerning how, within our case studies, this representation translates into the generation of distinct value types.

The results show three overall (organizational structure strategies) organizational responses due to DDI including: 1) redefining the value proposition (Tesla); 2) enhancing the existing value proposition (BMW); and 3) transforming the value proposition.

During these discussions, a crucial insight comes to light: data exchange emerges as a significant driving force, evident across our various instances. The coordination of data and its subsequent network effects serve as the guiding factors in shaping the transformative trajectory of BMI within the EV ecosystem. Contributions include extending the existing literature on digital strategies and responses to digital disruptions in incumbent firms as well as providing implications to practice.

4.2 The MLP of socio-technical transitions and the disruptive EV ecosystem

Under the MLP of socio-technical transitions approach, a landscape environment creates an opportunity for a niche technology to disrupt the established regime. We use this framework (Lepoutre & Oguntoye, 2017) to investigate the evolution of the EV ecosystem (Sun et al., 2016). The objective is to explore how the development and evolution of the niche EV ecosystem affect the BMs of car manufacturers and how car manufacturers have managed the configuration of their ecosystem strategies in time. Based on the MLP approach and a business ecosystem context, we analyze the conditions that have made a favorable landscape and the barriers pushing the traditional auto industry against a transition to electrified mobility. Considering macroeconomic trends as well as multidisciplinary, we explain the evolution of the automotive industry and its transitioning into a new electric regime. We base our study on the theoretical concepts of the MLP of socio-technical transitions and disruptive innovation ecosystems.

4.2.1 Socio-technical transitions

Studies on socio-technical transitions emerged in the early 2000s in the field of economics, science, technology, and innovation studies (Whitmarsh, 2012; Geels, 2019). By bringing together institutional theory, evolutionary economics, and technological sociology, the theory of socio-technical system transitions integrates the notion that technology and innovation diffusion can only be understood by examining the socio-technical context in which they are embedded (Geels, 2002). Transitions are described as changes towards new systems, which are considered an improved version of the established ones (Moradi and Vagnoni, 2018). Transitions involve the interaction and co-evolution of new technologies with multiple actors and structures (Fraedrich et al., 2015), addressing a complex network of interactions among different societal groups. The socio-technical transition approach provides a useful perspective to explore the dynamics and complexities of sustainable transitions (Canitez, 2019). Socio-technical transitions are frequently analyzed through the lens of the multi-level perspective (MLP) approach, which considers long-term societal changes that involve technological, social, institutional, and economic systems. In this context, we address the ongoing momentum of EVs developing alongside with current mobility system dominated by ICEVs.

4.2.2. The Multi-Level Perspective (MLP) framework

The MLP is an approach used for the analysis of transition, innovation, and stability within socio-technical systems (Geels, 2010; Foxon et al., 2010). This framework investigates the fundamental transformations in systems that are in need to address sustainability challenges, and which could provide societal functions or end-use services (ex. Energy, transport, housing) (F. W. Geels, 2004). This systematic analysis is important in mobility and transportation due to the fundamental changes that are needed to address the increasing environmental impacts. These socio-technical challenges affect societal functions involving not only technology but also business models, public policies, markets, and infrastructures, as well as behavior, norms, and values (Elzen et al., 2004). The MLP emphasizes the importance of radical innovations while explaining socio-technical transitions depicting multiple social groups, who participate in multiple activities (F. W. Geels, 2019). Researchers usually apply this framework to project future scenarios based on past performance (Foxon et al., 2010) and case study analysis.

The MLP provides an explanation for evolutions based on interactions at three levels: the macro-level landscape, the meso-level socio-technical regime, and micro-level niche innovations (Geels, 2012). Transition pathways result from the dynamic interactions between actors and activities at the different levels (Geels and Schot, 2007). In turn, the diffusion of technologies

and innovations is regarded as a socio-technical transition between socio-technical regimes. These regimes are the “deep structure” that gives stability to a socio-technical system (Geels, 2011). The regime is the central concept of the framework (F. W. Geels, 2004), as it captures the interconnected and mutually reinforcing components within and between technologies, infrastructures, actors, and other institutions (Hughes, 2013). It also contains the main stabilizing processes and barriers to change, such as infrastructure, user behavior, market governance, and BMs (Bree, van B. et al., 2010). This stability is generated through “the material aspects of the system, the embedded actors and organizational networks, and the rules and regimes which guide perceptions and actions” (Gnus and Coles, 2008: 1428).

The MLP offers a model of diffusion of innovations where actors seeking to disrupt an established regime face significant multi-level forces acting as barriers against such transitions. Then, evolutions occurring at the landscape level open opportunities for niche activities to become more structurally embedded at the regime level (Geels, 2002, 2011; Geels and Schot, 2007). These niches can only survive the inertial pressures that avoid disruption when they are able to create an “immunity” (Lepoutre and Valente, 2012), which can be exogenous (e.g. regulatory exemptions, subsidies) and/or endogenous (e.g. innovative business models, new ecosystems) (Walrave et al., 2018). If enough pressure is applied from the landscape and the niches, the system will transition and the regime will be reconfigured (Nilsson & Nykvist, 2016).

In the MLP, transition is analyzed as a sequence of four phases (F. Geels & Schot, 2010):

- a) Pre-development: characterized by high uncertainty, experiments, deployment, and trials of new technologies and innovations. The status quo of the system changes in the background, but these changes are not visible.
- b) Take-off phase: point of ignition for the process of structural changes. It entails learning processes, standardization, guidelines, and best practices. Innovation stabilizes and resistance in the regime occurs.
- c) Acceleration: characterized by struggles between niche innovations and the existing regime. Innovation diffuses into mainstream markets due to better performance, economies of scale, and opportunities created by the landscape and niche pressures on the regime.
- d) Stabilization: a new dynamic state of equilibrium is achieved, anchored in regulations and standards, user habits, and societal norms. This new system then replaces part of the old system.

Additionally, based on the timing and nature of the interactions at the different levels, four transition pathways are possible (Geels and Schot, 2007):

- a) The transformation path: occurs at moderate landscape pressure when niche innovations are not yet completely mature. In response, regime actors react by reorienting the direction of development paths and innovations. Consequently, a new regime may arise or be rebuilt, allowing regime actors to survive.
- b) The de-alignment and re-alignment path: occurs when regime actors lose credibility due to a sudden landscape change, creating a de-alignment from the current regime. If niche innovations are not yet mature, multiple others will emerge and co-exist, and eventually, one will become a dominant design and re-align with a new regime.
- c) Technological substitution: occurs when a 'specific shock' causes high landscape pressure, creating an opportunity for niche innovations to break-through. Driven by a technology push, niche innovations are sufficiently mature to replace the existing regime.
- d) Reconfiguration pathway: occurs when the combination of niche symbiotic technologies and innovations are adopted to solve local problems. Over time, the symbiotic innovations may entail reconfigurations in the regime, driven by multiple component innovations.

4.2.3. The MLP and the EV ecosystem

Regarding the context of our study, the introduction of EVs represents a socio-technical transition in the mobility ecosystem, since it entails changes in infrastructure, industrial networks, policies, market, mobility behavior, and customer habits (Fagnant and Kockelman, 2015; Hopkins and Schwanen, 2018; Milakis and Müller, 2021). The MLP provides a framework to understand the ways in which the socio-technical system behaves during EV expansion. We focus on a car-based mobility regime primarily influenced by social behaviors such as culture, norms, and practices around ICEVs, and dominated by actors such as car manufacturers, fleet owners, fuel companies, and other institutions, who focus on the innovation of ICE technology and solutions. We apply the MLP framework to examine the transition that is happening in the automotive industry (Foxon et al., 2009; Berkeley et al., 2017; Lepoutre and Oguntoye, 2018) as a result of the introduction of EVs.

We adopt the MLP framework of Wang (2017) and Wu et al. (2021). We define the landscape level as the exogenous general context of politics, economics, and culture. The regime is

represented by the current socio-technical system of the traditional automotive industry, and the niche level denotes the emergent EV ecosystem. The interactions among levels occur as follows. First, innovations in the EV ecosystem (niche) put pressure on the current auto industry (regime) and force it to change. Then, the external environment (landscape) supports the development of EVs and put pressure on the existing industrial system. Finally, this dual pressure destabilizes the traditional automotive industry, providing an opportunity for the consolidation of a new EV ecosystem. The interplay among these levels explains the transition paths for the creation of a new ecosystem adapted to technological innovation.

At the landscape level, several socio-political-technical levers push towards EV adoption: international policy drivers in the form of environmental regulations and energy security; national policies pushing battery R&D, charging infrastructure development, and consumer take-up; and a favorable societal landscape driven by technology and the need for convenience. In theory, these factors could open the window for a suitable transition to electric mobility (Berkeley et al., 2017). At the regime level, however, numerous socio-economic-technical barriers pull against transition. First, consumers and car manufacturers face socio-technical barriers to EV technology development due to range anxiety caused by limitations in battery performance and the availability of charging infrastructure. Second, there are economic barriers driven by the uncertainty of the operationalization of the EV ecosystem due to the cost of current battery technology and the investments for charging infrastructure deployment. Finally, there exist the awareness/attitudinal barriers that constrain adoption in mainstream consumers. Today, the combination of these factors creates a situation where EV penetration remains low compared to the levels required for market transition (Berkeley et al., 2017).

4.3. Business ecosystem and BM evolution

In the MLP model, niches represent the baseline for forming a socio-technical regime. In the case of the EV innovative ecosystem, these niches are defined and managed in relation to the structure of the business ecosystems, the innovations that emerge, and the change and innovation in the BM or in the organization itself.

For instance, technological progress of mass-produced complex products, such as automobiles, follows a process of refinement of the dominant design (Utterback, 1994). The dominant design is based on the technological architecture of products around which a socio-technical regime has developed. In this context, niche innovations co-exist with the dominant design in the

market (Windrum and Birchenhall, 1998), and innovation in these niches accumulates into alternative trajectories. The different trajectories of regimes and niches have their suppliers and users, researchers, product strategies, and development. In a nascent industry, a range of different architectures is possible, resulting in a small number of competing platforms or co-specialized business ecosystems, that have their own sponsors, orchestrators, and key members (Gawer and Cusmano, 2002; Iansiti and Levien, 2004). Sectors become interdependent ecosystems with members of an industry architecture connected in ways to minimize costs (Dalziel, 2005). Finally, the BM that might eventually become the industry standard is said to be shaped by path-dependent behavior, which is different for incumbents and entrepreneurial firms (Chesbrough, 2010).

Within this literature, the concept of path dependence is crucial to understand the phenomenon where choices of the past make certain choices in the future more or less likely. Firms differentiate from others in their sector in terms of the resources they have and in the strategies they follow based on the choices they made and the competitive positions they took in the past. The specific resources accumulated over time are continually reacting with each other in unique combinations that determine the idiosyncratic bundle of capabilities of the firm (Kor & Mahoney, 2002). These firm capabilities are intangible assets representing the knowledge of firms about the production of goods and services, as well as the organization of that production. They are inherently tied to the interaction of agents within the firm and may include what is known as “learning capabilities” (see Teece et al., Foss, 1993). Therefore, the growth of the firm depends on these skills and resources, which are based on complementary assets (Penrose, 1959), and the way these resources are managed enables the creation of innovative value propositions. Companies wishing to maintain their position in a new ecosystem establish their value propositions by making investment decisions to gain know-how and consolidate stable supply chains.

Therefore, in order to understand the mechanisms that structure niches into more stable regimes, a wide range of transition mechanisms are possible, which depend on the actors, their relationships, their roles, and their activities, and how these are embedded in the broader context (Lepoutre & Oguntoye, 2017). Therefore, by integrating an ecosystem perspective, we add structure to the complex interactions behind socio-technical transitions. Business ecosystems are defined as “the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize” (Adner, 2017: 42). They differentiate themselves from loosely coupled networks because of their interdependence

between each of its components, consisting of four types: activities, actors, positions, and links (Adner, 2017). Whether or not an ecosystem can evolve from a niche to a regime depends on whether it has achieved sufficient stability in its constellation of elements, and, as such, provide a better equilibrium (in terms of the ecosystem) than its predecessor (Walrave et al., 2018).

Once an industry architecture stabilizes, it is difficult to deviate from it, for reasons such as inter-operability, regulation, and information. Before this happens, innovators have a substantial opportunity to shape the architecture of complementors around them and influence the organization of the ecosystem (Jacobides et al., 2006). Successful ecosystems tend to have a focal actor, an actor in the ecosystem that assures the continued alignment of actors both within and outside the ecosystem (Adner, 2012, 2017; Lansky and Levien, 2004, Walrave et al., 2018). Any actor for whom there is no reason to contribute to the ecosystem value proposition may impact the chances of success of the entire ecosystem, and consequently, the way value is distributed across it is a defining component (Autio and Thomas, 2014). In line with Santos and Eisenhardt (2006), the case of Tesla shows how entrepreneurial ventures can achieve a relevant position in the emergent EV ecosystem and shape the structure of the sector to fit their own capabilities. A new ecosystem, disrupts the architecture of relationships and interdependencies in the industry, forcing incumbents to adapt their business models.

Following the Penrosian view of the BM, Demil and Lecocq (2010) proposed the RCOV framework to explore the evolution of BMs. This transformative approach is used as a tool for managing organizational change and innovation, whether within the organization itself or within the model. They define BM evolution as a meticulous process involving purposeful and emergent adjustments within and between interconnected core components. The framework suggest that the sustainability of a firm relies on its capacity to anticipate and respond to sequences of intentional and emerging modifications.

In the RCOV framework (figure 16), the core components of the BM, consist of resources and competences (RC), the organization (O), and the value proposition (V). Each of these core components encompasses various elements, such as diverse types of resources, partnerships with various firms within the value network, and a range of products offered to customers. The accumulation of resources and how they are orchestrated by the organization's management can drive the exploration of novel avenues for productivity and the introduction of new products or services. The structure and extent of the organization's expenses and income stem from these core components. Value propositions are the exclusive sources of revenue, and the

organization's activities and the acquisition, integration, or development of resources drive the costs of the BM. The distinction between revenues and costs ultimately generates a margin directly relational to the value captured by the organization. This margin can subsequently fuel the accumulation of resources and competences, thereby influencing the BM's sustainability over time.

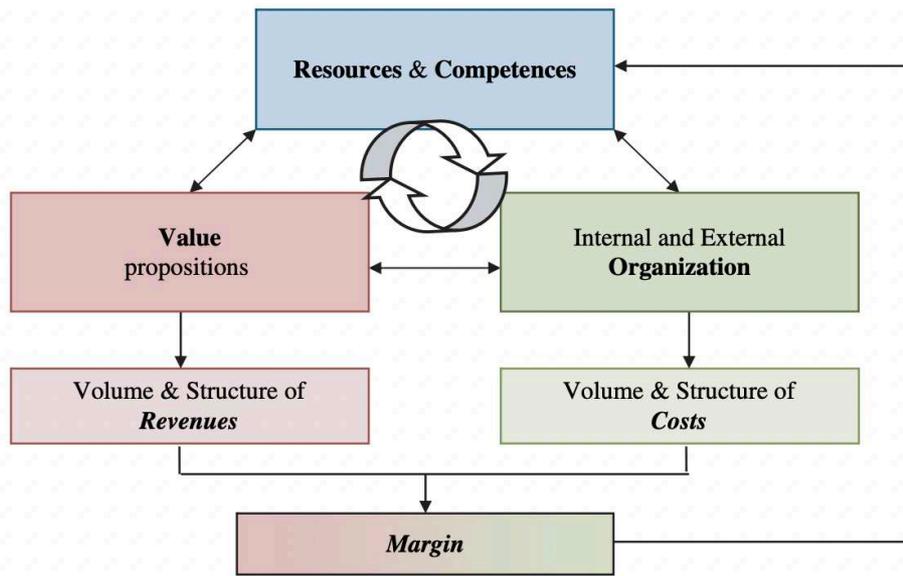


Figure 36 RCOV framework. Source: Demil and Lecocq (2010)

Finally, the authors coined the term 'dynamic consistency' arising from transformations taking place within the core components. Changes within the set of resources and competencies can trigger subsequent changes in other elements of the same component. Certain value propositions might lead to new opportunities for additional value propositions, while adjustments within the internal organization or external network can directly influence other aspects of the organizational structure. The choices made by a firm regarding its BM components serve as a primary source of its dynamics, by setting further alterations within that specific component or across others.

4.3.1 EV ecosystem market regime evolution

In order to assess the potential of the EV ecosystem to transition to a new market regime through a process of niche development and co-evolution, we elaborate on different innovation typologies. Among the several innovation typologies in the field of economics and management, the most well-known market-related is the theory of *disruptive innovation* (Christensen, 1997). In his theory, Christensen (1997) differentiates sustaining from disruptive technologies. He

observes that technologies, per se, are rarely intrinsically disruptive or sustaining; rather, it is the business model enabled by the technology, that generates the disruptive effect. The term *disruptive innovation* is used to designate any innovation that revolutionizes an industry and substantially changes its competitive patterns (Christensen et al., 2015; Kumaraswamy et al., 2018). Disruptive innovations bring to the market a different value proposition, with the potential to tumble incumbent firms.

Early research on disruptive innovation (e.g., Christensen, 1997) initially described *disruption* as a process whereby a smaller company with fewer resources is able to successfully challenge established incumbents. According to this theory, a disruptive innovation is one that offers lower-than-expected performance alongside new features that create new markets and value networks. As the innovation improves, it is eventually able to disrupt established leaders. At this point, innovating products and services is not enough; companies must innovate their BMs. On the other hand, sustaining innovations are those that foster improved product performance. Most technologies fall into this category, and most of them are incremental in nature. Sustaining innovations improve the performance of established products that customers have historically valued. In the context of the automotive industry, the electronic fuel injection introduced in the 1980s is an example of a sustaining innovation, as it improved fuel efficiency in ICEs, but did not disrupt the automotive market.

Applying his theory of disruptive innovation, Christensen himself concluded that Tesla's offer - and consequently EVs - do not meet the criteria for a disruptive innovation. He classified them as a *classic sustaining innovation*, essentially because EVs emerged as a product that offers incrementally better performance at a higher price. As a high-end, high-margin product in direct competition with established luxury car makers, incumbents should be motivated to challenge a new entrant like Tesla, by allocating a huge number of resources for the development of their EV offerings. While Christensen's theory has proven to be valuable when thinking about innovation-driven growth, its focus is placed on the strategic output of firms. Although his analysis refers to market evolution, recommendations are kept at the firm level, and on how companies should behave when confronted with disruptive innovations. In order to assess how the evolution of the market share of a disruptive innovation may or may not lead to a new market regime through a process of niche development and co-evolution, we call on the regime evolution framework (REF) (Dijk et al, 2015).

The evolution of industries goes beyond just organizational change. As developed in the section above, socio-technical transitions focus on the embeddedness of technology in actor constellations, local contexts, and historical settings (Weber, 2007, p. 113). The focus is on the structures, agents, and processes that reproduce a socio-technical practice and those that have the potential to destabilize it. The REF elaborates on the elements of disruptive innovation (Christensen, 1997) and the transition pathways defined by Geels and Schot (2007). However, rather than identifying transition pathways, it maps out the market evolution in general and considers *transition* as one of the possible ways. The REF is based on changes in technology and the institutional context of production and use, mainly consumer perspectives and government regulation. In our context of study, we think that these perspectives are of vital importance for the future of electric mobility. The actual ICE automotive regime is a socio-technical system, whose stability is given by economies of scale and scope, sunk costs, and social learning. For EVs to be able to disrupt the established regime, they need to go through a process of realignment during which they must compete against other developing alternatives.

The REF framework (Dijk et al., 2015) suggests a typology of market evolution with four possible quadrants: regime reproduction and regime reorganization (innovations sustaining the regime), and regime amidst diversification and regime transition (innovations disrupting the regime). The vertical axis refers to the nature of the innovation; niches may develop strong links with the regime or provide an alternative with weaker links to the regime. The horizontal axis represents the level of market share of the niches. Applied to the case of electric mobility, Dijk et al. (2015) depict the innovation pathway of the market, connecting five phases of high innovation momentum of the European automotive industry (Figure 17).

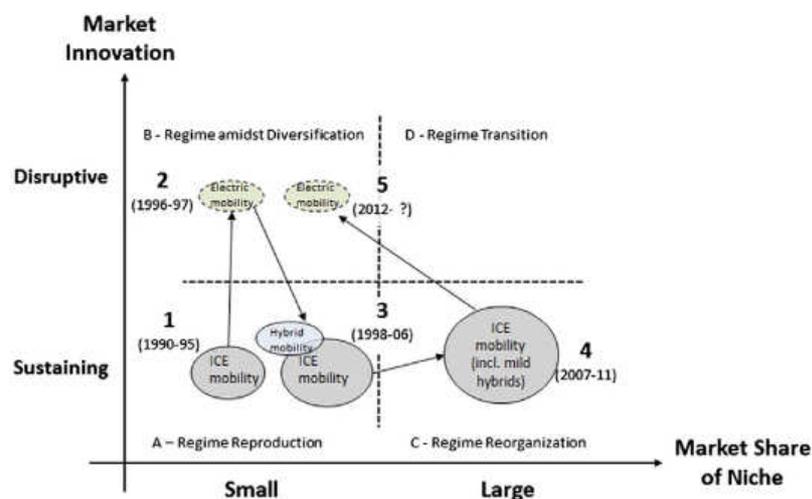


Figure 17 Innovation pathway of the European automotive market. Source: Dijk et al. (2015).

The first phase (Regime reproduction: 1990-1995) is characterized by sustaining innovations of ICEs, specifically in the number and arrangement of valves and wider applications for turbocharging. The second phase (Regime amidst diversification: 1996-1997) showed the first signs of electric vehicles being launched by large manufactures. However, market diversification was driven by regulation rather than demand. At that time, EV technology gained some momentum, but its growth stopped due to very low sales. Quickly, EVs were withdrawn from the market and just few firms incorporated hybrid technology. The next phase (Regime reproduction: 1998-2006) was characterized by the decision of most of the incumbent firms to focus on the conventional ICE engine. Diesel technology went through a period of improvement with direct injection and particle filters being widely applied. This meant a return to a regime reproduction, as hybrids lost momentum, with very low impact on the regime. The fourth phase (Regime reorganization: 2007-2011) saw again the intention of the regime to develop hybrid models, however, its market share stalled. The regime continued to develop around ICEVs, integrating more electronics into the established technology. Most car manufacturers postponed the launch of hybrids and, instead, launched what they called cleantech ICEs, which include a number of electronic components, hybridizing in a certain way the ICE technology. Finally, the re-introduction of EVs after the year 2012, suggests a new momentum, a fifth phase build around full electric vehicles that could either disrupt the market profoundly or reinforce the ICE regime better than ever to resist disruptive influences.

4.3.2 Disruptive innovation ecosystems

Finally, in line with the theory of disruptive innovation and the concept of architectural innovation, we also draw from the concept of disruptive innovation ecosystems (Palmié, 2020). Contrary to the idea of innovations originating from individual firms, this broader perspective allows for the reflection of how disruptive innovations emerge around an ecosystem. As Palmié so clearly stated:

“A disruptive innovative ecosystem is an economic community of interdependent actors that, without hierarchical governance, coevolve around an innovation that does not exclusively improve performance in the dimensions that customers have historically valued but rather in at least one hitherto neglected dimension. These actors (organizations and individuals) display complementarities in the production and/or consumption of products and/or services related to this innovation” (Palmié et al., 2020, p. 3).

This perspective could be useful in addressing the dynamics of “sustaining innovations” like Uber or the iPhone, which have systematically disrupted the existing relationships among the members of an ecosystem instead of affecting specific incumbents (Kumaraswamy et al., 2018). We consider this to be the case with electric vehicles.

An important difference between a disruptive ecosystem and an individual disruptor is how incumbents can respond to disruptive innovations. Two generally preferred options are making additional investments in current customer-preference trajectories or moving to other market segments (Christensen et al., 2018). Other alternatives are partnering with entrants, licensing their technology, or acquiring them (Cozzolino et al., 2018). In contrast, in an ecosystem context, different strategies could be viable for a variety of reasons. First, multi-company systems might have more resources than a single firm. On the one hand, higher resource potential could limit the effectiveness of incumbents’ investments, but on the other hand, incumbents could have more favorable conditions to join the ecosystem. A second reason for viability is that the potential of disruptive innovation to grow into a position of dominance is likely to be strengthened when it is embedded in an ecosystem. Third, complementary innovations co-developed with other members of the ecosystem can substantially increase the appeal to customers (Adner, 2006). Finally, a multi-company system may be able to grow faster because of “legitimacy-by-numbers”, increasing acceptance by society, policymakers, regulatory bodies, and capital investors (Carayannis and Campbell, 2009; De Clercq et al., 2006; Hillman and Hitt, 1999). Thus, disruptive innovations do not necessarily cause incumbents to fail (Palmié et al., 2020); nevertheless, they do affect the relationships and interdependencies in the new ecosystem organization, forcing incumbents to adapt.

The development of an innovative EV ecosystem thus requires a transition model that will seek to question the interrelationships between actors in several value chains. Companies change their innovation trajectory over time through selection and sociotechnical adaptation to develop a BMI. The Multi-Level Perspective (MLP) framework (Geels, 2002, Geels and Schot, 2007, Geels and Kemp, 2012) can be a model to analyze how to characterize a BMI for a transition to the electric vehicle. However, from this perspective, the sociotechnical transition process needs to be analyzed from an operational point of view and not as an element of strategy (Mason and Spring, 2011). A practice lens has much to offer to describe bottom-up processes during the BMI process focusing on the micro-level practices (Feldman and Orlikowski, 2011). Practice theory is the relationship between a specific situated action and the social dimension in which the action takes place that continuously recreates organizational structures (Giddens, 1984). The strategy

is studied from the perspective of practices to account for the actors' roles in the formulation, specification, and implementation of the strategy.

Beyond performance-based models of strategic management, the "strategy as practice perspective" explains how strategy-making is made possible. The strategy is studied from the perspective of practices to account for the roles and identity of actors in the formulation, specification, and implementation of the strategy (Vaara and Whittington 2012). The "strategy as practice perspective" stresses the need for a greater emphasis on detailed processes to focus on the micro activities that are often invisible in traditional research (Johnson et al., 2003).

4.4 Methodology for the comparative case study

The objective of "strategy as practice perspective" is to investigate how different actors engage a strategy implementation (Whittington, 2006). Strategy is seen as a social practice that highlights the work involved in implementing business models (Jarzabrowski, 2005). According to this literature, practices are inseparable from the individual. They are part of everyday organizational life and routines (Nicolini, 2012). Practices consist of different elements interconnected to produce organizational phenomena: forms of bodily and mental activities, objects and artifacts, skills, emotions, and motivational knowledge. The mobilization of the "strategy as practice perspective" allows for a greater emphasis on the detailed processes of stakeholder partnerships to focus on the micro-activities of resource and competence acquisition (Johnson, Melin, and Whittington, 2003). In this way, it is possible to account for bottom-up local emergent phenomena that arise from interactions between actors and that will manifest themselves at the meso-level.

The "strategy as practice perspective" applied to an EV ecosystem shifts the focus from individual actions to what partner organizations collectively undertake based on their legitimacy and competencies in implementing innovations, as outlined by Jarzabkowski, Kaplan, Seidl, & Whittington (2015). First, we present the characteristics of the socio-technical dynamics of the EV disruptive ecosystem. Then, through the lens of the "strategy as practice perspective", we discuss the different possible evolutionary modes for the interdependent relationships between the stakeholders of this ecosystem. To do this, we develop a comparative case study analysis with three OEMs that have chosen different innovation models. In this approach to practice, the attention is focused on how actors act in an organizational context during their partnership practices.

Our analysis employs a comparative case study approach, integrating archival materials with a series of in-depth discussions involving stakeholders from within the EV ecosystem. We investigate the diverse ecosystem strategies pursued by Renault, BMW, and Tesla, in response to their unique socio-technical context. By exploring the historical context and the critical strategic decisions, we develop a comprehensive understanding of the stakeholders involved in the value proposition and analyze the drivers and antecedents of the coopetition mechanisms that build up their ecosystem strategies. We then provide illustrative cases in the form of ecosystem maps, to graphically represent the dynamic created by the interactions in the different configurations. We use the ecosystem maps of the selected firms to provide an understanding of the characteristics and features of three distinct types of BMs evolving within the EV ecosystem.

4.4.1 Setting the stage

The concepts discussed in section 2 are the theoretical foundation and guidance structuring our qualitative study into the EV ecosystem. Next, we conduct a comparative case study, contrasting the development of the strategies followed by three OEMs: Renault, BMW, and Tesla. Based on a conceptual ecosystem mapping, we explore the configurations unfolding in the different EV ecosystems. This allows to understand a modern phenomenon in a practical scenario, shedding light on the reasons behind the emergence and development of the business model evolution process, and the way it unfolded.

4.4.2 Selection of the cases

The focal firms investigated were Renault, BMW, and Tesla. The companies were selected because they are leaders in the EV market and have successfully managed to establish their initial EV ecosystem. They offer an opportunity to explore the evolution of car companies BMs within a complex innovative landscape. They all started to commercialize EVs around the year 2007; while Tesla was a start-up company, and BMW and Renault were incumbents, they were all new to the nascent EV ecosystem. Committed to developing a dominant design in the EV ecosystem, these companies call for distinctive organizational structures and capabilities, different from the established design of the automotive regime. For instance, Renault, BMW, and Tesla represent three different configurations in their approaches to ensuring the required

accessibility to public recharging stations: independence, partnership, and integration, correspondingly (Yoo et al., 2021).

In addition, the selected firms have intended different choices concerning its BM components, in line with the RCOV framework. In the Tesla scenario, we witness the entry of a new company into an established industry, introducing a new value proposition that systematically disrupts existing relationships. The success of Tesla radically redefines the value proposition of electric vehicles, making incumbent manufacturers to react and redesign their strategies. The BMW case, on the other hand, illustrates an OEM that strengthens its existing value proposition. As a successful luxury car brand sustained by strong car sales, BMW has harnessed its success to invest in new resources and competences, thereby expanding its diverse product range. In contrast, Renault is focused on reestablishing competitiveness, embarking on an ambitious transformation plan in their internal and external organization, that initiates a shift from volume-oriented approaches to prioritizing value-driven strategies.

In terms of the research objectives outlined in this chapter, we explore the BM evolution of Tesla and its EV ecosystem's potential to disrupt the automotive industry. Furthermore, we conduct an analysis of how established players, such as Renault and BMW, respond to this disruptive innovation ecosystem. Finally, we aim to show three different strategic choices for BMI in the EV ecosystem. As such, the primary focus is on tracing the evolution of business models and strategic reactions over time, without aiming to present a comprehensive assessment of effectiveness or success. Instead, the intention behind the multi-case examination is to illustrate the range of variations in business model evolution and shed light on practical approaches to managing business model innovation.

4.4.3 Data collection and analysis

To create a narrative of the different contexts, the data for our comparative case study came from several sources. We performed this data collection through secondary data sources, including; academic publications comprised of existing case studies on the selected firms and the EV industry (Chen, 2017; Chen & Perez, 2018; Chen, 2018); corporate archival material such as annual reports from the selected firms; and gray literature which included newspapers, magazine articles, blogs, and video interviews.

We then traced the various actions taken that resulted in the emergence of a favorable socio-technical landscape, the distinct barriers protecting the automotive industry regimes, and the

EV ecosystem strategies of Renault, BMW, and Tesla. Next, to analyze the different ecosystems, we explored the main events changing the BM components in the different scenarios. This exploration of the historical context, critical decisions, and configuration of complementary assets allowed us to identify the main actors and their roles, as well as the types of exchanges that they can have within the ecosystem. We then develop an overall analysis of the underlying interrelationships among these actors, as well as the main interactions regarding the flows of value that build up the ecosystem. To further validate the narratives constructed, we also conducted a series of discussions with informants working at the different companies to provide us with detailed data on the strategic directions of the firms. Finally, we depicted the different economic, social, and environmental benefits derived by a stakeholder from an exchange in conceptual ecosystem maps, with color-coded arrows indicating the directions of the flow and the value being exchanged. In this way, we defined four generic value flows: financial (green), usage (red), data (blue), and energy (yellow).

4.5 EV ecosystem dynamics in time

The transition of the automotive industry from fuel-powered vehicles to EVs can only be accomplished over the long term, therefore, using the proposed theoretical framework, we have established four phases in the evolution of the EV ecosystem, in line with F. Geels & Schot (2010): organizing and testing the minimum viable ecosystem (2007-2011), developing and scaling-up the ecosystem (2012-2020), accelerating the ecosystem (2021-2035), and stabilizing the ecosystem (2035-). Based on the timing and the nature of the multi-level interactions occurring in the ecosystem, we argue that EVs follow a *technological substitution path* (Geels and Schot, 2007).

Technological substitution is characterized by the initial development of radical innovations in niches, but that then stagnate because the regime is stable. Then, a “disruptive change” exerts a high landscape pressure, leading to tensions in the regime and creating opportunities for niche innovations. At this moment, these innovations are sufficiently mature enough to break through and replace the existing regime. When the innovation enters mainstream markets, regime actors try to defend themselves by adapting their BM; market competition and dominance influence the fight between incumbents and newcomers. This pathway is characterized by a technology push where co-evolution processes follow substitution. Because it often leads to the downfall of incumbents, a lot of research has been done on this pathway in business and

technology management (Tushman and Anderson, 1986; Christensen, 1997). The proposed EV pathway is described by the technological roadmap in figure 18.

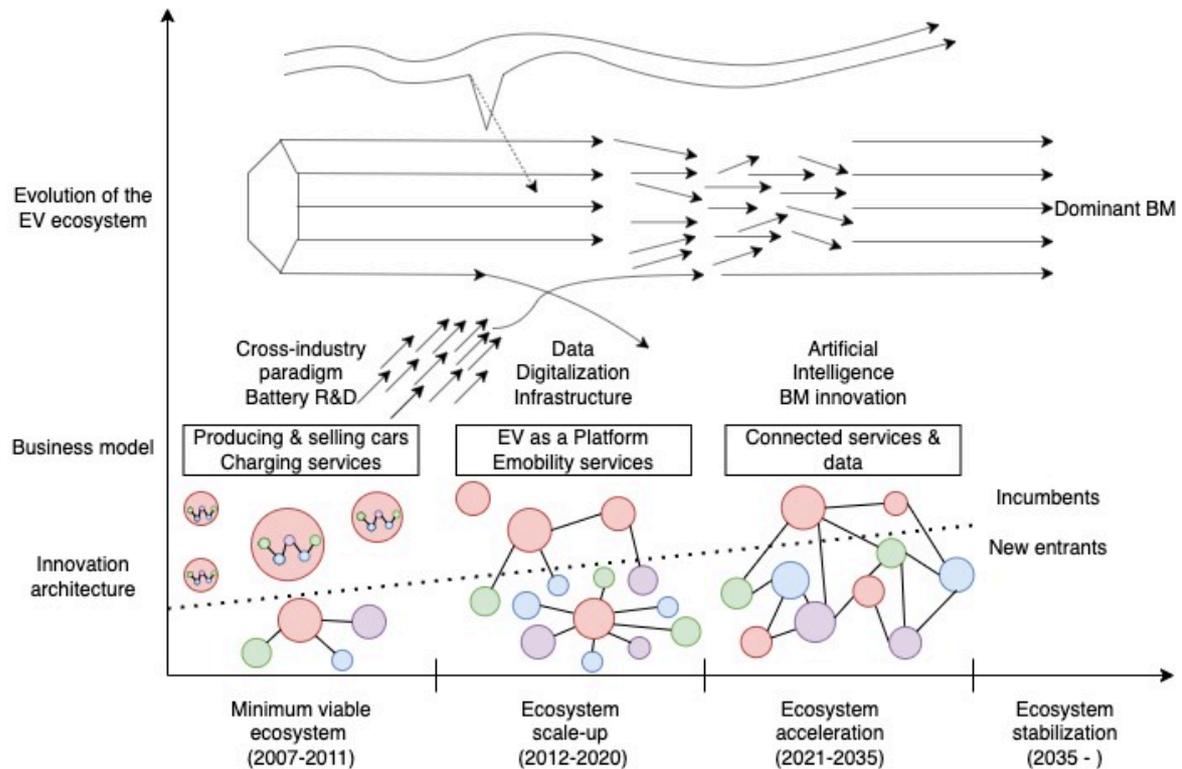


Figure 18 Technological substitution pathway of the EV ecosystem. Source: adapted from Geels and Schot (2010)

The minimum viable ecosystem phase is characterized by the worldwide environmental issues that influenced landscape changes affecting the development of EVs. Specifically, general concerns regarding the decarbonization of transportation made electrified vehicles an attractive substitute for internal combustion. At the regime level, national governments played an important role by formulating a series of supportive policies to develop EV technology. They provided financial inputs for R&D, introduced standard specifications, conducted EV pilot demonstrations, and subsidized EV purchases. With car manufacturers being the most important and strong actors in this phase, incumbent companies strengthened their EV efforts, developing their niche innovations to obtain future competitive advantages. However, these actions also made it possible for start-ups to compete with century-old companies in the manufacturing of vehicles. However, the business models used to commercialize this first wave of EVs remained very similar to those of ICEVs, mainly based on the production and selling of cars, including some charging services at home, offered as any other after-sales service, like insurance, maintenance, or repairs.

Then, in the ecosystem scale-up phase, EVs expanded significantly, mainly due to the strong public policy signal for EVs in many countries. At this stage, we observe the willingness of certain companies and consumers to engage in EV innovations supported by consumer behavior on a big scale. However, the ICE/EV cost differential made it difficult for EVs to compete with traditional cars, making bottlenecks increasingly prominent. In December 2015, 196 countries adopted the Paris Agreement, a legally binding international treaty on climate change with the objective of advancing the global momentum for electro-mobility. To achieve the transition to electric mobility, the goal is to achieve a 35% of EV global sales by 2030. These “sudden” changes (see Figure 18) affected the stability of the automotive industry, forcing the regime to reconfigure its pathway.

However, adoption has been slower than expected and still far from the level required for a mass-market transition, putting significant pressure on OEMs, their supply chains, and the broader EV ecosystem to meet these targets, especially concerning the development of the much-needed charging infrastructure. Given the increased development in battery technology, concentrating on home charging was not enough; bigger batteries required faster chargers, making the deployment of public charging infrastructure a critical bottleneck. This period is characterized by the regime actors trying to defend themselves from new competition and adapting their BMs accordingly, transforming their value chain into an ecosystem. This way, business models expanded into PS platform configurations, benefitting from digital services and data, to offer additional e-mobility services.

Later, despite the economic crisis caused by COVID-19, EV sales and adoption accelerated in major markets. In 2020, EV adoption in Europe reached 8%, mainly because of policy mandates such as stricter emissions targets for OEMs and significant subsidies for consumers. Several countries have announced 10-year timelines for bans on gas-powered car sales, as new regulatory targets expect EV shares to be at least 50% by 2030. Consequently, OEMs have announced their intentions to stop investing in new ICE platforms, and others have even defined a specific date to end their manufacturing. Even though EV demand and charging infrastructure deployment are increasing, the numbers remain far below the level expected for mass-market transition.

Further, figure 19 shows that the integration of the public charging infrastructure to the EV offerings revealed platform characteristics based on indirect network effects in a two-sided

market, with consumers on one side and service providers of charging stations on the other (Yu et al., 2016; Jang et al., 2018). By considering the characteristics of a PSS (Cherubini et al., 2015) and how the value-creating platform operates between consumers and charging stations (Jang et al., 2018), Yoo et al. (2021) identified three strategic choices that have emerged in the EV industry as PSPs (product service platforms). These PSPs were described as either integrated cases, cases where the service provider operates independently, or cases where the manufacturer and service provider form a partnership.

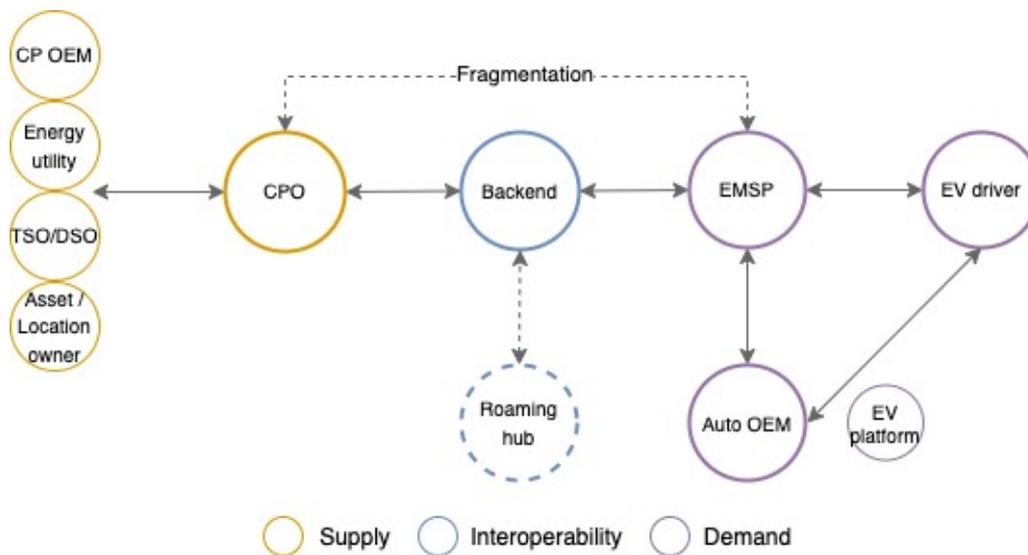


Figure 19 Two-sided platform for public EV charging. Source: prepared by the authors.

These new BMs have been enabled by IT developments, with AI playing a key role in radically transforming the way car manufacturing firms create and capture value. This research has shed light on the potential of EV technology to generate new opportunities and efficiency gains related to innovative BMs.

4.5.1 Business model evolution for OEMs

Next, we explore the actions taken by the three companies under study in the different phases: Renault, BMW, and Tesla. Based on the narrative descriptions of each scenario, we traced the events affecting the EV ecosystem of the three selected manufacturers. To establish the current state of the ecosystem configurations, we mapped the value interactions for each company at the different phases.

4.5.1.1 Minimum viable ecosystem phase (2007-2011)

The three selected firms started to develop their EV technology around the year 2007, carrying out regional real-world experiments. Renault and BMW tested their ecosystem through pilot projects, while Tesla conducted different market tests. At this stage, companies established their minimum viable ecosystems and addressed the main challenges: the system integration capabilities and range anxiety. For years, incumbent car manufacturers had controlled the automotive industry thanks to their role as system integrators. Historically, this has made it difficult for new companies to enter the industry (Jacobides et al., 2016); nevertheless, the cross-industry paradigm of EVs rendered OEMs' system integration and power train capabilities partly irrelevant, lowering entry barriers and changing the architecture of the automotive industry. For instance, previous research suggests that Tesla entered the automotive industry having spent only 2 billion dollars (Perkins and Murmann, 2018). However, as a new entrant, Tesla had limited resources and knowledge in the manufacturing of vehicles, and by 2007 the company was on the verge of bankruptcy. In addition, the most critical bottleneck affecting range anxiety in the ecosystem was battery cell technology. In 2007, the main technology used in vehicles was the nickel-metal battery, which was effectively used for hybrid vehicles but had a low energy density for pure EVs. The lithium-ion cell technology, which had a higher energy density, was at the time too extensive and supply was limited. At this stage, the actual battery technology allowed for EVs to be charged at home, and therefore, the development of charging infrastructure was a secondary concern.

Tesla: Founded in 2003, Tesla came into the well-established automotive industry as a new entrant. To organize its ecosystem, Tesla had to solve the initial bottleneck concerning the system integration capabilities of OEMs to assemble cars. The Roadster, a refitted "Elise" Lotus, was Tesla's first EV experiment to understand the complexities in production and marketing. Using the platform of a traditional vehicle proved to be difficult, raising the expected costs. In 2008, CEO Elon Musk made a series of radical changes addressing manufacturing capabilities and financial problems. Tesla formed alliances with companies such as Daimler, Toyota, and Panasonic, and used several strategies to raise capital. They also innovated their battery technology, doubling the capacity of the battery compared to other EVs in the market; in fact, the Roadster became the first EV to be powered with a 53kWh Li-on battery.

BMW: Similarly, in 2007, BMW set up what they called Project I, a series of experiments in major cities around the world that aimed to understand how to manage the EV ecosystem. The company leveraged its own competencies and focused on innovation for the vehicle and onboard charger components. They developed the Mini E, a refitted Mini Cooper model, to experiment with users' charging behavior. Combining home charging and existing public charging, they considered that these charging solutions were sufficient for the deployment of EVs for urban commuting.

Renault: In the case of Renault, the company also developed a refitted EV model, the Fluence ZE. However, their strategy was placed on battery swapping. In 2007, they partnered with Better Place, a start-up offering battery-swapping services for EVs, to overcome the challenges associated with both the battery and the charging bottlenecks. Besides the Fluence ZE, the company developed two other EVs, a converted Kangoo ZE and the Twizy, resulting in different pilot experiments with other actors in the ecosystem. Such a cooperation focused heavily on addressing the public charging bottleneck.

4.5.1.2 Ecosystem scale-up (2012-2020)

Around 2012, the selected firms launched their EVs with enhanced product performances, and they expanded their sales in Europe and the US. The battery cell continued to be the EV ecosystem's most important bottleneck from 2012 to 2015. Manufacturers of BEVs heavily incorporated lithium-ion cell technology. However, the energy density of the cells was still insufficient for a long-distance EV, and the cost of the cells per unit remained expensive. Battery manufacturers made significant investments to increase production capabilities. Between 2007 and 2017 battery cell technology saw substantial advancements. Battery cell prices were reduced while improving in quality (McKinsey, 2017). Particularly, in 2015, the cost decreased by 35% compared to 2014 and by 75% compared to 2010 (Bloomberg, 2017). Consequently, the firms under study launched an updated model of their EV with a significantly bigger battery around the year 2017. At this point, the battery was no longer the EV ecosystem's biggest limiting factor. However, the interdependence effect raised the need for a public fast-charging infrastructure. In order to reach full charge in the same period of time, a bigger battery pack needs a higher charging speed. This way, the public charging system became the main bottleneck.

Tesla: After some initial collaborative efforts with other car manufacturers to launch the Roadster, Tesla decided to change its strategy. They built an integrated platform for its new Model S and moved into different activities in order to diversify their offer beyond just selling cars. To solve the battery bottleneck, together with Panasonic, they invested USD 5 billion to build the largest battery factory in the world– the Gigafactory. In parallel, in 2013, Tesla rolled out the supercharger program, an aggressive long-term plan to solve the charging infrastructure bottleneck. Counting on the slow deployment of infrastructure from governments and complementors, Tesla’s CEO Elon Musk decided to build public fast-charging stations to solve the problem himself. Despite the company’s competitive strategy and limited cooperation, in 2014, Tesla opened to the public all its patents, including the supercharger stations, to have a common standard that could help evolve the EV technology platform. This accelerated battery and electricity purchases, solidifying the market power that Tesla already had in its integrated ecosystem (figure 20).

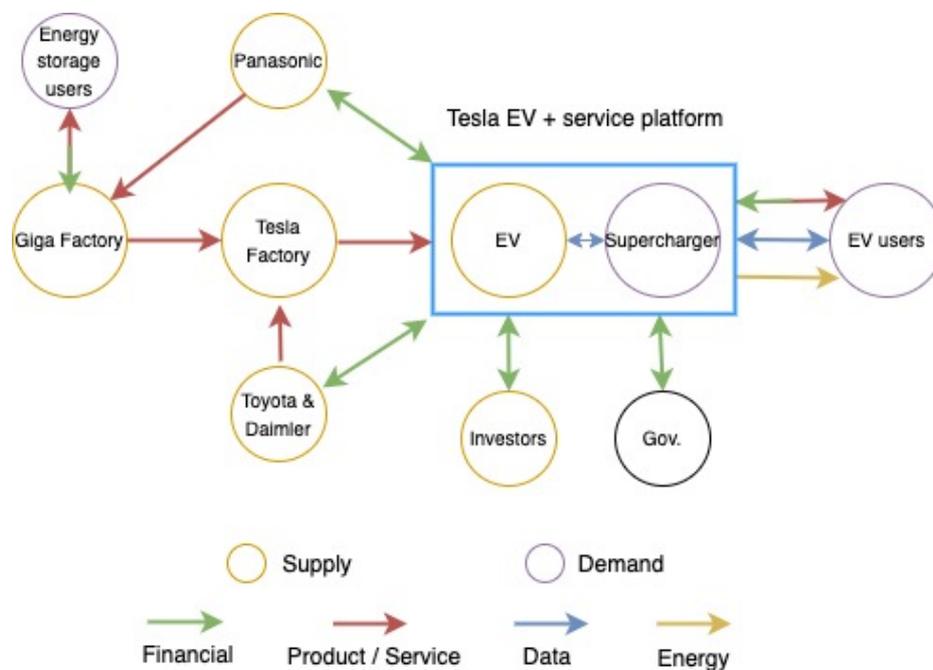


Figure 20 Integrated ecosystem of Tesla. Source: prepared by the authors.

BMW: Despite the actions taken by the German government and the progress made in favor of EV technology, they have been very protective of its traditional car industry. Due to the importance of car manufacturing for its economy, the government actively opposed more strict restrictions from the European Commission, instead advocating for the benefits of biofuels. This lobbying for alternative ways to reduce carbon emissions displays the German automotive industry's skepticism about the feasibility of 100% electric mobility. According to one of our

informants, “we [BMW] do not think it is feasible to install the charging infrastructure needed in many places, such as in Russia”. This is in line with a statement from Volker Wissing, who has been the German Minister for Transport since 2021, “We cannot only bank on electric mobility or hydrogen for the future. We need to remain technology-agnostic”.

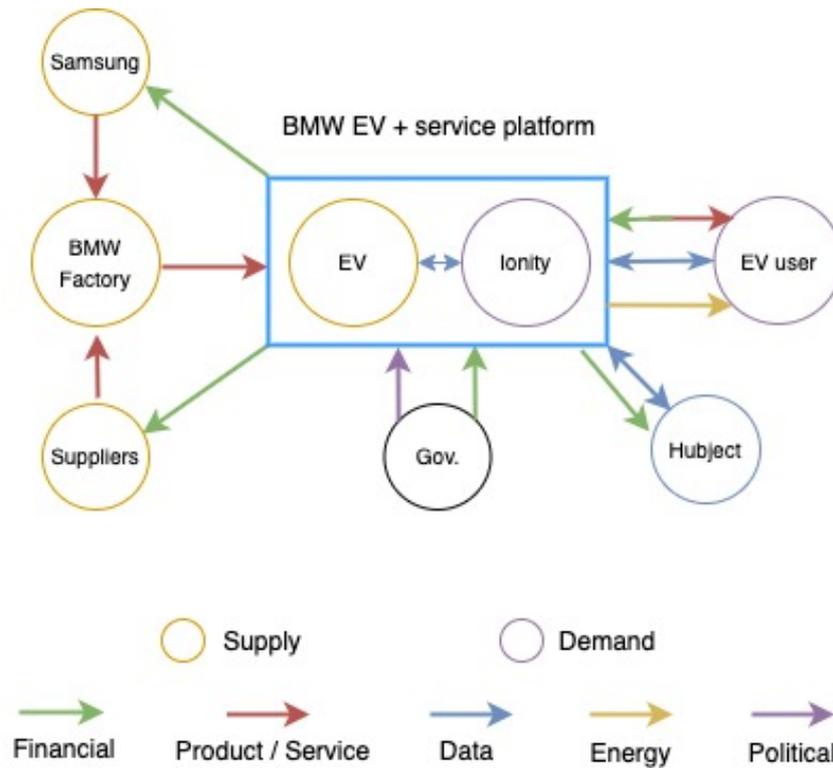


Figure 21 Ecosystem of BMW. Source: prepared by the authors.

In 2011, BMW launched its first mass-production EV, the BMW i3. The battery was considered their main bottleneck. Early on, the company signed a buyer-supplier contract with Samsung. Like Renault, BMW did not enter the battery market, rather focusing on their core competence in the innovation of the vehicle. The company innovated the vehicle design to tackle the battery bottleneck, developing a very lightweight carbon fiber material that enhanced range. Its initial charging strategy also focused on overnight charging at home or work. However, with the advancements in battery technology, fast charging became of significant importance. In 2017, BMW joined Ionity in a joint venture with Ford, Hyundai, Mercedes-Benz, and Volkswagen, to build a high-power charging network connecting all of Europe. The ecosystem strategy of BMW for this phase is shown in figure 21.

Renault: Even though the partnership with Better Place came to an end in 2013, it offered Renault the opportunity to experiment together with public charging complementors and to develop expertise in charging technologies. In 2013, the Renault-Nissan Alliance surpassed the

100,000 EV units sold and presented itself as the largest manufacturer of "zero-emission" vehicles in the world. In the same year, the Renault group was the very first manufacturer in Europe to offer a model designed entirely for a 100% electric engine. The Zoe became its first mass-market electric vehicle. In an immature EV market, the main challenges for mass penetration were the high purchase price resulting from the cost of batteries, and the lack of public charging points. To reduce the criticality of the battery bottleneck, in 2012, Renault formed a partnership with LG for the supply of custom battery cells. Additionally, they offered the option of leasing the battery and purchasing only the vehicle; this dropped the initial vehicle price of its EVs. However, Renault refused to enter the battery business. The same decision was taken, regarding the deployment of public charging infrastructure. After some discussions with Ionity about the possibility of integrating the network, Renault decided not to invest in the construction of charging stations. Instead, they would rely on third companies and the developments carried out by the French government. As mentioned by one of our informants: "We [Renault] are focusing on home charging for every user and pushing hard for the government to deploy more charging stations."

To soften the criticality of the charging infrastructure bottleneck, they developed an onboard charger and an integrated fast-charging system for the Zoe, which allowed them to reduce costs in fast charging. In 2013, lead players in electric mobility, Renault, CNR, la Caisse des Dépôts, EDF, and Enedis, created a digital platform for e-mobility: Gireve. With a fragmented market consisting of numerous individual players providing electric mobility solutions, Gireve manages the interoperability of the charging network. This platform connects CSOs and EMPs while building an open market interface for electric mobility services. In order to include the mapping of all the charging stations already plotted by Gireve in the multimedia systems of their vehicles, Renault formed a partnership with Tom-Tom. Renault is also actively working with external EMP service providers, for the launch of the Mobilize Charge Pass, a roaming badge that allows privileged pricing access to a vast network of public charging stations and better user-experience features.

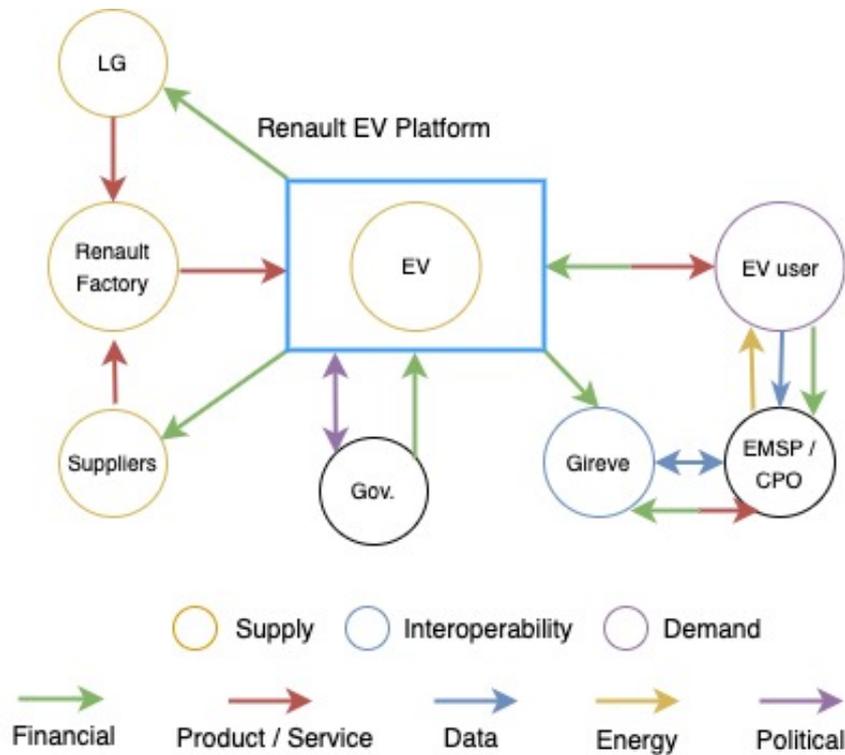


Figure 22 Ecosystem of Renault. Source: prepared by the authors.

To further production plans, in 2018, the company increased EV production capacity with an investment plan of €1 billion for its factories with the following actions: adapting the Douai plant to host the Alliance’s EV manufacturing platform producing vehicles other than the Zoe (e.g., Megane); doubling production capacity of the Zoe at the Yvelines plant (up to 120,000 units a year); and tripling production capacity for electric motors at the Cleón plant (240,000 units a year). The plan of Renault is to launch 10 new battery-electric vehicles by 2025, and to have 90% of battery electric vehicles in the sale mix by 2030. Batteries are being produced in an alliance with LG, and they recently partnered with Connected Energy for second-life battery energy storage technology. Renault’s offer consists of economy BEVs with and without fast charging, and battery leasing. They have also co-founded Gireve to ensure interoperability. The ecosystem strategy of Renault for this phase is shown in figure 22.

4.5.1.3 Accelerating the ecosystem (2021-2035)

Based on the disclosed strategies of the companies for the following 10 to 15 years, we explore how different PS platform strategies unfold in the EV ecosystem. Today, the three firms have developed different ecosystem strategies in response to their contexts. In the upstream part, two different choices emerge. As battery makers continue to improve their technology, incumbents, Renault, and BMW, have chosen to establish contracts with technology leaders for

the supply of batteries. Tesla, in contrast, uses a complementors technology to manufacture its batteries in-house at the Giga factory. In the downstream part, all firms have adopted different kinds of PS platform configurations (Yoo et al., 2021). Renault has decided not to invest in charging infrastructure deployment, and instead, developed Mobilize, operating as an EMP for services associated with sales and maintenance such as fleet management, charging and financing. The choice of BMW was to create a CPO partnership for fast charging with important mobility players, including other competing OEMs, by co-founding Ionity. Also, similar to Renault, they have developed their own EMP solution. Finally, the strategy of Tesla has been to focus on an integrated platform, developing its own platform and a network of Superchargers.

Tesla: The strategy of Tesla has prioritized an integrated solution, where the company controls the supply and the demand side of the PS platform (figure 23). Today, the Supercharger network is one of the largest fast charging networks in place, however, investment has been very high. Thereupon, Tesla has decided to open the Supercharging network to non-Tesla EV drivers and, recently, has also opened the Supercharger network to other EMPs.

For the coming years, the strategy of Tesla is focused on combining energy storage with renewable energy production, under its newly created "Tesla Energy" division. The company has also prioritized the development of improved self-driving capabilities. The intention of Tesla is not just to add new products to its ecosystem, but betting for a future reliant on energy services.

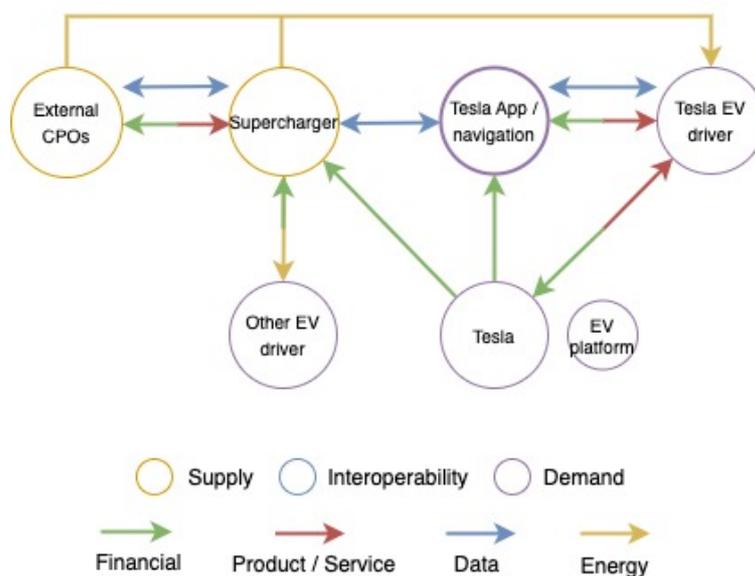


Figure 23 PS platform of Tesla. Source: prepared by the authors.

BMW: The electrified product portfolio of the BMW Group includes battery electric cars (BEV) and plug-in hybrid versions (PHEV). Apart from the existing all-electric BMW i3, MINI Cooper SE, and BMW iX3 models, two important innovation drivers were added: the BMW iX6 and the BMW i4. The all-electric BMW 7 Series, BMW X1, high-volume 5 Series, and MINI Countryman will follow in the next two years, as will the all-electric Rolls-Royce brand. With the "Neue Klasse" assembly platform, BMW will take the fundamental BMW brand into a new all-electric dimension beginning in 2025. BMW provides free return of high-voltage batteries at the end of their life cycle.

In terms of charging, the BMW Group provides a wide range of charging solutions through BMW Charging to make the usage of electric vehicles more convenient. BMW is actively working with the company Digital Charging Solutions, as EMPs to access the charging network including the maps of their charging networks in the navigation systems of their cars. Customers can use their BMW charging cards to access public charging services, giving them direct access to over 250,000 charging points across Europe, including 48,000 in Germany alone, and fast charging stations with more than 150 kilowatts of capacity (kW), including the European IONITY high-power charging service. Today, the network counts with 6,600 IONITY charging points, powered by 100% green electricity, accessible to all vehicle brands, and in accordance with the CCS standard. Additionally, in 2021, the BMW Group managed to introduce a standardized tariff structure for public charging in 22 European countries.

Finally, the technical diversification strategy also involves the advancement of fuel cell technology, with hydrogen-powered electric drive systems considered as a complementing addition to battery-powered electric mobility and a chance to cut carbon emissions even quicker. The PS platform of BMW for this phase is shown in figure 24.

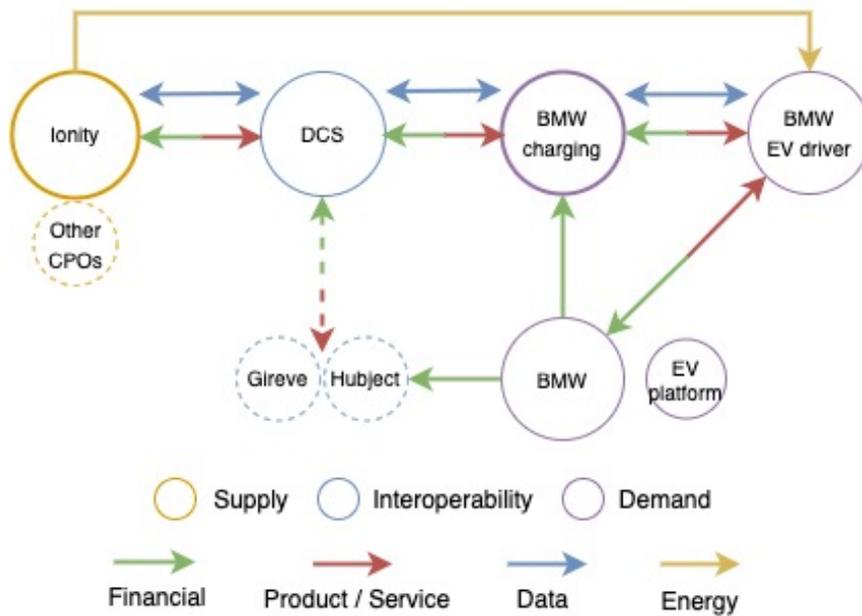


Figure 24 PS platform of BMW

Renault: Luca de Meo, CEO of Renault, presented in 2021 the Renaulution plan; the Renault group's strategic plan for the coming years. The main focus is to become a profitable company again. This plan consists of 3 phases: Resurrection, which will last until 2023 and will focus on recovering profits; Renovation, until 2025 and focusing mainly on product strategy; and Revolution, which goes beyond 2025 and will consist of transforming the business model towards a threefold technology-energy-mobility. The change of strategy will focus on electrification on 3 different pillars. First, maintaining the lead in pure electrics. Renault sold 100,000 units of the Zoe in 2021 in Europe, a higher number than any of its competitors. Second, to challenge Toyota for the lead in hybrids in Europe. And third, to rely on the synergies of the alliance with Nissan, in aspects such as electrification, but also on the issue of the connected and autonomous car. The structure of the group is established with two product development and manufacturing companies: Amper for electric and Power for combustion, including hybrids. A service company, mobilize. One for the circular economy, the future is neutral. Finally alpine, the Group's premium brand.

This way, we see how Renault will divide their EV business from the ICE. Also, they will revive Alpine, as a pure electric brand that will compete for the premium sector dominated by Tesla. Finally with the creation of Mobilize, Renault establishes its PS platform, establishing as an EMP for services related with charging. The PS platform of Renault for this phase is shown in figure 25.

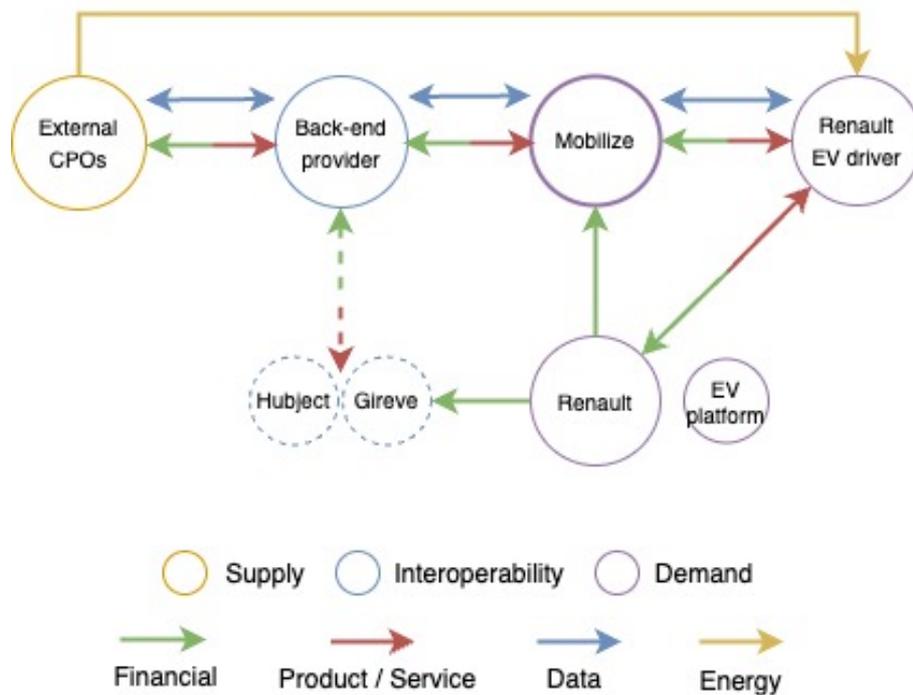


Figure 25 PS Platform of Renault

4.6 Discussion and conclusions

4.6.1 Proposition 1: Tesla's disruptive EV ecosystem and its impact on the value proposition of the automotive industry

Tesla has radically changed the business model of car companies, going from being a company that incorporate technology to being a technology company that makes cars. With its integrated PS platform in place, the “Tesla experience” has been a reference point for other new and incumbent companies. Today, two approaches are evident in the race for a dominant design in the EV ecosystem. On the one hand, newcomers like Tesla have adopted an integral approach for the design of its ecosystem. Implementing a strategy of vertical integration, Tesla manufactures in-house electric powertrains, batteries and its components, IT systems, and charging stations. Lucid Motors, another EV start-up, has also adopted a more vertically integrated business model. On the other hand, incumbent manufacturers have divided the business between combustion and electrification, because they are very different technologies, with different objectives. Maintaining the combustion is needed for markets that cannot be electrified in the short term, such as Latin America, India, Africa, or Southeast Asia. In these markets, Hybrids will be very important in the transition to electric vehicles. Therefore, we see how traditional car makers have adopted a more collaborative approach, working together with third party companies as one of the bases of growth. This type of agreement allows to share

investment costs, to partner with specialists in their respective fields, and to reduce development times. These makes incumbents more agile and reactive in an environment in which technology is so changeable and must evolve fast. Finally, the services associated with sales and maintenance of EVs such as fleet management, maintenance and financing will become more important in the future.

Finally, building upon the sketched historical journey of the automotive market elaborated by Dijk et al. (2015), we assess the potential of EVs to disrupt the market of mobility dominated by internal combustion engines (ICE). This framework allows the mapping of the market interactions between sustaining and disruptive technologies overtime. By exploring the historical development of the EV niche ecosystem, unfolding together with the established regime of ICEVs, and elaborating on the concept of disruptive innovation ecosystems according to market evolution, we discuss about the possible path of a transition in the automotive market. Our analysis suggests that based on the projected market share for the year 2030, the automotive industry is transitioning into a new regime of electric propulsion systems, operating in a different social and technical context. At this point, the three car makers under study, have successfully managed to establish an EV ecosystem that generates externalities by means of network effects on the supply side.

4.6.2 Proposition 2: BM evolution choices and organizational strategies unlocking new value in the EV ecosystem.

We have identified three BMI strategies that generate new forms of value within the EV ecosystem: 1) Redefining the value proposition: Tesla completely reimagines the value proposition offered to customers (V); 2) Enhancing the existing value proposition (exemplified by BMW): BMW strengthens its current value proposition by leveraging new combinations of resources and competences (RC); and 3) Transitioning to a new value proposition (exemplified by Renault): Renault undergoes a thorough organizational transformation, resulting in the emergence of a novel value proposition (O).

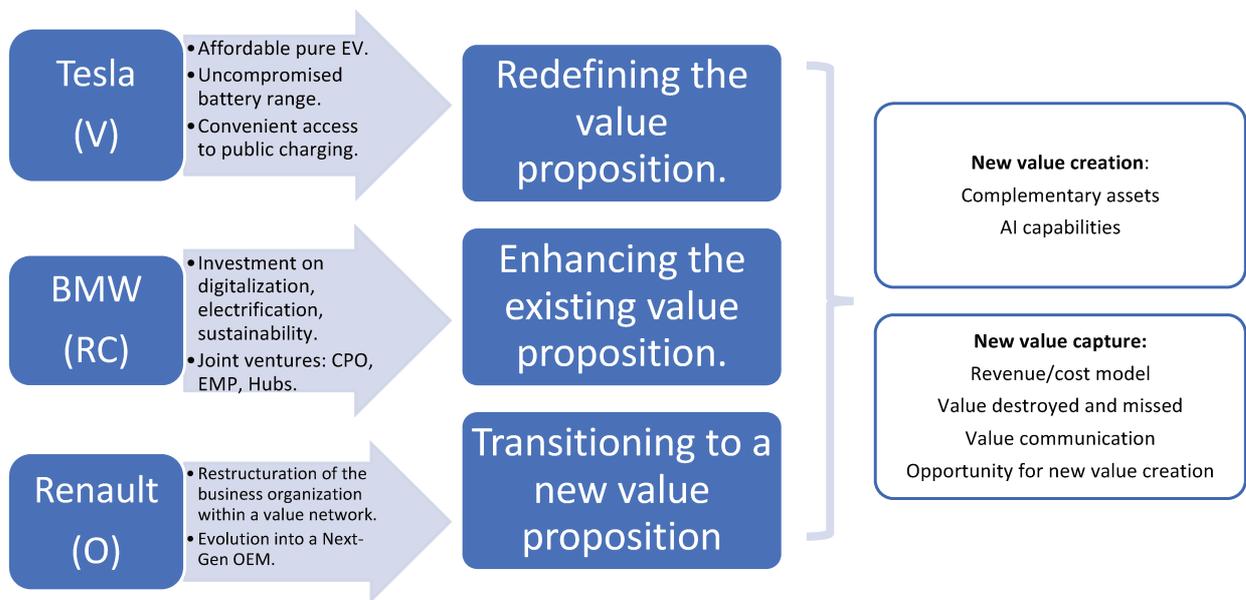


Figure 26 Illustration of BMI strategies and new forms of value creation and capture. Source: prepared by the author. Adapted from the RCOV model (Demil and Lecocq, 2010)

Next, we elaborate on these three strategies by aligning them with the dynamics of the business model innovation. This alignment considers changes occurring within the various core components of the model, as well as their interrelationships. These insights are derived from the RCOV framework (figure 26).

4.6.3 Redefining the value proposition – Tesla

With the overarching objective of accelerating the transition from a carbon-intensive economy to a sustainable electric economy, Tesla embarked on its initial plan to create an uncompromising 100% EV. Following a preliminary exploration that adhered to the traditional business model employed by automotive companies to produce the Roadster, Tesla underwent a profound shift in its value proposition in 2008. This transformation brought about organizational changes and the incorporation of novel resources and competences. Tesla's strategy evolved to include forming collaborations with other OEMs and complementary actors. Additionally, the company employed various strategies to secure capital infusion. Significantly, Tesla established an integrated platform for its groundbreaking Model S, branching out into diverse initiatives to expand its offerings beyond the realm of car sales. Addressing the challenge of battery supply, Tesla joined forces with Panasonic, in the construction of the Gigafactory. By 2013, Tesla initiated the supercharger program, a proactive and long-term initiative aimed at

deploying public fast-charging stations to surmount the limitations of the charging infrastructure.

Table 3 The case of Tesla. Source: prepared by the authors.

Impact	Resources and competences	Organization	Value proposition
Value proposition	Vehicle manufacturing and assembling, battery technology, EV charging and other mobility services.	Collaboration with incumbent OEMs, partnerships with technology providers, and private equity.	Offer an accessible pure EV that ensures uncompromised battery range and convenient access to public charging.
New value created		New value captured	
Manufacturing and assembling of EVs and batteries factories. Largest network of fast-charging stations. Closed ecosystem and full control of generated data.		High market positioning and evaluation. Revenue from battery manufacturing, charging and emobility services for Tesla users and EV users in general. Software integrations and Autonomous driving technology.	

Tesla embraced a closed ecosystem strategy, exercising control over both the upstream and downstream aspects of its value chain. Tesla's value proposition in the EV market combines technological excellence, a strong brand image, a commitment to sustainability, and a focus on user experience. Its focus on technology and data has allowed it to deliver impressive range, performance, and novel features in its vehicles. These factors have not only bolstered Tesla's sales but have also established the brand as a pioneer in a rapidly expanding market. Tesla's venture into new markets, including energy storage, autonomous technology, and international expansion, has further stoked investor optimism and propelled its market valuation. This innovative ecosystem has contributed to Tesla's success in disrupting the automotive industry and driving widespread EV adoption (Table 3).

4.6.4 Enhancing the existing value proposition – BMW

BMW, a luxury brand with a recent track record of profitability, has channeled its financial strength into substantial efforts to reduce its carbon footprint across the entire lifespan of its

vehicles. Recognizing the critical role of electric drivetrains in achieving climate-neutral mobility, BMW is committed to expanding its electric vehicle lineup significantly, with the introduction of the Neue Klasse platform. BMW envisions setting new benchmarks in digitalization, electrification, and sustainability within the company, with a particular focus on battery-electric drivetrains (Table 4).

Through the innovative New Cluster Architecture, BMW will create exceptionally efficient and high-performance fully electric vehicles, delivering the signature BMW driving experience marked by emotional design and a potent, highly efficient drivetrain. These vehicles will also feature cutting-edge digital functionalities, compelling driver assistance systems, and automated driving capabilities. Furthermore, BMW is committed to prioritizing the use of secondary materials whenever possible, contributing significantly to the reduction of the carbon footprint throughout the entire lifecycle of the Neue Klasse.

Table 4 The case of BMW. Source: prepared by the authors.

Impact	Resources and competences	Organization	Value proposition
Resources and competences	Innovative Cluster Architecture to expand EV lineup. R&D to advance digital, battery and electric powertrains technology.	Cooperative partnerships for fast charging network, hub to aggregate CPOs and EMPs for charging and other mobility services.	High performance EVs, delivering the signature BMW experience. At least one EV model in all relevant market series.
New value created		New value captured	
Expertise in electric drivetrains, batteries, and digitalization. Provisioning of fast charging and other mobility services for their customers. Collaborative ecosystem with access to data generated by partnership companies.		Tap into new customer segments. Reinforce its brand image as a leader in sustainability and innovation. Adapt to changing regulatory environments. Product innovations, software integrations and technologies like autonomous driving.	

BMW has committed substantial resources to research and development aimed at advancing their knowledge on battery technology and electric powertrains. This ongoing effort is oriented

towards enhancing the range and overall performance of their electric vehicles. Simultaneously, BMW is actively engaged in the expansion of charging infrastructure to support its growing electric vehicle lineup. Collaborative joint ventures with other German companies have played an important role in ensuring convenient and efficient charging solutions for BMW customers. These cooperative partnerships have resulted in the establishment of relationships such as Ionity, which operates a fast-charging network, Hsubject, focused on developing a hub that aggregates various CPOs and offers other mobility services, and DCS, a joint-venture EMP for the delivering of charging services customized for BMW drivers.

BMW's dedication to three core pillars of the future: "electric," "digital," and "circular", signify not only technological innovation and expertise in e-mobility but also novel approaches to working methods. The ongoing transformation towards electrification, digitalization, efficiency, and sustainability affects every facet of the BMW Group, encompassing human resources, research and development, supplier relationships, and sales channels. This transformation is particularly pronounced within the global production network, reflecting BMW's unwavering commitment to a more sustainable and electrified future. BMW Group customers will have the option to select from a range of vehicles, including fully electric, plug-in hybrid, and highly efficient combustion engine models, all showcasing the distinctive quality and efficiencies associated with the BMW brand. This array of choices reinforces its value proposition as a top-tier premium automotive brand.

4.6.5 Transitioning to a new value proposition – Renault

With the vision of being a more profitable, competitive, and efficient company, Renault followed an ambitious transformation roadmap with a shift from prioritizing volume to emphasizing value. The strategy involves enhancing operational efficiency through rigorous cost management, harnessing the Group's industrial capabilities and leadership in European EV market, and procuring data, mobility, and energy services. Through a thorough restructuring of the business organization within a value network, Renault aims to evolve into a Next-Generation automotive company (table 5).

The Renault Group has undergone a significant reorganization, with a strong brand-centric structure featuring independent business units. Additionally, the establishment of Mobilize represents a strategic response to the evolving mobility landscape. This restructuring marks the initial phase in aligning the Group with consumer needs and placing a renewed emphasis on

performance. Collaborative efforts with diverse partners have been crucial in expanding the availability of charging stations and facilitating convenient charging solutions for electric vehicle users. Renault is forging alliances with top players across various sectors, consolidating resources, expertise, and risk-sharing to drive investment, innovation, and growth. These partnerships encompass a wide range of organizations, tech companies, and government bodies, all working together to expedite the adoption of electric mobility. Collaborations with energy companies and other stakeholders are aimed at developing an ecosystem favorable to EV adoption.

Table 5 The case of Renault. Source: prepared by the authors.

Impact	Resources and competences	Organization	Value proposition
Organization	Progressive re-engineering projects for expertise in emerging trends: EVs, software, and mobility solutions.	Significant restructuring, internally and externally, to adapt to a changing a landscape.	Shift from prioritizing volume to emphasizing value. Vehicle sales and mobility services. Nex-Gen OEM.
New value created		New value captured	
Affordable electric mobility and urban mobility solutions. Provision of charging and mobility services. Open ecosystem with access to data generated with third companies.		Cost reductions and profitability. Sustainability and digitalization to address the changing preferences and needs of consumers. Growing sales and additional revenue from charging and other mobility services.	

Simultaneously, Renault is preparing to launch 25 new models between 2022 and 2025, strategically positioning the Group in lucrative market segments while prioritizing environmental sustainability. Remarkably, Renault achieved its 2025 profitability target in 2022 and remains on track to reach a €3 billion target in 2023, enabling increased investments in research and development, exceeding 8%. The company is committed to transitioning to a fully electric lineup in Europe by 2030. However, it will maintain ICE and hybrid offerings in regions with slower electrification trajectories, reflecting its global presence.

Leveraging the opportunities presented by the electric vehicle and digital revolutions, Renault has initiated a comprehensive transformation, capitalizing on the changing automotive landscape. This transformation entails a shift from vehicle sales to mobility services, driven by a commitment to sustainability, fundamentally reshaping its value proposition. To harness these challenges as growth opportunities, Renault is accelerating its transformation efforts, excelling in emerging value chains such as technology, industry, services, and circular economy. Specialized teams are being established to concentrate talents, expertise, and energy in each domain, promoting the development of new competencies. Renault is actively building open ecosystems to participate in the expanding EV ecosystem.

4.7 Conclusions: stimulate data network effects

Finding the most profitable business model is one of the major questions surrounding EVs today. The problem lies with the uncertainty faced by firms transitioning to electric mobility, which is complex in nature and in constant change. A structured approach can provide insights into such a phase of uncertainty. Drawing on a combination of the MLP of sociotechnical transitions and innovation ecosystems, we explored three different strategies currently developing in the EV ecosystem. We carried out a multi-case study of the ecosystems of Renault, BMW, and Tesla, analyzing the different contexts and the respective firm choices. To uncover the specific ecosystem dynamics, we collected and analyzed archival and interview data. We developed an understanding of key decisions of firms when evolving their BM strategies as they considered the current challenges of their individual contexts. We created a series of ecosystem maps that show a detailed representation of the processes underlying the different strategies.

Much like many other established industries, the EV ecosystem has encountered profound disruptive forces stemming from the digital transformation and electrification of mobility. These disruptions have been driven by shifting consumer preferences, emerging market entrants, and the proliferation of digital platforms. In response to these transformative challenges, car manufacturers within the EV ecosystem have developed diverse strategies to innovate their business models and create and capture new forms of value. Our study suggests that the actual momentum built up by the EV ecosystem is shifting the automotive market into a new regime of electric mobility. The development of a new ecosystem configuration is driven by new companies like Tesla, which affect the way incumbents envision and align their ecosystem strategies. Accordingly, car manufacturers have distinctively managed to establish sustainable

BMs for an electric mobility, leveraging the network effects generated by platforms within the EV ecosystem.

This study has identified three overarching organizational strategies within the EV ecosystem. First, the case of Tesla illustrates how a new entrant stunned the automotive industry with an innovative value proposition and successfully expanded its resources and capabilities, while introducing a unique ecosystem organization distinct from automotive industry norms. Second, the case of BMW demonstrates how an established firm, having demonstrated sustained profitability in recent years, invested in new resources and capabilities to elevate its existing value proposition, maintaining its leadership position in the market. Lastly, the case of Renault highlights the transformation of an incumbent firm, which opted to re-structure its internal and external organizational structure and proposed an innovative open ecosystem, enabling shared investments and knowledge exchange with external partners. This strategic shift has yielded positive outcomes, including profitability and a novel value proposition, positioning Renault for potential industry recovery.

These findings highlight the importance of business models that foster platform dynamics and network effects. Network effects are the economic mechanisms that provide an understanding of the potential of a niche to disrupt a regime in socio-technical transitions. They can be empirically detected when the value for the user increases with the number of users in the system (Katz & Shapiro, 1985, p. 424). For the case of EV platforms, the growth of the product-service platform depends on network effects externalities generated between EV consumers on one side and charging station service providers on the other. As the ecosystem depends on a very fragmented base of CPOs that are very difficult to engage, a more integrated ecosystem generates larger network effects. However, the size of the network effects does not necessarily guarantee platform economic superiority. We suggest that, theoretically, the different ecosystem configurations have managed to create solid conditions for a positive feedback loop that could allow for transition, each with a different BMI strategy.

We consider that traditional network effects are present in the different ecosystem configurations, however, it is not yet possible to determine which specific strategy, if any, will become the dominant design. We also highlight the value missed associated with data network effects; “a platform exhibits data network effects when the more the platform learns from the data it collects on users, the more valuable the platform becomes to each user” (Gregory et al., 2021, p. 535). We believe that data will become the next bottleneck asset and that the AI

capabilities of the platform have the potential for new value creation that could consolidate the EV ecosystem.

To encompass new capabilities in their offer, innovative BMs should look to stimulate data network effects. This occurs when “the ability of a platform to learn from data to continuously improve its products or services for each user, gives rise to new platform externalities, where a user’s utility of a platform is a function of the scale of data-driven learning and improvements realized with AI” (Gregory et al., 2021, p. 535). The AI capabilities of a platform and the corresponding user value are moderated by platform legitimation, data stewardship, and user-centric design. Thus, OEMs must make decisions as to how to get ahead of data processing technologies and the data itself. Most car manufacturers have already formed partnerships with big IT players; on the one hand, it is very challenging for OEMs to match the progress of their data-driven learning technology, and on the other hand, it seems like Tech giants have also decided that create alliances with OEMs is the best way of entering the ecosystem at the moment.

This chapter considers only three strategic configurations unfolding in the EV ecosystem, we don’t expect our three scenarios to include every configuration and we do not include other mobility services such as V2X or sharing services. Future work should address innovative business models creating user value by exploiting data network effects in the context of a digital business ecosystem. The value perceived by users in a platform or its offer, may depend on combinations of data network effects and indirect network effects.

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Chapter 5: Digital Transformation and Business Model Innovation in the EV Ecosystem

With a backdrop of shifting automotive practices, including functional economy, digitization, and electromobility, in chapter 4, we highlighted data's central role and its network effects in shaping BMI capabilities for car manufacturers operating in the EV ecosystem. Chapter 5 narrows its focus on this concept, specifically exploring a data architecture's contribution to value with a case study on group Renault. Drawing from the VISOR framework (El Sawy and Pereira, 2013) and a taxonomy of Digital Business Models as proposed by Bock and Wiener (2017), we study the influence of data exchange architecture on the BMI capabilities of OEMs within their EV platform. The chapter deepens our understanding of how data orchestration influences the future value landscape within the EV ecosystem.

5.1 Business model innovation for connected EVs

In recent years, the automotive industry has undergone a profound transformation, driven by the convergence of technological advancements, changing consumer preferences, and the growing emphasis on sustainability. This transformation has led to a significant departure from traditional linear and value chain-based BMs towards the emergence of dynamic and interconnected ecosystems. This shift from product-centric approaches to industry-wide platforms has become a focal point of research, as it holds the potential to reshape the landscape of the automotive sector as we know it.

This chapter seeks to explore the role of digitalization in stimulating disruptive changes within existing BMs, in the context of incumbent car manufacturers. As Hanelt et al. (2015) highlighted, digitalization has the power to redefine established norms and challenge traditional business strategies. Its impact resonates across industries, and the automotive sector is no exception. One of the most significant trends that has emerged within this context is the evolution from car ownership to mobility services. This shift has been driven by a confluence of factors, including the growing emphasis on eco-friendly lifestyles, the desire for personalized experiences, and the rise of the sharing economy. As a result, cars are no longer confined to their traditional role as mere modes of transportation; they are rapidly evolving into multifaceted platforms that accommodate an array of services. Mohaghegzadeh and Svahn

(2015) noted that cars are becoming pivotal in enabling a diverse range of digital services, marking a significant departure from the conventional view of vehicles as standalone products.

Furthermore, this transformation has intensified industry competition, emphasizing the role of digital platforms in providing electro-mobility and associated digital services. The thriving EV ecosystem is fostering collaboration and partnerships among traditional automakers, tech companies, and new entrants, all striving for a share of the rapidly expanding market. Therefore, companies need to have the capacity to adapt their modularity models to facilitate ecosystem reconfiguration, especially in the context of digital convergence. As exemplified by a comprehensive case study on the evolution of software architecture in Renault's vehicles, Azoulay and Attour's (2022) demonstrated that the restructuring of the ecosystem of Renault relies on architectural innovation, involving the transformation of the modular framework within their automobile software architecture. Innovation at the modularity model level has a critical importance in driving the reconfiguration of business ecosystems, facilitating the evolution of knowledge combinations within them. This chapter will delve into the ways in which these digital platforms are shaping the ecosystem and driving innovation in the context of electro-mobility.

As the automotive industry's transformation unfolds, data exchange has emerged as a fundamental factor expectant to have far-reaching implications on BMI. The ability to collect, analyze, and utilize vast amounts of data presents both unprecedented opportunities and challenges. The insights derived from data-driven approaches are anticipated to redefine traditional BMI strategies, enabling organizations to create value in novel ways and adapt to evolving consumer demands. In this context, literature offers valuable insights into the intricate dynamics of data exchange and control within the digitalized automotive ecosystem. In our comparative study developed in Chapter 4, we analyze the strategies adopted by three distinct OEMs for the establishment of their EV platforms. Through an exploration of these strategies, the research shows how the various actors in the ecosystem position themselves to assert control over data sources and orchestrate the exchange of this data. The roles of EMPs, CPOs, backends, or complementors become crucial in understanding the orchestration of data flows within the EV ecosystem.

The investigation by Mikusz et al. (2015) into connected cars' data platforms reveals varying approaches to data control. The prevalence of closed platforms, exemplified by the Audi-Google partnership, exemplifies one form of control where access to data is governed by preferred

partnerships. Conversely, the research of Svahn et al. (2017), delves into open in-car platforms, exemplified by Volvo's integration with Google's Android platform. This exploration underscores the complexities and trade-offs involved in determining who controls data sources and the resulting implications for data-driven value creation, such as the risks associated to share knowledge based on user data vis-à-vis offering new products and services by the means of an open platform.

Finally, the study by Gregory et al. (2020) interlaces the role of Artificial Intelligence (AI) and data network effects with new user value creation. A platform demonstrates data network effects as it capitalizes on user data, making itself progressively more indispensable to individual users, proposing an existing correlation between a platform's AI capability and the perceived value it offers to its users.

In synthesis, literature collectively emphasizes that the control of data sources within the digitalized automotive ecosystem is a multifaceted issue and the control and management of data sources have emerged as significant considerations. The roles of various stakeholders—OEMs, EMPs, CPOs, and technology partners—intersect to determine data governance strategies. The contrasting dynamics of closed and open platforms illustrate the diverse mechanisms through which data control can manifest. With the proliferation of digital services and the inherent economic value of data, understanding the actors that orchestrate data flows becomes crucial. Moreover, the potential of data network effects for the proposition of innovative value propositions and revenue models, the question of data control takes on even greater significance.

This study addresses a significant research gap concerning the extent of data control exercised by established car manufacturers and the strategies they employ to efficiently orchestrate the data generated through collaboration with complementary actors. The primary objective is to examine a data architecture that holds the potential to introduce novel value propositions within the EV ecosystem. This chapter focuses on investigating how do data network effects exert an influence on the value dynamics of OEM platforms for the creation and capture of new value. The study contributes to the existing literature by augmenting the understanding of Business Model Innovation (BMI) through the lenses of Digital Business Models (DBMs), connected EV platforms, and the evolving digital ecosystem of incumbent OEMs.

5.1.1 The rise of digital ecosystems in the EV industry

The advent of advanced information technology, particularly the Internet, has profoundly changed the production and consumption of information goods and services. These goods and services exhibit characteristics such as network externalities and low variable costs of reproduction. These features arise from the interoperability and increasing returns associated with information management technologies (Shapiro and Varian, 1999) and the nature of information as a public good (Arrow, 1962). The term digital economy is commonly used to describe the economic dynamics of information industries with these characteristics. Within the digital economy, new business models have emerged as significant innovations. In this context, the automotive industry is positioned for significant transformation, driven by the rise of digital ecosystems and the platform economy. These disruptive forces are expected to impact the industry in multiple ways, creating new opportunities and challenges for industry players.

5.1.2 Digital ecosystems: definition and characteristics

A digital ecosystem represents a collaborative socio-technical system where independent companies and individuals work together to achieve mutual benefits. At the heart of the ecosystem lies a digital platform that facilitates this cooperation through the provision of ecosystem services. By addressing the actual needs of potential consumers and delivering previously unattainable added value, a digital ecosystem appeals to both service providers and consumers. Crucially, the interactions between the partners through the digital platform lead to network effects, creating significant overall benefits. As a result, a successful digital ecosystem combines a broad network of partners with the platform's capabilities to deliver value for all actors involved.

The emergence of digital ecosystems represents a fundamental shift in the way companies do business. They require a new way of thinking and a willingness to challenge traditional business models. To create a successful digital ecosystem, companies need to be agile and able to adapt quickly to changing market conditions. This means providing an initial version of the digital platform and finding the first partners who are willing to participate. Digital ecosystems are constantly evolving and require continuous expansion of both the platform and the partner network. In addition to the direct partners, companies must also consider the interests and potential business models of all partners end-to-end, as digital ecosystems often have a profound impact on existing businesses. With competition intensifying on a global scale, building

a successful digital ecosystem requires careful planning, strategic partnerships, and a deep understanding of the evolving market dynamics.

Digital ecosystems and the platform economy are closely related as a digital ecosystem can be built to operate under the principles of the platform economy (Koch et al., 2023). In this context, a digital ecosystem is focused on economic interests, and participants engage in transactions via a digital platform that supports multi-sided markets. However, not all digital ecosystems are part of the platform economy, as some may have different objectives and goals. It is important to recognize that a digital ecosystem can be a tool for businesses to leverage the platform economy and create value for their customers and partners.

Digital ecosystems offer companies numerous opportunities to create new business models, increase efficiency, and earn revenue through the platform economy. Companies that initiate digital ecosystems can design the platform to fit the specific needs of their industry and offer added value to partners. This motivates the ecosystem initiator to expand the network, leading to network effects and increasing benefits for all involved. Furthermore, companies can identify untapped business segments that could benefit significantly from a digital ecosystem and initiate a platform, giving them a competitive advantage. In the current business landscape, where many companies are considering initiating digital platforms, acting quickly is essential to ensure success. These opportunities are especially relevant for B2B ecosystems.

5.1.3 Economics of digital ecosystems

This section delves into the economic dynamics inherent in innovative digital business models by examining existing literature that emphasizes the key trade-offs underlying these digital ecosystems. Traditionally, both managerial and economic literature have primarily analyzed BMs at the firm level. This analysis involves considering how investments in online service provision should be made in terms of volume, temporality, and technical choices. It also explores the selection of marketing strategies, such as pricing, customer loyalty management, and provision portfolio, to ensure successful returns on investments. For instance, Carvalho and Siegel (2003) examined these factors in the context of online banking services. Furthermore, the strategic literature explores the possibilities of pricing information and managing lock-in effects, as highlighted by Varian and Shapiro (1999). This perspective sheds light on how businesses can leverage pricing strategies and effectively manage customer lock-in to enhance their competitive advantage. In addition to these approaches, Brousseau and Penard (2007) propose

an alternative viewpoint that focuses on coordinating the various parties involved in the production and use of information and network-based services. This approach emphasizes the phenomena of horizontal and vertical "co-opetition" along transaction chains. It investigates how value can be created and shared among these parties to establish sustainable business models.

In this chapter, we specifically focus on the latter, which corresponds to three distinct domains of existing literature on Digital Business Models (DBMs). Brousseau and Penard (2007) propose three "dimensions" for comparing various DBMs. These dimensions relate to the roles played by platforms as pure market intermediaries, pure assemblers, or pure knowledge managers, as well as combinations of these roles. Building upon these dimensions, they developed an analytical framework that enables the evaluation of various business models involved in the production of information goods and digital services. This framework offers a typology of digital business models that is centered around the roles performed by platforms. Its primary objective is to identify the fundamental trade-offs associated with selecting among different digital business models and to assess their competitiveness and efficiency. Furthermore, the framework highlights the active participation of users in the production of information goods and their competition with traditional suppliers. It recognizes the evolving dynamics where users contribute to the creation and sharing of information, challenging established norms of information production and distribution. This emphasis on user involvement and competition with conventional suppliers is a key aspect of the framework, shedding light on the transformative nature of digital business models.

The first dimension examines the economics of intermediation and centers on transaction costs. According to this perspective, digital networks primarily function as marketplaces where the meeting of supply and demand takes place. Efficient transactions between providers and consumers require dedicated resources to address transactional challenges, such as matching demand and supply, ensuring secure transactions, and managing risks. DBMs in this context rely on their ability to organize transactions between the two sides of the market, aiming to reduce costs or enhance transaction efficiency.

The second dimension focuses on the economics of assembling and highlights what we refer to as "assembling costs." Digital networks are viewed as production networks in which productive resources (i.e., functionalities) are combined or assembled to produce outputs that are valuable to users. Different ways of combining these resources result in trade-offs between the levels of

assembling costs, the ability to meet users' needs, and the extraction of value from consumers to reward the efforts of functionality producers. DBMs represent alternative approaches to address this trade-off.

The third-dimension centers on the economics of knowledge management and emphasizes the efficiency with which information generated by users of digital goods is utilized to improve services and drive innovation. Digital networks are seen as tools that facilitate the sharing of information and knowledge. The different approaches to knowledge management within DBMs have implications for the effectiveness of collective knowledge accumulation and creation. They influence individual incentives to share information with others, the ability to access relevant information for individual innovators, and the distribution of knowledge (which is a public good). Alternative DBMs possess varying capabilities to efficiently utilize existing cognitive resources and organize knowledge accumulation.

Within this three-dimensional framework, companies are faced with the task of strategically positioning themselves by selecting their approach to organizing transactions, assembling functionalities, and managing knowledge in the production and distribution of digital goods. Importantly, these dimensions are independent of one another, meaning that choices made in terms of transaction organization do not necessarily dictate choices made for knowledge management, and vice versa. Furthermore, it is crucial to recognize that each of the potential business models within this framework can be dominated by a monopolistic entity, taking advantage of the winner-takes-all dynamics commonly observed in digital industries (Shapiro and Varian, 1999). Therefore, competition primarily arises between different business models rather than within each individual business model. Companies must navigate this landscape and strategically position themselves to gain a competitive edge based on their chosen business model.

Rather than seeking an optimal model, the aim is to find practical compromises among the various digital business models. These compromises are based on factors such as the specific characteristics of the assembled goods, the diversity and preferences of users, the production constraints faced by the function provider (such as cost levels and the proportion of fixed costs), and the competitive landscape among platforms. Recognizing the inherent complexities and variations within the digital business environment, the focus is on identifying models that strike the best balance in addressing these multifaceted considerations. By carefully considering the unique dynamics and trade-offs associated with each dimension, companies can strive to find a

practical compromise that aligns with the nature of the assembled goods, user preferences, production constraints, and the competitive structure among platforms.

5.1.4 Digital transformation in the automotive ecosystem

The automotive industry is undergoing a rapid digital transformation that promises to reshape the global landscape of the sector. This transformation is driving substantial changes in how car manufacturers and service providers deliver goods and services, propelled by government regulations addressing environmental concerns and soaring consumer demand. This section presents adaptation strategies related to digital transformation within the automotive industry, considering perspectives from a diverse range of stakeholders. Drawing on the insights from the study conducted by C. Llopis-Albert et al. (2020), which involved a case study-based empirical analysis of digital transformation in the Spanish automotive industry, it becomes evident that companies that lead the way in developing innovative digital services and products will attain a substantial competitive advantage. As a result, they highlight the importance of investing in suitable adaptation measures for digital transformation, leading to increased profitability, productivity, and competitiveness for manufacturers.

To effectively adapt to the transformative impacts, car manufacturers have made substantial investments in digital transformation to gain a competitive edge in the global automotive market. This investment encompasses infrastructure projects as well as research, development, and innovation activities. However, there is a hesitancy among companies to allocate substantial capital to these efforts due to the absence of immediate payoffs, associated capital risks, and uncertain returns on investment. Notably, certain impacts, such as the gradual introduction of electric vehicles, have far-reaching effects on business profits, leading to a time lag between current technology investments and anticipated future benefits. As a result, only a small number of organizations have completed their digital transformation rollout, while the majority are still in the process of defining implementation procedures or conducting mid-term test projects to ensure an appropriate approach.

Stakeholder satisfaction strongly depends on their role within the automotive industry, leading to a broad range of factors being considered. For instance, manufacturers, supply chain companies, and logistics firms prioritize profit and productivity, while consumer satisfaction with purchased products or services centers around accessibility, connectivity, simplicity, cost, quality, real-time services, user choice and support, personalization options, and deliverability.

From a consumer perspective, having access to a wider range of high-quality services will lead to increased satisfaction, as these services align with their high demand. Consumers will play a crucial role due to their ability to choose vehicles and services. However, consumers exhibit reluctance to purchase electric or hybrid vehicles in the short run due to concerns over high purchase prices, lengthy battery recharge times, limited driving range, and inadequate recharging infrastructure. Nevertheless, improvements in these areas, along with lower energy costs and emissions, heightened energy efficiency, reduced car maintenance and repair expenses, designated parking areas, and tax incentives, could tip the balance in favor of electric cars.

Car manufacturers, in this regard, have preferred a gradual implementation of electric vehicles due to the substantial investment required for transitioning from traditional fuel-powered vehicles and their opposition to highly restrictive environmental regulations. Conversely, consumers demonstrate a greater awareness of environmental issues, highlighting the conflicting and competing interests among different stakeholders. Moreover, consumer opinions enable other industry actors to better identify the threats and opportunities, such as exploring new emerging markets and services, posed by digital transformation within the automotive industry.

5.2 EV ecosystem architecture: a platform business strategy

5.2.1 Platform economy

The landscape of modern business has been reshaped by the advent of the platform economy, a dynamic paradigm that distinguishes between product and industry platforms as well as internal and supply chain versus external platforms. Industry platforms, serving as foundational products or technologies, enable firms to innovate and transact, thereby generating escalating value through network effects. The more innovations and transactions integrated into the platform, the more pronounced its value becomes. An essential characteristic shared among industry platforms is their ability to unite multiple market sides, thereby leveraging network effects and addressing the chicken-and-egg problem.

The essence of industry platforms lies in their capacity to bridge market sides, harness network effects, and resolve the intricacies of demand-and-supply imbalances. Results stemming from their implementation include intricate business models and a transformation of market dynamics. These industry platforms manifest in diverse forms:

- Transaction Platforms: These intermediaries facilitate direct exchanges or transactions and flourish through network effects.
- Innovation Platforms: Serving as technological bedrock, these platforms pave the way for firms to develop complementary innovations.
- Hybrid Platforms: These platforms encompass both transactional and innovation sides, fostering distribution and addition of complements.

The adaptability of platform strategies hinges upon the nature of the business. In the context of product-oriented endeavors, employing an innovation platform strategy can yield value through third-party complementary innovations. Conversely, service-oriented entities might opt for a transaction platform strategy, capitalizing on the value derived from connecting market sides rather than direct ownership of assets or service production. In some instances, a hybrid strategy combines both transactional and innovation components.

Thriving within the platform economy mandates a strategic approach, marked by openness, accessibility, modularity, and the fostering of a dynamic ecosystem. Building a platform business follows a structured progression:

- Identify Market Sides: Determining the market side crucial to platform growth.
- Overcome Chicken-and-Egg Challenge: Strategically addressing the challenge of initiating network effects.
- Design Business Model: Tailoring a business model aligned with platform objectives.
- Establish Ecosystem Rules: Formulating and enforcing rules that govern the platform's ecosystem.
- Network Effects and their Implications

Network effects, engendered by the interconnectedness of users and complementary components, yield self-reinforcing feedback loops leading to exponential growth. Although the sequence of initiating network effects might not be evident, the outcomes often align with the Winner Takes All framework, characterized by strong network effects, minimal differentiation among competitive platforms, rare multi-homing, and formidable barriers to entry for potential newcomers.

Navigating the landscape of platform business models presents both challenges and opportunities. While many nascent platforms operate at a deficit, sustained by substantial subsidies, weak network effects, multi-homing, modest scale/scope economies, competition, and legal constraints, the transformational potential remains. Platforms introduce new types of scale and scope economies, leverage digitalization to achieve efficiency, and stimulate innovation by welcoming external contributions. The vibrancy of a platform hinges upon its openness. For platforms primarily oriented toward innovation, success relies on the provision of APIs, while those grounded in transaction benefit from exposing demand or supply sides to the broader market. It is crucial to distinguish between companies undergoing digital transformation and authentic platforms that generate network effects. As the platform economy continues to evolve, enterprises must strategize meticulously, embracing the inherent complexities and leveraging the unprecedented opportunities this paradigm offers.

5.2.2 Network effects theoretical background

Network effects are a fundamental characteristic of platforms. According to various sources in the literature, platforms are described as market intermediaries that facilitate transactions between multiple parties (Parker et al., 2016; Evans and Schmalensee, 2016; Gawer and Cusumano, 2014). Platforms are evolving systems comprised of three key stakeholders: the platform owner, the supply side ecosystem, and the demand side ecosystem; all connected through an interface that integrates these elements with the platform owner's core. Initial discussions about economic platforms were centered around bilateral markets considered to be organizations that: facilitate coordination between two groups of competitive stakeholders (Gawer, 2014); create value by leveraging economies of scope on both the supply and demand side, as proposed by Teece (1980); and consist of a modular technology architecture comprised of a core and a periphery, as outlined by Baldwin and Woodard (2009).

Network effects take place when a product or service becomes more valuable as more users benefit from it, thus attracting more participants that increase the value of the product or service. Network effects are considered as the main source of value creation and competitive advantage in platform theory (Parker et al., 2016). According to Rochet and Tirole (2003) and Evans (2009), platforms are specific marketplaces that can internalize externalities at no additional cost. The positive externalities resulting from interactions between users, combined with network effects, cause the value of the service provided to increase with the number of users affiliated with the platform, as described by Katz and Shapiro (1985). Caillaud and Jullien

(2001) have also noted that these bilateral markets are characterized by indirect network externalities, whereby the abundance of participants on one side of the platform affects the utility enjoyed by participants on the other side. The complementarity between the two groups in the two-sided market results in a self-reinforcing feedback loop that benefits the platform owners.

Network effects are also linked to the concept of the winner takes it all. This means that the platform that attracts the largest number of customers and partners with complementary products or technologies will emerge as the market leader (Gawer and Cusumano, 2008). However, the process of incorporating actors into the platform can be challenging due to issues such as the chicken-and-egg problem and coordination problems. For platforms to be successful, there is a matter of governance that must be taken into account; in other words, who has access to the platform, how is value distributed among participants of the ecosystem, how to resolve eventual conflicts or disputes, and how to conduct the different objectives and strategies. The goal is to create a set of policies, rules, and incentives to encourage value creation and high-quality participations for the preservation of the ecosystem (Reillier and Reillier, 2017). Therefore, it is essential to carefully construct the platform to maintain a delicate balance between opening to third-party partners and keeping them at bay (Parker and van Alstyne, 2018).

Platform owners aim to stimulate positive network effects (Gawer, 2014), which requires achieving a critical mass of participants to initiate mass adoption, as defined by the minimum user-base size necessary. A platform that has virally spread, indicates that networks effects have been successfully stimulated (Rochet and Tirole, 2003). Factors that impact the participants critical mass include platform pricing, demand curve and market structure (Luis Arroyo-Barriguet et al., 2010), and network stimulation strategies (Parker and Van Alstyne, 2005; Gawer and Cusumano, 2008). Finally, cross-side network effects require the participation of at least two types of platform participants: customers and suppliers (Evans, 2009).

Previous studies on stimulation of network effects have explored strategies of aggressive and early investment, but such studies have been challenged by other scholars arguing that they are very prone to fail, because of being very costly and ultimately risky. In order to identify features for success, some other studies have compared cases where network effects have been stimulated and with cases that have resulted in failure (e.g., Evans and Schmalensee, 2007). In this study, we propose to investigate the interplay between indirect network effects and data

network effects, to stimulate positive externalities. In fact, the role of data network effects for creating user value on a multi-sided platform, depends on the scale of data-driven learnings and improvements realized with AI (Gregory et al., 2021). Nonetheless, it is important to recognize that the intrinsic value of data is limited since the most data fails to generate a real data network effect, and even once established, today most data network effects are not exceptionally potent.

5.2.3 Platform business models

The critical feature of a platform business model that distinguishes it from other business models are network effects (Gawer and Cusumano, 2014). With the emergence of the Internet, the world became increasingly connected. The Internet of Things (IoT) or things with computing devices in them that can connect to each other and exchange data using the internet, came to transform the way we think and do business. IoT created a perfect storm where broadband internet is becoming widely accessible, the cost of connecting is falling, more devices with Wi-Fi capabilities and sensors are being developed, technology prices are decreasing, and smartphone usage is surging. This led to a massive scalable business model called platforms. Platforms challenge the actual linear production model, deep-rooted at the heart of our economy and unchanged since the Industrial Revolution. Platform ecosystems are reshaping the world's panorama, not merely thanks to the digitalization of products, services, and business processes, but also by transforming their business models. Companies employing platform business models, are no longer just in domains such as social media, music or traveling; they are gaining ground also in transportation, banking, healthcare, and energy.

These platform companies have taken advantage of highly efficient matching and a more efficient utilization of assets to drive up productivity, generating a big potential for the so-called "share economy". Additionally, platforms can be "combined with traditional business models to create powerful self-reinforcing ecosystems" or can have part of their business supported by platforms. This is why, platforms are a great stage for innovation with the potential to be disruptive to traditional industries. In contrast with the actual linear view of firms, platform-based business models take a holistic view of complex ecosystems: interconnected and only possible to explain by reference to the whole. In this context, traditional companies adopting platform-based ecosystems uncover new perspectives into the internal dynamics of their business models, their disruptive potential, and possible strategic responses.

A platform enables value-creating interactions between external producers and consumers. The platform provides an open, participative infrastructure for these interactions and sets governance conditions for them. The platform's overarching purpose is to match users and facilitate the exchange of goods, services, or money, thereby enabling value creation for all participants. Platforms create value in two main ways. First, as a *transaction platform*, also known as *multi-sided market*, by facilitating transactions between different types of entities, that would otherwise have trouble to find each other. Second, as an *innovation platform*, where "technological building blocks are used as a foundation on top of which a large number of innovators can develop complementary services or products" creating an innovation ecosystem around the platform. These platform-powered ecosystems leverage the interaction of the ecosystem's multiple business models to reinforce user value propositions and drive stickiness, often with great results.

Business ecosystems are formed when reasonable conditions for innovation scope and transactional scale are met. Industry platforms are oriented towards innovation, and multi-sided platforms (MSPs) reflect the transactional scale that is subject to network effects. Regarding the issue of value creation, a platform based-ecosystem strategy is used to organize an ecosystem of interactions that exist around a product or service, that is a component of a value chain and that has potentially higher value services. This way, the strategy looks to better organize this existing ecosystem to facilitate higher value interactions. Nevertheless, any change in the platform design will lead to a new configuration and a new dominant design, that are set as a consequence of complex dependencies across actors and the value chain (Rosenkopf and Tushman, 1994). Platform "owners" or "shapers", a firm or group of firms with the goal of shaping industry-wide innovation for an evolving system of separately developed components, have the role of controlling this design. Ergo, a platform strategy can be defined as the strategy run by a platform shaper with the objective of mobilizing an ecosystem that creates value in interaction, capturing part of this value. To ignite, platforms must solve the complex coordination problem, to generate profits through positive feedback effects. Nevertheless, sustaining those profits requires navigation in an n-dimensional universe of colliding platforms.

Drawing on insights from economics, strategic management, and information systems research, Gawer (2020) proposes that digital platforms make strategic decisions concerning three interconnected boundaries: (1) the platform firm's scope, including its owned assets, employed labor, and activities; (2) the configuration and arrangement of the platform's different customer groups that have access to the platform; and (3) the digital interfaces that define the two-way

exchange of data between the platform firm and its customers. The decisions regarding the boundaries of digital platforms are mutually dependent and can vary depending on the platform type and its stage of development. This aligns with the strategic objective of how companies establish and manipulate platform boundaries to generate and capture value. For instance, the concept of network effects and the importance of pricing structures to overcome adoption issues have been explored in platform economics (Rochet and Tirole, 2003). The choices made regarding digital interfaces, scope, and sides can impact competition, stimulate complementary innovation, and generate new value combinations. Therefore, coherence in these decisions can be crucial to the success of digital platform strategies, as decisions on scope and interfaces can have opposite effects. In this chapter, we aim to add to this stream of literature, by exploring how boundary decisions in combination with AI platform capabilities can influence positive and negative data network effects.

5.2.4. EV ecosystem and network effects

The evolution of the automotive market toward the connected car is radically restructuring companies, and the scenarios for the transition from internal combustion engine to electric power are set to happen in the following 15 years. The automotive value chain is transforming into a cross-domain and inter-organizational business ecosystem of partnerships among the EV industry participants. A variety of organizational levels are involved, including car manufacturers, battery manufacturers, electronic equipment and other auto component suppliers, players in the power generation and entire infrastructural network, government organizations, industry associations, users, and other new protagonists such as ICT and software businesses. Several leading scenarios predict stagnation in revenues from car sales, where growth will be driven by mobility and financial services, accounting for one quarter of the whole industry's revenues. Over the same period, the share of green vehicles is expected to rise to 35% of total new sales and vehicles with V2X technology is expected to go to 30%, transforming the organization of the industry. The time is right for car manufacturers to take a leader position in the EV ecosystem.

The rise of platforms is creating challenges and opportunities in a global scale for established companies, as well as for start-ups. At the industry level, platforms are being consolidated through mergers and acquisitions. At the firm level, technology has a fundamental role, and building successful platforms will require cutting-edge complex IT systems, machine learning, AI, and developing technologies such as blockchain. In the EV industry, OEMs are ecosystem

keystone players or orchestrators (Iansiti and Levien, 2004, Dhanarag and Parkhe, 2006) that have the challenge of coordinating the complex network of relationships and designing successful governance systems. They coordinate with other stakeholders to obtain knowledge mobility during the design of new EVs, innovation appropriability by sharing profits in the ecosystem, and network stability with the selection of their ecosystem partners.

Firms in the automotive industry recognize that data and the information economy are strategic assets in the transition to a new electromobility regime. Both incumbent and new car manufacturers have built their ecosystem strategies around a portfolio of EV brands and business units in complementary fields such as electricity and software, mobility services and the circular economy. Today, most of the automotive firms' own platforms for the provision of electromobility services, relying on network effects to secure growth. These established product-service platforms exhibit indirect network effects in a two-sided market with EV users on one side and service providers on the other; the more EV users are attracted to a certain ecosystem, the greater are the incentives to enhance the value of the complements of products and services. In addition, these platforms generate enormous amounts of data, making way for a separate type of network effects, namely data network effects, that allow the improvement of services and the creation of new business opportunities. Data network effects occur when the value of a product or service increases because of increased usage via the accretion of data.

Network effects play a crucial role in shaping the dynamics of the EV ecosystem and the provision of electromobility services. For instance, the availability of charging infrastructure is a key driver of EV adoption. The more charging stations there are, the more attractive it becomes for consumers to switch to an electric vehicle. This, in turn, can incentivize more companies to invest in charging infrastructure, creating a positive feedback loop that reinforces the growth of the ecosystem. Moreover, data is becoming an increasingly valuable resource. As more EVs are deployed and more data is collected on their usage patterns, this data can be used to optimize charging infrastructure, improve battery technology, and develop new services. The more data that is available, the more valuable it becomes, and the more companies are incentivized to participate in the ecosystem. Understanding these dynamics is crucial for policymakers, industry players, and consumers alike as they seek to navigate the rapidly evolving world of electric mobility. For car companies, the integration of AI capabilities into their exchange partnerships and user networks, stand to gain a significant competitive advantage in the new EV ecosystem.

5.3 Data network effects theoretical background

Based on the premise of same-side or multi-sided exchanges between users, network effect theory argues that a growing network of interconnected users will lead to network externalities, where the usefulness of a platform to users is a function of the total number of users (Katz & Shapiro, 1985). Using network size as the main determinant of user value (Parker & Van Alstyne, 2018), network effects theory examines how an increase in the network size of a user group creates a virtuous circle, simultaneously increasing the same user group (direct network effects) or the network size of another user group that complements the platform (indirect network effects) (Katz & Shapiro, 1992; Rochet & Tirole, 2003, 2006).

However, literature on traditional network effects cannot explain how data-driven learning and improvement on platforms via data network effects contribute to user value (e.g., Farrell & Saloner, 1985; Katz & Shapiro, 1985). The baseline of this argument is that the perceived value of each user is dependent on the quantity of data-driven learning and AI-enabled improvements. Learning and development rely on producing faster and more accurate predictions using data-driven machine learning tools. The ability of a platform to learn from data to continuously improve its product or service for each user leads to new platform externalities, in which the value of a platform to the user is a function of the amount of data-driven learning and the improvements possible with AI. These improvements are reflected in stronger product features, platform quality and experience for each user (Cennamo & Santaló, 2018; Zhu & Iansiti, 2012; Zhu & Liu, 2018), giving rise to new platform externalities namely data network effects.

The use of AI has opened new opportunities for creating value for users. First, data network effects can significantly impact the value that users perceive in platforms, products, or services under certain conditions. This is particularly true in the context of platforms that enable the creation and sharing of information or experience goods. In these cases, the user experience is largely influenced by the amount of data collected on users and the resulting opportunities for learning (Shapiro & Varian, 1999; Varian, 2014). In the case of EVs, as more EVs are on the road, companies can collect and share data on driving patterns, traffic congestion, and charging station availability. This data can be analyzed to optimize the performance and range of the electric vehicles, as well as to improve the overall driving experience. This can increase the perceived value of EVs to users and make them more attractive.

Second, data network effects are particularly pronounced when learning capabilities play a major role in determining the quality of a platform, product, or service, as demonstrated by Tesla's Autopilot functionality; the value of this feature for users is directly impacted by Tesla's ability to use AI and learn from data collected from sensors, cameras, and radar in cars to enhance the self-driving algorithms and improve the Autopilot functionality over time. Third, the perceived value of a platform or its products and services can depend on both data network effects and direct or indirect network effects. For the case of indirect network effects, as more data is collected and analyzed, the connection between a product's demand and the availability of complements is enhanced. For example, charging infrastructure can be better planned, and the availability of charging stations can be improved when complementors are able to use the platform's AI capabilities of an OEM, to learn from user data and improve their electromobility services.

Finally, data network effects have an impact on the competitive advantage of the platform owner, as its "idiosyncratic capacity to learn from data is enabled by complementarities between the platform AI capability and various management, governance and design capabilities by the company" (source). When paired to related platform-based products and services in the ecosystem, these data-driven learning processes could lead to the diversification of the platform to stimulate new related application areas (Cennamo & Santaló, 2018; Ghazawneh & Henfridsson, 2013).

According to Gregory et al., 2019, to obtain the strategic benefits of data assets, in addition to developing or acquiring superior platform AI capabilities, particular attention must be paid to three important processes of data network effects. First, make sure that the machine learning algorithms on the platform are fed the appropriate amount and quality of data, and that they employ an enterprise-wide approach to holistically manage the enterprise's data assets. Second, include consumerization in the development process to create user-centered product and service designs on the platform that increase performance expectations (e.g., better personalization) and work expectations (e.g., higher usability). Third, responsibly handle of personal data collected from users and ensure the interpretability of predictions generated by AI on the platform by implementing privacy by design and security by design principles. If all these mechanisms are successfully activated, users are likely to perceive the continued value of the platform's AI capabilities as a source of competitive advantage.

However, while platform owners have the ability to leverage AI capabilities and data for value creation, it is important to acknowledge that there is a distinction between the installed base of users and complementors on a platform and the data derived from them. Users and complementors who engage with a platform exist outside of the platform-owning firm's boundaries, and the governance structure of the platform ecosystem is decentralized. Therefore, when examining an innovation ecosystem with a decentralized structure, it is crucial to consider value capture, and not just value creation (Adner & Kapoor, 2010). Conversely, the data collected by the firm is an internal asset and subject to centralized control within the firm's boundaries. As a result, it is possible for a platform to use AI and data to increase the proportion of value captured by the platform owner from the ecosystem, which could result in a decline in the value perceived by users. In this context, there is a loosely coupled relationship between the quantity and quality of the platform's data stock and the size of its installed base.

When assessing the value perceived by users, it is vital to consider the influence of data-driven learning on value capture, which can be equally and more significant than its impact on value creation. Due to the decentralized nature of users and complementors, conflicts arise between the value they capture, and the value captured by the firm. For instance, if a platform increases its price, it may capture a more substantial portion of the value, but the user may perceive a reduction in the total value created. In addition, if the mechanism of value capture employed by the platform diminishes the intrinsic quality or installed base of the platform, it could also have an adverse impact on the total value created. In line with our BMI framework for EVs, this study aims to identify both positive and negative perspectives of value creation and capture, to better understand the sustainable process of digital business model innovation and the stimulation of data network effects in the EV ecosystem.

5.3.1 Data network effects in the context of car manufacturers

While indirect network effects in the EV ecosystem have been explored to some extent (Ex. Yu et al., (2015) and Jang et al. (2018), Yoo et al. (2021)), recent studies have boosted research in a new category of network effects, referred to as data network effects. A platform exhibits data network effects when its increasing ability to learn from user data leads to greater value for each user. Data network effects show a positive direct association between a platform's AI capabilities and the value perceived by its users. In the EV ecosystem, the example of Tesla shows how the perceived value of Tesla cars is enhanced by the self-driving algorithms that are fed with a huge amount of driving data gathered from sensors, cameras, and radar units.

New data platform externalities complement the value inherent in the network externalities deriving from the scale of the ecosystem. Therefore, recent research encourages the integration of network effects literature, arguing that the value that a user derives from a platform is both a function of the scale of the ecosystem and the data learning AI capabilities of the platform. This perceived user value is increasingly becoming a function of integration of direct and indirect network effects with data network effects. In the specific case of indirect network effects, the interplay between the demand for a product/service and the supply of complements for that product/service affecting each other (Stremersch, Tellis, Franses, & Binken, 2007) may be influenced by data network effects, if complementors are able to use the platform AI capability to learn from data collected on users of the product/service to improve the quality of their complements and overall ecosystem value for each user (source). These positive externalities are regulated by platform legitimacy, data stewardship, and user-centric design. However, evidence shows that car manufacturers in the EV ecosystem have struggled to successfully assimilate AI capabilities into their BMs and operations on a larger scale (Sjödín et al., 2021).

Mobility platforms facilitate the exchange of goods, services, and data among the actors in the ecosystem. The electric mobility landscape is now recognized as being intricate, with a variety of actors and transactional relationships involved. Transactions occur between actors from different industry sectors who possess complementary skills, and this encompasses mobility services, vehicles, and infrastructure. Such organizations that exist on multi-sided platforms evolve in diverse patterns (Trabucchi and Buganza, 2019), where a two-sided platform can transform into a multi-sided one (Hagiu and Wright, 2015). This can be achieved through the introduction of new non-transactional relationships or through the addition of new partners and activities. The involvement of these many different types of players results in a highly fragmented landscape. This fragmentation and its lack of interoperability prevent the development of widely adopted EV ecosystems.

In most IoT ecosystems, entry barriers are high, and the potential rewards are limited for individual stakeholders. Therefore, platform providers require a well-established approach to sell access to their assets. OEMs trying to establish a product/service platform for the provision of EV charging services, require the development of marketplaces where they could create services and applications and build their EV products around them. Marketplaces offer a range of advanced features such as dynamic discovery, advertising, automated orchestration, and

services negotiation, facilitating the usage of services. By doing so, revenue streams can be shared among all stakeholders contributing to the marketplace.

However, to provide their full potential, mobility marketplaces must overcome a serious entry barrier in the ecosystem: the absence of interoperability across IoT platforms. The current state of EV charging services is characterized by a multitude of vertically oriented and largely closed systems, with architectures based on diverse and often incompatible standards or even proprietary interfaces. For example, the Tesla Supercharger Network or the Open Intercharge Protocol (OICP) developed by Hubject; these protocols are often used by specific charging network operators and can limit the ability of other operators to access and utilize their charging stations. To stimulate the growth of such ecosystems, it is crucial to establish interoperability between different platforms. This would allow developers to create applications that merge data from various platforms (e.g., enabling users to use different charging stations from different providers without needing to register separately for each service). Additionally, platforms from different domains can be integrated (e.g., using data from smart grid platforms to identify the cheapest times to charge EVs). Applications can be developed to work with different gateways, which would enable the core APIs to be used interchangeably, independently of a platform's scale.

To achieve interoperability in an IoT ecosystem, it is essential to examine how the key components interact within the architecture model (Figure 27). According to the IoT architecture model developed by Broring et al. (2017), interoperability encompasses both the syntax and semantics of interfaces. Syntactic interoperability can be accomplished by establishing clearly defined and mutually agreed-upon data and interface formats. Semantic interoperability can be achieved through mutually agreed-upon information models for the terms used within the interfaces and exchanged data. This open marketplace for IoT platforms and services at the core of the platform architecture can be utilized in the context of EV charging services.

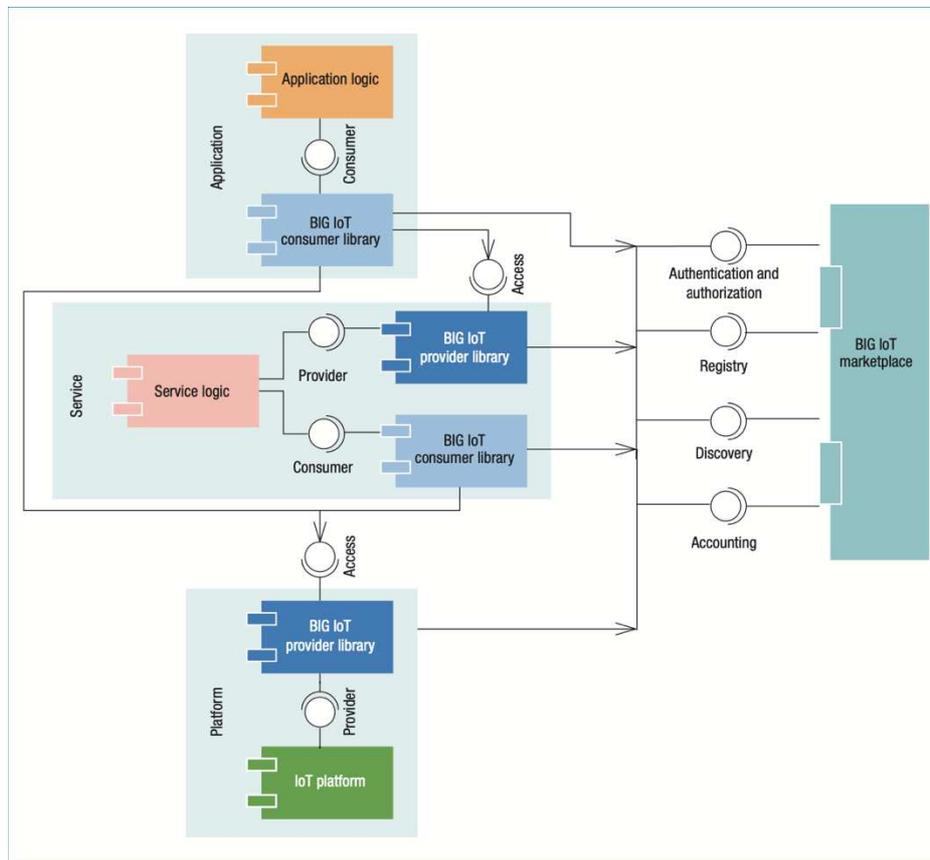


Figure 27 IoT ecosystem architecture. Source: Broring et al. (2017)

In this scenario, providers of charging services and related resources could trade available information and functions via the marketplace. EV charging applications or services could then use the marketplace to access resources in real-time, such as authentication and authorization, resource registration and discovery, access to charging resources, and accounting of the resources provided and consumed. This facilitates interoperability and enhance the overall efficiency and accessibility of EV charging services. The marketplace and the APIs are the basis for enabling interoperability, where providers of charging services and consumers can discover each other, communicate, and exchange resources, and perform charging, billing, and payment.

In order to bridge the gap of interoperability, the architecture imposes a requirement for the implementation of standardized information models. These models enable providers of platforms or services to accurately describe their offered resources in a manner that is easily interpreted by machines. Consequently, this facilitates comprehension and processing of the information by consumers of services or applications, even when situated within different domains, regions, or systems. For example, the Open Charge Point Protocol (OCPP) is an open-source communication standard utilized by both EV charging stations and network software

firms. This standard ensures that any EV charging station that conforms to OCPP can be conveniently configured to operate any other OCPP-compliant software.

Also, the marketplace employs information models to match the supplies and demands of providers and consumers. This is facilitated by utilizing common vocabularies for relevant concepts, which are shared by data providers and consumers. Such is the case of the use of APIs in the field of EV charging; a company that provides EV charging solutions may offer APIs to enable third-party software developers to access their charging station data and integrate it into their own applications. This can include information on the location, status, and availability of charging stations, as well as charging session data such as usage history and fees. By utilizing APIs, developers can build innovative applications and services that leverage the capabilities of the charging infrastructure to enhance the overall user experience.

Finally, in this architecture, ecosystem functionalities are implemented through provider and consumer libraries. For instance, a provider library for an EV charging service may implement a registry interface that allows charging station operators to offer their stations for use through the marketplace. Similarly, an access interface may provide EV drivers with real-time information on the location, status, and availability of charging stations, as well as charging session data such as usage history and fees. These libraries help to streamline the process for developers looking to build applications and services that interact with EV charging infrastructure. By implementing the provider or consumer interface once, developers can easily access and integrate with the marketplace and keep their applications up to date with any changes in the underlying message formats and interactions.

In this perspective, interoperability in the EV ecosystem plays a crucial role in facilitating data network effects for the provision of EV related services. It allows for the seamless exchange and use of data between different systems and platforms, that can create a virtuous cycle where the value of the network increases as more participants join and contribute to the shared ecosystem. Without interoperability, the data generated by charging stations would remain segregated, limiting the value and insights that could be gained from it. By ensuring that charging stations and network software companies use common information models, such as the Open Charge Point Protocol (OCPP), charging stations can be configured to run any similarly OCPP-compliant software, allowing data to be shared and utilized across different platforms. This promotes the development of a more open and connected EV charging ecosystem, enabling

greater collaboration and innovation among industry players, while also creating a better user experience for EV drivers.

5.3.2 Information exchange protocols in the EV ecosystem

As the electrification of the automotive industry advances, the travel patterns of EVs can deviate from those of ICEVs. Information from EV users on their travel routes and charging patterns can help develop holistic insights for companies. Digital technology, such as GPS data, can provide information about specific trips routes and help in the deployment of charging infrastructure. Charging behavior analysis helps improve information about actual connections and charging times, discover flexibility and provide information on charging infrastructure deployment strategy. Open access to collected data, such as type, volume, location, availability, and utilization can help determine whether charging points are convenient and reliable. However, given the potential sensitivity to personal data, its collection efforts require extensive discussions with stakeholders to balancing the value of getting information with the risks of sharing data to apply the appropriate data protection measures.

In this context, standardization and interoperability are key for EV adoption as they allow owners of different car brands to charge in a network of charging stations. This increases consumer choice by controlling charging and billing and could lead to a higher degree of potential grid services provided by the power system. To achieve this interoperability, common communication protocols are needed. Protocols are set of rules and guidelines that demonstrate smooth communication and data exchange between different entities in the electric vehicle (EV) industry. These are effective tools to ensure broad interoperability between systems of industry stakeholders, facilitate electric vehicle adoption, reduce operating costs, develop scalable future-proof infrastructure, and ensure the exchange of information. Figure 28 shows the EV ecosystem communication protocols.

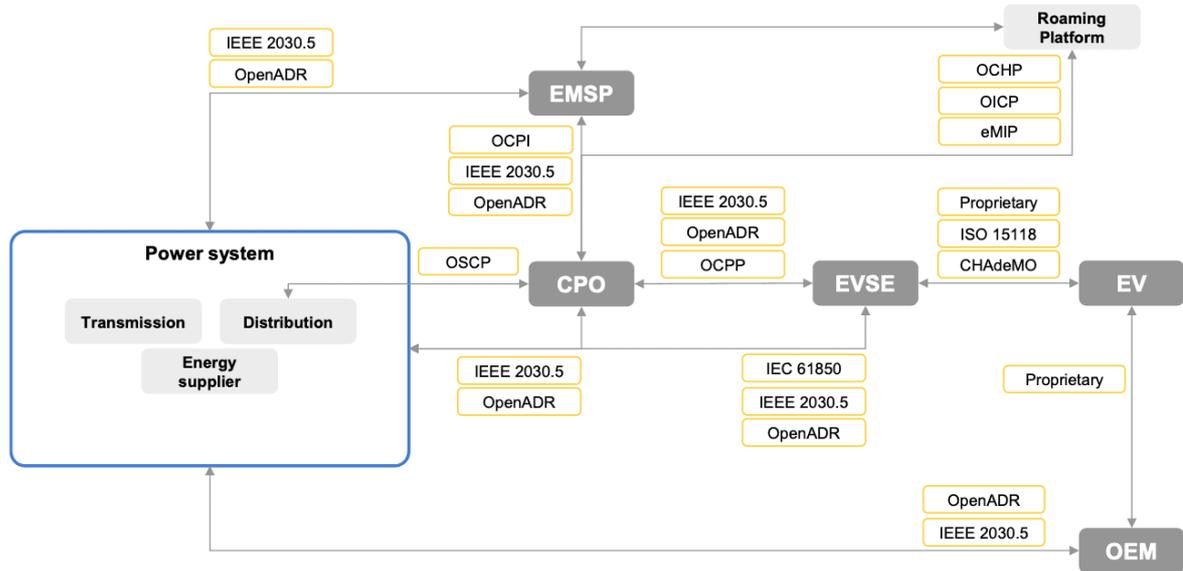


Figure 48 EV ecosystem communication protocols. Source: IEA CC by 4.0 (2022)

- ISO/IEC 15118: facilitates communication between EVs and EVSEs. It sends charging parameters based on user request and charging profile from CPO. The latest update includes a two-way loading protocol.
- CHAdeMO: protocol developed in Japan with a specific CHAdeMO connector that enables physical bi-directional DC charging.
- IEC 61850: set of standards defining communication protocols for intelligent electronic devices in substations. It is the basic standard of smart grid.
- Open Charge Point Protocol (OCPP): communicates smart charging capabilities such as grid capacity, energy prices, local sustainable energy supply and user preferences. It is currently being incorporated into IEC 63110 to establish a general international technical standard.
- Open Charge Point Interface (OCPI): enables connectivity between EV service providers and CPOs, allowing EV users to access different charging points and simplifying payments across jurisdictions. This helps support the use of electric vehicles through roaming. OCPI supports most functions under different roaming protocols, including smart charging. It is commonly used in the European Union.
- Open Automated Demand Response (OpenADR): communicates prices and event notifications between utilities and connected distributed energy resources for demand-side management. It focuses on sharing information, while OCPP focuses more on control. OpenADR is widely recognized worldwide.

- IEEE 2030.5: supports supply management of distributed energy resources, such as EVs, through demand response, load control, and time-dependent pricing. It is commonly used in California.
- Open Smart Charging Protocol (OSCP): communicates forecasts about locally available capacity to charging station operators. The current release includes use cases using more general terms for the integration of solar PV, batteries, and other devices. However, the use of OSCP is still limited.
- eMobility Interoperation Protocol (eMIP): designed and managed by GIREVE. Supports roaming via the GIREVE platform and peer-to-peer connections. Allows CPOs and EMPs to add any sort of data messages or identification methods. This allows new features to be implemented without the need for repeat protocol version updates.
- Open Interchange Protocol (OICP): developed by Hubject in 2012. Together with OCPI, is one of the roaming protocols that facilitates the exchange of meter data. Meter data confirms the amount of electricity provided to an EV during a charging session, helping CPOs conform to calibration law requirements.

Next, we focus on a broader lens of network effects research that encompasses more than just the economic perspective of platforms (as discussed in Gawer, 2014), and considers also technical aspects; specifically, how indirect network effects interact with data network effects in the EV ecosystem. We use the case of Renault to illustrate the *independent* business model, wherein the car manufacturer relies on its partnerships with other players to develop its EV platform architecture. This results in reduced control over the end user experience in the provision of EV mobility services. We think that this case study can serve as a starting point for the introduction of future governance scenarios, where the car manufacturer has more control over the strategic decisions to improve interoperability, and consequently, over the EV driver user experience.

5.4 Study case of Renault Group

5.4.1 Methodology

We use the case of Renault to understand how the platform architecture of an incumbent OEM creates and captures new value from the combination of network effects to establish a competitive advantage. We select the case of Renault for various reasons. First, Renault is a multinational leader automobile manufacturer pioneer in EV technology and a driving

innovation towards electromobility. In January 2021, the Group announced its strategic plan aiming to transform the company into a leader in electric vehicles and sustainable mobility with the target of improving its financial performance. The plan includes the launch of a new line of electric vehicles, the development of new technologies such as autonomous driving, and the implementation of cost-cutting measures. Additionally, they have entered the EV ecosystem as an EMP with the creation of Mobilize, offering customers a range of flexible, connected, and sustainable mobility solutions, both for personal and professional use. Renault also aims to develop new business models and services in the field of sustainable mobility, such as car-sharing and ride-hailing, and to provide customers with a seamless and convenient user experience. In this context, we consider that the company has developed a platform configuration that exhibits indirect and data network effects. We believe that this case provides interesting insights to discuss about possible positive and negative data network effects in the context of the EV ecosystem.

This research adopts a comprehensive case study methodology, focusing on the analysis of Renault's data-platform business model that facilitates the provision of electromobility services, particularly within the Mobilize framework. By delving into this specific case, we analyze the organization of the platform of group Renault, the actors, roles, and data exchange patterns between the different stakeholders and the configuration of its data exchange mechanisms. By explaining the role of data network effects in the context of the indirect network effects present in this ecosystem, we aim to explain how car manufacturers can create and capture new value in the EV ecosystem by leveraging on their user base and data collection capabilities. We delimit our scope of analysis to the product/service EV platform for the provision of electric mobility services. Highlighted by the nature of AI for creating user value in the context of multi-sided platforms (Hagiu & Wright, 2015; Evans, 2003), we distinguish between positive and negative data network effects, like the common distinction between positive and negative direct or indirect network effects (Parker et al., 2016), to consider both the intended and unintended consequences of data network effects in this context. We elaborate on the implications of data network effects in the creation and capture of the different types of value as defined in our previous work on BMI for EVs (Santos & Nicolai, 2021) in Chapter 3.

Our research methodology encompasses a robust data collection process, utilizing diverse sources to construct a holistic perspective:

- Academic Literature: We engage with a wide array of academic literature, including research papers, articles, and publications, to establish a theoretical foundation. This literature review enables us to contextualize our analysis within the broader landscape of business model innovation, digital ecosystems, and the EV industry.
- Corporate Material: In-depth insights are derived from the examination of corporate documents, reports, whitepapers, and publications issued by Renault. These materials provide invaluable insights into Renault's strategic decisions, operational approaches, and the underlying architecture of the Mobilize platform.
- Stakeholder Engagements: Our research benefits from discussions and interactions with key stakeholders, including representatives from Renault and associated entities. These conversations facilitate the validation of findings and provide practical insights into the operational intricacies and strategic considerations related to Renault's Mobilize platform.

Our analysis employs a structured approach combining distinct frameworks:

- The VISOR framework (figure 29) serves as a cornerstone of our analytical process. This comprehensive framework dissects digital business models across multiple dimensions, including value proposition, interface, service platforms, organizing model, and revenue/cost. We conduct a deep dive into each of these dimensions to thoroughly understand the nuances of Renault's business model within the context of the Mobilize platform.

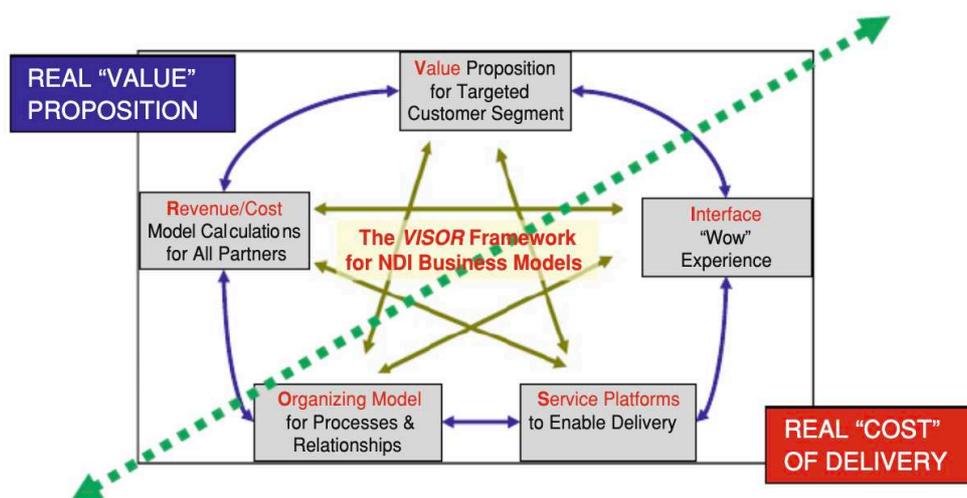


Figure 29 VISOR framework. Source: El Sawy and Pereira (2013)

- Taxonomy of Digital Business Models (Bock and Wiener, 2007): In parallel, we leverage the taxonomy introduced by Bock and Wiener in 2007 to categorize and analyze the digital business model of Mobilize within a broader landscape. This taxonomy provides a structured lens for understanding the intricate facets of digital business models and their implications.

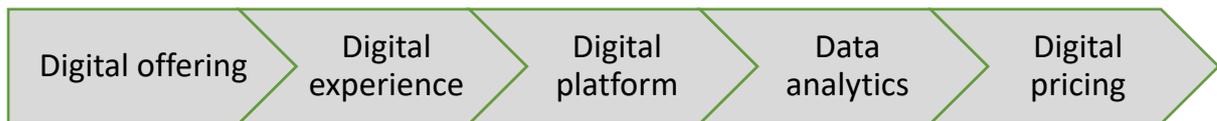


Figure 30 DBM taxonomy. Source: Bock and Wiener (2007)

Our analysis places emphasis on the following key areas:

- Importance of Customer Interface: We closely scrutinize the customer interface to discern how Mobilize strategically engages with its users. This involves an in-depth exploration of user experience, value delivery mechanisms, and strategies to enhance customer satisfaction and engagement.
- Central Role of the Data Platform: Our analysis delves into the pivotal role played by the data platform within Mobilize business model. This entails understanding how data orchestration shapes interactions, drives insights, and catalyzes value creation within the broader EV ecosystem.
- Orchestration of the Digital EV Ecosystem: A core focus is devoted to examining how Mobilize effectively orchestrates relationships and collaborations within the digital EV ecosystem. We investigate how these orchestrated interactions foster innovation, synergy, and sustainable growth.

By meticulously integrating these data collection and analysis methodologies, with a particular emphasis on the in-depth exploration of the VISOR framework, our study aspires to offer a nuanced understanding of Renault's data-platform business model for electromobility services. Through this analysis, we aim to provide insights that extend beyond the specific case, contributing to the broader understanding of business model innovation, digital ecosystems, and the electric vehicle industry.

5.4.2 The Renaulution strategic plan and its horizontal integration strategy

With the goal of becoming a new-generation automotive company, in 2021, Group Renault revealed the *Renaulution* strategic plan. This plan outlines an ambitious transformation roadmap and ushers in a shift from volume to value. It consists of 3 phases: Resurrection, focusing on regaining competitiveness through cost cutting and profitability; Renovation, aiming to ensure brand profitability through product renewal and enrichment; and Revolution, establishing their position as forerunner in the new-mobility ecosystem by reorienting the business model towards technology, energy, and mobility.

The *Renaulution* has achieved tangible results. The Resurrection phase was completed ahead of schedule, and today the group is profitable again; with €2.7 billion in revenue by the end of 2022, the group is on track to reach the €3 billion target by 2023. Consequently, the company is more profitable, more competitive, has a stronger brand, and is heavily investing in R&D. By achieving the 2025 profitability target in 2022, the group launched the Renovation phase, which is undergoing and with solid foundations. The new group's configuration, now organized by brand, is showing results: Renault, Dacia and Alpine are now strong independent business units, and the group has created Mobilize to meet new mobility challenges. At the same time, with 25 launches from 2022 to 2025, the aim is to position the group in the most profitable market segments while striving to achieve the smallest environmental footprint in its industry. This restructuring is the first step in aligning the group with consumer needs and shifting the focus to performance. Now, the group is entering into the Revolution phase, a full transition into a *Next Gen* automotive company designed to tap into the new opportunities deriving from the electromobility paradigm.

The group's structure consists of five companies: two existing and three new ones. The product development and manufacturing companies: Amper for electric and Power for combustion, including hybrids; a company for electromobility services, mobilize; another for the circular economy, The Future is Neutral; and finally Alpine, the Group's premium brand.

The Renault and Dacia brands will continue to operate as commercial brands, Renault will grow while maintaining combustion models worldwide, except in Europe, where it will be 100 percent electric by 2030. Renault expects the brand to grow in volume and increase its sales of hybrid vehicles in Europe and the rest of the world with increased profits. For its part, Dacia will maintain its philosophy of an economic brand but will progress towards the C segment, where

it will launch three new models. Finally, the commercial vehicle business of vans is oriented towards two projects, the first one developing a complete ecosystem of hydrogen vans for fleets, including the production of green hydrogen and its distribution, and the sale or rental of the vans. The other project foresees the development of a new electric van with different body variants, the size of a Kangoo, the load capacity of a Traffic and the city drivability of a Clio. This van should be on the market in 2026 with a cost of use 30% lower than any similar van today.

The electromobility transition will bring about new ways to create and to capture new value needed to build sustainable business models for electric mobility. At least in Europe, this new market for financing, mobility and energy services is expected to double its value in the following 15 years. According to the group, this new strategy is addressed at five new profit pools in 2030, that are two times bigger in terms of revenue (Figure 31).

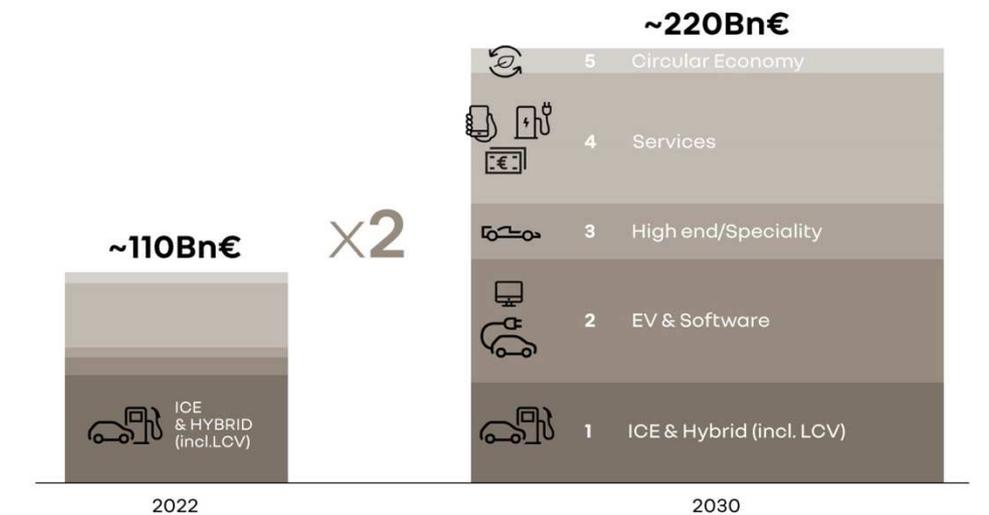


Figure 31 Profit pools - Renault Group (2022-2030). Source: Renault group Strategic Plan (2022).

The vertical organization, by brands, with common services for all is a common strategy for car manufacturers in stable market environments and mature technology, just as it was the case years ago in the competitive, but stable, market of ICEVs. But in an unstable market context, with global challenges such as the pandemic, the shortage of chips, socio-political conflicts, increasing inflation, new mobility trends, and the nascent technology of electrification in all its variants, another type of organization has been imposed among incumbents. To turn these challenges into growth opportunities, OEMs are building open ecosystems to take on a growing portion of new value chains, such as technology, electro mobility, energy services, circular economy, etc.

The complexity of modern vehicles requires a common IT platform and optimized data access. Benefits include the use of artificial intelligence and machine learning to tailor services to users' habits and typical targets. EVs and the digital revolution are allowing car manufacturers to enter new markets, transitioning from selling automobiles to selling mobility services, as well as making the automotive industry more sustainable. To describe the data exchange process of Renault, we consider the VaaS (vehicle as a Service) model, combining financial, mobility and energy services with data-based algorithms.

5.4.3 Renault's Digital Business Model: Mobilize Data-platform

Mobilize is the brand focused on providing sustainable mobility solutions to its customers. Specifically for the provision of electro mobility services, the company developed MyRenault App, a mobile application which allows Renault vehicle owners to easily manage, and access important information related to their EVs and related services. In this app, Renault offers charging services to its electric vehicle owners through its charging network called "Mobilize Charge Pass". The pass provides access to over 500,000 charging points across Europe, including fast chargers, public charging stations, and destination chargers. Renault works with existing infrastructure, third party CPOs, as well as service and data providers, for the management of its back-end infrastructure and the provision of the roaming platform. Mobilize is also in charge of all the financial services and the management of payment transactions, such as automated top-up payments or public charging. Finally, the investment of Renault Group in Gireve and its commercial partnerships with other roaming hubs, like Hsubject, gives EV users access to a vast network of public charging points (EVSE). The developed B2B relationships with trusted partners in the ecosystem, has allowed Renault to focus on its core competencies and differentiators.

In addition, a primary objective of the transition to EVs in the automotive industry has been to leverage the big amounts of data generated by autonomous driving, connectivity, electrification, and shared mobility (ACES). The connected car offers a distinct user experience while also providing cost and financial benefits to mobility providers, including OEMs. By forming partnerships with leading companies, Renault has designed and built a new ecosystem architecture allowing the company to achieve a secure, reliable, and cost-effective data management solution. Renault's data collection platform allows them to develop analytics, AI, and predictive applications to promote data-business decisions and create new opportunities. However, the data capture process is complex and aggregates several components.

At the heart of its value architecture, Mobilize places data as a central and essential element, leveraging digital platforms to capitalize on the power of network effects through a data-platform business model (DBM). This form of DBM emerges when a digital platform seamlessly incorporates data-driven services into its business model, as observed by Guggenberger et al. in 2020. In the case of Mobilize, this integration of data-driven services serves as a catalyst for value creation and enhancement. Mobilize employs a multifaceted approach, offering a trio of services as outlined by Brousseau and Penard in 2007 (figure 32).

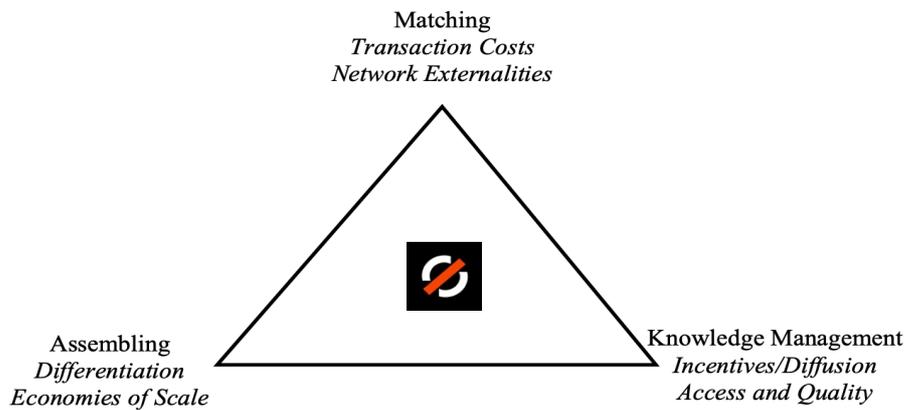


Figure 32 Mix of services by Mobilize. Source: adapted from Brousseau and Penard (2007)

These services encompass the matching of users with providers, the adept management of combined services provisioning, and the efficient handling of knowledge pertinent to electric vehicles (EVs) and associated services. Through this amalgamation of services, Mobilize not only optimizes user experiences but also stands as a prime example of a data-driven business model with network effects at its core.

Based on our proposed framework, table 6 shows the BM of the data-platform of Mobilize:

Table 6 BM components of the data-platform of Mobilize. Source: prepared by the authors.

BM component (VISOR)	Dimensions (Bock & Wiener, 2007)	Characteristics		
Value proposition	Digital offering	Physical products and complementary digital technologies		
Interface	Digital experience	Personalization	Engagement	Community building

<i>Design model</i>	<i>Digital platform</i>	Internal integration	Integration of partners	Inbound/outbound integration of users
<i>Service platform</i>	<i>Data analytics</i>	Process/product data	Customer data	(Free) external data
<i>Revenue/cost</i>	<i>Digital pricing</i>	Demand-based pricing.		

Mobilize, functioning as a data-platform business model, presents a distinctive digital offering that encapsulates both electric vehicle (EV) capabilities and an array of e-mobility services. At the forefront of this offering lies a user-centric interface, exemplified in figure 33, where the Mobilize platform seamlessly integrates with the My Renault app, fostering a cohesive digital experience for users. The app serves as a conduit, facilitating the interaction between users and the spectrum of services available. One such service prominently featured within this ecosystem is EV charging, ensuring that users have access to a convenient and efficient charging infrastructure. This carefully designed digital interface not only streamlines the user experience but also showcases Mobilize commitment to harnessing data-driven insights to enhance convenience and satisfaction.

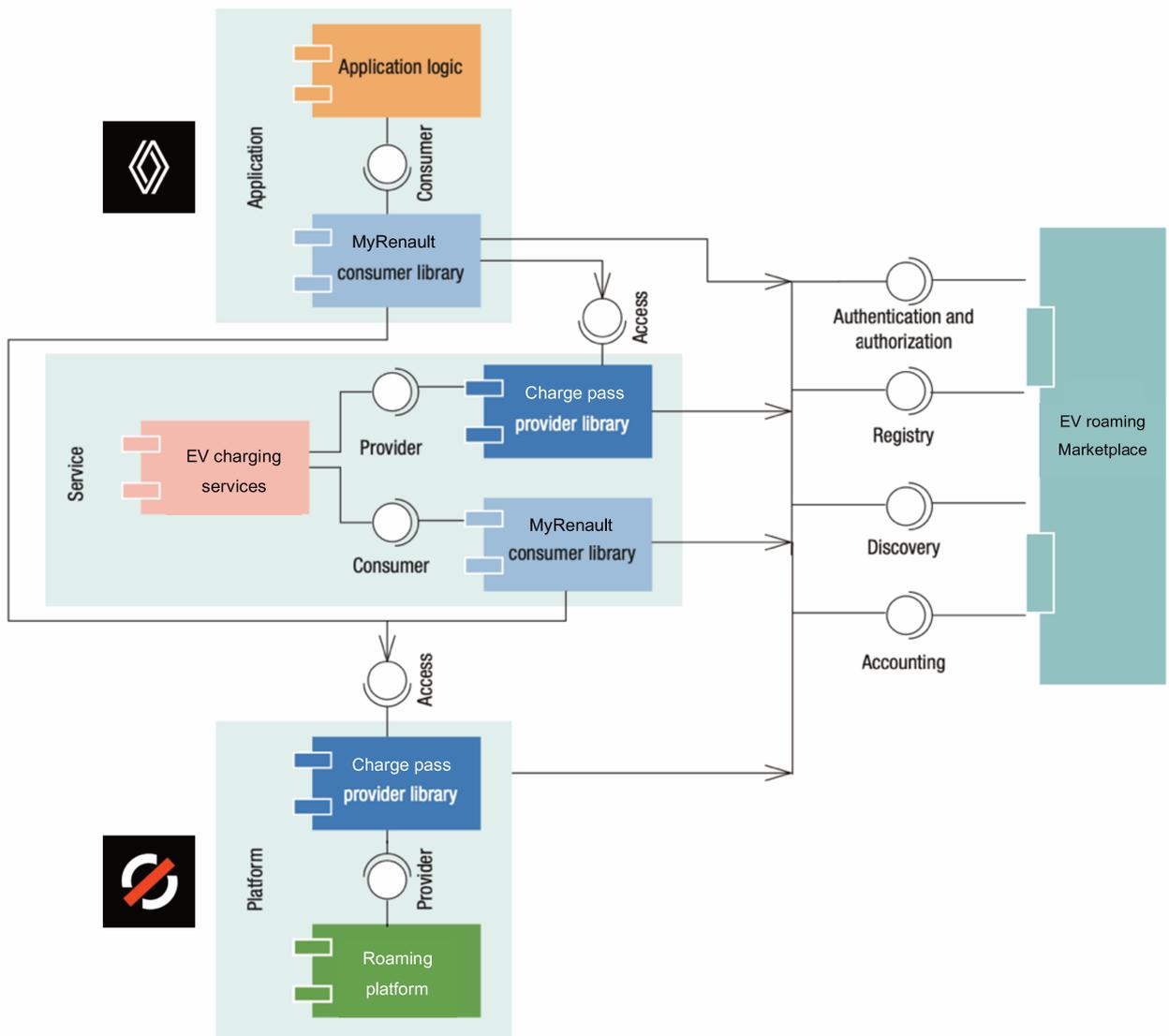


Figure 33 Renault's IoT ecosystem architecture. Source: adapted from Broring et al. (2017)

Then, the design model of the platform includes an internal alignment of new and existing companies within the group (Figure 34). Amper and Power are the brands for the development of automotive hardware and the assembly of cars. Power, the traditional core business of the Renault Group, will be 50% owned by Renault and the Chinese group Geely. It will continue to develop the innovative low emissions ICEVs and hybrid technologies for Renault, Dacia, Nissan, and Mitsubishi models. Power will also work for Renault's commercial vehicle division.

The other company that will be involved in production is Amper, the first EV and software pure player born from an OEM. Amper, will oversee the development, manufacturing and sales of EVs under the Renault brand, developing all the components of electric propulsion systems. This new company plans to produce one million Renault-branded EVs by 2030 and to offer a range

of 6 electric models in the B and C segments. In this regard Renault confirmed the launch for the 2023-2024 period of the Renault 5, Renault 4 and Renault Scenic. The 3 models will complement the current Megane Tech electric offer. Amper will be responsible to produce the electric models in northern France; the former Renault factories in the area will be converted to the manufacturing of components and pure EVs.

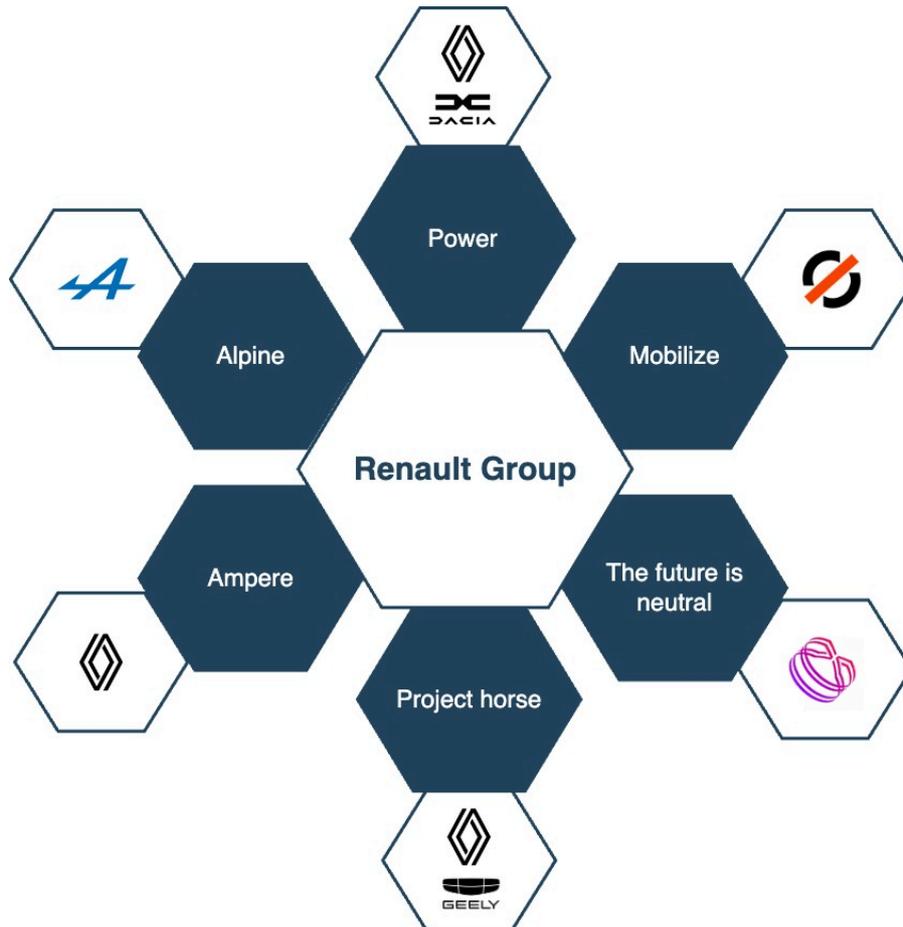


Figure 34 Renault Group's internal structure. Source: prepared by the authors.

Another of the companies into which the group will be divided is Alpine, which goes from being a simple brand to a high-tech company that will develop, produce, and sell premium sports cars and will be responsible for representing the group in segments D and E of the market. Alpine will launch 5 new all-electric models. Alpine will also enter new markets such as the United States and China and will behave almost like a startup to gain speed of implementation and responsiveness in a complex market such as the luxury car market. The other two companies are Mobilize and The Future is Neutral. The first, Mobilize, is built around a financial services company to enter the market of new mobility, energy, and data-based services. This new company focuses on everything related to financing, loans, leasing, and other financial solutions, as well as insurance and warranties. It will also be offering the services to both private and

professional customers; maintenance and repair, fleet management, recharging networks, refurbishment, cab services, and car sharing. Then, The future is Neutral is the company in charge of working on the so-called new circular economy and will serve the group's brands while offering consultancy and training to external companies, working on vehicle recycling, vehicle recovery and upgrading, and on the resources, services and technologies needed for the Renault group to become carbon neutral by 2040 in Europe and 2050 worldwide.

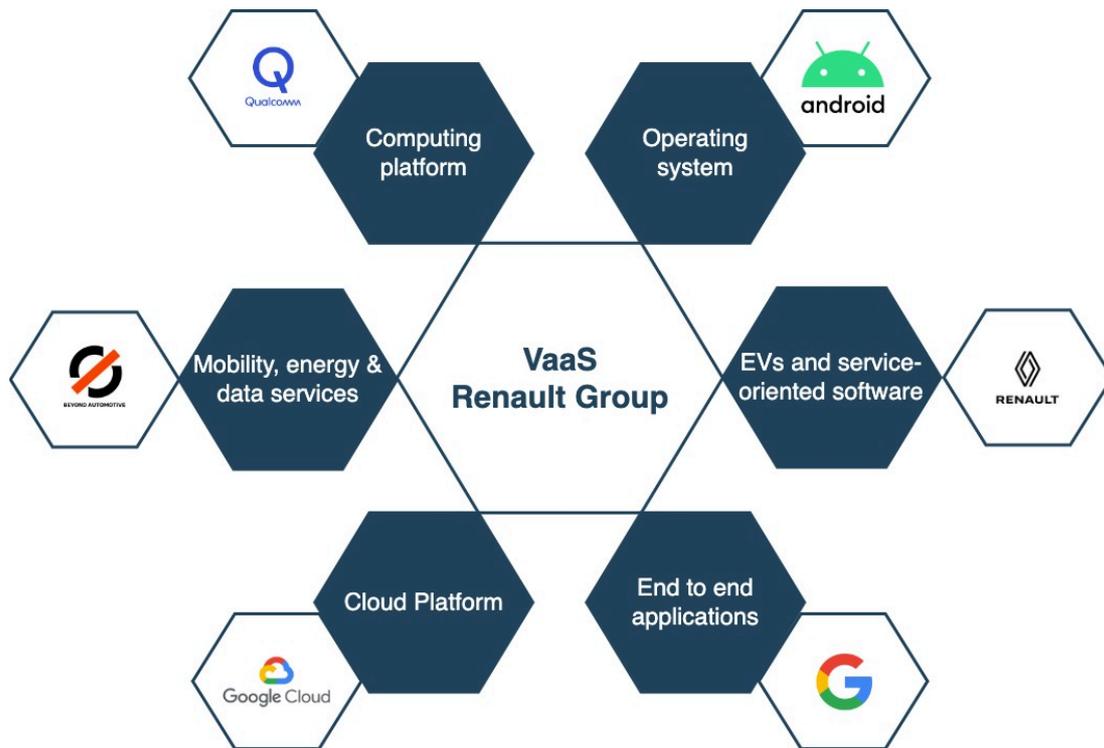


Figure 35 Renault's partnership ecosystem- connected EV. Source: prepared by the authors.

Renault is further expanding its cooperation with external third-party companies as one of the bases of the group's growth (figure 35). This type of agreements with innovative players in their respective fields allows to co-invest, build together, expand innovation opportunities and share risk. Since 2018, Renault established a partnership with Google for the provision of cloud computing services as the company plans to migrate its operations to the cloud for greater flexibility, better performance, and higher profitability. The plan is to develop the digital architecture for the Software Defined Car. Also, Qualcomm serves as a strategic partner for Ampere, with the goal of developing a centralized high-performance computing platform architecture for "Software Defined Vehicle" (SDV). Building on the existing Android Automotive Operating System and Google Cloud technology partnership, the SDV will bring together the best of the automotive and digital worlds to allow new on-demand services and continual

improvements for EVs. Finally, with mobilize, Renault's target is to generate three times more revenue during the life cycle of a vehicle than it would simply by selling cars.

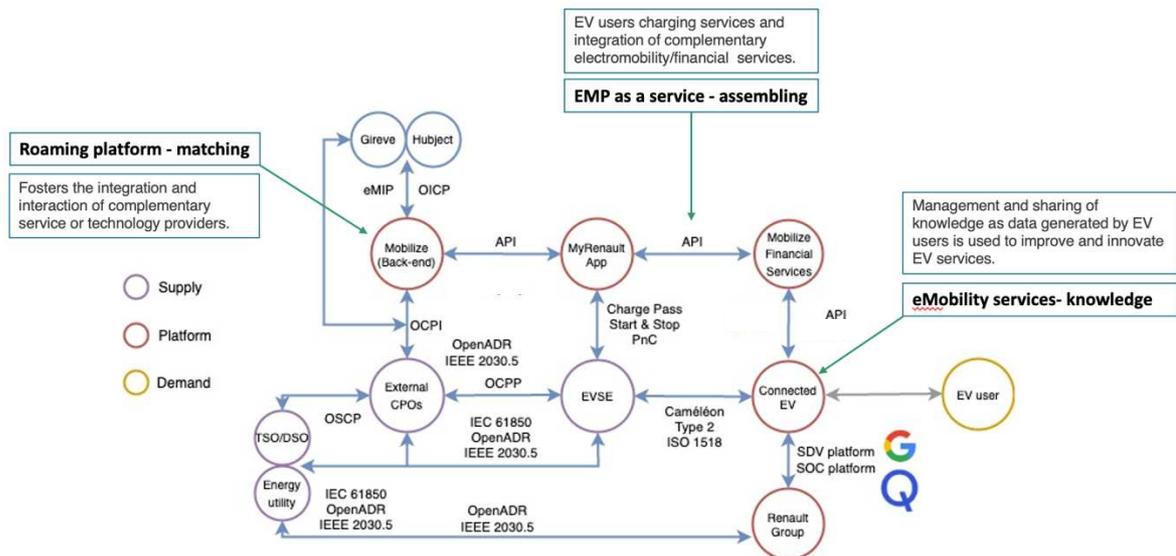


Figure 36 Renault's data exchange ecosystem. Source: prepared by the authors.

Renault participates as an OEM in the manufacturing of electrical drivetrains and the assembly of EVs. Leveraging on the partnerships with Qualcomm and Google, Renault SDV controls the data generated from driver interactions with vehicle systems. This interplay provides end-to-end access to a substantial volume of raw data, enabling continuous improvements in products and services. With the creation of mobilize, Renault enters the EV ecosystem as an EMP, incorporating the capabilities to effectively monetize data throughout the vehicle lifecycle and generate revenue through monthly subscriptions, such as premium connectivity services, paid over-the-air (OTA) upgrades, and eventually those related to full-self-driving capabilities.

Based on our BMI ecosystem map architecture, figure 36 shows the data flow process in Renault's EV ecosystem. The Mobilize data-platform ecosystem is structured to offer a diverse range of services, aligning with the framework proposed by Brousseau and Penard (2007). The ecosystem encompasses three focal services, each contributing to a new type of value. First, a roaming platform with a matching function, facilitates the seamless integration and interaction of complementary service or technology providers. This dynamic approach fosters collaboration and interoperability among different facets of the EV ecosystem, ensuring an integrated and comprehensive offering. Second, EMP as a Service, functioning as an assembly point where EV users gain access to an array of charging services while concurrently integrating complementary electromobility and financial services. This convergence not only optimizes user convenience

but also underlines Mobilize's commitment to facilitating a comprehensive and interconnected EV journey. Third, a service is centered on eMobility services and knowledge management. This facet underscores the strategic utilization of data generated by EV users to enhance and innovate EV services. The data-driven approach not only refines existing offerings but also shapes the trajectory of future EV services, ultimately contributing to a dynamic and evolving ecosystem.

In this context, Renault can leverage the data exchange platform to gain valuable insights into the usage patterns, performance, and efficiency of their electric vehicles, as well as the behavior and preferences of their customers. The raw data collected from their EVs and charging sessions can be analyzed to improve the design and performance of their vehicles and develop new features and services that better meet the needs of their customers. This data is used to improve the design and performance of their vehicles, as well as to develop new features and services that better meet the needs of their customers. By analyzing data on vehicle usage patterns, driving behavior, and battery performance, Renault can identify areas where vehicle performance can be optimized, such as through improvements in battery management or regenerative braking. By analyzing data on charging sessions, Renault can identify areas where charging infrastructure can be optimized, such as through the deployment of new charging stations or the implementation of more efficient charging protocols. Finally, by analyzing data on customer behavior and preferences, Renault can gain insights into the needs and preferences of their customers, which can be used to develop new features and services that better meet their needs. Overall, the data collected in the platform has the potential to provide valuable insights that can be used to improve the performance, efficiency, and customer experience of Renault's EV drivers.

5.5 Data network effects for the creation and capture of new value in the EV ecosystem

5.5.1 Discussion

Dividing the business between combustion and electrification, makes perfect sense to incumbent car companies transitioning to a new electric mobility. Maintaining the ICEVs business is needed for markets that cannot be electrified in the short term, such as Latin America, India, Africa, or Southeast Asia. Nevertheless, it is important to continue investing in technologies that are also increasingly cleaner. On their behalf, hybrid vehicles will be very important in the transition to electric vehicles in such markets, however, investing a lot of money

in them makes little sense, as they will be difficult to amortize when they disappear in Europe. With the EV adoption targets on the horizon, OEMs are very well positioned to monetize new revenues coming from their direct customer access and data, thanks to their regular and extensive interactions with their end customers.

In addition to building and selling electric vehicles (EVs), the new strategy of Renault shows how OEMs are considering the provision of a range of services to support EV owners. With the creation of Mobilize, the group provides a range of charging solutions for EV owners, including home charging stations, public charging stations, and fast-charging stations. Renault developed MyRenault App, a mobile application that allows EV owners to locate and pay for charging services. The group also offers a remote monitoring service that allows EV owners to track the performance and status of their vehicles, including battery level, range, and charging status. This service can also be used to schedule charging sessions and view the vehicle's historical usage data. In addition to this, Renault also provides maintenance and repair services for its EVs, including battery maintenance and replacement, as well as regular services such as oil changes and tire rotations. Finally, the offer is completed with a battery rental service, allowing EV owners to lease the battery separately from the vehicle, thus reducing the purchase price of the vehicle. This also allows Renault to manage the battery maintenance, replacement, and recycling, which can be costly and time-consuming for EV owners.

Based on our activity framework for BMI in the EV ecosystem developed in Chapter 3 (figure 37), value creation can be characterized based on complementary asset and AI capabilities. In the context of network effects, complementary assets define the potential for indirect network effects, and AI capabilities for data network effects. To balance the value creation and capture mechanisms, our framework also considers the positive and negative perspectives of value, defining five dimensions of captured and uncaptured value: value from innovations, value destroyed, value missed, value opportunity, and value communication.

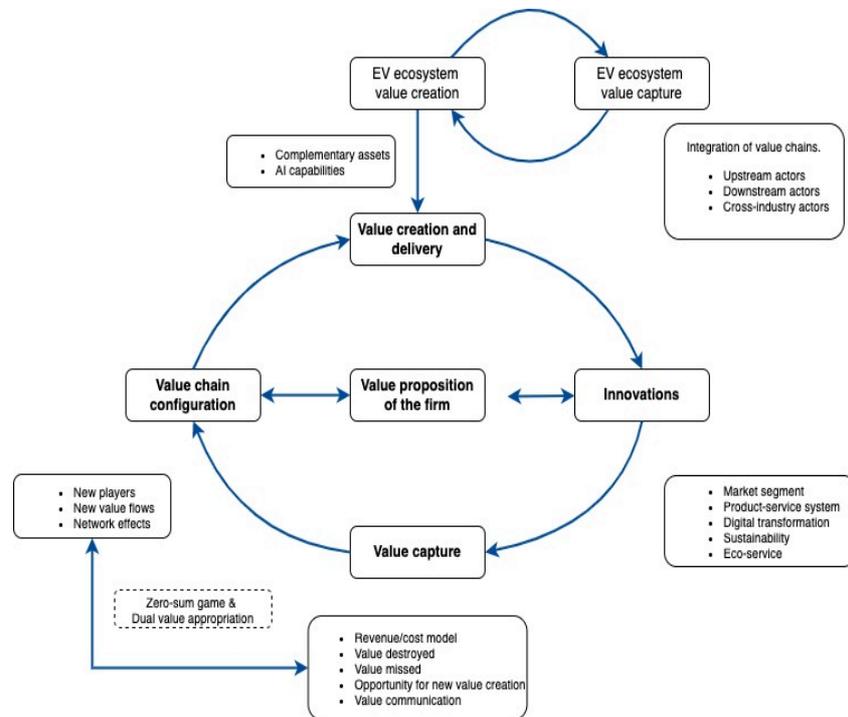


Figure 37 BMI framework for the EV ecosystem. Source: prepared by the authors.

Renault is leveraging indirect network effects in the EV ecosystem is through their management of complementary assets, based on its partnership with other companies and organizations for the deployment of public charging. With the creation of its EMP platform, Renault is making more convenient for EV owners to charge their vehicles on the go, without the group having to invest in the construction of charging infrastructure. The more EVs on their platform, the more interesting it is for third party CPOs to open their charging network and to offer preferential prices to Renault users. This is enhanced by the aggregation of EV users from other competitor OEMs, with the adoption of a third-party roaming platform for a faster market coverage. The more charging transactions from different OEM users occurring in the platform, the better conditions the whole client portfolio gets from third party CPOs.

In addition to indirect network effects, Renault is also creating new value by leveraging its AI capabilities for the stimulation of data network effects in its EV service offer. Renault is using machine learning to improve the customer experience by analyzing data from connected vehicles to better understand and predict customer needs and preferences. This includes using data from sensors and cameras to monitor driver behavior and using machine learning algorithms to develop personalized driving recommendations and services. In addition, the Renault-Nissan-Mitsubishi alliance is using machine learning to improve the safety and reliability of its vehicles, by analyzing sensor data to detect and predict potential maintenance issues

before they occur. With the creation of its EMP, they have also managed to gather dynamic data on all the charging sessions incurred by Renault users.

Renault's interoperability on data exchange enables communication benefits of seamless connectivity between Renault's electric vehicles and other systems and services in the EV ecosystem. Renault can communicate to its customers that their electric vehicles are designed to seamlessly integrate with charging infrastructure providers, energy companies, and other stakeholders in the EV ecosystem. By communicating the value proposition of interoperability, Renault can emphasize the benefits of a smooth and effortless charging experience, such as easy access to charging stations, real-time information on charging status, and flexible payment options. Renault can also work with charging infrastructure providers and other stakeholders to establish interactions that ensure the delivery of the value proposition, such as developing open data exchange protocols and collaborating on interoperability standards. In addition, Renault can communicate the benefits of data exchange for improving vehicle performance, such as the ability to analyze data on vehicle usage, performance, and charging behavior to optimize vehicle design and improve the customer experience. This can help customers feel confident that their electric vehicles are designed to provide the best possible experience and can help build trust and loyalty.

The development of Renault's AI capabilities has made it possible to identify value missed, for example, by adding subscription models for public charging services, prioritizing their strategic partners, or directing their investment efforts. With the help of AI algorithms, Renault can analyze large volumes of data generated by its electric vehicles and charging infrastructure to identify patterns and trends that were previously difficult to detect. This can help Renault identify areas where value is being missed, such as inefficiencies in the charging process, underutilization of certain vehicle features, or the development of subscription models. The analysis of data on customer usage patterns, feedback, and complaints, allows the identification of areas where customers are not getting the value they expect, such as issues with vehicle performance or charging infrastructure availability. Data on vehicle performance and usage, allows to identify areas where maintenance or repair work is needed, reducing downtime and improving vehicle reliability. Renault can also use AI to optimize its charging infrastructure, ensuring that charging stations are located where they are most needed, and that energy usage is optimized. Finally, Renault's AI capabilities can help the company develop predictive models that can anticipate future trends and customer behavior. By using data to identify patterns and

trends, Renault can anticipate changes in the market and identify opportunities to deliver value to customers.

In terms value from innovations, Renault can capture new value by leveraging new technologies such as the use blockchain technology to improve data security and transparency in its ecosystem. For example, by providing secure data storage, traceability of transactions, the creation of smart contracts, and a shared database to improve collaboration among stakeholders. Also, the alliance has been working on the development of advanced driver assistance systems (ADAS) and autonomous driving technologies. The more data that Renault collects from its EVs on the road and in connection with other data gathered from its EMP, the more they can improve the performance and safety of these technologies, making the platform more valuable for Renault itself.

Renault can capture additional income by offering new business models that are tailored to emerging customer needs; this can include customized vehicle features, insurance, predictive maintenance, personalized marketing campaigns, and subscription-based models that provide customers with access to a range of EVs and charging, fleet management, or vehicle usage services (i.e. energy packages or distance covered). Another topic for future consideration is the opportunity related to car data monetization. New guidelines for data protection in Europe (Europe's General Data Protection) have establish a clear framework for OEMs and data customers. Therefore, European companies are likely to sell personalized data to third companies in the future. These figures include additional revenue from service and data sales, as well as cost savings from vehicle data. In addition to new technology companies directly involved in the automotive technology ecosystem, other players such as telecommunications, retail stores and media outlets are also entering the expanded EV ecosystem as data users and suppliers. While they don't currently use car data, many would benefit from it. Collaboration among multiple players in an ecosystem is necessary to fully realize its value. OEMs, suppliers, and others can monetize mobile data in various ways, such as through data marketplaces or partnering with companies in industries such as insurance or mobility.

However, in a developing ecosystem, there are several negative network effects that must be considered. These negative externalities can destroy the perceived value of a platform for users, for example, when data quality and quantity is low. Connected services for OEMs could decrease its value caused by poor customer experience and execution issues, leading to low retention. Complex sign-up and log-in processes across different devices and challenging interfaces put

OEMs at a disadvantage compared to companies with easy one-click smartphone solutions. It becomes difficult to lock-in customers and extend their connected-service packages beyond the initial trial period. Another factor for negative externalities occurs when data privacy and security are compromised. However, with data regulation becoming increasingly strict, the European Union has established more comprehensive guidance on the use of private data, including who may handle it, which gives users more legal security when sharing its personal information.

5.5.2. Conclusions

The classification of the platform chosen by OEMs stands as a key determinant in shaping the trajectory of new value creation and capture within the Electric Vehicle (EV) ecosystem. This determination is particularly highlighted by the data network effects; inherent in the platform's data exchange configuration and driving the generation of novel and diverse forms of value. Our study extends the conventional focus on data network effects, transitioning from their conventional role in influencing user-perceived value to exploring their broader implications for competitive advantage through value creation and capture.

In this context, the process of value creation is propelled by the convergence of complementary assets, which foster network effects, and the augmentation provided by Artificial Intelligence (AI) capabilities, fueling data network effects. Concurrently, the facet of value capture assumes significance, encompassing both the value that is harnessed and the untapped potential that remains. Emerging revenue streams, such as vouchers, charging sessions, or predictive maintenance, contribute to new value accrual. Furthermore, value is derived from innovations that leverage emergent technologies like autonomous driving and blockchain. As value opportunities arise, avenues such as subscription models, strategic partnerships, and directed investment efforts remain to be harnessed. Finally, the opportunity to seize value through B2B services, fleet management, and the monetization of car data underlines the potential of value within the EV ecosystem, while concurrently, suboptimal data quality and poor customer experiences can erode the real value of a platform.

In sum, the determination of the data architecture within the EV ecosystem serves as a guide for navigating the complex process of BMI. Our study case helps to understand how Renault's strategic choice of platform and its approach to its relationships within actors in the EV ecosystem are crucial to shape its future BM. The distinct way they have conceptualized the

platform within the EV ecosystem underscores the main role it plays in generating value. This platform's interconnectedness within the EV landscape aligns with the key components of the EV BMI framework, enabling innovative BM configurations. Notably, the integration of Data Network Effects emerges as a compelling driver of innovation, signifying an innovative framework overtaking traditional concepts of value generation. Through these effects, car manufacturers not only bring about novel efficiencies and heightened productivity but also opens the way for unprecedented value generation. As data network effects continue to expand and evolve, they serve as a catalyst for groundbreaking value propositions, unveiling an exciting frontier in the ongoing EV revolution.

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Chapter 6: Conclusion

6.1 Answering the research question

This thesis explores the field of BMI for EVs, a critical aspect in the continuously evolving automotive sector. Our primary objective is to address the extent to which the design of an EV product service platform can stimulate BMI. This overarching query acts as the guide of our exploration, leading us to investigate three subsequent questions in pursuit of a comprehensive answer to our main research question.

The transformation of the value chain analysis into a BMI analysis, as investigated in Chapter 3, sets the stage for understanding the complexities of value creation within the EV ecosystem. We introduce a concept of the EV ecosystem, characterized by various actors essential to EV production and the provision of electro-mobility services. In this context, Chapter 3 clarifies the design of BMs configured to the unique requirements of a product-service platform within a business ecosystem, highlighting the importance of BMI architecture.

The transition from Chapter 3 to Chapter 4 leads us into the domain of complex transitions within the EV ecosystem. Chapter 4 employs an evolutionism model, grounded in socio-technical change, to feed the RCOV analysis. We engage in a multi-level process and socio-technical analysis, identifying the niches that structure BMs and proposing strategic models to simplify the process. An essential aspect of this chapter is the comparative study of ecosystem strategies and their exchanges, basing the analysis in the value framework established in Chapter 3. Furthermore, Chapter 4 highlights the critical role of data exchange in shaping the trajectory of BMI within the EV ecosystem, demonstrated through a comparative case study of three distinct OEMs.

Chapter 5 turns towards exploring the digital dimension of the EV ecosystem. It outlines EVs as digital ecosystems, highlighting their defining characteristics and the impacts of digitalization on the automotive sector. This chapter delves into the concepts of digital business ecosystems and data network effects, exploring the digital dimension of the BM. It also adds to the significance of platform economies and coopetition within the EV ecosystem, shedding light on the control of data in various digital platform types. The case study on Renault illustrates the architecture

of data exchange, employing the VISOR model, which encompasses the five key dimensions of a digital BM, and a taxonomy of platform business models (Hodappetal, 2019).

In conclusion, this work offers a holistic exploration through the domain of BMI within the EV ecosystem. We examine the evolving automotive sector, where new products, services, players, and digitalization are reshaping the traditional value chain. By investigating the intricate processes, strategies, and data dynamics, this work contributes valuable insights into the creation and capture of value within product-service platforms in the thriving EV ecosystem. We highlight the significant role of BMI architecture, socio-technical change, data exchange, and digital transformation in shaping the future of the automotive industry. As the industry continues to undergo transformation, this research serves as a foundation for understanding and navigating through the complex and continually evolving paradigm of the EV ecosystem and the process of business model innovation.

6.2 Scientific contribution and adaptation to other contexts

From this research, the main contributions of this thesis are:

- The development of a business ecosystem methodology for BMI based on a role-based framework defined by Spieth et al. (2014). Our methodology considers a dual perspective of actors with different objectives: a) the development innovative BMs within established enterprises (Markides, 2006); and b) the exploration of novel business logics that facilitate the creation and capture of value (Casadesus-Masanell and Zhu, 2013). We advance knowledge by exploring the dimension that exists between the design and the re-design of a BM to explain how a product-service platform can promote BMI.
- Our framework presents a novel approach to BMI within interconnected value chains in established industries. It explores the understanding of profitability dynamics in business ecosystems, particularly in the face of potential disruption by new entrants. It offers strategic insights for incumbent players seeking to maintain their leadership positions.
- We propose a Multi-Level Perspective (MLP) transformational approach to balance BM performance with real-world development. This approach provides insights into how BMI addresses operational aspects of running a business and how dynamic organizational strategies lead to the promotion of innovative value propositions.

- Our research introduces and applies a BMI framework that serves as a way for supporting the strategic growth of firms within the ecosystem. We emphasize the organization's role in strategy development and highlight the increasing importance of data. The interplay of traditional network effects and data network effects are key for firm growth within the ecosystem.

6.3 Industrial contribution and perspectives

The transformation of the automotive industry, driven by the emergence of EVs as product-service platforms and the growing influence of digitalization, is having a disruptive effect on traditional BMs as noted by Hanelt et al. (2015). Conventional BMs in this industry historically relied on a linear value chain, primarily centered around the production and sale of ICEVs, often accompanied by after-sales maintenance services provided through established dealerships. Car manufacturers primarily focused on their core competencies in engineering, design, and electronics, while software components were typically sourced from external suppliers. This changing landscape in the automotive sector has given rise to ecosystems, where various stakeholders are seeking to redefine their roles, not merely as service providers but also as technology and transaction facilitators. Despite these profound shifts, limited prior research has explored the dynamics of BMs in the context of a digitalized automotive industry and how key industry players are adapting their BMs to navigate this transition effectively.

In light of this study, several key contributions related to the automotive industry come to the forefront:

- The research addresses key challenges in the digitalized EV industry, offering insights into how existing players can both acquire the necessary resources and capabilities for BMI, to successfully transition from traditional BMs to new service-oriented models.
- This research thesis contributes by addressing the pressing need for the design and redesign of innovative business models within the digitalized automotive industry. It offers insights and strategies for companies to navigate the digital transformation effectively, enabling them to craft adaptable BMs that align with the evolving EV ecosystem.
- Other key contribution of this research is its exploration of strategies to enhance the competitive resilience of established automotive players. In the face of mounting

competition from new entrants in the electromobility and digitalization landscape, we provide valuable insights to help industry incumbents maintain and fortify their market relevance.

- Finally, this thesis investigates the emergence of new BMs and ecosystem innovation in the digitalized automotive industry, along with strategies for collaborative BM development as the industry shifts towards mobility services. We contribute to the creation of value through digital co-creation emphasizing the departure from traditional practices and the adoption of collaborative digital platforms to unlock the potential of data network effects. The research thesis delves into the intricacies of this value creation process, providing practical and strategical guidance for businesses operating within this evolving digital ecosystem.
- This thesis investigates the emergence of new BMs and ecosystem innovation within the digitalized automotive industry. It also explores strategies for collaborative BM development as the industry transitions towards mobility services. A key contribution lies in highlighting the creation of value through digital co-creation, underlining the shift away from traditional practices to embrace collaborative digital platforms. These platforms are essential to unlock the potential of data network effects. This research thesis offers practical and strategic guidance for businesses navigating this transformative digital ecosystem.

6.4 Limitations

Given the focus of our thesis on the dynamics of BMI within the EV ecosystem, it is important to recognize that our research primarily emphasizes the interplay between BMI and EVs. However, there are certain limitations that need consideration.

- While the study thoroughly examines BMI in the EV ecosystem, it is important to acknowledge that this research primarily concentrates on the automotive sector. Consequently, the findings may not be directly transferrable to other industries, which may have different characteristics and dynamics, limiting the generalizability of the results.
- The study assumes a relatively homogenous view of the EV ecosystem. However, the EV market can vary significantly between regions, regulatory environments, and technological advancements. The thesis may not fully capture regional or market-specific differences within the broader EV ecosystem.

- Although data is a key element in the study, the availability and quality of data can be a limiting factor. Depending on the sources and data used, there may be biases or limitations in the analysis.
- While the thesis deep dives into case studies of specific companies, it falls short of capturing the full array and diversity of approaches and strategies within the OEMs in the EV ecosystem.
- An important limitation of this study, specifically in Chapter 4, is the omission of a comprehensive examination of the managerial practices in the context of Business Model Innovation. While this thesis uses the Multi-Level Perspective framework to explore various aspects of the EV ecosystem and the influence of BMI on operational dimensions, it does not delve into the specific micro-level practices and behaviors of middle and lower-level managers within organizations involved in BMI. In this context, the work of Do Vale et al. (2021) highlights the significance of micro-level practices by lower-level managers in the BMI process, emphasizing the intertwining of both top-down and bottom-up approaches. The capacity of middle and lower-level managers to develop their practices in BMI is a noteworthy insight, as it suggests that BMI is not only orchestrated by top management but involves contributions from various organizational levels. This study might benefit from integrating the contributions of managers at various levels within the organization.

6.5 Future research

Our research has shed light on the significant challenges posed by the amount of data generated by connected EVs and the necessity of efficiently collecting, orchestrating, and distributing this data to service providers to harness the potential of data network effects. As we conclude this study, we identify several promising avenues for future research in the field of EVs and data-driven service ecosystems.

Future research can delve deeper into the dynamics of platform competition within the automotive industry. With car manufacturers and operating system vendors like Apple and Google offering competing platforms, it is essential to investigate how these dynamics influence market dynamics, consumer choices, and the evolution of connected EV ecosystems. Research can explore strategies for car manufacturers to navigate this competitive landscape effectively. A core concern is the potential of car manufacturers being "enveloped" into the platforms of operating system vendors, as highlighted by Mohaghegzadeh and Svahn (2015). Research can

explore strategies for car manufacturers to maintain their independence and unique value propositions while collaborating with operating system vendors to enhance the connected EV experience. This may involve examining partnership models, contractual agreements, and governance mechanisms to safeguard the interests of all stakeholders.

Additionally, as EVs continue to amass vast amounts of sensitive data, future research should place an increased focus on privacy and data security. Investigating methods for ensuring data privacy, securing data transmission, and preventing unauthorized access will be essential to build trust among consumers and stakeholders. The regulatory landscape for connected EVs is evolving rapidly. Research can contribute by examining the development and impact of regulatory frameworks and standards related to data collection, sharing, and usage in the automotive sector.

Given the potential economic value of the data generated by EVs; research can explore innovative data monetization strategies. This may involve analyzing successful business models and value propositions that leverage car-generated data and examining the ethical and regulatory considerations associated with data monetization. Understanding consumer behavior and acceptance of connected EV technologies remains a critical area for future research. Investigating factors influencing consumers' decisions to adopt and engage with connected car services can provide valuable insights for both car manufacturers and service providers.

Finally, a potential avenue for future research could involve a more detailed exploration of how micro-level practices impact and shape the BMI process, including how top management utilizes them in the design and implementation of new business models. Integrating this micro-level perspective could provide a more holistic understanding of BMI and its operational implications.

6.6 References

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