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# Exploring the Role of Business Models in Innovation-Centered Ecosystems

## A Multiple Case Study of Actors in the Ecosystem for Electrified Vehicles

**DOCTORAL THESIS**

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Graz, May 2021

# AFFIDAVIT

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*”Je n’ai fait celle-ci plus longue que parce que je n’ai pas eu le loisir de la faire plus courte.”*

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*”I only made that one longer because I didn’t have the time to make it shorter.”*

Quote
attributed to
Blaise Pascal
anno 1657

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# Abstract

## Purpose

Since its rise in popularity more than two decades ago, research on business models has extensively explored how companies can create and deliver value for their customers as well as how value can be captured from these undertakings. Thereby, two dominant themes in the literature are the realization of value based on technological innovations and the relations between business models and their environment. These themes are becoming increasingly important in the complex and interconnected business world today, as single companies are often unable to create technological innovations and provide value to customers on their own. Instead, innovations are increasingly being created by an ecosystem of related companies, which requires the alignment of individual business models of the companies in an ecosystem to establish a joint ecosystem value proposition. Despite the crucial importance of the described topic, research on business models that considers relations among multiple companies is still in its infancy. Similarly, research investigating ecosystems holistically is scarce. To address the described gap in research, this thesis work was carried out to investigate how individual actors might align their business models to contribute to a innovation-centered ecosystem value proposition.

## Design/Methodology/Approach

A comprehensive qualitative investigation was conducted to examine the alignment of business models in the case of a newly formed ecosystem centered around a technological innovation. For this investigation, the ecosystem of electric and electrified vehicles was chosen as an example. Factors supporting the choice of the empirical setting included (1), the early stage of the ecosystem, (2) the high expected degree of changes in ecosystem companies' business models, (3) the existence of regulatory discontinuities, and (4) the overall technological uncertainty in the ecosystem. The empirical investigation comprised 27 cases and relied on a total of 46 semi-structured interviews with high-level informants in the chosen ecosystem. Based on these, results were validated by performing a focus group with experts from the automotive industry.

## Findings

First, a conceptual construct is proposed to describe the relations of business model change and ecosystems. Second, factors are laid out that influence companies, encouraging them to participate in an ecosystem centered around a technological innovation. Data indicated that the central ecosystem actors' participation in the investigated ecosystem was largely driven by regulatory discontinuities while they were also held back by initiatives in their current ecosystem. One crucial oberservation was that central ecosystem actors might take on the role of ecosystem leaders and use their substantial influence to pull upstream actors into the ecosystem. In the downstream ecosystem, leaders needed to take a different approach and ensure the ecosystem's overall health to make it more attractive for additional companies that provided complementary offerings. Third, collected data allowed to broaden the understanding of how actors interact to create value within a newly

emerged ecosystem. Novel requirements with regard to components and complementing offers necessitated the entry of actors from other industries as well as the formation of new actors. Established actors from other ecosystems in part facilitated these undertakings. While the newly emerged ecosystem had its roots in an established ecosystem, it relied on a substantially different *"value blueprint."* Actors needed to adopt multiple, simultaneous ecosystem strategies to address specific areas of the ecosystem and balance the competition and collaboration within and between different ecosystems. Fourth, factors influencing the changes in ecosystem business models were identified, and their impacts on individual actors' business models were described. The governance of an ecosystem directly impacted the involved business models through the pace of industry processes and by facilitating flexibility within the ecosystem by increasing the modularity of offered values. Misaligned business models thereby may represent bottlenecks in the ecosystem, preventing the realization of ecosystem value. The necessary degree of change in the actors' business models depended on actors' roles and positions in the ecosystem. Therefore, upstream suppliers of components needed to adapt their business models, while downstream providers of complements needed to perform complex types of business model innovation. Another critical finding was that changes in the ecosystem companies' business models needed to be coordinated in order to realize an attractive ecosystem value proposition.

## Kurzfassung


**Forschungshintergrund**
Die Forschung zu Geschäftsmodellen beschäftigt sich mit der Frage, wie Unternehmen Werte für ihre Kunden schaffen und bereitstellen sowie aus besagten Werten Einnahmen generieren können. Kernthemen in der Literatur sind dabei die Schaffung von Wert basierend auf technologischen Innovationen und die Beziehungen von Geschäftsmodellen zu ihrer Unternehmensumwelt. Diese beiden Themen gewinnen in der heutigen komplexen und vernetzten Geschäftsrealität immer mehr an Bedeutung, da einzelne Unternehmen oft nicht mehr in der Lage sind, technologische Innovationen alleine zu realisieren und mit diesen für ihre Kunden Mehrwert zu generieren. Vielmehr werden Innovationen zunehmend von einem Ökosystem verbundener Unternehmen geschaffen, was die Ausrichtung der einzelnen Geschäftsmodelle der Unternehmen in einem Ökosystem auf ein gemeinsames Ökosystem-Wertversprechen erfordert. Trotz der hohen Bedeutung des beschriebenen Themas steckt die diesbezügliche Forschung noch in den Kinderschuhen. Um die beschriebene Forschungslücke zu schließen, wird in dieser Arbeit untersucht, wie einzelne Akteure ihre Geschäftsmodelle hinsichtlich eines gemeinsamen innovationsbasierten Ökosystem-Wertversprechens ausrichten können.

**Design/Methodik/Vorgehensweise**
Zunächst wurde eine umfassende qualitative Untersuchung zur Ausrichtung von Geschäftsmodellen anhand eines rund um eine technologische Innovation neu gebildeten Ökosystems durchgeführt. Für diese Untersuchung wurde das Ökosystem elektrischer und elektrifizierter Fahrzeuge als Beispiel gewählt. Faktoren für die Wahl des empirischen Settings waren (1) das frühe Stadium des Ökosystems, (2) der hohe erwartete Grad an Veränderungen von Geschäftsmodellen im Ökosystem aktiver Unternehmen, (3) das Vorhandensein von regulatorischen Diskontinuitäten und (4) die im Ökosystem vorherrschende allgemeine technologische Unsicherheit. Die empirische Untersuchung umfasste insgesamt 27 Fallstudien einzelner Akteure im Ökosystem, welche sich wiederum auf 46 halbstrukturierte Interviews mit hochrangigen Informanten im ausgewählten Ökosystem stützten. Darauf aufbauend wurden die Ergebnisse mittels Durchführung einer Fokusgruppe mit Experten aus der Automobilindustrie validiert.

**Resultate**
Erstens wurde literaturgestützt ein konzeptionelles Konstrukt zur Betrachtung von Geschäftsmodelländerungen im Kontext von Geschäfts-Ökosystemen eingeführt. Zweitens wurden Einflussfaktoren hinsichtlich der Partizipation von Unternehmen an einem technologiezentrierten Ökosystem dargelegt. Die Ergebnisse zeigen den maßgeblichen Einfluss von regulatorischen Diskontinuitäten auf zentrale Ökosystemakteure. Diese Akteure wurden jedoch durch Initiativen in ihrem bestehenden Ökosystem zurückgehalten. Zentrale Ökosystemakteure, welche die Rolle von Ökosystem-Leadern übernehmen, können ihren erheblichen Einfluss nutzen, um vorgelagerte (upstream) Akteure zum Eintritt in das Ökosystem zu bewegen. Im nachgelagerten (downstream) Ökosystem waren Ökosystem-Leader darauf angewiesen, die allgemeine Gesundheit des Ökosystems zu

forcieren, um dieses für zusätzliche Akteure - spezielle Akteure, die komplementäre Werte offerieren - attraktiver zu machen. Drittens erlaubten es die Ergebnisse, die Interaktionen im Ökosystem zur Schaffung von Werten besser zu verstehen. Geänderte Anforderungen in Bezug auf Komponenten und komplementäre Wertangebote erforderten den Eintritt von Akteuren aus anderen Branchen sowie die Schaffung neuer Akteure. Trotz der Wurzeln in einem etablierten Ökosystem beruhte das neue technologiezentrierte Ökosystem auf einer substanziell anderen Wertschöpfungsarchitektur. Unternehmen in neu geschaffenen Ökosystemen verfolgten oft mehrere Ökosystemstrategien gleichzeitig. Diese Strategien adressierten in der Regel ausgewählte Bereiche des Ökosystems. Zudem galt es für die besagten Akteure ein Gleichgewicht zwischen Wettbewerb und Zusammenarbeit - sowohl innerhalb als auch zwischen verschiedenen Ökosystemen - herzustellen. Viertens wurden Einflussfaktoren auf Geschäftsmodelländerungen im Ökosystem dargelegt. Kernaspekte diesbezüglich waren das Management und die Steuerung des Ökosystems, die Geschwindigkeit von Prozessen im Ökosystem, die Flexibilität im Ökosystem sowie die Modularität der angebotenen Werte. Unzureichend auf eine gemeinsame Wertversprechung ausgerichtete Geschäftsmodelle können hierbei Engpässe in der Werterstellung im Ökosystem darstellen. Der notwendige Grad der Geschäftsmodelländerung einzelner Akteure hing von deren Rolle und deren Position im Ökosystem ab. Vorgelagerte Anbieter von Komponenten führten geringfügige Anpassungen ihrer Geschäftsmodelle durch, während nachgelagerte Anbieter von komplementären Wertangeboten tendenziell hochgradige und komplexe Typen von Geschäftsmodelländerungen durchführten. Ein kritischer Faktor für die Erstellung eines attraktiven Ökosystem-Wertangebots war die Koordination der Geschäftsmodelländerungen.

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# Abbreviations

| | |
|---|---|
| **B2B** | Business-to-Business |
| **B2C** | Business-to-Customer |
| **BEV** | Battery Electric Vehicle |
| **CAGR** | Compound Annual Growth Rate |
| **CPO** | Charge Point Operator |
| **EC** | Energy Company |
| **ETP** | Engineering and Technology Provider |
| **FCEV** | Fuel Cell Electric Vehicle |
| **FO** | (Corporate) Vehicle Fleet Operator |
| **HEV** | Hybrid Electric Vehicle |
| **ICE** | Internal Combustion Engine |
| **INF** | Infrastructure Company |
| **ISO** | International Organization for Standardization |
| **M&A** | Mergers and Acquisitions |
| **OEM** | Original Equipment Manufacturer |
| **PHEV** | Plugin Hybrid Electric Vehicle |
| **REX** | Range Extender |
| **R&D** | Research and Development |

| | |
|---|---|
| **RI** | Research institution |
| **RET** | Retailer |
| **SC** | Supply Chain |
| **SOP** | Start of Production |
| **SUP** | Supplier |
| **TCO** | Total Cost of Ownership |
| **WoS** | Web of Science |
| **xEV** | Electric and Electrified Vehicles |

# Part I

# Introduction and Research Approach

# 1 Introduction

In this chapter, first, the basic problem addressed in this thesis work is outlined. Second, based on the outlined problem, concrete research questions addressed in this thesis are derived. Third, the structure and content of this thesis used to answer the posed research questions are described.

## 1.1 Problem outline and relevance

Business models have been subject to research for more than two decades (compare with Amit and Zott (2001)). On a principle level, these models provide an approach that can be used to explain how individual companies create and deliver value to customers as well as how companies might generate revenues from their undertakings (Clauss, 2017; Remane et al., 2017). Early on, business models were seen as a crucial aspect for companies that wanted to be innovative. This went as far as researchers proclaiming that technological innovations had little objective value on their own (Chesbrough, 2007a, p. 12). Instead, researchers said that technologies required a suitable business model to generate economic value (Chesbrough, 2010, p. 354).

However, in today's complex and interdependent world, performing innovations is becoming more and more difficult (McGrath, 2011) and increasingly relies on actors located in the companies' environments (Adner and Kapoor, 2010, p. 306). When a single innovation is a component of a larger system, comprising multiple components, Adner (2006, p. 100) stated that the success of the single innovation is linked to the success of the overall system and, therefore, of all involved components. Unsurprisingly, in a study by the World Economic Forum, it was proposed that the way economists and practitioners approached innovation has evolved considerably (Sala-I-Martin et al., 2015, p. 53). Thus, innovation is often rooted in an ecosystem in order to generate and implement ideas (Sala-I-Martin et al., 2015, p. 53). The Deloitte consultancy also identified a trend, i.e., that value needs not exclusively be created within single companies but rather through rich, iterative, and innovation-oriented interactions between multiple companies (Kelly and Marchese, 2015, p. 57). A study conducted by IBM reached a congruent conclusion, namely, that innovative organizations would likely shift their focus away from innovating exclusively within their company's boundaries toward taking an ecosystem centric view of innovation (Davidson et al., 2014). The cited examples stem from traditional areas such as logistics, retail, healthcare, financial services and transportation, as well as technology oriented sectors, such as mobile computing and software (Davidson et al., 2014). Therefore, innovation challenges are often not limited to a specific company, but instead involve the issues faced by external innovation partners (Adner and Kapoor, 2010, p. 307).

As a consequence, companies must consider influences on their business models from other actors - in part even actors located in other sectors (Baden-Fuller and Haefliger, 2013, p. 425). In a similar vein, companies might also need to deal with *"tectonic industry changes"* rooted in technological discontinuities or policy changes (Massa and Tucci, 2014, p. 435). In turn, business model decisions might also select a competitive landscape (Demil et al., 2018, p. 1213). Necessary adaptions of business models to cope with influences stemming from their environment can range from gradual changes (to align business models to external changes) up to substantial changes in the companies' business models (to actively influence their surroundings) (Saebi, 2015, p. 151). Companies, therefore, might not only adapt to their environment, but also shape it through innovation and collaboration with other actors (Teece, 2007, p. 1319). One crucial aspect is that, as individual companies typically control different sets of resources and pursue distinct activities, networks of companies are likely to emerge where actors do not yield total control over their own operations (Berglund and Sandström, 2013, p. 278).

Moreover, technological development rarely takes place in isolation, since the companies are likely not able to yield sufficient innovation capabilities on their own (Enrietti and Patrucco, 2011, p. 6). As a result, the change in the individual companies' business models might be insufficient in an interconnected business environment - particularly when confronted with aforementioned technological discontinuities in their ecosystems (Massa and Tucci, 2014, p. 435). Consequently, ecosystem analysis might provide a valuable approach for the problem at hand as the results of the analysis can be used to describe the evolution of actors, activities, artifacts, institutions, and their relations (Granstrand and Holgersson, 2020). Thereby, based on the perception that the classical notion of "ownership" in ecosystems was replaced by "control" (Bitran et al., 2006; Kelly and Marchese, 2015), Kelly and Marchese (2015, p. 55) concluded that in ecosystems *"[...] influence will need to be achieved across increasingly complex networks—through relationships, collaboration, and co-creation."* Consequently, multiple actors will likely need to align and form an ecosystem centered around a specific innovation to create and deliver a joint value proposition to customers (Adner, 2017, p. 42). This bears particular relevance, as the companies' performance might be heavily related to the features of the ecosystem they populate (Shipilov and Gawer, 2020). The described undertaking arguably requires the coordination of elements on several levels:

- First, on the level of the ecosystem, actors and customers need to be coordinated to contribute towards an overall *"ecosystem value proposition"* (Adner, 2017; Talmar et al., 2018).
- Second, individual ecosystem actors will probably need to perform changes to elements in their business models in order to align them with those of other ecosystem actors (Saebi, 2015). This will enable them to contribute to an ecosystem value proposition (Adner, 2017; Talmar et al., 2018).

Naturally, individual actors are likely to take on different roles and contribute individual values when participating in an ecosystem. Avoiding possible shortcomings that could undermine the value of an ecosystem's value proposition can therefore be seen as a challenging undertaking. Actors in an ecosystem require a vision for the overall ecosystem (Shalender, 2018) and appropriate governance to ensure alignment of actors (Moore, 1993, 1996; Iansiti and Levien, 2004b; Adner, 2017) as well as overall ecosystem health (Dattee et al., 2018). Subsequently, those actors that *"play the* *ecosystem game"* need not only be aware of their own resources - and the business models they use these resources in - but must also understand how ecosystems are governed on a holistic level (Dattee et al., 2018, p. 490). This bears particular relevance, as the move towards adopting an ecosystem model can represent a type of business model change in and of itself (Dattee et al., 2018, p. 469). Therefore, actors participating in ecosystems centered around an innovation or novel technology need to align their respective business models to add value to a joint ecosystem value proposition (Adner, 2017). However, knowledge about how to accomplish this goal is scarce. As a result, practitioners lack guidance on how to adjust their business models in an ecosystem centered around a novel technological innovation.

Arguably, the actors' activities to align their individual business models to add value to an ecosystem's value proposition are particularly pronounced in cases where an ecosystem centered around a specific innovation has only recently emerged (Dedehayir et al., 2018) and, thus, is still in its early stages of evolution (Moore, 1996, pp. 64 ff.). A prominent example of an ecosystem fitting the aspects described above is the ecosystem for electric and electrified vehicles (xEVs)[1]. While several waves of xEVs have been mentioned in the literature going back to the 1890s (Santini, 2011), recent developments with regard to governmental policies (Arena et al., 2014) strongly indicate that the ecosystem centered around the innovation of xEVs will gain substantial relevance in the near future. This, in turn, will likely require actors active in the ecosystem to align their business models to contribute to the ecosystems' xEV-centered value proposition. In specific terms, the xEV ecosystem is particularly relevant for this thesis work, because it has the following characteristics:

- First, the current regulations and policies favor xEV because they define tight emission goals (Knupfer et al., 2017; Mosquet et al., 2020). As argued by Massa and Tucci (2014, p. 435), xEVs and their respective ecosystems, therefore, represent a discontinuity that is driven by policies and regulations.

- Second, while similarities to the ecosystem of conventional vehicles exist, the value propositions in the xEV ecosystem rely on different core technologies, such as the charging technology and batteries (Holland-Letz et al., 2019, p. 21).

- Third, the xEV ecosystem is still in the early stages of its development (Draschbacher et al., 2020) and, therefore, will still undergo substantial changes. While the current market penetration of xEVs is still marginal, it was estimated that purely battery electric vehicles (BEVs) would have a market share of close to 20% by 2030, while all xEVs are expected to have a combined market share close to 50% (Wu et al., 2019; Mosquet et al., 2020).

- Fourth, the existence of shifting technologies for vehicle propulsion and the availability of multiple alternative technologies are predicted to have a severe impact on the structure and composition of both the conventional vehicles' ecosystem as well as the xEV ecosystem (Abdelkafi et al., 2013, p. 1340003-5).

[1] A more detailed description of technologies summarized under the term xEV is provided in section 6.4.

- Fifth, actors in the xEV ecosystem are expected to adapt their business models and/or change roles while new roles might gain relevance. (cf. Abdelkafi et al. (2013); Bohnsack et al. (2014); Bohnsack and Pinkse (2017); Helbig et al. (2017); Mosquet et al. (2020); Monios and Bergqvist (2020)).

- Finally, xEVs and their respective ecosystem have been used by various authors to demonstrate the relations and specific functions of ecosystems centered around a specific innovation (compare, for example, Moore (1996); Kapoor (2018)).

In summary, the ecosystem in which actors participate might impact their - often connected - business models. Consequently, in order to create value in the ecosystem, the business models of multiple ecosystem actors might need to be changed in order for an ecosystem to provide an attractive value proposition. In turn, shortcomings rooted in the misalignment of the individual actors' business models could undermine the efforts of other ecosystem actors. Thereby, viewing business models in the context of their environment bears particular relevance, as the involved choices implicitly determine the business model's stakeholders, competitors, the technological infrastructure and regulations, which are relevant for a focal company as well as its overall relevance in an ecosystem (Demil et al., 2018, p. 1220). In investigating the role of business models in ecosystems, this research was conducted following the recommendations of Rong et al. (2018, p. 175), who proposed further investigating ecosystem stakeholders and their interactions as well as how resources embedded in business ecosystems can be mobilized for use in business models. Such research can yield novel insights, as the previous studies on business models tended to focus on single actors - neglecting a wider context - (compare with, for example, Berglund and Sandström (2013, p. 275) or Amit and Zott (2015, p. 346)) and empirical studies on whole ecosystems represent a rather new trend (Järvi and Kortelainen, 2017, p. 223). Therefore, the literature still contains little information about the relations of individual ecosystem actors' business models with their respective ecosystems. The relevance of this research was further underlined by Järvi and Kortelainen (2017, p. 223), who recognized ecosystem research as a growing field in business research *"[...] both in terms of the examination of different actors in the ecosystem and in terms of studies of the relationships between those actors."*

## 1.2 Research gap and research questions

In this section the outlined problem introduced in Section 1.1 is connected with relevant research streams. As illustrated in Figure 1, the aim of carrying out this thesis work was to explore the role of business models, as well as their respective change, in the context of ecosystems that are centered around a technological innovation.

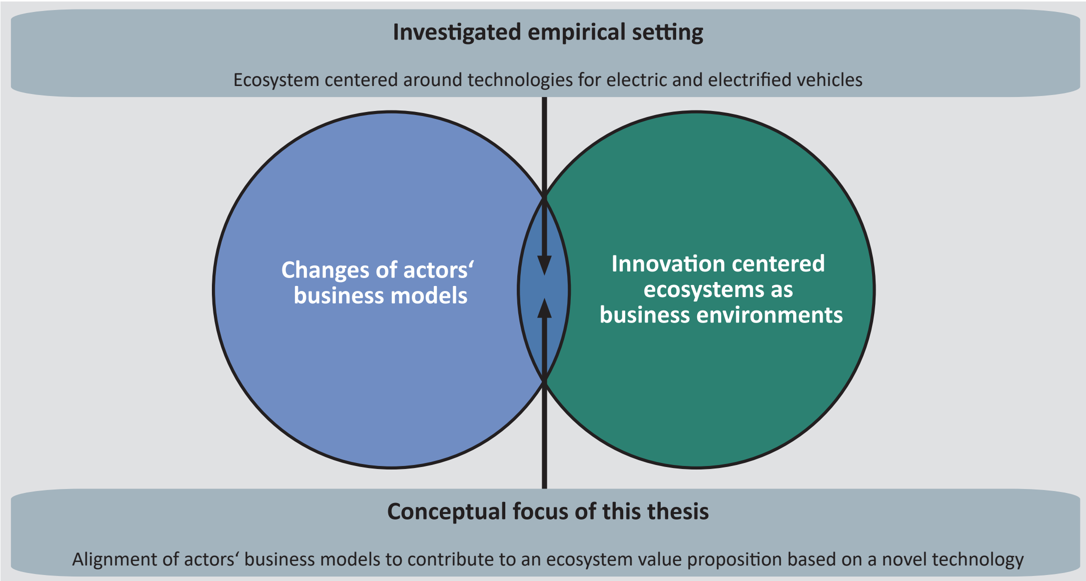


**Figure 1:** Conceptual focus of this thesis work (personal illustration)

In the following segment, the concrete research questions are derived that will be answered later in this thesis.

### Research Question 1

Early on, business model researchers acknowledged that the construct had strong ties with aspects lying outside a focal organization (Amit and Zott, 2001). The notion was further developed over time, particularly with regard to mutual influences of business models and their environment (Giesen et al., 2010; Saebi, 2015; Saebi et al., 2017). Moreover, recent descriptions of the ecosystem concept (compare with, for example, Adner (2017) and Granstrand and Holgersson (2020)) show striking similarities with the constructs and approaches in the area of business models. Unsurprisingly, several authors began to link the research on ecosystems and business models. For instance, Fjeldstad and Snow (2018, p. 37) pointed out that ecosystems *"[...] represent a promising source of business model innovation and operation."* At the same time, ecosystem actors needed to collaborate and combine resources in complex evolving systems in order to create innovations and, in turn, provide value to customers (Moore, 1998, p. 167). One essential aspect in this regard is that companies need to establish business models that combine a network of complementary functions, mainly provided by external actors (Moore, 1998, p. 168). Moreover, companies might go as far as to introduce new ecosystems (Moore, 1996, p. 16), which - following the argumentation of Fjeldstad and Snow (2018, p. 37) - could pave the way for new business models:

> *"Ecosystems, and the organizational designs that enable them, are important to business model innovation. They make new business models viable and offer firms new arenas, structures, and processes for business model experimentation."* (Fjeldstad and Snow, 2018, p. 37)

Although the topics of business models and business model change (Amit and Zott, 2001; Zott et al., 2011; Amit and Zott, 2015; Saebi, 2015; Foss and Saebi, 2017) and the innovation-centered ecosystems (Adner, 2006; Adner and Kapoor, 2010; Adner, 2017; Hannah and Eisenhardt, 2018; Talmar et al., 2018; Jacobides et al., 2018) were subject to research for more than a decade, the understanding of the individual topics is not consistent, and the vast body of the literature is still explorative in nature. Furthermore, while both business models and ecosystems show conceptual similarities and overlaps in their focal areas (cf. Amit and Zott (2015); Granstrand and Holgersson (2020)), the literature explicitly combining both topics is scarce. In addition, while some publications implicitly relate ecosystem level constructs to actor-level constructs, the terminology used is ambiguous (cf. Talmar et al. (2018)). To address these issues, research question 1 was developed to summarize the existing literature combining changes in business models and ecosystems:

**Research Question 1:**
What are relevant issues in the literature addressing changes in business models in combination with ecosystems?

This research question holds potential for making valuable insights, as recent publications have acknowledged the relationship between business models and ecosystems (Demil et al., 2018). However, the literature investigating changes in business models in the context of their environment is fragmented. For instance, Anggraeni et al. (2007, p. 1) proposed the business ecosystem concept as a theoretical lens that could be used to investigate the relations between companies and their business networks, while business model researchers investigated the alignment of individual actors' business models with their respective environments (compare, for example, Amit and Zott (2001), Giesen et al. (2010), Saebi (2015), or Foss and Saebi (2017)). By performing a systematic literature review, the existing ecosystem frameworks are extended to include mutual relations between business model innovation and ecosystems properties. Based on the results of the review, and taking into consideration existing approaches used to describe ecosystems, a conceptual framework illustrating the interplay between ecosystems and business models is derived. Grounded in the existing body of knowledge on the topic, this framework subsequently acts as an *"a priori"* construct and guides the empirical research presented in this thesis.

## Research Question 2

As traditional industry boundaries erode, companies often find themselves in competition with the most unlikely rivals. At the same time, companies might exploit this as an opportunity by transforming the landscape with new ecosystems (Moore, 1996, p. 16). Arguably, this applies in particular to ecosystems centered around innovations. For instance, Gomes et al. (2018, p. 46) ascertained that they could be particularly useful *"[...] to address radical innovation, new markets, or emerging industries."* However, the concrete factors that companies need to consider when participating in ecosystems that are centered around specific innovations are largely unexplored. Notable exceptions include Dattee et al. (2018), who investigated the dynamics of innovation ecosystem creation, and Almpanopoulou et al. (2019) who explored barriers to the emergence of innovation ecosystems. This lays the ground for a fruitful empirical investigation, which will allow to better understand why and how individual actors participate in certain ecosystems. Consequently, the following question is posed:

> **Research Question 2:**
> What influences do ecosystem actors perceive that encourage them to participate in an ecosystem centered around novel technologies?

Research Question 2 thereby bridges the gap between the literature and the investigated empirical phenomenon. Using xEVs as an example, it sheds light on relevant aspects of why certain actors participate in an ecosystem that is centered around a novel technology.

## Research Question 3

Interactions in ecosystems are influenced by relational aspects on multiple levels. Factors such as collaboration (Nardelli and Rajala, 2018), co-creation and co-evolution (Fehrer et al., 2018; Dellyana et al., 2018), co-opetition (Velu, 2016) as well as competition (Giesen et al., 2007) could influence the value created by individual actors and, as a result, the overall ecosystem value proposition. In addition, competition can take place both within an ecosystem involving ecosystem actors and their respective business models as well as between different ecosystems (Adner, 2017, p. 49). Consequently, ecosystems require an appropriate level of governance (Jacobides et al., 2018), which, in turn, often relies on actors taking on specific ecosystem roles (Moore, 1993, 1996; Iansiti and Levien, 2004b). This aspect is particularly pronounced in ecosystems centered around specific technological innovations, as actors need to be aligned within a *"value blueprint"* to create value in a way that considers individual actors' needs while generating a joint value proposition (Adner, 2012; Adner and Kapoor, 2016a,b; Adner, 2017; Dedehayir et al., 2017). Actors participating in an ecosystem centered around a novel technology often need to balance accessing resources and capabilities from other actors in their ecosystem while simultaneously building up capabilities around the novel technologies themselves (Kale et al., 2000; Mazur et al., 2013). Accessing resources can represent challenges and might need actors that take on the role of intermediaries (Katzy et al., 2013).

As empirical studies investigating whole ecosystems have only recently begun to gain traction (Järvi and Kortelainen, 2017, p. 223), investigating the interactions of ecosystem actors holds substantial potential for novel insights. However, the low number of studies on whole ecosystems might be rooted in the ambitious nature of ecosystem research in the area of managing innovation and technology.[1] To address this gap in the literature, the following research question is posed:

> **Research Question 3:**
> How do ecosystem actors interact to create value in an ecosystem centered around novel technologies?

Thereby, building on the insights provided by answering research questions one and two, the example of the xEV ecosystem was used in this thesis work to explore how individual ecosystem actors might interact to create value in an ecosystem centered around a novel technology.

## Research Question 4

The literature on innovation-centered ecosystems suggests the notion that actors need to be aligned in order to contribute to a joint ecosystem value proposition (Adner, 2017). However, despite the fact that the recent literature points out the relevance of combining business models with an ecosystem logic (Demil et al., 2018; Talmar et al., 2018), the exact way individual actors might approach this undertaking is largely unexplored. Consequently, investigating this aspect could be particularly fruitful as, on the one hand, ecosystems form around specific innovations (Adner, 2017), while, on the other hand, they could also influence the realized performance of technologies within an ecosystem (Adner and Kapoor, 2016b,a). In that regard, Shalender (2018, p. 78) proposed available resources and capabilities of the interconnected network of companies should be mapped out, which required *"[...] conceiving the business model which is weaved around compatibility of related ecosystem players so that benefits arising from related firms can also be utilized to its own advantage."* Moreover, the literature on business models provides a suitable lens that enables researchers to understand how individual actors can create value around technological innovations. In specific terms, business models were stated to be (1) a means to transform technological input into economic outputs (Chesbrough and Rosenbloom, 2002; Baden-Fuller and Haefliger, 2013), (2) increase technology-based company performance (Smajlović et al., 2019), and (3) translate distinct characteristics of disruptive innovations to appeal to customers (Christensen, 2006; Bohnsack and Pinkse, 2017), while (4) distinct business model patterns could also support the uptake of new - potentially disruptive - technologies (Abdelkafi et al., 2013; Amshoff et al., 2015). Furthermore, if used in appropriate business models, disruptive technologies

[1] For instance, Tsujimoto et al. (2018, p. 56) argued that researchers ought to consider *"the technological inevitability, path dependency, actor network, chain reaction structure, function, and utility of the whole ecosystem."*

could influence the established industry logics and reshape collaboration patterns (Vorbach et al., 2017). In addition, business models were often impacted by the technology itself, while also potentially being able to influence their surrounding ecosystems (Saebi, 2015). For instance, Chapman (2006, p. 36) highlighted the catalyzing role of technology in *"industry-altering business models"* that could enable or even drive innovation. Thereby, technology might catalyze other factors supporting innovation, such as collaboration (Chapman, 2006, p. 36). To explore the alignment of business models in the context of innovation centered ecosystems, the following questions were addressed in this thesis work:

**Research Question 4:**
How can actors participating in an ecosystem centered around novel technologies align their individual business models to contribute to a joint ecosystem value proposition?

**Sub-question 1:**
How does participating in an ecosystem centered around novel technologies influence the individual actors' business models?

**Sub-question 2:**
How do individual ecosystem actors change their business models when participating in an ecosystem centered around a novel technology?

First, in sub-question one, based on the insights derived from research questions one to three, the influences on the actors' business models when participating in the xEV ecosystem were explored. Second, in sub-question two, the concrete business model changes performed by individual actors participating in the xEV ecosystem were investigated. Third, to answer research question four, insights gained from asking sub-question one and two were combined to improve the understanding of how actors participating in the xEV ecosystem could align their business models to contribute to the ecosystems' value proposition.

Overall, this thesis work was carried out to (1) identify factors that influence the participation of individual actors in an ecosystem, (2) improve the understanding on how these actors interact to create value, and to (3) shed light on how actors align their business models to contribute to an overall ecosystem value that is centered around a novel technology using the example of xEVs.

In conclusion, this research provided valuable insights by combining two previously largely separate theoretical lenses. The following chapter provides an overview of the applied research process used to derive conceptually and methodologically sound results.

# 2 Research approach and structure of the thesis

Figure 2 illustrates the structure of this thesis and the conducted research process of this thesis work. Following recommendations by Edmondson and McManus (2007, p. 1174), an iterative and cyclic approach was applied. Consequently, the research design evolved, and the research focus and the alignment of individual elements of research performed in this thesis work were improved (Edmondson and McManus, 2007, p. 1174).

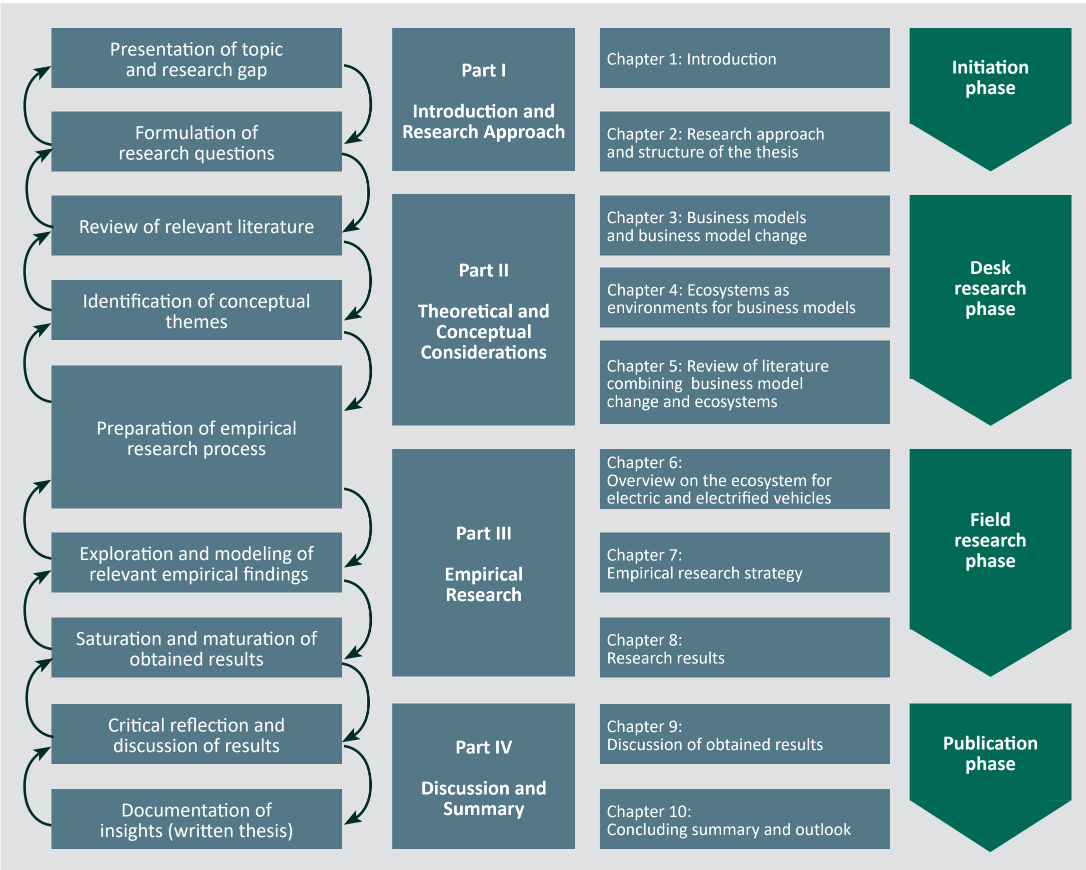


**Figure 2:** Overview of the research process applied in this thesis work (based on Edmondson and McManus (2007, p. 1174))

**Part I** of this thesis provides an argument for the relevance of the work and the selection of the investigated empirical setting (Chapter 1). As data collection narrows the scope of subsequent decisions in the research process, multiple iterations were performed in this thesis work to (1) identify a research area of interest, (2) review the literature, and (3) develop appropriate research questions (Edmondson and McManus, 2007, p. 1174). This subsequently allowed for the formulation of concrete research questions which, according to Crotty (1998, p. 2), together with epistemological[1], ontological[2], and axiological[3] assumptions guided further investigations by, for instance, informing the choice of methods and methodologies. As a result, the pursued iterative process supported the refinement and elaboration of the applied research design. Furthermore, in Part I, the research approach taken in the thesis work is presented, and the structure of this thesis is defined (Chapter 2).

**Part II** provides an overview of the literature on business models (Chapter 3) and ecosystems (Chapter 4). The relations between these topics and with technological aspects are explained. Subsequently, based on this review of relevant literature and guided by the formulated research questions, the intersection of both aspects was investigated by systematically reviewing relevant publications (compare Chapter 5). Using the results of this systematic review, a conceptual framework was derived that highlights constructs, the key factors, and the relationships that are presumed to be relevant for business model innovation in business ecosystems (Miles and Huberman, 1994, p. 18). This conceptual framework guided the empirical thesis research by providing an *"a priori"* construct (Eisenhardt, 1989, p. 533) as well as the research process by specifying what would - and respectively what would not - be studied (Miles and Huberman, 1994, p. 18).

**Part III** provides an overview of the studied ecosystem of xEVs (Chapter 6), presents the applied empirical research methodology (Chapter 7), and lays out the obtained results (Chapter 8). As research in business contexts is often multidisciplinary, and knowledge can take various forms[4], business scholars need to adopt epistemologies that fit their specific research (Saunders et al., 2016, p. 127). The possible variety of appropriate epistemologies in business management research allows for a - compared to other disciplines - wider range of applicable methods (Saunders et al., 2016, p. 127). The interpretivist[5] approach is deemed particularly suitable for this research, as it can be taken to consider the context, factors, and interactions of multiple actors (Ang, 2014,

[1] Crotty (1998, p. 2) defined epistemology as *"[...] the theory of knowledge embedded in the theoretical perspective and thereby in the methodology."* Along those lines, Burell and Morgan (1979, p. 1) described epistemological assumptions as *"[...] assumptions about the grounds of knowledge - about how one might begin to understand the world and communicate this as knowlege to fellow human beings."*

[2] Saunders et al. (2016, p. 127) defined ontology as the *"[...] assumptions about the nature of reality [...]"*. These assumptions shape the perception and investigation of research objects (Saunders et al., 2016, p. 127).

[3] Axiology, according to Saunders et al. (2016, p. 128) describes *"[...] the roles of values and ethics within the research process [...]"*. This includes the role of the researcher's own values as well as the values of participants.

[4] These could be, for instance, numerical or textual data.

[5] Interpretivism is sometimes also referred to as constructivism (Ang, 2014, p. 53). As described by Saunders et al. (2016, p. 140) interpretivism *"[...] argues that human beings and their social worlds cannot be studied in the same way as physical phenomena, and that therefore social sciences research needs to be different from natural sciences research rather than trying to emulate the latter."*

p. 53). Interpretivist research approaches as described by Saunders et al. (2016, p. 140) are exploratory as they aim to *"[...] create new, richer understandings and interpretations of social worlds and contexts."* As a result, by using an interpretivist research approach, observations from complex relations between elements can be made while considering research issues holistically (Ang, 2014, p. 53). This makes it well suited for business management research, as business situations are complex and - at least in terms of context - often unique (Saunders et al., 2016, p. 141). Moreover, business management research requires the consideration of views of multiple interest groups when investigating research topics (Saunders et al., 2016, p. 140).

As investigations of ecosystems - particularly in the context of technological innovation and business models - represent a nascent stream in the literature (Järvi and Kortelainen, 2017; Demil et al., 2018; Rong et al., 2018; Tsujimoto et al., 2018), adopting an interpretivist approach and following an exploratory qualitative research design is a suitable way to obtain novel insights (Edmondson and McManus, 2007, p. 1177). In addition, by utilizing characteristics of (innovation) ecosystems (Adner and Kapoor, 2010; Adner, 2012), in this work a focus could be placed on specific elements of actors that contribute with their activities towards a joint ecosystem value proposition (Adner, 2017). Thereby, specific developments - as well as individual actor's business models - can be isolated that add value to an ecosystem value proposition centered around a technological innovation. Moreover, if multiple parts contributed towards an ecosystem value proposition in different ways, these individual parts could be investigated separately. Subsequently, in this thesis work, a research design was applied that integrated several qualitative methods (i.e., multiple interview-based case studies and a focus group). This was deemed a fruitful approach, as it enables (1) the investigation of relevant ecosystem actors in sufficient depth while (2) viewing the research field from multiple angles (both in terms of informants and methods). Moreover, by considering multiple actors' perspectives in an innovation-centered ecosystem, the results presented in this thesis provide a rich picture of relevant factors (Eisenhardt, 1989). The approach is in line with insights by Abdelkafi et al. (2013, p. 1340003-35), who proposed the use of interviews to generate knowledge for business models in the context of xEVs. (Eisenhardt, 1989; Yin, 2009; Gioia et al., 2012; Krueger and Casey, 2015)

**Part IV** concludes this thesis. First, the individual views of single ecosystem actors that were obtained and are summarized in Part III are placed in a joint ecosystem context. Second, based on the obtained data, factors that encourage actors to enter an ecosystem are presented. Also, the actors' interactions in the ecosystem and adjustments in individual actors' business models to contribute towards an overall ecosystem value proposition centered around a technological innovation are highlighted.

Consequently, the analysis of the obtained data is presented in detail and discussed with reference to the relevant literature. Based on the analysis and discussion, both theoretical and managerial implications are derived and presented. All findings are reflected upon, and the limitations of this work as well as potential areas for further research are proposed.

# Part II

# Theoretical and Conceptual Considerations

# 3 Business models and business model change

Looking at the literature on business models, several relevant themes emerge. On the one hand, business models - initially originating from new technological developments towards e-business (e.g., Timmers (1998); Amit and Zott (2001)) - were regularly used to investigate how to capture value from (technological) innovation (e.g., Chesbrough and Rosenbloom (2002); Chesbrough (2007b)). On the other hand, business models were conceptualized as taking into account elements outside the companies' boundaries (Amit and Zott, 2001; Zott et al., 2011; Amit and Zott, 2015). This is reflected in common definitions of the concept. For instance, Amit and Zott (2001, p. 511) defined it as follows: *"A business model depicts the design of transaction content, structure, and governance so as to create value through the exploitation of business opportunities."*

This chapter sheds light on the relations between business model changes and both technological innovations and business environments. It is structured as follows: In Sections 3.1 and 3.2 basic concepts and definitions of business models and business model change concepts are provided. Then, in Section 3.3 and Section 3.4 a review of the literature is presented, addressing the relations between business models and both technologies and business environments.

## 3.1 Overview of business models

The relevance of business models as a distinct construct was emphasized early on. For instance, Magretta (2002, p. 89) highlighted that viable organizations had a sound business model, but also pointed out that, although sometimes used as a synonym, *"[...] a business model isn't the same thing as a strategy [...]"* (Magretta, 2002, p. 89). This distinction was further explored by DaSilva and Trkman (2014), who attempted to separate business models from related concepts. Cavalcante et al. (2011, p. 1328) theorized that the two key purposes of a business model were to (1) offer stability to develop the activities a company performs while (2) providing flexibility to allow for change.

Nonetheless, both researchers and practitioners understand what business models are and how they can be categorized in many different ways. Having their roots in topics such as e-business, business models were often conceptualized in the context of technologies (Timmers, 1998; Amit and Zott, 2001; Govindaraj and Gupta, 2001; Chesbrough and Rosenbloom, 2002). This aspect was investigated in greater detail by Zott et al. (2011, p. 1035) who compared and contrasted the literature on business models with regard to their purposes, antecedents, mechanisms, and outcomes as well as their origins in the literature (i.e., e-commerce, strategy as well as technology and innovation management (cf. Zott et al. (2011)). Similarly, Wirtz et al. (2016, p. 38), who provided an overview of the origins and development of the literature on business models, differentiated between (1) technology-oriented, (2) organization-oriented, and (3) strategy-oriented conceptions of business models. In another classification provided by Foss and Saebi (2017, p. 202), three research streams on business models were highlighted: (1) business models to classify enterprises, (2) business models as an antecedent of heterogeneity in the performance of companies (i.e., as a factor contributing to the performance of companies), and (3) as a unit of innovation. In addition, Massa et al. (2017, pp. 73-75) extracted three meanings of business models in the management literature (1) business models as attributes of real companies, (2), business models as *"cognitive/linguistic schemas"* and (3) business models as *"conceptual representations"* of how a business functions. Magretta (2002, p. 89) described a business model on a generic level as a *"[...] system, how the pieces of a business fit together."* Chesbrough also, in a series of articles, propagated a specific understanding of business models. In Chesbrough and Rosenbloom (2002) and Chesbrough (2007a, 2010), he proposed that the functions of a business model comprised (1) articulating a value proposition, (2) identifying a target market or market segment, (3) defining a value chain to create and distribute a company's offerings, (4) specifying how value is generated by considering costs and profits with respect to other elements of the business model (e.g., value proposition, profit potential, the structure of the value chain), (5) describing the position of a company in its ecosystem (or value network), and (6) formulating a competitive strategy.

On a critical note, several authors have stated that no generally accepted operational definition of business models has emerged (cf. Porter (2001); Zott et al. (2011); Berglund and Sandström (2013); Foss and Saebi (2017); Massa et al. (2017); Saebi et al. (2017); Foss and Saebi (2018)). A strong critical statement was made by Porter (2001, p. 13), who perceived that the *"[...] definition of a business model is murky at best."* Porter (2001, p. 13) further noted that business models often *"[...] refer to a loose conception of how a company does business and generates revenue."* Berglund and Sandström (2013, p. 276) argued that criticism of business models partly traces back to the multidisciplinary use of the concept (e.g., technology management, innovation management, strategy) (Berglund and Sandström, 2013, p. 276). However, Berglund and Sandström (2013, p. 276) also identified a consensus in the literature, indicating that (1) business models consisted of a set of interrelated components that (2) transcended companies' boundaries and (3) described how companies created, delivered, and appropriated value (cf. Amit and Zott (2001); Osterwalder (2004); Johnson et al. (2008)). Table 1 presents an overview of definitions and approaches applied in the past to business models.

**Table 1:** Overview of selected articles providing definitions for business models as well as the research approaches taken in these articles. Articles are sorted by date of publication.

| Author | Type & approach | Provided business model definition |
|---|---|---|
| Amit and Zott (2001) | • Article<br>• Qualitative | *"A business model depicts the design of transaction content, structure, and governance so as to create value through the exploitation of business opportunities."* (Amit and Zott, 2001, p. 511) |
| Govindaraj and Gupta (2001) | • Article<br>• Qualitative | Business models are formulated by answering the questions: *"1. Who are my target customers?"; "2. What value do I want to deliver to them?"; "3. How will I create it?"* (Govindaraj and Gupta, 2001, p. 3) |
| Magretta (2002) | • Article<br>• Conceptual<br>• Examples | Business models are *"[...] stories that explain how enterprises work. A good business model answers Peter Drucker's age-old questions: Who is the customer? And what does the customer value? It also answers the fundamental questions every manager must ask: How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?."* (Magretta, 2002, p. 87) |
| Chesbrough and Rosenbloom (2002) | • Article<br>• Conceptual<br>• Examples | Business model function to *"[...] articulate the value proposition, that is, the value created for users by the offering based on the technology; identify a market segment, that is, the users for whom the technology is useful and for what purpose, and specify the revenue generation mechanism(s) for the firm; define the structure of the value chain within the firm required to create and distribute the offering, and determine the complementary assets needed to support the firms position in this chain; estimate the cost structure and profit potential of producing the offering, given the value proposition and value chain structure chosen; describe the position of the firm within the value network linking suppliers and customers, including identification of potential complementors and competitors; formulate the competitive strategy by which the innovating firm will gain and hold advantage over rivals."* (Chesbrough and Rosenbloom, 2002, p. 532-533) |
| Morris et al. (2005) | • Article<br>• Conceptual<br>• Example | *"A business model is a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets."* (Morris et al., 2005, p. 727) |
| Shafer et al. (2005) | • Article<br>• Conceptual | *"[...] we define a business model as a representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network."* (Shafer et al., 2005, p. 202) |
| Osterwalder et al. (2005) | • Article<br>• Conceptual | *"A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences."* (Osterwalder et al., 2005, p. 5) |

Table 1 continues on next page

Table 1 continued from previous page

| Author | Type & approach | Provided business model definition |
|---|---|---|
| Chesbrough (2007a) | • Article<br>• Conceptual | *"At its heart, a business model performs two important functions: value creation and value capture."* (Chesbrough, 2007a, p. 12) |
| Chesbrough (2007b) | • Article<br>• Conceptual | A *"[...] business model performs two important functions: It creates value, and it captures a portion of that value."* (Chesbrough, 2007b, p. 22) |
| Johnson et al. (2008) | • Article<br>• Conceptual<br>• Examples | *"A business model [...] consists of four interlocking elements that, taken together, create and deliver value."* (Johnson et al., 2008, p. 53) (According to Johnson et al. (2008) these elements are customer value proposition, profit formula, key resources and key processes.) |
| Zott and Amit (2008) | • Article<br>• Quantitative | *"The business model is a structural template that describes the organization of a focal firm's transactions with all of its external constituents in factor and product market.* (Zott and Amit, 2008, p. 1) |
| Doganova and Eyquem-Renault (2009) | • Article<br>• Qualitative | The *"[...] business model is a narrative and calculative device that allows entrepreneurs to explore a market and plays a performative role by contributing to the construction of the techno-economic network of an innovation."* (Doganova and Eyquem-Renault, 2009, p. 1559) |
| Casadesus-Masanell and Ricart (2010) | • Article<br>• Conceptual<br>• Example | A business model is *"[...] a reflection of the firm's realized strategy."* (Casadesus-Masanell and Ricart, 2010, p. 195)<br>*"Business Model refers to the logic of the firm, the way it operates and how it creates value for its stakeholders; [...]* (Casadesus-Masanell and Ricart, 2010, p. 196) |
| Osterwalder and Pigneur (2010) | • Book<br>• Conceptual<br>• Examples | *"A business model describes the rationale of how an organization creates, delivers, and captures value"* (Osterwalder and Pigneur, 2010, p. 14) |
| Schallmo and Brecht (2010) | • Conference paper<br>• Qualitative | *"A business model is a description of how an organization combines a set of elements to create value to customers and partners. The value maintains relationships to customers, supports differentiation from competitors and is created with products and services."* (Schallmo and Brecht, 2010, p. 4) |
| Teece (2010) | • Article<br>• Conceptual<br>• Examples | *"A business model articulates the logic and provides data and other evidence that demonstrates how a business creates and delivers value to customers. It also outlines the architecture of revenues, costs, and profits associated with the business enterprise delivering that value."* (Teece, 2010, p. 173) |
| Zott and Amit (2010) | • Article<br>• Conceptual | Zott and Amit *"[...] conceptualize a firm's business model as a system of interdependent activities that transcends the focal firm and spans its boundaries. The activity system enables the firm, in concert with its partners, to create value and also to appropriate a share of that value"* (Zott and Amit, 2010, p. 216) |

Table 1 continues on next page

Table 1 continued from previous page

| Author | Type & approach | Provided business model definition |
|---|---|---|
| Gassmann et al. (2011) | • Book (chapter)<br>• Conceptual<br>• Examples | *"Im Grunde ist ein Geschäftsmodell die Art und Weise, in der ein Unternehmen Wert schafft, seinen Kunden Nutzen stiftet und Kunden davon überzeugt, für diesen Nutzen Geld zu zahlen. Ein Geschäftsmodell ist also die Umsetzung dessen, was das Management denkt, das der Kunde haben will, wie er es haben will und wie man damit etwas verdienen kann."*[1] (Gassmann et al., 2011, p. 198) |
| Amit and Zott (2012) | • Article<br>• Conceptual<br>• Examples | *"We define a company's business model as a system of interconnected and interdependent activities that determines the way the company "does business" with its customers, partners and vendors. In other words, a business model is a "bundle of specific activities - an activity system - conducted to serve the perceived needs of the market, along with the specification of which parties (a company or its partners) conduct which activities, and how these activities are linked to each other."* (Amit and Zott, 2012, p. 42) |
| Berglund and Sandström (2013) | • Article<br>• Conceptual | According to the authors, a business model *"[...] is (a) a high-level description of how a firm (or part of the firm) creates, delivers and appropriates value, that is (b) centered on a focal firm, but that also (c) transcends the boundaries of the focal firm."* (Berglund and Sandström, 2013, p. 276) |
| Baden-Fuller and Haefliger (2013) | • Conceptual<br>• Examples | *"We define the business model as a system that solves the problem of identifying who is (or are) the customer(s), engaging with their needs, delivering satisfaction, and monetizing the value."* (Baden-Fuller and Haefliger, 2013, p. 419) |
| Massa and Tucci (2014) | • Book<br>• Conceptual | The business model *"[...] is a systemic and conceptually rich construct, involving multiple components, several actors (boundary spanning) and complex interdependencies and dynamics."* (Massa and Tucci, 2014, p. 431) |
| Spieth et al. (2014) | • Article<br>• Conceptual | Business models *"[...] represent boundary spanning entities that link dimensions of corporate strategy, technological capabilities and innovation processes of the firm."* (Spieth et al., 2014, p. 242) |
| Amit and Zott (2015) | • Article<br>• Conceptual<br>• Examples | *"The business model describes the system of interdependent activities performed by a focal firm and its partners and the mechanisms that link these activities to each other."* (Amit and Zott, 2015, p. 331) |
| Wirtz et al. (2016) | • Article<br>• Review | *"A business model is a simplified and aggregated representation of the relevant activities of a company. It describes how marketable information, products and/or services are generated by means of a company's value-added component."* (Wirtz et al., 2016, p. 41) |

Table 1 continues on next page

[1]Translated from German to English: *"Basically, a business model is how a company creates value, provides benefits to its customers, and convinces customers to pay money for those benefits. So, a business model is an implementation of what the management thinks the customer wants, how they want it and how to earn something with it."*

Table 1 continued from previous page

| Author | Type & approach | Provided business model definition |
|---|---|---|
| Massa et al. (2017) | • Article<br>• Conceptual | *"At a very general and intuitive level, a business model is a description of an organization and how that organization functions in achieving its goals (e.g., profitability, growth, social impact, . . .)."* (Massa et al., 2017, p. 73) |
| Saebi et al. (2017) | • Article<br>• Quantitative | *"Although there is no generally agreed upon definition, many contributions to the literature define it in terms of the firm's value proposition and market segments, the structure of the value chain required for realizing the value proposition, the mechanisms of value capture that the firm deploys, and how these elements are linked together in an architecture"* (Saebi et al., 2017, p. 567) |

As summarized in Table 1, the definitions of researchers cover a wide variety of understandings, including *"stories"* (Madsen, 2020) and *"narratives"* (Doganova and Eyquem-Renault, 2009), ways to address *"decision variables"* (Morris et al., 2005), *"conceptual tools"* (Osterwalder et al., 2005), as well as *"boundary spanning entities"* (Spieth et al., 2014).

However, despite the researchers' initially ambiguous perceptions of business models, recent publications have contributed towards a more uniform understanding of the topic (Wirtz et al., 2016, p. 38). For instance, Zott et al. (2011) and Clauss (2017) provided an overview of the current research, while both Gassmann et al. (2014) and Remane et al. (2017) identified distinct business model patterns. In addition, the literature provides a detailed overview of individual elements of business models which are structured along the dimensions of (1) *"value proposition,"* (2) *"value delivery,"* (3) *"value capture,"* and (4) *"value creation"* (Arnold et al., 2016, p. 1640015-11; Clauss, 2017, p. 391; Remane et al. 2017, p. 1750004-5). Foss and Saebi (2018, p. 14) underlined the role of the complexity of a business model's architecture for creating, delivering, and capturing value as well as its underlying mechanisms.

In a series of articles, Amit and Zott proposed design elements and design themes that serve to arrange and link the elements of business models (cf. Zott and Amit (2007, 2008, 2010); Zott et al. (2011); Amit and Zott (2012, 2015)). Moreover, Amit and Zott (2012, p. 46) highlighted the interdependence between their proposed business model design elements (see Table 2). Interestingly, Amit and Zott (2012, p. 46) distinguished between the business model and the revenue model, noting that they were closely related and intertwined but also distinct entities. Santos et al. (2009) expanded on this theme by proposing that a business model consisted of four *"[...] separate but interrelated components [...]"*: (1) elemental activities, (2) organizational units (both internal and external) to execute activities, (3) linkages between activities (i.e., physical transactions and human relations), and (4) governance mechanisms overseeing organizational units and their linkages.

**Table 2:** Overview of design elements and design themes for business models as proposed in a series of articles by Amit and Zott (cf. Amit and Zott (2001); Zott and Amit (2007, 2008, 2010); Zott et al. (2011); Amit and Zott (2012) and Amit and Zott (2015))

| **Design elements** | | **Design themes** | |
|---|---|---|---|
| **Content** | Selection of activities | **Novelty** | Degree of business model innovation in the activity system |
| **Structure** | Links between activities | **Lock-in** | Involved partners face switching costs and/or high incentives to stay and transact within a business model's activity system |
| **Governance** | Governance of activity system | **Efficiency** | Interdependencies between business model activities result in enhanced value |
| | | **Complementarities** | Interconnections between the activity systems result in cost savings |

Similarly, Massa and Tucci (2014, p. 423) noted that business models tended to emphasize *"[...] a systemic and holistic understanding of how an organization orchestrates its system of activities for value creation [...]"* that tends to take place in networks and potentially included *"[...] suppliers, partners, distribution channels, and coalitions that extend the company's resources."* As a result, they concluded that the understanding of business models was flexible with regards to how value is created (Massa and Tucci, 2014, p. 423). Subsequently, while a generally accepted definition of business models is yet to emerge (Wirtz et al., 2016, p. 38), Foss and Saebi (2018, p. 14) found that the literature on business models was converging with respect to their dimensions.

Besides structuring business models along the described dimensions, another distinction can be made with regard to the level of business models (Schallmo and Brecht, 2010, p. 6). As illustrated in Figure 3, Schallmo and Brecht (2010, p. 6) differentiated between generic levels (i.e., abstract level, industry level) and specific levels (i.e., corporate, business unit, product, and service) of business models. Massa and Tucci (2014, p. 433) also proposed a description similar to that of Schallmo and Brecht (2010), which distinguished between different levels of abstraction (compare with Figure 4). Massa and Tucci (2014, p. 431) found that scholars, as well as practitioners, introduced numerous frameworks, ontologies, and perspectives describing business models to (1) foster dialogue and collective sensemaking, (2) support experiments with business models, and (3) engage with audiences and foster action. Popular examples are Osterwalder and Pigneur's business model canvas or Gassmann et al.'s business model triangle (cf. Osterwalder and Pigneur (2010); Gassmann et al. (2014)). However, the approaches tended to have a particular focus and, therefore, limited areas of application (cf. Massa and Tucci (2014, p. 431)).

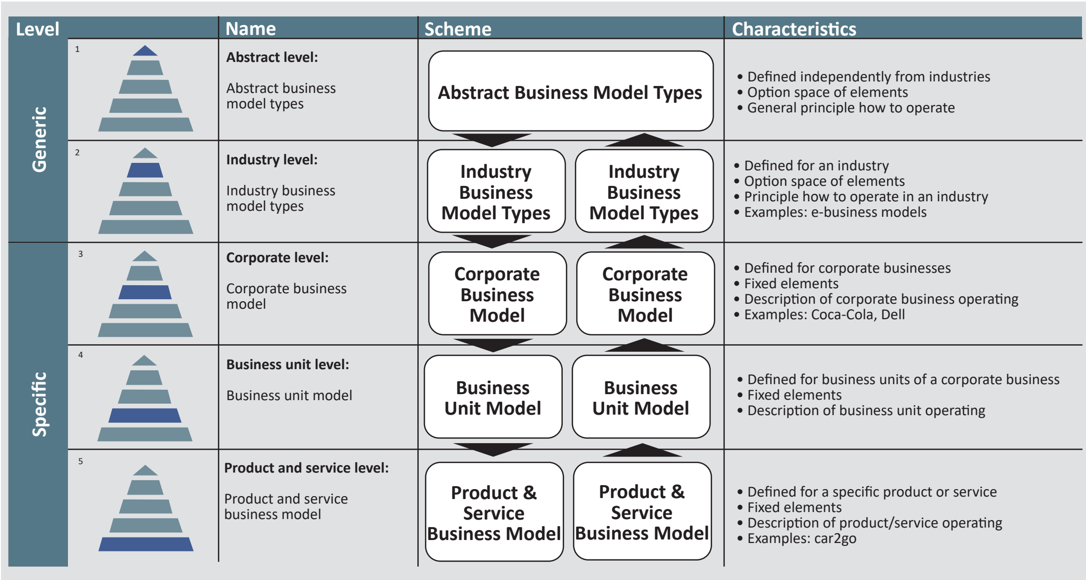


**Figure 3:** Levels of business models according to Schallmo and Brecht (2010, p. 6)

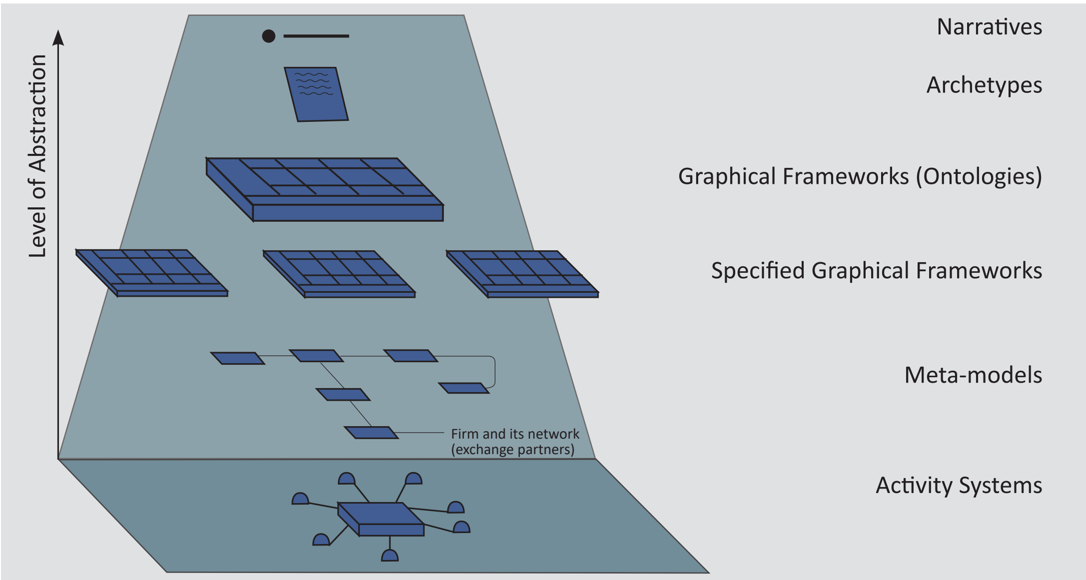


**Figure 4:** Levels of business models according to Massa and Tucci (2014, p. 433)

Table 3 provides an overview of key insights taken from selected articles on business models. It also gives an overview of how the literature has addressed the topic of technologies and business environments.

**Table 3:** Selected articles on the topic of business models, stating definitions as well as key insights from the articles. The symbols on the right-hand side of the table indicate whether the topic was mentioned in the context of business environments and/or technologies. Articles are sorted by date of publication.

| Author | Key insights from the literature | Addresses technology | Addresses environment |
|---|---|---|---|
| Amit and Zott (2001) | • Business models are firm-centric extensions of strategic networks encompassing multiple firms and industries.<br>• Innovative business models have the potential to disrupt existing industry structures.<br>• Innovation can take place through novel exchange mechanisms and transaction structures.<br>• Novelty, lock-in, complementarity, and efficiency are value drivers. | ✗ | ✓ |
| Govindaraj and Gupta (2001) | • Business models are characterized by customers (customer-segments and -relations), the value proposition towards customers and the design of a value creation architecture.<br>• Individual elements of business models are interrelated.<br>• Business models could be used to shape and exploit their external environment (e.g., technology, industry-structure). | ✗ | ✓ |
| Magretta (2002) | • Business models could be used as analytical tool to ex ante model businesses based on assumptions and success measures.<br>• Business models need to be paired with appropriate strategies since they do not reflect strategic influences (e.g., competitors) themselves.<br>• Business models that influence industries and are hard to replicate can be a competitive advantage. | ✗ | ✓ |
| Chesbrough and Rosenbloom (2002) | • Revenue-architecture could be a necessary element to capture value from technologies.<br>• Establishing alignment with the value network could be necessary to capture value from technologies and enable business model scalability.<br>• Business models mediate between the creation of value using technology and economic value to ensure value delivery to customers. | ✓ | ✓ |
| Morris et al. (2005) | • Three levels of decision-making were proposed: business model elements, unique combinations and guiding principles.<br>• Possible business model elements are: offering, market, internal capabilities, competitive strategy, economic model, personal/investor factors.<br>• Strategic decision elements for business models include stakeholders, value creation, differentiation, vision, values, networks and alliances.<br>• Value networks could be critical factors for value creation. | ✗ | ✓ |

Table 3 continues on next page

Table 3 continued from previous page

| Author | Key insights from the literature | Addresses technology | Addresses environment |
|---|---|---|---|
| Osterwalder et al. (2005) | • Business models might exist on different hierarchical levels (conceptual, taxonomy, instance).<br>• Business models were seen as a technology-related concept that is subject to external influences.<br>• Business models represent a conceptual link between strategy, organisation and systems. Thus they require translation into structures, processes, infrastructure and systems.<br>• Nine business model building blocks:<br>Value Proposition, Target Customer, Distribution Channel, Relationship, Value Configuration, Core Competences, Partner Network, Cost Structure, Revenue Model | ✓ | ✓ |
| Johnson et al. (2008) | • Precisely addressing customers' "jobs" with a value proposition is a crucial element of business models.<br>• Resources and processes need to be geared towards creating the customer value proposition. | ✗ | ✗ |
| Chesbrough (2007b) | • Open business models could help address rising costs of technology development and shorten innovation cycles to improve the creation and capture of value. | ✓ | ✓ |
| Zott and Amit (2008) | • Business models could serve as a contingency factor for exchanges spanning the companies' boundaries.<br>• Product market strategy and business model can be seen as distinct and complementary constructs that influence companies' performance. | ✗ | ✓ |
| Casadesus-Masanell and Ricart (2010) | • Business models are a result of concrete choices guided by a company's strategy.<br>• Tactics (residual and largely adaptable open choices after deciding on a business model) are crucial in determining value creation and value capture.<br>• Tactical choices affect the focal company as well as other companies (*tactical interaction* of business models in both directions). | ✗ | ✓ |
| Osterwalder and Pigneur (2010) | • A graphic representation of business models consisting of nine building blocks (Business Model Canvas) was highlighted.<br>• Distinct patterns of business models were proposed.<br>• External factors likely have an influence on business models (industry forces, key-trends, macroeconomic forces, market forces). | ✗ | ✓ |

Table 3 continues on next page

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| Author | Key insights from the literature | Addresses technology | Addresses environment |
|---|---|---|---|
| Teece (2010) | • Business models need to be designed towards and evaluated against the state of the business ecosystem (business/customer environment).<br>• Product innovation needs to be accompanied by appropriate business models.<br>• Business model design requires understanding of customer needs and technological trajectories.<br>• Technologies can influence the value itself as well as value delivery and cost aspects of business models. | ✓ | ✓ |
| Gassmann et al. (2011) | • A number of industry-spanning business model patterns were proposed.<br>• A differentiation between business model elements located inside and outside of companies was provided.<br>• Business models originate in an ecosystem and are influenced by dominant industry logics. | ✗ | ✓ |
| Baden-Fuller and Haefliger (2013) | • Business models represent a link between technology and company performance.<br>• The relation between business models and technology is bidirectional and complex.<br>• Technology (from other sectors) might influence creation and change of business models. | ✓ | ✓ |
| Berglund and Sandström (2013) | • The focus of business model research is surprising considering the construct's emphasis on interactions with its environment.<br>• Business models can be viewed as open systems to manage innovation across company boundaries.<br>• Business models are not under the complete control of a focal company, as several actors supply resources. Consequently, companies changing their business models act under restricted freedom.<br>• A company's network and unpredictable outcomes of change activities can hinder the companies within this network, causing them to change their business models. | ✗ | ✓ |
| Saebi et al. (2017) | • External threats increase the likelihood of companies performing (low) degrees of business model change.<br>• External opportunities seldomly lead to changes in the companies' business models. | ✗ | ✓ |

The overview presented in Table 3 illustrates that business models were used in combination with a wide array of topics and approaches. While early articles addressed the issue of how to properly describe business models, they tended to agree on the boundary-spanning nature of the concept (Amit and Zott, 2001; Govindaraj and Gupta, 2001; Magretta, 2002; Morris et al., 2005; Zott and Amit, 2008). Moreover, business models were investigated in the context of technologies. Technology, thereby, was seen as an integral part of business models (Osterwalder et al., 2005) or as factor that needed to be translated into economic performance (Chesbrough and Rosenbloom, 2002). Further themes were the role of "openness" (Chesbrough, 2007b; Berglund and Sandström, 2013) as well as the bidirectional relations between technologies and the environments of business models (Teece, 2010; Baden-Fuller and Haefliger, 2013). Consequently, changes in business models and their relation to business environments and technologies are further explored in the following sections. In doing so, in this thesis, the understanding is adopted that business models comprise the essential elements of *"value creation," "value capture"* as well as *"value proposition and delivery,"* as this is an understanding deeply rooted in the literature (cf. (Clauss, 2017; Remane et al., 2017)). This understanding also enabled a practical approach to be taken toward describing relevant elements of business models.

## 3.2 Changing business models

Over the course of more than two decades, business models have become a relevant issue in innovation management - both as a facilitator *for* innovation as well as a subject *of* innovation (Massa and Tucci, 2014, p. 420, 424). Teece (2010, p. 176) noted that (new) *"[...] business models can both facilitate and represent innovation."* In that regard, Pohle and Chapman (2006, p. 37) highlighted that internal (i.e., organizational structure changes) as well as external (i.e., strategic partnerships) factors were common aspects of business model innovation. Reducing costs, improving strategic flexibility, as well as applying a specialized focus, and exploiting arising opportunities or new markets, were cited as the most common benefits of business model innovation (Pohle and Chapman, 2006, p. 37).

As with business models, researchers noted that the research on business model innovation also suffered from a lack of clarity regarding the construct and a lack of an agreed-upon definition (e.g., Casadesus-Masanell and Zhu, (2013), p. 480; Schneider and Spieth, (2013), p. 1340001-25; Spieth et al., (2014), p. 238; Foss and Saebi, (2017), p. 203; Foss and Saebi, (2018), p. 9). In addition, despite their close relations, *"business model innovation"* was less well understood than *"business models"* (Foss and Saebi, 2017, p. 201). This was arguably due to its more recent emergence and the additional innovation dimension (Foss and Saebi, 2017, p. 201). Therefore, business model innovation can benefit from being conceptualized and theorized as a distinct construct (Foss and Saebi, 2017, p. 201).

In an attempt to apply a structure to the research streams, Schneider and Spieth (2013, p. 1340001-25) found that (1) challenges, (2) process and elements, and (3) effects and results for business models were major themes in the literature on business model innovation. In a later review, Foss and Saebi (2017, p. 206) identified four research streams on business model innovation: (1) conceptualization and classification, (2) process views on the topic, (3) business model innovation as an outcome, and (4) organizational implications and performance (cf. Schneider and Spieth (2013); Foss and Saebi (2017)). Müller (2014, p. 5) provided an overview of the terminology used to address business models. She identified that publications applied the following concepts to address business model change: (1) business model innovation, (2) strategic innovation, (3) value innovation, (4) dynamic business models, (5) business model evolution, (6) business model reconfiguration, (7) business model reinvention, and (8) business model flexibility.

Casadesus-Masanell and Ricart (2010, p. 199) argued that business models could be thought of as a set of components, their relations, and feedback loops and recommend to aim for creating virtuous cycles, leading to changes in the business model. Another understanding was propagated by Demil and Lecocq (2010, p. 243), who recognized business model innovation as the ongoing management of the *"permanent state of disequilibrium"* present in any functioning business model to establish sustained performance. Foss and Saebi (2018, p. 9) also underlined the role of business model innovation to enact novel changes in a business model's underlying mechanisms. The examples serve to illustrate the broad array of different ways in which business model innovation is understood in the literature.

One reason why researchers may be struggling to find a general approach that can be applied to conceptualize business model innovation could be the levels of similarities and overlaps between concepts of business model innovation with other concepts of innovation (Schallmo, 2013, p. 24). As shown in Figure 5, these related concepts are the innovation of performance, processes, markets, and social innovation (Schallmo, 2013, p. 24).

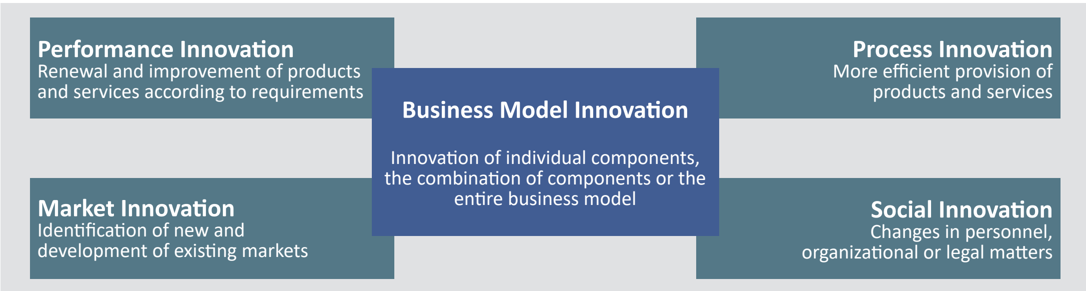


**Figure 5:** Classification of business model innovation with respect to related innovation concepts according to Schallmo (2013, p. 24)

To provide an overview of how business model innovation is described in the literature, Table 4 presents a selection of articles that provide definitions for business model innovation.

**Table 4:** Selected articles on business model innovation. The table summarizes the applied research approaches as well as the authors' definitions. Articles are sorted by date of publication. (The selection is partly based on previous reviews performed by Zott et al. (2011), Müller (2014), and Foss and Saebi (2017))

| Authors | Type & approach | Proposed definition of business model change concept |
|---|---|---|
| Markides (2006) | • Article<br>• Conceptual<br>• Examples | *"Business-model innovation is the discovery of a fundamentally different business model in an existing business."* (Markides, 2006, p. 20) |

Table 4 continues on next page

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| Authors | Type & approach | Proposed definition of business model change concept |
|---|---|---|
| Santos et al. (2009) | • Working Paper<br>• Conceptual<br>• Examples | Business model innovation *"[...] is a reconfiguration of activities in the existing business model of a firm that is new to the product/service market in which the firm competes."* (Santos et al., 2009, p. 14) |
| Gambardella and McGahan (2010) | • Article<br>• Conceptual | They note that *"[...] business-model innovation occurs when a firm adopts a novel approach to commercializing its underlying assets."* (Gambardella and McGahan, 2010, p. 263) |
| Schallmo and Brecht (2010) | • Conference paper<br>• Conceptual (qualitative) | *"Business model innovation is the development of a new business model that changes an industry. Business model innovation is future and customer-oriented, considers the macro and micro environment and is valid for all business model levels. Business model innovation can be made for one or more element(s) of a business model. The target is to have knowledge on future customer needs and to satisfy them in a new way of creating value. Similar to other innovations such as product, service, process, business model innovation should be executed in a structured way."* (Schallmo and Brecht, 2010, p. 8) |
| Zott et al. (2011) | • Article<br>• Review | The *"[...] business model represents a new subject of innovation, which complements the traditional subjects of process, product, and organizational innovation and involves new forms of cooperation and collaboration."* (Zott et al., 2011, p. 1032) |
| Aspara et al. (2013) | • Article<br>• Qualitative<br>• Longitudinal | The transformation of corporate business models was described as *"[...] a change in the perceived logic of how value is created by the corporation, when it comes to the value-creating links among the corporation's portfolio of businesses, from one point of time to another."* (Aspara et al., 2013, p. 640) |
| Berglund and Sandström (2013) | • Article<br>• Conceptual | A business model innovation *"[...] can thus be thought of as the introduction of a new business model aimed to create commercial value. It should be underlined here that we focus on procedural rather than substantive success."* (Berglund and Sandström, 2013, p. 276) |
| Amit and Zott (2015) | • Article<br>• Conceptual<br>• Examples | Business model design *"involves the conceptualization of a boundary spanning activity system that includes the mechanisms that connect these interdependent activities and the identification of the party that carries out each of the activities within the system"* (Amit and Zott, 2015, p. 332) |
| Saebi (2015) | • Book (chapter)<br>• Conceptual | Business model innovation *"[...] can be defined as the process by which management actively innovates the internal and/or external dimensions of the business model to disrupt market conditions."* (Saebi, 2015, p. 149)<br><br>*"Business model evolution refers to the effective standardization, replication, implementation, and maintenance of the existing business model."* (Saebi, 2015, p. 150) |

Table 4 continues on next page

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| Authors | Type & approach | Proposed definition of business model change concept |
|---|---|---|
| Saebi et al. (2017) | • Article<br>• Quantitative | Saebi et al. defined business model *adaption* as *"[...] the process by which management actively aligns the firm's business model to a changing environment, for example, changes in the preferences of customers, supplier bargaining power, technological changes, competition, etc."* Similarly, *"[...] business model innovation is defined as the process by which management actively innovates the business model to disrupt market conditions."* (Saebi et al., 2017, p. 569) |

The fragmented nature of the literature on business model innovation (see Table 4) highlights the need for a more general understanding of the concept. In that regard, one concrete approach to describe business model innovation, laid out by Massa and Tucci (2014), is illustrated in Figure 6. They differentiated between (1) *"business model design"* as conceiving business models for new organizations and (2) *"business model reconfiguration"* as the adaptation of existing business models (Massa and Tucci, 2014, p. 424). Despite being different, both approaches could lead to business model innovation (Massa and Tucci, 2014, p. 424, 425).


**Figure 6:** Categorization of business model innovation with regard to business model design and business model reconfiguration (Massa and Tucci, 2014, p. 425)

Moreover, Saebi et al. (2017, p. 569) added to the understanding of business model change concepts by clarifying the differences between the concepts of *business model innovation* and *business model adaption*:

- **Business model adaption:** Response to external causes; does not necessarily need to be innovative (Saebi et al., 2017, p. 569)

- **Business model innovation:** Response to internal and/or external factors (Bucherer et al., 2012, p. 195; Saebi et al., 2017, p. 569)

In line with the previous literature (cf. Teece (2010)), Foss and Saebi (2018, p. 9) argued that business models as well as business model innovation were centered around the creation, delivery, and capture of value. Adding to this understanding, Clauss (2017, p. 391) summarized that sub-constructs underlying the innovation of business models can be grouped into similar categories as the business model itself: (1) *"value creation innovation"*, (2) *"value proposition innovation"*, and (3) *"value capture innovation"*. Interestingly, Foss and Saebi (2018, p. 15) recognized a disagreement in the literature regarding the necessary degree of change in a business model's scope that would constitute *"business model innovation"*. Foss and Saebi (2017, p. 12) categorized the literature into three groups as follows:

- Literature that recognized business model innovation in cases where a single element of a business model changed (cf. Santos et al. (2009); Amit and Zott (2012); Bock et al. (2012); Abdelkafi et al. (2013); Schneider and Spieth (2013)),

- Literature that proposed that at least two components of a business model needed to be changed to characterize it as business model innovation (cf. Lindgardt et al. (2009); Gassmann et al. (2014)),

- Literature that considered business model innovation only when a completely new business model was developed (cf. Yunus et al. (2010); Velamuri et al. (2013)).

In contrast, adopting the understanding of business models encompassing *"content"*, *"structure"*, and *"governance"* (cf. Amit and Zott (2001, p. 511)), Amit and Zott (2012, p. 42) proposed that changes in any of these aspects resulted in business model innovation. Specifically, they highlighted changes in (1) *"content"* - changing (add new, remove current) activities (e.g., forward- or backward integration), (2) *"structure"* - linking activities in new ways, and (3) *"governance"* of the activity system - changes in the actors' performed activities (Amit and Zott, 2012, p. 42).

In addition to a basic description of what constitutes business model innovation, Saebi (2015, p. 151) provided a more concrete approach that could be taken to classify changes in business models. As shown in Table 5, specific characteristics of business model change can be used to differentiate between their evolution, adaption, and innovation (Saebi, 2015, p. 151).

**Table 5:** Characterization of evolution, adaption, or innovation of business models according to Saebi (2015, p. 153)

| | **Business model evolution** | **Business model adaption** | **Business model innovation** |
|---|---|---|---|
| **Planned outcome** | Natural, minor adjustments | Alignment with the environment | Disruption of market conditions |
| **Scope of change (affected areas)** | Narrow | Narrow to wide | Wide |
| **Degree of radicalness** | Incremental | Incremental to radical | Radical |
| **Change frequency** | Gradual, continuous changes | Periodical | Infrequent |
| **Degree of novelty** | n.a. | Novelty not necessarily required | Needs to be novel to the industry |

Table 5 illustrates that both evolution and adaption show similarities in their impacts on organizational processes (Saebi, 2015, p. 151). The approaches differ, however, with regard to the processes occurring naturally (business model evolution) or in reaction to changes in the company's environment (business model adaption) (Saebi, 2015, p. 151). In a later article Foss and Saebi

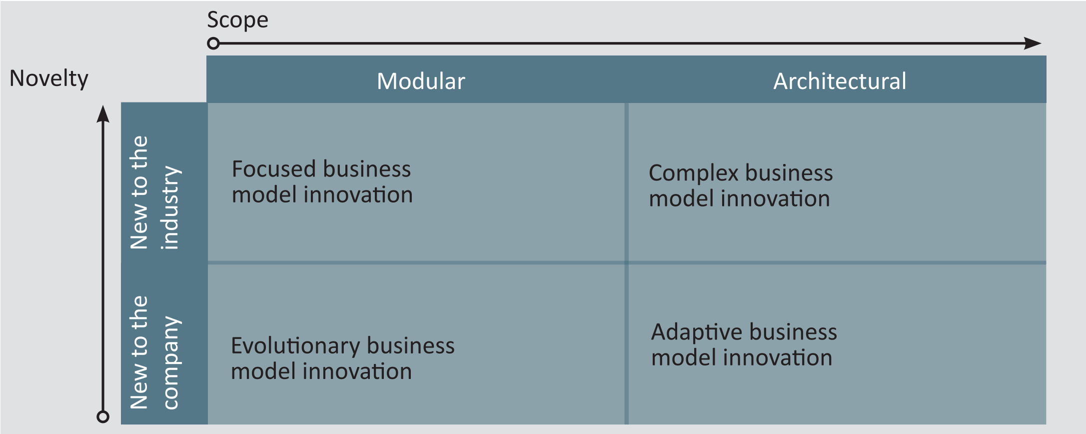



**Figure 7:** Typology of business model change as proposed by Foss and Saebi (2017, p. 217)

(2017, p. 217) extended their characterization of the business model change types and proposed a typology that could be used to characterize business model innovation based on the dimensions *"scope"* and *"novelty"*, as illustrated in Figure 7. Specifically, Figure 7 illustrates a way to distinguish among four types of business model change concepts (Foss and Saebi, 2017, p. 217):

- **Evolutionary business model innovation** often describes naturally occurring changes that fine-tune individual components of business models with respect to voluntary and emergent changes (compare Demil and Lecocq (2010)).

- **Adaptive business model innovation** involves changes to the overall business model that are new to a certain company, but not new to a certain industry. These changes are often triggered by changes in a company's environment (compare Teece (2010) and Saebi et al. (2017)).

- **Focused business model innovation** is actively pursued by management. It typically involves a certain area of the business model. One example could be addressing markets that have been previously ignored by competitors while keeping the business model largely constant (i.e., in terms of unchanged value proposition, delivery, and capture).

- **Complex business model innovation** - like focused business model innovation - is pursued by management. However, instead of involving single elements of a business model, it addresses the business model as a whole.

The approach described by Foss and Saebi (2017, p. 217) finds itself in agreement with approaches for business model change reported in the literature. For example, Schneider and Spieth (2013, p. 1340001-26) found that business model innovation was focused on exploiting opportunities in the company's increasingly volatile environments, while business model development was more company-centric.

Consequently, to describe the changes observed in business models studied in this thesis work, the approach of Foss and Saebi (2017) was adopted. The chosen approach is particularly beneficial regarding the focus of this thesis work, as it could be applied to characterize changes in business models with respect to their environments. As the presented literature review indicated that business models and business model innovation are often used in combination with technologies and/or aspects from their respective business environments, the literature in these areas was subsequently investigated in greater detail.

## 3.3 Business environments and business models

As described in Section 3.2, changes in business models are often related to changes in a business model's environment. Business models and their environments, thereby, are subject to interdependent relations (Gassmann et al., 2011). From a theoretical perspective, the literature on business models stands in contrast with the established theories on strategy, which trace a competitive advantage back to a single issue (e.g., resource-based view, positioning view) (Massa et al., 2017, p. 75). In particular, Massa et al. (2017, p. 75) underlined that when the business model perspective is taken, *"[...] competitive advantage can be multi sourced — that is, competitive advantage can be resource based and activities based, in the supply side and/or demand side."*

However, several authors indicate (e.g., Berglund and Sandström (2013, p. 275), Amit and Zott (2015, p. 346)) that the majority of literature on business models addresses internal company-level characteristics rather than presenting a view of it as a boundary-spanning entity embedded in its environment. This is curious, as Amit and Zott (2001, p. 514) suggested early on that business models should be seen in the context of their environments. They compared value sources in business models and strategic networks concerning their content, structure, and governance. Recent definitions also reflect the notion that business models should be seen as constructs that are embedded in their environments. For instance, Amit and Zott (2015) highlighted the role of the environmental aspects of business model design by describing it as *"[...] the conceptualization of a boundary spanning activity system that includes the mechanisms that connect these interdependent activities and the identification of the party that carries outreach of the activities within the system."* Berglund and Sandström (2013, p. 277) also stated that business models arguably spanned companies' boundaries, while Santos et al. (2009, p. i) suggested that, since business models consisted of activities and linkages (transactions, relationships), the innovation of business models needed to take into account the social context in which both internal and external relations occur. Therefore, focusing on issues inside single companies would leave important aspects of business model innovation unexplored (Berglund and Sandström, 2013, p. 277). Along these lines, Schallmo and Brecht (2010, p. 13) proposed to use what they called *"business model environments"* which incorporated the macro- and micro-environments of a company, as well as market forces, to develop business models. This idea is reflected in a concept proposed by Demil et al. (2018, p. 1224), who argued that through the choices inherent in business models, companies would determine key factors, such as its stakeholders, the nature of competition and technological infrastructure, as well as the regulatory regime.

Subsequently, authors began to explore the relations between business model innovation and business environments. For example, Spieth and Meissner (2018) and Spieth et al. (2020) studied business model innovation in alliances. Along that line, Velu (2016) investigated the role of co-opetition in the context of business models. Pohle and Chapman (2006, p. 34) found that competitive pressure resulted in an increased amount of attention from practitioners on the topic of business model innovation, while Giesen et al. (2010, p. 20) proposed that a number of environment-related factors were relevant to achieve successful business model innovation. As illustrated in Table 6, Giesen et al. (2010, p. 20) emphasized the importance of aligning internal and external aspects, integrating flexibility into the business model, as well as having strategic foresight, and performing planning activities.

**Table 6:** Factors for successful business model innovation (adapted from Giesen et al. (2010, pp. 20 ff.))

| Factor | Focus | Description |
|---|---|---|
| **Aligned** | **Customer value** | • Leverage existing assets and capabilities (e.g, skills, talent, processes or technology)<br>• Establish consistency across business model dimensions (internal, external) to demonstrate value to customers<br>• **Internal consistency:** Align business model elements (e.g., value delivery and value capture) around a customer value proposition<br>• **External consistency:** Orchestrate the collaborations and partnerships with customers, partners and suppliers (e.g., through "open" business model approaches) |
| **Analytical** | **Strategic foresight activities** | • Strategic use of information to perform rapidly paced course corrections<br>• Emphasize financial business modeling and effective measurements to support decision making |
| **Adaptable** | **Leaderhip, change, operational flexibility** | • Integrate flexibility/adaptability into the business model to manage environmental uncertainties<br>• Emphasize leadership and foster the (organizational) ability to perform innovations and to adapt to innovations |

Ultimately the review results indicate that research on business models and business model innovation in the context of their environments has gained attention in recent years. This is also the case because authors began to point out the critical importance of business model innovation in complex and fast-changing business environments (Giesen et al., 2010, p. 17). Here, according to Saebi (2015, p. 145), *"[...] different environmental conditions need to be matched with appropriate adjustments in the firm's business model."* This idea is illustrated in Figure 8, which shows that, while incremental changes in business models might be sufficient to adapt to gradually changing environments, substantial changes to business models will likely be necessary at some point.

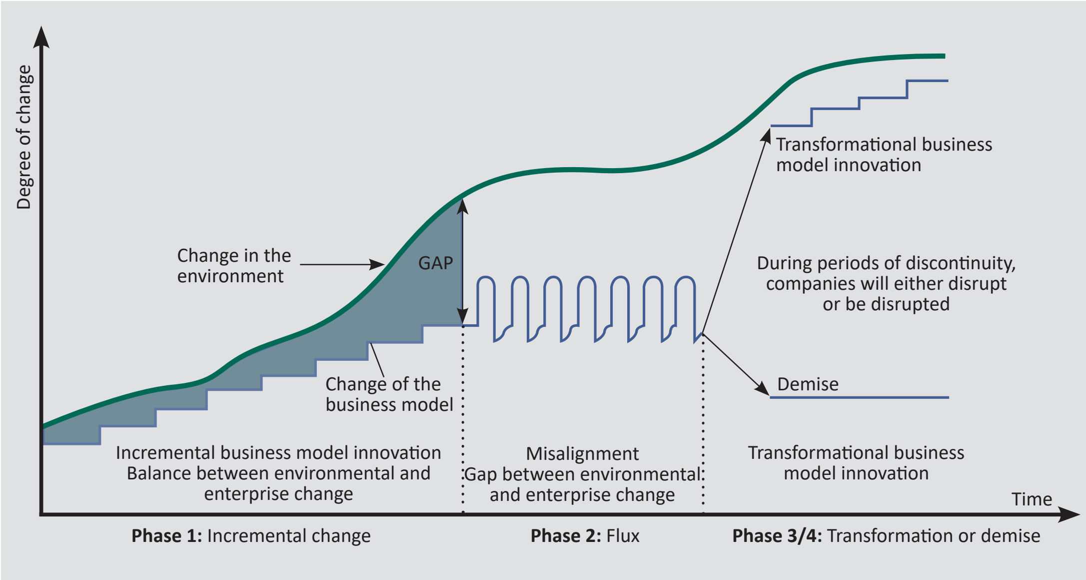



**Figure 8:** Business model innovation to establish alignment with environmental changes (adapted from Johnson et al. (2005, p. 27) and Giesen et al. (2010, p. 19))

### 3.3.1 Influences on the change in business models in the context of their environments

With regard to adjusting individual business models to fit their environments, Saebi (2015, p. 153) highlighted the roles of environmental factors that could potentially yield substantial influences on business models. A rough differentiation was provided by Demil and Lecocq (2010, p. 239), who distinguished between *"voluntary"* business model changes and *"emerging"* changes. These can either stem from a company's environment or be an unanticipated result of voluntary actions. Table 7 provides a literature-based characterization of *"dynamic environments"* and the respective degree of appropriate change to business models (Saebi, 2015, p. 153). Particularly in the case of *"environmental shifts"*, which Saebi (2015, p. 153) described as *"[...] dramatic or discontinuous changes [...]"* that typically had their roots in (1) disruptive technologies, (2) new competitors, as well as (3) substantial changes in political regimes and/or regulations (cf. Tushman and Anderson (1986); Christensen (1992); Suarez and Oliva (2005); Sirmon et al. (2009); Christensen et al. (2011)), a high degree of business model innovation might be necessary.

**Table 7:** Patterns of environmental conditions and appropriate business model change approaches according to considerations by Saebi (2015, pp. 153, 161), Suarez and Oliva (2005, p. 1022), and Wholey and Brittain (1989, p. 869)

| | **Regular environmental changes** | **Environmental competitiveness** | **Environmental shifts** |
|---|---|---|---|
| **Frequency** (number of disturbances in environment per unit of time) | Low | High | Low |
| **Amplitude** (magnitude of deviation with respect to initial status caused by disturbance) | Low | Moderate to low | High |
| **Velocity** (change of amplitude over time) | Low | Continuously high | Punctuated (two stages) |
| **Predictability** (Degree of irregularity in change patterns) | High | Moderate | Low |
| **Proposed business model change approach** | Business model evolution | Business model adaption | Business model innovation |

However, performing successful business model innovation in the context of their environment is believed to require an understanding of both constructs, how they impact each other, and considerations of companies performing the undertaking.

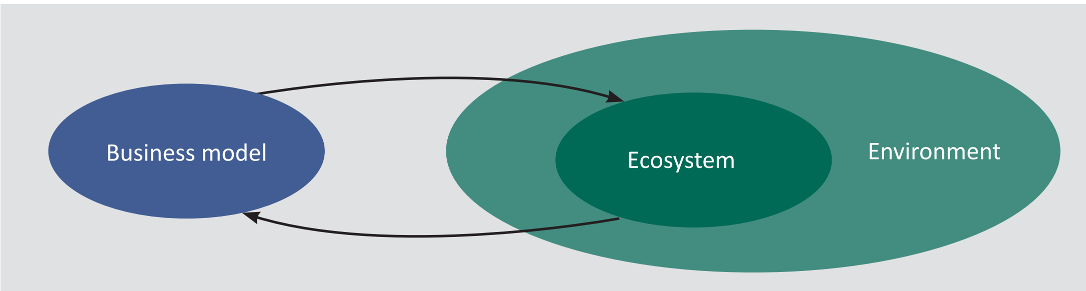



**Figure 9:** Interactions between an organization's business model, the ecosystem and the environment according to Demil et al. (2018, p. 1224)

Thus, organizations in similar environments might participate in different ecosystems (Demil et al., 2018, p. 1224). On the one hand, ecosystems might be selected by making choices regarding their business models; on the other hand, stakeholders in a company's environment might influence the design of a company's business model (Demil et al., 2018, p. 1224). This, in turn, has its roots in the co-evolution (Lewin and Volberda, 1999) that occurs between business models and their ecosystems, as illustrated in Figure 9 (Demil et al., 2018, p. 1225).

In an attempt to categorize the literature on the topic, Saebi et al. (2017, p. 569) found that essential drivers for business model adaption included (1) adapting to external stakeholders, (2) changes in the competitive environment, and (3) opportunities provided by new technologies (i.e., technologies for information and communication). They subsequently underlined the role of external factors in changing business models. Moreover, relevant aspects mentioned in the literature for companies performing business model innovation in the context of their respective environments were accessing resources and creating markets. In particular, Amit and Zott (2015, p. 343) emphasized resource constraints as well as cost-benefit trade-offs related to innovation by involving partners in a company's value creation activities (cf. Amit and Zott (2012, p. 42) and Amit and Zott (2015, p. 343)). Spieth and Meissner (2018, p. 1850042-1) also pointed out that incumbent companies were increasingly involving alliance partners in their business model innovation activities to mutually access their resources and commercialize the results. Spieth et al. (2020, p. 12) emphasized that practitioners should consider the resources and complementary competencies as well as the long-term fit of cooperation partners' business models. Moreover, Amit and Zott (2015, p. 341,346) drew correlations between the literature on business models and business ecosystems (cf. Moore (1993, 1996); Adner and Kapoor (2010)). They particularly highlighted the ecosystem's role in business models with regard to outsourcing functions or activities, providing finances, and offering a source of technologies that a company can access. They further stated that in a business model, *"[...] the focal firm collaborates with business model stakeholders across its ecosystem (partners, customers, suppliers, financiers) to craft a unique solution [...]"* and emphasized the need for the appropriate governance of the involved actors and their activities (Amit and Zott, 2015, p. 341).

Several authors have also emphasized market-related factors for undertaking business model innovation. (e.g., Saebi et al. (2017, p. 569), Amit and Zott (2012, p. 44)). This is particularly because *"[...] an innovative business model can either create a new market or allow a company to create and exploit new opportunities in existing markets [...]"* Amit and Zott (2012, p. 44). (cf. Markides (2006); Teece (2010); Saebi (2015)) Further relevant aspects in the literature were the joint creation of value when performing business model innovation in the context of environments (cf. Massa and Tucci (2014, p. 426) or Zott and Amit (2007)) and the governance of interactions (cf. Berglund and Sandström (2013, p. 279)). For instance, Berglund and Sandström (2013, p. 279) pointed out that business models were not under the control of the focal company alone. They ascertained that multiple companies were involved in supplying resources to ensure the operation of a focal company's business model (Berglund and Sandström, 2013, p. 279). Based on this, they concluded that companies that engaged in business model innovation *"[...] are therefore subject to restricted freedom and are forced to act under conditions of interdependence [...]"* (Berglund and Sandström, 2013, p. 279). In a similar vein, Spieth et al. (2019, p. 276) stated that a *"[...] network-embedded business model relied on network level value creation processes and business exchange patterns that are not clearly aligned."* They further distinguished between innovating the (1) value architecture, (2) value offerings, and (3) revenue models when changing network embedded business models (Spieth et al., 2019, p. 277).

### 3.3.2 Capabilities for performing business model innovation in environments

One particular difficulty to be faced with when connecting business models and their respective environments was described by Teece (2010, p. 191), who proposed that *"[...] a business model cannot be assessed in the abstract; its suitability can only be determined against a particular business environment or context."* Therefore, business models needed to be calibrated with regard to a certain context or business environment (Teece, 2010, p. 191). This idea is supported by the work of Porter (2001, p. 13), who, despite his criticism of business models, recognized that *"[...] no business model can be evaluated independently of industry structure."* The aspect is further reflected in the recent literature that underlines the fact that the value of business models - as well as business model innovation - depends on its context (i.e., its environment) (Foss and Saebi, 2018, p. 17). It can be noted that changing business models in the context of their environments requires the alignment of multiple aspects. In particular, Teece (2010, pp. 188-189) highlighted the fact that the *"[...] elements of a business model must be designed with reference to each other, and to the business/customer environment and the trajectory of technological development in the industry."* Therefore, Teece (2010, pp. 188-189) considered not only the impact of technologies but also the role of industries with respect to business models. The relevance of this more holistic approach to business model innovation is underlined by the idea that with business models *"[...] value creation is both a supply- and demand-side phenomenon—where value is created not only by producers, but also by customers and other members of their value-creation ecosystems [...]"* (Massa et al., 2017, p. 75). To address these difficulties, Saebi (2015, p. 157) proposed that companies needed to demonstrate a *"business model change capability"* which she defined as *"[...] the firm's capacity to adjust, adapt, and innovate its business model in the face of environmental dynamics."* Consequently, Saebi (2015, p. 157) argued that this capability might prove valuable to overcome business model rigidities *"[...] and implement change processes in a structured and systematic way."*

As illustrated in Table 8, Saebi (2015, p. 161) ascertained that business model change was contingent on environmental dynamics. Depending on the type of change in a company's environment, different degrees of business model change involved specific types of dynamic capabilities. Saebi (2015, p. 161) further highlighted the idea that each type of dynamic capability relied on specific dimensions of capability.

**Table 8:** Contingency framework for environmental dynamics and respective types of business model changes and dynamic capabilities (Saebi, 2015, p. 161)

| | Environmental dynamics | | |
|---|---|---|---|
| | **Regular change** | **Environmental competitiveness** | **Environmental shift** |
| **Type of business model change** | Business model evolution | Business model adaption | Business model innovation |
| **Type of business dynamic capability** | Evolutionary change capability | Adaptive change capability | Innovative change capability |
| **Underlying capability dimensions** | • Dynamic consistency[1] | • Customer agility[2]<br>• Strategic flexibility[3]<br>• Exploration[4] | • Exploration[4]<br>• Business model know-how<br>• Dedicated organizational units and functions for business model innovation |

Moreover, while most authors stated that business models depended on environments, others said that they were also able to influence their environment (compare with Saebi (2015, p. 151)). For instance, Gassmann et al. (2011) suggested considering an industry's dominant logic when adopting specific business model patterns. Business model patterns could thereby follow similar patterns in their environment or confront an industry with radically different business model patterns (Gassmann et al., 2011). In that regard, Teece (2010, p. 191) proposed that a bidirectional relation existed between business models and business environments. Thereby, companies could (1) select their business environments, (2) be selected by their environments, or (3) shape their environments (Massa and Tucci, 2014, p. 438). Specifically, these authors suggest that companies facing *"dynamic environments"* can change their business models in the following ways (Saebi, 2015, p. 151):

- **Align the business model with the environment:** The first principle alternative that Saebi (2015, p. 151) proposed was to perform business model adaption to align the business model in response to changes in external conditions.

- **Perform business model innovation to influence the environment:** The second alternative according to Saebi (2015, p. 151) was to *"[...] shape market conditions by means of creating disruptive innovation (i.e., business model innovation)."*

These suggestions are complemented by insights provided by Dellyana et al. (2018, p. 214), who proposed that business models could provide a platform for individual actors to interact with their

[1]See Doz and Kosonen (2010) for capabilities with regard to dynamic consistency.
[2]See Roberts and Grover (2012) for capabilities with regard to customer agility.
[3]See Wang and Ahmed (2007) for capabilities with regard to strategic flexibility.
[4]See (March, 1991; Jansen et al., 2006; Dixon et al., 2014) for capabilities with regard to exploration.

network. Along these lines, Lindgren et al. (2010, p. 122) argued that altering business models *"[...] to become network-based is a complex venture, but critical for the survival of many companies."* In particular this is because business models need to embrace both internal and external relations to create value for an interlinked network of companies and other agencies (Budde Christensen et al., 2012, p. 504). Leminen et al. (2020, p. 299) also differentiated between company-specific business model innovation, on the one hand (taking place inside-out), and systemic (connected) business model innovation (taking place outside in), on the other hand. The degree of innovation in both cases could range from incremental to radical (Leminen et al., 2020, p. 299). Moreover, as business model innovation often spans the companies' boundaries, it likely goes hand in hand with redefining value networks (e.g., as new business partners emerge) (Guo et al., 2013, p. 453) and is affected by co-opetition and the industry structure (Velu, 2016, p. 134).

However, the degree to which business models can be designed with regard to their environment is disputed in the literature. For instance, Simmons et al. (2013, p. 751) questioned whether business models could be designed and implemented in a deterministic manner. Instead they proposed that *"[...] business models develop in an evolutionary manner, influenced by and influencing the context within which they are set, with often 'messy' social interactions and negotiations promoting this process through value inscriptions with supporting marketing activities [...]"* (Simmons et al., 2013, p. 751). This idea was supported by the work of Chesbrough (2010, p. 356), who highlighted that business model innovation relied more on trial and error and subsequent adaptation than on determining a business model using superior foresight.

## 3.4 Technologies and innovation in business models

As proposed by Vorbach (2016) and as supported by the insights provided in this chapter, business models are often used in the context of technologies and (disruptive) innovation. In particular, technology can act as a catalyst that might both drive and enable innovation (Chapman, 2006, p. 36). Chapman (2006, p. 36) argued that technology may *"[...] play a vital part in new products, services, channels, market-entry strategies, operational transformation and industry-altering business models."* In addition, Chapman (2006, p. 36) highlighted the fact that technology *"[...] can even enable other innovation enablers such as collaboration."*

Before this aspect is explored further, a short overview on approaches for characterizing technologies and their development is provided[1]. Based on this overview, the literature on technologies and innovation in the context of business models as well as their respective environments is reviewed in more detail.

[1] For more detailed considerations of technology management, the reader is referred to the literature on the topic (cf. Christensen (1992, 1997); Cetindamar et al. (2010); Sood and Gerard (2011); Taylor and Taylor (2012); Christensen et al. (2018)).

### 3.4.1 Relevant concepts of innovation and technological change

The idea that companies struggle when confronted with technological innovation - both radical and incremental - is a topic that is deeply rooted in theory (cf. Schumpeter (1939)). Unsurprisingly, the topic has spawned substantial research and debate (Sood and Gerard, 2011, p. 339). To address the issue, different concepts have been proposed in the past, such as the technology S-curve[1] (Foster, 1986), disruptive innovation[2] (Christensen, 1997), or the technology life cycle (Tushman and Rosenkopf, 1992).

As shown in Figure 10, the technology life cycle (cf. Tushman and Rosenkopf (1992); Kaplan and Tripsas (2008); Taylor and Taylor (2012)) illustrates the difference between phases with a clear industry standard (i.e., dominant design) and incremental changes that are interrupted by technological discontinuities. These, in turn, lead to phases with high technological uncertainty and ambiguous preferences. S-curves, in contrast, proved to be a helpful tool both on the industry

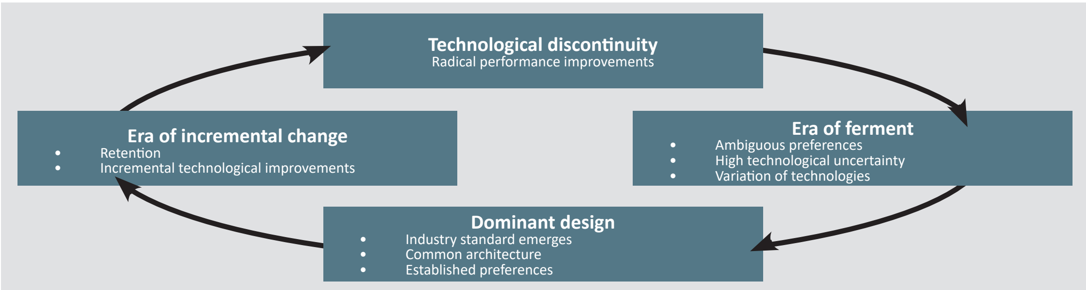



**Figure 10:** *"Technology life cycle"* adapted based on work by Tushman and Rosenkopf (1992), Kaplan and Tripsas (2008, p. 794) as well as Taylor and Taylor (2012, p. 544)

and the component levels, which can be used to gain insights into how different technologies might improve (Christensen, 1992, p. 353). On the downside, however, these S-curves failed to represent market factors. *"Disruptive Innovation,"*[3] in contrast, allowed considerations to be made of both technological performance and market factors (Christensen, 1997). While initially serving a small market segment that places value on disruptive innovations' *"nonstandard performance attributes,"* further developments in performance enable them to serve the mainstream market (Adner, 2002, p. 668). Adner (2002, p. 668) summarizes that, as a result, the new technology - despite showing lower performance in certain attributes - *"[...] displaces the mainstream technology from the mainstream market."* Interestingly, Christensen (1997, p. 29) proposed that the *"value network"* was a key factor that allowed companies to succeed with (disruptive) technologies. He

[1] As described by Foster (1986) and several authors thereafter (e.g., Cetindamar et al. (2010); Schuh et al. (2011)), the S-curves serve to illustrate the performance of a technology either over time or the cumulative efforts with regard to research and development (R&D).

[2] Adner (2002, p. 668) characterized disruptive technologies as *"[...] technologies that introduce a different performance package from mainstream technologies and are inferior to mainstream technologies along the dimensions of performance that are most important to mainstream customers."*

[3] Christensen (1997) used the terms *"Disruptive Innovation"* and *"Disruptive Technology"* interchangeably.

further argued that *"[...] a disruptive innovation, by definition, must measure different attributes of performance than those relevant in established value networks [...]"* (Christensen, 1997, p. 29). Christensen and Raynor (2003) later added the third dimension of *"New-Market Disruption"* and highlighted the fact that these new-market disruptions relied on different contexts of consumption and competition that previously could not be utilized (e.g., due to overly high costs or a lack of skills) or were not needed to fulfill specific performance attributes of products. (cf. Christensen (1997); Adner (2002); Christensen and Raynor (2003); Christensen et al. (2011))

However, the concept of disruptive innovation is not without criticism. This led several authors to propose extensions. For instance, Adner (2002, p. 670) highlighted the role of the *"[...] demand environment in which technologies compete [...]"*, Carr (2005, p. 2) proposed a differentiation between top-down or bottom-up disruption, and Govindarajan and Kopalle (2006, p. 189) criticized the lack of measures for disruptive innovation. Meanwhile, Sood and Gerard (2011, p. 342) proposed that researchers needed to distinguish between the *"lower attack"* and *"upper attack"*, depending on the domain of a disruption and the performance of the entering technology. In addition, Sood and Gerard (2011, p. 349, 350) highlighted the critical fact that (1) typically, competing technologies coexisted, since even disrupted technologies can be relegated to a niche to survive, (2) technologies can face disruptions in selected domains[1], (3) technologies do not necessarily develop in the form of S-curves, and (4) new technologies introduce *"[...] a new dimension of importance even while competing with old technologies on the primary dimension [...]"* (compare also with Christensen (1997, p. 29)). Based on these outlined concepts, the following sections provide an overview of the literature that addresses business models and business model change in the context of technologies and business environments.

### 3.4.2 Relations between technologies and business models

Despite the high relevance of technologies both in research and practical applications, some authors have argued that technology alone would have little economic value and, thus, require a suitable business model (cf. (Massa and Tucci, 2014, p. 424), Chesbrough and Rosenbloom (2002, p. 529)). As Chesbrough (2007a, p. 12) stated, a *"[...] better business model will beat a better idea or technology."* Chesbrough (2010, p. 354) also refined his stance on the relation of business models and technology by highlighting the fact that technology on its own yielded little objective value and, thus, required commercialization in a company's business model to demonstrate economic benefit. As illustrated in Figure 11, business models, therefore, play a crucial role in transforming technological properties in economic outputs (Chesbrough and Rosenbloom, 2002, p. 549). The literature also supports the relationship illustrated in Figure 11. For instance, Baden-Fuller and Haefliger (2013, p. 419) argued that business models acted as mediators by linking technology and companies' performances, and Smajlović et al. (2019, pp. 63-73) empirically showed that technological innovation positively impacted business model innovation, which, in turn, increased business success.

[1]This idea is in line with Christensen and Raynor (2003, p. 41), who stated that disruption was a relative concept, whereby an idea that might disrupt one business may sustain a different one.

In an attempt to clarify the issue, Baden-Fuller and Haefliger (2013, p. 424) proposed that the relationship between business models and technology was complex and bidirectional: While choosing a business model influenced how technology is monetized and profit is generated, technology itself influences business model possibilities (Baden-Fuller and Haefliger, 2013, p. 424). Subsequently, while business model innovation not necessarily relies on technology, technological development has the potential to facilitate the development and implementation of (new) business models (Baden-Fuller and Haefliger, 2013, p. 419).

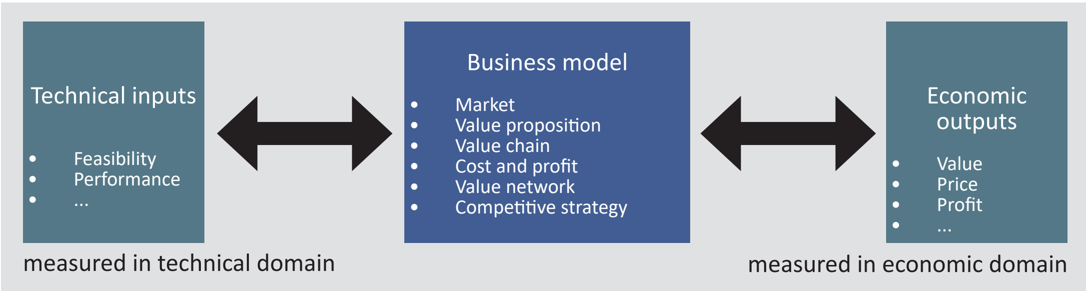



**Figure 11:** The business model as a mediator between technological and economical aspects as proposed by Chesbrough and Rosenbloom (2002, p. 536)

However, business models unlocked the value potential of technologies (e.g., by introducing a certain heuristic logic), but also constrained the scope of new, alternative business models with respect to different technologies (Chesbrough and Rosenbloom, 2002, p. 529). The business models' elements might also need to be changed to develop technology that addresses customer requirements (Hienerth et al., 2011). Tongur and Engwall (2014, p. 533) also added to this understanding by arguing that incumbent companies faced a *"business model dilemma"* if they were confronted with a shift in technologies. This dilemma - if not addressed - could have severe impacts on the viability of a company's business model as it *"[...] risks holding back necessary radical changes within the firm's value proposition, value creation, and value capture processes."* Along these lines, Saebi et al. (2017, p. 570) highlighted the role of path dependency, organizational inertia, and uncertainty of outcomes as factors that kept companies from changing their business models unless they had a strong incentive to do so. Interestingly, external threats encouraged companies to adapt their business model while external opportunities did not lead to changes in business models (Saebi et al., 2017, p. 576). This finding is in agreement with those of Cavalcante et al. (2011, p. 1328), who critically claimed that practitioners *"[...] might fail to recognize, explore, seize and exploit valuable new technological and/or market opportunities in time since this may require commercial approaches that are not consistent with the present business model."* Moreover, pursuing a *"dominant logic"* might keep companies from generating value with technologies that are not suited for use in their current business model (Chesbrough, 2010, p. 359). This is especially relevant, as disruptive product innovations could destabilize existing business models and market structures (Simmons et al., 2013, p. 751). One approach in that regard was proposed by Baden-Fuller and Haefliger (2013, p. 425), who underlined the role of modularity as a *"[...] model of technology development that could help explain technological development and the joint implications of changing customer demands and technological evolution for the business model."* Another interesting proposition to address the outlined dilemma was made by Tongur and

Engwall (2014, p. 534), namely, to pursue *"double ambidexterity"*, where companies needed to manage incremental and radical innovation while simultaneously also attempting to *"[...] advance both technological and business model innovation."*

The relevance of viewing technologies in combination with business models was also recognized by Christensen (2006, p. 43), which led him to refine his theory on disruptive innovation. He acknowledged that disruption occurred not only due to technologies but rather due to the business models a technology was used in (Christensen, 2006, p. 43). McGrath (2010, p. 257) followed Christensen's lead and further emphasized the link between business models and disruptive innovation by stating that *"[...] new models are often designed for customers that an incumbent doesn't serve, at price points they would consider unattractive, and builds on resources that they don't have [...]"*. She further illustrated that new business models were often seen as unattractive by incumbent companies (McGrath, 2010). In a similar vein, Markides (2006, p. 21) explained the incumbents' low levels of interest in new business models by stating that (1) *"[...] new business models attract different customers from those that established companies focus on [...]"* and (2) *"[...] require different and conflicting value chains from the ones established companies currently have."* Two approaches described in the literature to deal with disruptive innovations in business models are (1) to reconfigure value propositions and (2) to continuously develop business models:

- **Reconfigure value propositions:** Disruptive technologies are believed to require different value propositions in order to appeal to customers (Bohnsack and Pinkse, 2017, pp. 79, 93). Consequently, Bohnsack and Pinkse (2017, p. 89) proposed taking three tactics to reconfigure value propositions using disruptive technologies: (1) compensation tactics, which emphasize points of inferiority and aim to achieve parity in performance between the disruptive and incumbent technologies, (2) enhancing tactics, which emphasize points of superior value and typically require large changes in the business model as well as the value network, and (3) coupling tactics, which add *"[...] so-far-unrelated customer value [...]"* and subsequently have a substantial influence on the business model.

- **Continuous business model improvements:** Another approach taken to change business models facing disruptive technologies was proposed by Markides (2006). In particular, Markides (2006, p. 21) pointed out that new business models improve over time until they are able to satisfy the requirements of the mass market at some point while being superior regarding new aspects. At this specific point, customers are likely beginning to switch to the new business models offered (Markides, 2006, p. 21). This idea is similar to the idea of disruptive innovation described by Christensen (1997).

Another critical aspect addressed by Markides (2006, p. 21) was that, although he acknowledged similarities between new business models and disruptive innovation, he explicitly highlighted distinct differences among the constructs. He argued that, despite the fact that new business models often delivered high amount of initial growth, they tended to fail to completely take over a market and change the logic of competition (Markides, 2006, p. 21). While agreeing with Christensen (1997), Markides (2006, p. 22) argued that new business models do not necessarily make economic sense for incumbent companies. However, some notable exceptions can be found in the literature for situations that occur when pursuing disruptive business model innovation was deemed a feasible approach for established companies (Markides, 2006). Markides (2006, p. 22) particularly highlighted situations where established companies (1) entered markets where they had to compete with actors who yielded a first-mover advantage, (2) faced a crisis where the current strategy/business model was no longer appropriate, and (3) attempted to introduce, scale-up, and market a "new-to-the-world product."

### 3.4.3 The role of environments for business models and technologies

Several authors have noted the relations between business models, technologies, and their respective environments. For instance, Baden-Fuller and Haefliger (2013, p. 425) found that technology from other sectors could influence the creation and adaption of business models while Massa and Tucci (2014, p. 435) proposed that business model innovation can support companies in case of *"tectonic industry changes."* Curiously, Massa and Tucci (2014, p. 435) observed that these industry changes might be rooted in technological discontinuities or dramatic shifts in government policies and regulations. These findings underline the fact that the technologies that influence business models are often not specific to one company but depend on the business environments (cf. Christensen (1992); Adner (2002); Kaplan and Tripsas (2008); Taylor and Taylor (2012)). Vorbach et al. (2017, p. 9) also highlighted the fact that, as long as a *"potentially disruptive technology"* can be *"[...] integrated within the existing industry value chain, it will not alter the balance of power between its actors or its established appropriation modes."* They observed that technological discontinuities needed to be introduced into different business models, allowing them to create new dependencies, change patterns of collaboration, and modify specificities of assets in order to impact dominant industry logics (Vorbach et al., 2017, p. 9). Accordingly, external factors, such as competitive dynamics as well as the influence of technology on business model innovation, have to be taken into consideration when modeling the link between technological development and the performance of companies (Baden-Fuller and Haefliger, 2013, p. 424). Consequently, Baden-Fuller and Haefliger (2013, p. 424) proposed to take an ecosystem perspective to understand the requirements of system integrators with regard to the scientific and technological fields founded on these components and sub-systems (Dosi et al., 2005; Baden-Fuller and Haefliger, 2013).

To address the issue, Amshoff et al. (2015, pp. 1540002-1, 1540002-19) proposed several business model patterns that could be applied to manage the shifts in value creation networks resulting from technological disruptions and to address the resulting new market segments. Amshoff et al. (2015, p. 1540002-19) propagated the idea that new business model patterns emerging due to the introduction of disruptive technologies could be applied to multiple industries.[1] However, researchers are still not entirely certain how a company's current business model (and its respective assets and technologies) influences its ability to react to changes in its environment.

[1] Amshoff et al. (2015, p. 1540002-5) distinguished between (1) basic solution patterns for (technology-based) business models, (2) industry-specific prototypical business models, and (3) the documentation of business models in frameworks (e.g., the business model canvas as proposed by Osterwalder and Pigneur (2010)).

## 3.5 Summary

In this chapter, the fundamental aspects of business models and the changes in business models were described. As described in detail in Section 3.1, an approach was adopted during this thesis work to characterize business models by looking at the dimensions of their *"value proposition and value delivery," "value capture,"* and *"value creation."* Moreover, the literature presented in Section 3.2 supported the use of the approach in this thesis work to characterize types of business model change with regard to their environment, as outlined by Saebi (2015) and Saebi et al. (2017). Thereby, depending on their scope (modular or architectural) and novelty (new to the company or new to the industry), investigated business model changes could be characterized as modular, adaptive, focused or complex. A dominant theme in the investigated literature on changing business models was the role of a business model's environment. Actors could either (1) align business models with regards towards its environment, (2) perform business model innovation to shape its surroundings, or (3) select a specific ecosystem by developing business models (cf. Giesen et al. (2010); Saebi (2015); Achtenhagen et al. (2013); Massa et al. (2017); Demil et al. (2018)). Furthermore, the literature showed that business models play a crucial role in conjunction with both technologies and their surrounding ecosystems (cf. Markides (2006); Christensen (2006); Chesbrough (2010); McGrath (2010); Baden-Fuller and Haefliger (2013); Tongur and Engwall (2014); Smajlović et al. (2019)). Subsequently, based on suggestions of Massa et al. (2017) and the presented literature, the following chapter presents a review of the literature on business ecosystems as environments for business models and business model innovation.

# 4 Ecosystems as environments for business models

As stated previously in Chapter 3, business model changes can either (1) enact an influence over their environment, (2) establish an alignment with their environment, or (3) select specific ecosystems in their environments (Massa and Tucci, 2014; Saebi, 2015; Demil et al., 2018). Consequently, in this chapter, relevant aspects of the companies environments for business models are described. This provides fruitful insights into the strategies and mechanisms that are related to a company's environment, which might explain the higher performance of certain business models (Massa et al., 2017, p. 75). In the following, the focus will be placed on the concept of "ecosystems," as an analysis of the ecosystem logic could be especially helpful when (1) ecosystem positions are unclear and (2) the alignment of actors needs to be established (Adner, 2017, p. 42).

Like research onto business models, the research on ecosystems suffers from an inconsistent level of understanding and unclear terminology. Therefore, first, in Section 4.1, an overview of ecosystems is provided. In Section 4.2, the concept of innovation ecosystems is then described in greater detail. The relevant aspects of the emergence as well as the evolution of ecosystems are then addressed (see Section 4.3). Finally, in Section 4.4, conceptual links between the concepts of ecosystems and business models are explored.

## 4.1 Overview of ecosystems

### 4.1.1 Origins and development of ecosystems in the literature

Companies are facing complex and dynamic business environments with increasing frequency (McGrath, 2011; Ketonen-Oksi and Valkokari, 2019). As a consequence, companies tend to rely on external networks spanning several professional areas and industries (Ketonen-Oksi and Valkokari, 2019, p. 25). Analyzing these ecosystems might be a fruitful approach to describe, categorize, and address the challenges imposed on companies by their environments. The ecosystem as a business concept can be traced back to the publications by Moore (1993, 1996, 1998), who drew analogies between business environments and biological ecosystems. In particular, Moore (1993, p. 75) argued that, despite the literature addressing networks using various lenses, the existing frameworks *"[...] provide little systematic assistance for managers who seek to understand the underlying strategic logic of change."* Moore (1993, p. 75) highlighted the lack of literature providing insights on how to attract resources, capital, as well as partners, suppliers, or customers to *"create cooperative networks."* In addition, Autio and Thomas (2014, p. 206) highlighted the fact that the ecosystem concept was suited to describing multiple areas in a company's environment with an appropriate level of detail. Specifically, Autio and Thomas (2014, p. 206) noted that ecosystems were *"[...] one of the few constructs that explicitly covers conceptually both upstream (production side) and downstream (user side) activities."* Therefore, arguably, applying the ecosystem concept provides a more holistic view of business environments than related concepts, such as strategic networks or value chains (Gomes et al., 2018). The versatility of the ecosystems

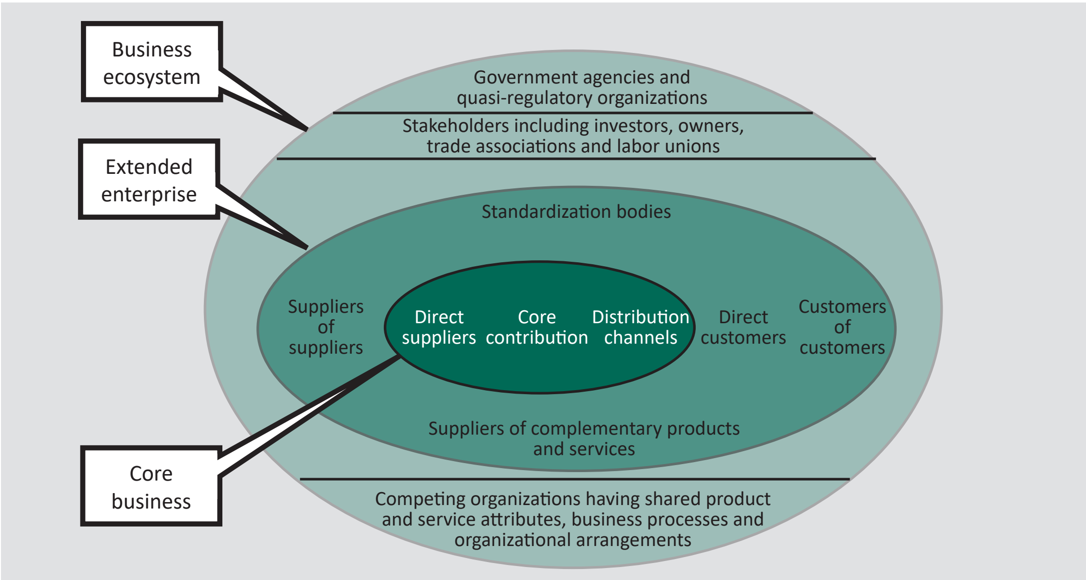



**Figure 12:** Business ecosystem based on considerations by Moore (1996, p. 27)

becomes particularly clear when looking at illustrations of the concept. Figure 12 provides a depiction of what Moore (1996, p. 27) called the *"business ecosystem."* On a principle level, a distinction between the (1) "core business" (comprising a focal company as well as suppliers and distribution channels), (2) an "extended enterprise" (additionally including the chain of customers and the suppliers, companies providing complements, and standardization bodies), and the overall (3) "business ecosystem" (also including governments/regulators, stakeholders, and competitors) was proposed (Moore, 1996, p. 27). It is noteworthy that Moore considered, the ecosystem to be viewed from the perspective of a focal company's core contribution.

Based on Moore's initial proposition of what constitutes business ecosystems, several authors adopted the concept and developed it further. For instance, Anggraeni et al. (2007, p. 24) described the following core aspects of business ecosystems: (1) characteristic roles and strategies of companies in the network, (2) structure and dynamics of the network, (3) performance of companies and the network, and (4) network governance. Moreover, as depicted in Figure 13, Thomas and Autio (2012, pp. 17-18) proposed an ecosystem model that embedded the elements of "value logic" (i.e., activities for value creation), "participant symbiosis" (i.e., value delivery; operationalization of the value logic) and "institutional stability" (including aspects of coordination

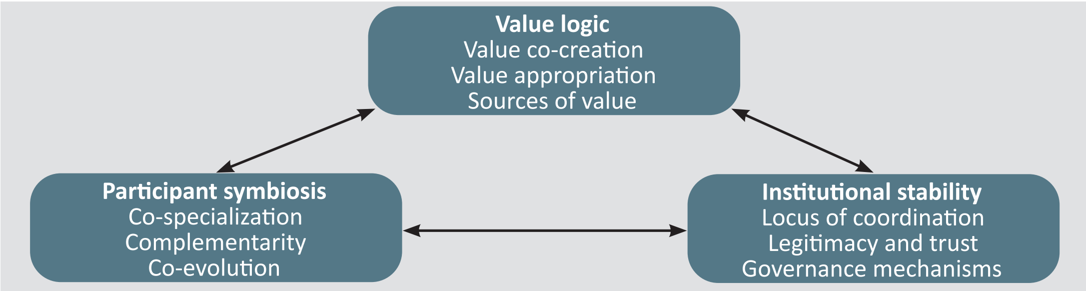



**Figure 13:** Ecosystem characteristics according to Thomas and Autio (2012, p. 7)

of actors and governance). More recently, the idea emerged that ecosystems were characterized by actors providing complements and interdependencies of actors that contributed towards a value proposition based on a focal offer (Kapoor, 2018, pp. 2-3). In that regard, Jacobides et al. (2018, pp. 2265-2266) argued that ecosystems could be characterized by looking at different types of complementarity. As illustrated in Figure 14, Jacobides et al. (2018, p. 2266) differentiated between "supermodular," "unique," and "generic" types of complementarities both in terms of production and consumption.[1] They argued that, in order to be considered as an "ecosystem" a set of actors needed to rely on non-generic complementarities that were not fully hierarchically controlled (Jacobides et al., 2018, p. 2264).

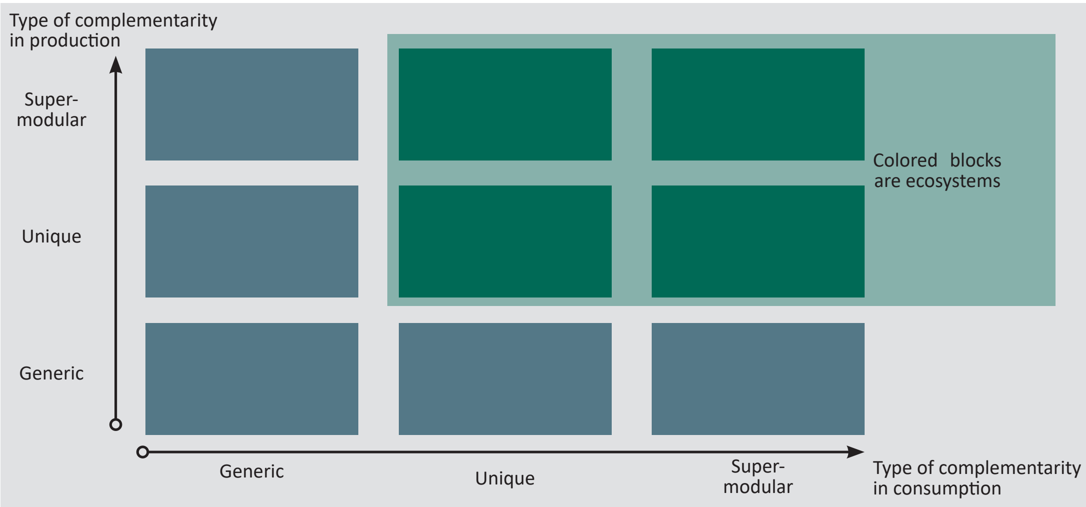



**Figure 14:** Types of complementarities and ecosystems (adapted from Jacobides et al. (2018, p. 2266))

[1] Jacobides et al. (2018) described the different types of complementarities as follows: First, in the case of supermodular complementarities one product/asset/activity makes another product/asset/activity more valuable. Second, with unique complementarities one activity/component requires another activity/component. The relation with regard to unique complementaries can be one-way or bi-directional. Third, generic complementarities are widely available and need not be coordinated.

Yet another approach to characterize ecosystems was provided by Thomas and Autio (2020), who suggested that ecosystems should be characterized based on the (1) heterogeneity of their participants, (2) ecosystem outputs, (3) the interdependence of participants, and (4) non-contractual governance.

Overall, by examining the described characteristics of ecosystems, it can be concluded that the value generated in an ecosystem relies on the co-creation and appropriation of values provided by multiple actors that have co-evolved, co-specialized, and/or offered complementary offerings. As the analysis of ecosystems represents an integrated approach that can be taken to characterize business environments, such analyses are arguably an attractive way to describe environments for business models. However, as outlined, the research on ecosystems was developed by a multitude of authors and - as of yet - does not represent a homogeneous field. To shed light on the development of ecosystem research, Table 9 provides an overview of definitions of ecosystems appearing in the literature, the author's understanding of the construct, and the research approaches used.

**Table 9:** Selected articles on ecosystems providing definitions of the concept. The table summarizes the type of publication and the researchers' understanding of the concept. Articles are sorted by date of publication.

| Author | Publication type & tesearch approach | Ecosystem understanding | Definition of rcosystem |
|---|---|---|---|
| Moore (1993) | • Article<br>• Conceptual<br>• Examples | Community | *"In a business ecosystem, companies co-evolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations."* (Moore, 1993, p. 76) |
| Moore (1996) | • Book<br>• Conceptual<br>• Examples | Community | *"An economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world. The economic community produces goods and services of value to the customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors and other stakeholders. Over time, they co-evolve their capabilities and roles, tend to align themselves with the directions by one or more central companies."* (Moore, 1996, p. 26) |
| Moore (1998) | • Article<br>• Conceptual<br>• Examples | Community | *"Business ecosystems are communities of customers, suppliers, lead producers, and other stakeholders interacting with one another to produce goods and services. We should also include in the business ecosystem those who provide financing, as well as relevant trade associations, standards bodies, labor unions, governmental and quasigovernmental institutions, and other interested parties."* (Moore, 1998, p. 168) |
| den Hartigh (2004) | • Article<br>• Conceptual | Network | *"We define a business ecosystem as a network of suppliers and customers around a core technology, who depend on each other for their success and survival."* (den Hartigh, 2004, p. 23) |

Table 9 continues on next page

Table 9 continued from previous page

| **Author** | **Publication type & research approach** | **Ecosystem understanding** | **Definition of ecosystem** |
|---|---|---|---|
| Iansiti and Levien (2004a) | • Book<br>• Conceptual<br>• Examples | Network | *"Like biological ecosystems, business ecosystems are formed by large, loosely connected networks of entities that interact with each other in complex ways, and the health and performance of a firm is dependent on the health and performance of the whole."* (Iansiti and Levien, 2004a, p. 35) |
| Iansiti and Levien (2004b) | • Article<br>• Conceptual<br>• Examples | Network | A business ecosystem includes, for example, *"[...] companies to which you outsource business functions, institutions that provide you with financing, firms that provide the technology needed to carry on your business, and makers of complementary products that are used in conjunction with your own. It even includes competitors and customers, when their actions and feedback affect the development of your own products and processes. The ecosystem also comprises entities like regulatory agencies and media outlets that can have a less immediate, but just as powerful, effect on your business."* (Iansiti and Levien, 2004b, p. 69) |
| Peltoniemi and Vuori (2004) | • Conference paper<br>• Conceptual | Population | A business ecosystem is a *"[...] dynamic structure which consists of an interconnected population of organizations. These organizations can be small firms, large corporations, universities, research centers, public sector organizations, and other parties which influence the system."* (Peltoniemi and Vuori, 2004, p. 279) |
| Quaadgras (2005) | • Conference paper<br>• Quantitative | Network | Business ecosystem as a *"[...] set of complex products and services made by multiple firms in which no firm is dominant."* (Quaadgras, 2005, p. 1) |
| Adner (2006) | • Article<br>• Conceptual<br>• Examples | Collaborative network | Innovation ecosystem as *'[...] collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution."* (Adner, 2006, p. 99) |
| Dourmas and Nikitakos (2009) | • Conference paper<br>• Conceptual<br>• Example | Network | *"Business ecosystems span a variety of industries. The companies within them co-evolve capabilities around innovation and work cooperatively and competitively to support new products, satisfy customer needs and incorporate the next round of innovation. To a certain extent, an ecosystem also includes direct and indirect competitors that, as circumstances shift, may also be collaborators."* (Dourmas and Nikitakos, 2009, p. 2) |

Table 9 continues on next page

Table 9 continued from previous page

| Author | Publication type & research approach | Ecosystem understanding | Definition of ecosystem |
|---|---|---|---|
| Li (2009) | • Article<br>• Qualitative | Network | *"A business ecosystem is an emerging concept analogized from biology. Business ecosystems move beyond market positioning and industrial structure by having three major characteristics: symbiosis, platform, and co-evolution."* (Li, 2009, p. 380) |
| Mäkinen and Ozgur (2012) | • Article<br>• Quantitative | Platform network | *"The business ecosystem describes the network of firms, which collectively produce a holistic, integrated technological system that creates value for customers"* (Mäkinen and Ozgur, 2012, p. 1) |
| Thomas and Autio (2012) | • Conference paper<br>• Conceptual | Network | A business ecosystem is *"[...] a network of interconnected organizations, organized around a focal firm or a platform and incorporating both production and use side participants."* (Thomas and Autio, 2012, p. 2) |
| Zahra and Nambisan (2012) | • Article<br>• Conceptual<br>• Examples | Group | *"A business ecosystem is a group of companies – and other entities including individuals, too, perhaps – that interacts and shares a set of dependencies as it produces the goods, technologies, and services customers need."* (Zahra and Nambisan, 2012, p. 220) |
| Mäkinen and Ozgur (2014) | • Article<br>• Qualitative | Network | A business ecosystem is *"[...] a network of sub-industries that specialize in producing the interdependent technical sub-systems of a hierarchically structured technological system."* (Mäkinen and Ozgur, 2014, p. 101) |
| Thomas and Autio (2014) | • Conference Paper<br>• Conceptual | | An *"[...] ecosystem is a dynamic and purposive value-creating network in which the participants co-create value."* (Thomas and Autio, 2014, p. 24) |
| Kelly and Marchese (2015) | • Report | Community | *"Ecosystems are dynamic and co-evolving communities of diverse actors who create new value through increasingly productive and sophisticated models of both collaboration and competition."* (Kelly and Marchese, 2015, p. 55) |
| Adner (2017) | • Article<br>• Conceptual<br>• Examples | Network | *"The ecosystem is defined by the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize."* (Adner, 2017, p. 42) |
| Jacobides et al. (2018) | • Article<br>• Conceptual | set of non generic complementary actors | *"An ecosystem is a set of actors with varying degrees of multilateral, nongeneric complementarities that are not fully hierarchically controlled."* (Jacobides et al., 2018, p. 2264) |

As summarized in Table 9, researchers working on ecosystems do not have a common understanding of the concept. This paves the way for several sub-fields of ecosystem research. Consequently, due to the plethora of different approaches taken to describe and use ecosystems in the literature, researchers started to categorize the different research streams which are summarized under the umbrella of "ecosystems." Table 10 provides an overview of these categories.

**Table 10:** Overview of different approaches and perspectives in the literature used to describe ecosystems. Articles are sorted by date of publication.

| Authors | Identified aspects and literature streams | Descriptions |
|---|---|---|
| Anggraeni et al. (2007) | • Metaphorical approaches<br>• Reality-based approaches | • Metaphorical approaches use analogies of natural ecosystems<br>• Reality-based approaches propose business ecosystems as new form of organization |
| Thomas and Autio (2012) | • Business Ecosystem according to Moore (1993)<br>• Business Ecosystem according to Iansiti and Levien (2004b)<br>• Innovation Ecosystem<br>• Technology Ecosystem and Industry Ecosystem | • Business ecosystems as proposed by Moore (1993) were seen as centered around a focal firm and focused on efficiency/flexibility (Thomas and Autio, 2012, p. 18).<br>• Business ecosystems according to Iansiti and Levien (2004b), were seen as platforms based and focused on efficiency/flexibility (Thomas and Autio, 2012, p. 18).<br>• Innovation ecosystems, as proposed by Adner (2006); Adner and Kapoor (2010), were focused on innovation and respective externalities and centered around a focal company (Thomas and Autio, 2012, p. 18).<br>• Technology ecosystems and the industry ecosystems are used as synonymous terms (Thomas and Autio, 2012, p. 18).[1] However, Thomas and Autio (2012, p. 18) noted that in contrast to the "innovation ecosystem" the technology ecosystem was centered around a platform. |
| Järvi and Kortelainen (2017) | • Business Ecosystems<br>• Digital business ecosystems<br>• Innovation ecosystems<br>• Technology ecosystems<br>• Platform ecosystems<br>• Supply ecosystems | • Business ecosystems (e.g., Moore (1993, 1996))<br>• Digital business ecosystems (e.g., Tsatsou et al. (2010)).<br>• Innovation ecosystems introduced and propagated by Adner (2006); Adner and Kapoor (2010).<br>• Technology ecosystems according (e.g., Adomavicius et al. (2006, 2007, 2008) and Wareham et al. (2014)).<br>• Platform ecosystems according to Thomas et al. (2014)<br>• Supply ecosystems according to Ketchen et al. (2014) |

Table 10 continues on next page

[1]According to Thomas and Autio (2012, p. 18), the concept *"[...] emphasizes innovation and externality benefits as the primary sources of value, with the participants in symbiosis to drive economies of complementarity and innovation."*

Table 10 continued from previous page

| Authors | Identified aspects and literature streams | Descriptions |
|---|---|---|
| Tsujimoto et al. (2018) | • Industrial Ecology Perspective<br>• Business Ecosystem Perspective<br>• Platform Management<br>• Multi-actor Network Perspective | • Focus on optimizing material and energy flows within the material flow network.<br>• Focus on creation and/or capture of value.<br>• Focus on the mechanisms of platform dynamics.<br>• Expanded view on ecosystems based on social network theory. |
| Jacobides et al. (2018) | • Business Ecosystems<br>• Innovation Ecosystems<br>• Platform Ecosystems | • Business ecosystems revolving around a (focal) company and its environment (Jacobides et al., 2018, p. 2256)<br>• Innovation ecosystems focusing on *"[...] a particular innovation or new value proposition and the constellation of actors that support it [...]"* (Jacobides et al., 2018, p. 2256)<br>• Platform ecosystems addressing actors that are organized around a platform (Jacobides et al., 2018, p. 2257) |
| Russel and Smorodinskaya (2018) | • Business Ecosystems<br>• Innovation Ecosystems (Networks)<br>• Knowledge exchange | • Literature basing on business ecosystems as proposed by Moore (1993, 1996).<br>• Economic and sociological literature on inter-company and business networks that applied the term *"innovation ecosystem"* to a broad range of networks.<br>• Economic literature on innovation policy and competitiveness agenda focusing on knowledge exchange and bringing innovations to markets. |
| Thomas and Autio (2020) | • Innovation Ecosystems<br>• Business Ecosystems<br>• Modular ecosystems<br>• Platform ecosystems<br>• Entrepreneurial ecosystems<br>• Knowledge ecosystems | • Ecosystems characterized by a coherent ecosystem level value offering.<br>• Ecosystems in the tradition of Moore (1996); Iansiti and Levien (2004b). Specific type of innovation ecosystem, but emphasizing a broader economic context.<br>• Specific type of innovation ecosystem. Ecosystems providing a collective generated value to customers. The emphasis is placed on a focal firm that is, in turn, supported by upstream components and downstream complements.<br>• Specific type of innovation ecosystem. The ecosystem emphasizes technological dependencies on the platform as a shared interface. The concept is related to technology ecosystems, digital ecosystems, and software ecosystems.<br>• Again similar to innovation ecosystems. However, they do not emphasize an ecosystem level value targeted at a defined audience. Main output is a shared knowledge for an internal audience (new ventures) base with regards to the feasibility of technologies and business models. These ecosystems tend to have a regional focus.<br>• Ecosystems focusing on research-based knowledge, as well as knowledge exchange and collective learning. Involved knowledge is often not yet fully developed. |

While no common understanding of ecosystems has emerged yet, Table 10 highlights the fact that literature can be divided into distinct fields of ecosystem research. For instance, Anggraeni et al. (2007, p. 2) differentiated between metaphorical and reality-based approaches, while Jacobides et al. (2018, pp. 2256-2257) identified the three literature streams *"business ecosystems," "innovation ecosystems,"* and *"platform ecosystems."* Järvi and Kortelainen (2017, p. 220) provided a more fine-grained view and highlighted differences between the concepts of (1) business ecosystems, (2) digital business ecosystems, (3) innovation ecosystems, (4) technology ecosystems, (5) platform ecosystems, as well as (6) supply ecosystems. Moreover, Russel and Smorodinskaya (2018) identified literature streams (1) based on the original concept of Moore (1993), (2) literature that addressed inter-company and business networks as *"innovation ecosystem"* and (3) literature that focused on knowledge exchange and innovation marketing. Despite the researchers' attempts to establish a common understanding of ecosystems, Table 10 shows that the literature on the topic is still fragmented. One possible explanation for this discontinuity could be that ecosystems are substantially different in terms of the ways they have been addressed in the literature - not at last as the authors have had the tendency to *"creatively combine labels"*[1] (Järvi and Kortelainen, 2017, p. 220). Another possible explanation for the fragmented knowledge on ecosystems could be rooted in the context ecosystem research was performed in (Autio and Thomas, 2014, p. 206). This becomes particularly clear when looking at the summary in Table 11. As is shown, Järvi and Kortelainen (2017, p. 221, 223) identified that research addressed (1) individual actors, (2) the relationship between actors and ecosystems, as well as, more recently, (3) the whole ecosystem.

**Table 11:** Overview of perspectives used in ecosystem research as compiled by Järvi and Kortelainen (2017, p. 221)

| | Unit of analysis | | |
|---|---|---|---|
| | **Individual actor** | **Ecosystem** | **Relationship** |
| **Applied research focus in literature** | • Adoption and diffusion<br>• Ecosystem governance<br>• Ecosystem position<br>• Firm-ecosystem alignment<br>• Transformation towards becoming a focal firm<br>• Value appropriation | • Collective and collaborative value creation<br>• Competition between ecosystems<br>• Ecosystem clockspeed<br>• Ecosystem life cycle<br>• Network structure<br>• Transformation from supply or value chain to ecosystem | • Interaction<br>• Interdependence and substitution<br>• The relationship between the focal firm and the complementor |

Moreover, depending on the type of ecosystem and the individual goals of the studies, the definitions of business ecosystems as well as the set boundaries used for investigation varied in the literature (compare, for example, Adner (2017, pp. 39-40) and Tsujimoto et al. (2018, p. 52)). Although the authors had different perceptions of ecosystems and used varying labels to describe the concept, the summaries provided in Table 9 and Table 10 make it possible to identify common themes for

[1] Järvi and Kortelainen (2017, p. 220) referred to Mäkinen et al. (2014) as an example of a group that investigated *"platform-based business ecosystems"* (Järvi and Kortelainen, 2017, p. 220).

the use of ecosystems among authors. As Jacobides et al. (2018, pp. 2256-2257) argued, three commonly accepted categories of ecosystems are arguably (1) business ecosystems (Moore, 1993, 1996; Iansiti and Levien, 2004a,b), (2) innovation ecosystems (Adner, 2006), and (3) platform ecosystems (Cusumano and Gawer, 2002).

Interestingly, the literature on ecosystems shows a *"turning point,"* indicating a shift from the business ecosystem concept towards the innovation ecosystem concept (Gomes et al., 2018, p. 30). Arguably, this separation point in the literature has its roots in a series of publications by Adner (cf. Adner (2006); Adner and Kapoor (2010); Adner (2012); Adner and Kapoor (2016b,a); Adner (2017)). The innovation ecosystem concept, however, did not develop in isolation and, in turn, developed on the basis of the earlier literature on business ecosystems (cf. Moore (1993, 1996); Iansiti and Levien (2004a,b)). However, Gomes et al. (2018, p. 30) noted that, while some authors perceive no difference between the terms *"innovation ecosystem"* and *"business ecosystem"* (e.g., Nambisan and Baron (2013); Gawer and Cusumano (2014)), others make an explicit distinction between the two terms (e.g., Valkokari (2015)). Adner, although a proponent of the *"innovation ecosystem,"* also tends to use the terms *"ecosystem"* and *"innovation ecosystem"* synonymously, thereby leaving room for ambiguity. In the course of this thesis work it was assumed that Adner considers ecosystems as *"innovation ecosystem."*

To differentiate between different types of ecosystems, examining the focus of individual ecosystem approaches might provide a viable starting point. In specific terms, the traditional ecosystem concept (as proposed, for instance, by Moore (1996)) was associated with both creation and capture of value (Gomes et al., 2018, pp. 30, 45). In current publications, however, the business ecosystem concept placed a stronger focus on value capture, while the innovation ecosystem emphasized value (co-)creation (Gomes et al., 2018, pp. 30, 45). In addition, Gomes et al. (2018, p. 46) argued that *"[...] the innovation ecosystem construct brings value creation to the center stage and offers a new lens for modeling the collective dimension of value creation."* Therefore, the innovation ecosystem concept places a focus on the joint creation of value through multiple actors and, in turn, on the individual benefits for involved actors. Another approach that can be taken to distinguish the literature on ecosystems was proposed by (Adner, 2017, p. 40), who suggested differentiating ecosystems based on their *"affiliations"* and *"structures"*:

- **"Ecosystem-as-affiliation"** In this view, ecosystems are seen as *"[...] communities of associated actors defined by their networks and platform affiliations [...]"* (Adner, 2017, p. 40). By viewing ecosystems per their affiliation, ecosystem positions are derived from the actors' links. The ecosystem, in turn, introduces value propositions and enhancements (Adner, 2017, pp. 43, 44).

- **"Ecosystem-as-structure"** The view focuses on activities and relations that are derived *"[...] from the alignment requirements that give rise to positions in the overall value blueprint."* (Adner, 2017, p. 43). According to Adner (2017, p. 40), seeing ecosystems as structures allows a consideration of them as *"[...] configurations of activity defined by a value proposition."* This approach can be specifically taken to consider activities and actors that a focal company has no influence on and/or is not in direct contact with (Adner, 2017, p. 44).

A comparison of both approaches is provided in Table 12. As shown in the table, Adner (2017, p. 44) puts activities to generate an ecosystem value proposition in the center stage. Consequently, in the *"ecosystem-as-structure"* approach, relevant ecosystem actors are considered based on their activities towards this ecosystem value proposition. In contrast, in the *"ecosystem-as-affiliation"* approach, Adner (2017, p. 44) argued that relevant actors were considered based on their affiliation to a focal actor.

Arguably, Adner (2017) used this distinction to, once again, differentiate the original business ecosystem concept and the innovation ecosystem concept. However, Adner's claim to be one of the few authors who saw ecosystems from the structuralist perspective, while most other researchers conceptualized ecosystems by their affiliation can be seen as a disputed point. In particular, as Adner (2017) thereby implicitly claims that several prominent researchers in the field of ecosystems, such as Moore (1996); Iansiti and Levien (2004a) and Thomas and Autio (2014) would adhere to the *"ecosystem-as-affiliation"* view. This, in turn, would exclude these authors - and their proposed views on ecosystems - from Adner's innovation-oriented ecosystem concept.

**Table 12:** Comparison of differences and similarities between viewing business ecosystems as per "structure" or "affiliation" (Adner, 2017, p. 44)

| Elements of ecosystem etructure | Perspective ecosystem-as-structure | Perspective ecosystem-as-affiliation |
|---|---|---|
| **Activities** | Discrete actions to be undertaken in order for the value proposition to be created | not applicable |
| **Actors** | Entities that undertake activities | Entities that are tied to the focal actor |
| **Positions** | Specified locations in the flow of activities across the system | Derived from links to other actors |
| **Links** | Transfers across positions, which may or may not include the focal actor | Ties between the focal actor and other actors |

It can be concluded that ecosystems have drawn substantial attention in recent years because their analysis can be considered as a novel approach to describing competitive environments, although they suffer from the outlined conceptual ambiguities (Jacobides et al., 2018, p. 2256). Moreover, in this thesis work, Adner's understanding of ecosystems was considered to represent a development in the previous ecosystem literature, and the key concepts developed under the idea of "business ecosystems" translate to the concept of "innovation ecosystem."

### 4.1.2 Similarities to and differences from related environment concepts

As outlined above, the ecosystem concept suffers from conceptual ambiguities. In part, these ambiguities stem from similarities to other environment concepts. This is arguably the case because research on the topic did not take place in isolation, although researchers have emphasized the ecosystems' distinctive characteristics (Jacobides et al., 2018, p. 2259). Moreover, only a small number of studies attempted to bridge the existing theoretical perspectives (e.g., analysis of networks, research on alliances). Those studies that did attempt to connect concepts tended to take *"ecosystems"* for granted to subsequently apply an existing theoretical perspective (Jacobides et al., 2018, p. 2259). A prominent exception is a recent study conducted by Shipilov and Gawer (2020), in which the authors attempted to bridge the network and ecosystem concepts.

Ambiguities may also be rooted in the strategy literature, which provides a plethora of different concepts and labels to describe systems of related companies (Kohtamäki et al., 2019, p. 382). As summarized by Kohtamäki et al. (2019, p. 382), *"[...] labels include the value system, ecosystem, interorganizational network, and sometimes even the platform, each with different meanings."* However, Kapoor (2018, p. 10) pointed out that while different concepts to describe environments exist[1], each concept places a focus on unique aspects (Kapoor, 2018, p. 10).

**Table 13:** Main characteristics and differences between the value chain, supply chain, business ecosystem, and innovation ecosystem according to Gomes et al. (2018, p. 43)

| **Concept** | **Value chain** | **Value chain** | **Supply chain** | **Business ecosystem** | **Innovation ecosystem** |
|---|---|---|---|---|---|
| **Level of analysis** | Company level | Industry level | Supply chain | Ecosystem level | Ecosystem level |
| **Main focus** | reduce costs and improve resources to gain competitive advantage through differentiation | co-specialization, bargaining power, relations of exchange-partners | flows of material and information across chain | value capture, location of actors, integration | value co-creation, location of actors, integration, challenges distributed across partners and complementors |
| **Agents** | one company and its resources | company, customers, suppliers | suppliers and assemblers | suppliers, focal company's complementors, customers | suppliers, focal company's complementors, customers |
| **Coordination mechanisms** | managerial hierarchies | formal contracts | formal contracts | ecosystem governance, formal contracts (with suppliers), loose to no informal agreements with complementors | ecosystem governance, formal contracts (with suppliers), loose to no informal agreements with complementors |

For instance, the literature states that business ecosystems comprise multiple value chains and value networks (Rong et al., 2018, p. 170). In an attempt to clarify this issue, Gomes et al. (2018, p. 43) provided a comparison of ecosystems with different concepts of value chains and supply chains. As summarized in Table 13, the concepts differed with regards to their

[1] Kapoor (2018) specifically addressed the distinct aspects of business ecosystems, strategic alliances and strategic networks.

focus, involved agents, as well as the mechanisms used to govern and coordinate interactions. The comparison provided in Table 13 further highlights the prominent limitations to the use of knowledge about value chains and supply chains to explain ecosystems. In particular, Gomes et al. (2018, p. 42) emphasized the fact that, as compared to ecosystems, a shortcoming of the supply chain concept was *"[...] that it does not include other important actors, notably the complementors."* Further distinctions were made by, for instance, Autio and Thomas (2014, p. 206), who pointed out that ecosystems were non-linear and comprised of both vertical and horizontal relations, as well as Tsujimoto et al. (2018, p. 25), who emphasized the focus placed in ecosystems on value capture and/or value creation. Moreover, the analysis of the business ecosystem concept could be a feasible approach to understand business networks (Anggraeni et al., 2007, p. 11). In that regard, Anggraeni et al. (2007, p. 10) argued that looking at a *"[...] business network as an ecosystem opens up a new way of looking at the structure, interaction and exchanges among organizations."* Therefore, the distinction between a business ecosystem and a network does not lie in the studied object but rather in the adopted perspective used to investigate interconnected companies (Anggraeni et al., 2007, p. 11). More specifically, Russel and Smorodinskaya (2018, p. 117) adopted Moore's understanding of ecosystems as *"cooperation networks"* (compare with Figure 15) to describe *"[...] a broad variety of business networks in which the development of mutual activities shapes a sustainable ecosystem of interactive linkages."* However, as illustrated in Figure 15, Russel and Smorodinskaya (2018, p. 117) provided a detailed view of different types of networks and their relations to the ecosystem literature. Specifically, Russel and Smorodinskaya (2018, p. 117) differentiated between (1) *"business networks,"* (2) *"cooperation networks"* (ecosystems), *"collaborative networks"* (ecosystems used for innovation) and (3) *"triple-helix collaborative networks"* (ecosystems used for continual innovation)[1].

However, the literature also highlights differences between networks and ecosystems. For instance, Autio and Thomas (2014, p. 205) pointed out that the *"[...] explicit inclusion of use side participants differentiates the ecosystem construct from other networks in management literature, such as clusters, innovation networks, industry networks, which tend to focus on the production side [...]"* as well as user networks, which *"[...] focus exclusively on the use end of industrial value chains [...]"* (cf. Thomas and Autio (2012); Autio and Thomas (2014)). They further argued that notable characteristics of the ecosystem construct were its inclusion of a broad spectrum of actors (i.e., actors providing complements, producers, users, or competitors) and its concentration on the co-creation and appropriation of value (Autio and Thomas, 2014, p. 205). Moreover, Peltoniemi (2005, p. 62) characterized business ecosystems and pointed out differences between ecosystems, networks, and clusters. While clusters were located in a specific region, as shown in Table 14, business ecosystems were seen as region-independent (Peltoniemi, 2005, p. 62). Furthermore, Peltoniemi (2005, p. 62) pointed out that (business) ecosystems[2] were characterized by decentralized governance as well as the high willingness of their actors to share knowledge, as compared to value networks and clusters.

[1] Russel and Smorodinskaya (2018) refer to Etzkowitz and Leydesdorff (1995) for a description of the triple-helix concept. On a basic level, the concept refers to collaborations between academic, industrial and governmental institutions.

[2] Peltoniemi (2005) published their insights before Adner (2006) introduced the concept of innovation ecosystems.

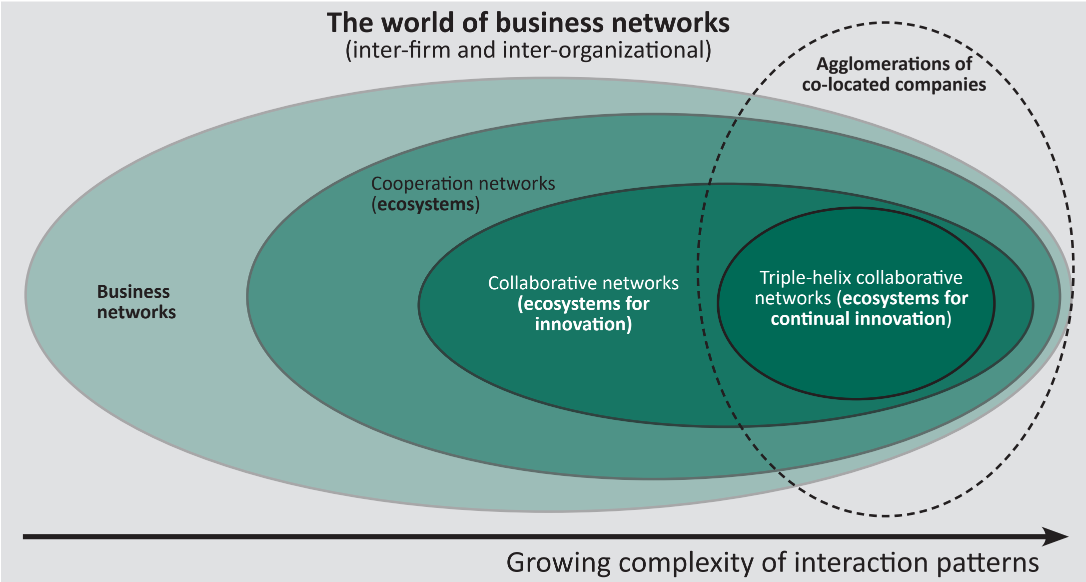



**Figure 15:** Differentiation among business networks according to the complexity of their internal interactions (Russel and Smorodinskaya, 2018, p. 117)

**Table 14:** Comparison of the key features in clusters, value networks and business ecosystems (Peltoniemi, 2005, p. 62)

| | Cluster | Value network | Business ecosystem |
|---|---|---|---|
| **Geography** | Geographic concentration | Anything from local to global | Rejects the role of geography |
| **Competition and cooperation** | Fierce rivalry | Cooperation | Co-opetition (Simultaneous competition and cooperation) |
| **Industry** | Firms represent the same industry | Different industries complement each other | Finds the term industry obsolete |
| **Knowledge** | Rivalry limits the willingness to share | Limited to operative information | Interconnectedness as the enabler and shared fate as the motivator of cooperation |
| **Control** | Members fairly independent | One powerful actor | Decentralized decision making |

Consequently, the analysis of ecosystems provides a distinct environment perspective, enabling researchers to consider a diverse set of actors holistically while – as outlined above – the literature review reveals similarities in ways different concepts are understood to describe environments.

## 4.2 Innovation ecosystems as a distinct type of ecosystem

As described in the previous chapter, the term "ecosystem" is used as an umbrella term to cover several similar but distinct concepts. Therefore, in the following chapter, a more concrete description of how ecosystems are understood in this thesis work is provided. The choice of a concrete ecosystem concept was guided by the focus in this thesis work on how actors in an ecosystem align their business model to center it around technological innovation. In this respect, the understanding of ecosystems as proposed by Adner and Kapoor might offer an appropriate perspective, as this emphasizes the alignment of actors around a specific innovation (Adner, 2006; Adner and Kapoor, 2010; Adner, 2012; Adner and Kapoor, 2016a; Adner, 2017). The chosen approach is deemed particularly well-suited for the purpose of this thesis work, as innovations often need to be embedded in an appropriate ecosystem to be created (Reynolds and Uygun, 2018, p. 179). Ultimately, these embedded innovations could allow for higher degrees of value creation than individual actors would be able to achieve (Adner, 2006, p. 99). Moreover, the innovation ecosystem construct could bear a particular relevance to this thesis work, as it is being used with increasing frequency to approach new markets and emerging industries (Gomes et al., 2018, p. 46) as well as "radical" / "path breaking" innovations that are designed and marketed in networks of co-creating actors (Walrave et al., 2018, p. 103). Consequently, in the following section, relevant aspects of innovation ecosystems are laid out to identify aspects that could hold relevance for this thesis understanding of business model environments.

### 4.2.1 Demarcation of innovation ecosystems

Like the literature on the business ecosystem, the literature on innovation ecosystems is still fragmented. This, arguably, has its roots in the inconsistent understanding of the concept and has led researchers to use the term "innovation ecosystem" without defining the concept precisely (Granstrand and Holgersson, 2020, p. 2). For instance, Gomes et al. (2018, p. 30) noted that researchers have *"[...] developed a set of definitions and concepts in a variety of contexts, employing innovation ecosystem with different labels and, in some cases, with different meanings and purposes."* Consequently, Gomes et al. (2018, p. 30) found a number of terms used in the literature, such as *"digital innovation ecosystems"*, *"hub ecosystems"*, *"open innovation ecosystems"*, *"platform-based ecosystems"* (cf. Nambisan and Baron (2013); Rao and Jimenez (2011); Chesbrough et al. (2014); Gawer (2014)). Subsequently, the innovation ecosystem concept is the subject of vigorous debates among researchers. For instance, Oh et al. (2016, p. 1) claimed that the innovation ecosystem *"[...] is not yet a clearly defined concept."* In a direct response to Oh et al. (2016), Ritala and Almpanopoulou (2017, p. 40) argued that, despite a lack of consistency in the use of the innovation ecosystem concept, *"[...] innovation is a goal or focus of the ecosystem in all cases; it is the actors, contexts, and boundaries that change."* Nonetheless, the literature on the innovation ecosystem as a separate concept is steadily increasing. This is reflected in the recent literature, whereby authors have attempted to establish an aggregated view of the topic (cf. Granstrand and Holgersson (2020) and Klimas and Czakon (2021)). For instance, Klimas and Czakon (2021) provided an overview of potentially relevant aspects that can be used to characterize innovation ecosystems. According to them, a rough distinction between innovation ecosystems can be made by looking at (1) factors related to their genesis and development, (2) their structure, (3) the type, and (4) the range of innovations pursued, (5) as well as the overall performance in the ecosystem (Klimas and Czakon, 2021). Table 15 provides an overview of proposed definitions of the term "innovation ecosystem."

**Table 15:** Selected articles providing an overview of research approaches, areas of investigations, and definitions of innovation ecosystems. Articles are sorted by date of publication.

| **Author** | **Publication type & research approach** | **Definition of innovation ecosystem** |
|---|---|---|
| Adner (2006) | • Article<br>• Conceptual<br>• Examples | The innovation ecosystem is a *"[...] collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution."* (Adner, 2006, p. 99) |
| Jackson (2011) | • Report | An innovation ecosystems models *"[...] the complex relationships that are formed between actors or entities whose functional goal is to enable technology development and innovation."* (Jackson, 2011, p. 2) |
| Autio and Thomas (2014) | • Book (chapter)<br>• Conceptual<br>• Examples | An innovation ecosystem is *"[...] a network of interconnected organizations, organized around a focal firm or a platform, and incorporating both production and use side participants, and focusing on the development of new value through innovation"* (Autio and Thomas, 2014, p. 205) |
| Adner (2017) | • Article<br>• Conceptual<br>• Examples | *"The ecosystem is defined by the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize."* (Adner, 2017, p. 42) |
| Ritala and Almpanopoulou (2017) | • Article<br>• Conceptual<br>• Examples | Innovation ecosystems are *"systems that focus on innovation activities (goal/purpose), involve the logic of actor interdependence within a particular context (spatial dimension) and address the inherent co-evolution of actors (temporal dimension)."* (Ritala and Almpanopoulou, 2017, p. 41) |
| Smorodinskaya et al. (2017) | • Conference paper<br>• Conceptual | Innovation ecosystems *"are special organizational spaces, tailored to co-creation of values through collaboration. More exactly, they constitute a sophisticated milieu of actors, assets and linkages, generated by collaborative activities of networks"* Smorodinskaya et al. (2017, p. 5252) |
| Reynolds and Uygun (2018) | • Article<br>• Qualitative | *"Innovation ecosystems can be seen as "inter-organizational", political, economic, environmental, and technological systems through which a milieu conducive to business growth is catalyzed, sustained, and supported."* (Reynolds and Uygun, 2018, p. 179) |
| Walrave et al. (2018) | • Article<br>• Conceptual | Innovation ecosystems are *"networks of co-creating actors"* that develop and comercialize path breaking innovations (Walrave et al., 2018, p. 103) |

Table 15 continues on next page

Table 15 continued from previous page

| Author | Publication type & research approach | Definition of innovation wcosystem |
|---|---|---|
| Granstrand and Holgersson (2020) | • Article<br>• Review | *"An innovation ecosystem is the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors."* (Granstrand and Holgersson, 2020, p. 3) |

One clear description of innovation ecosystems provided by Granstrand and Holgersson (2020, p. 7) is illustrated in Figure 16. This definition highlights the elements of the ecosystem actors, their activities, artifacts, as well as their relations. This partly is reflected by Adners' understanding of ecosystems, particularly as Adner (2017, p. 47) emphasized the fact that ecosystems consisted of multiple companies, whereby an individual company *"[...] defines its own ecosystem strategy, which encompasses a view on ecosystem structure, ecosystem roles, and ecosystem risks."* In line with his definition (see Table 15), Adner (2017, p. 42) proposed that researchers should view ecosystems as structures, leading him to underline the following aspects:

- **Alignment structure:** Adner emphasized the fact that ecosystem members typically rely on defined positions and activity flows between actors. In specific terms, Adner (2017, p. 42) views alignment as *"[...] the extent to which there is mutual agreement among the members regarding these positions and flow."* However, he noted that participation and alignment in an ecosystem must not be taken for granted, since the members probably pursue different goals (Adner, 2017, p. 42).

- **Multilateral:** According to Adner (2017, p. 42), ecosystems are intrinsically multilateral with a wide range of partners as well as *"[...] relations that are not decomposable to an aggregation of bilateral relations."*

- **Set of Partners:** Adner (2017, p. 42) defines the *"set of partners"* as *"[...] the participating actors in the system have a joint value creation effort as a general goal."* Partners, thereby, are actors who are necessary for generating a value proposition, independent of their possible direct connection to a focal company (Adner, 2017, p. 42).

- **For a focal value proposition to materialize:** As highlighted by Adner, a cornerstone of the presented definition is a focal value proposition as well as the involved partners and activities to fulfill the value proposition. He underlined the need to coordinate involved partners that subsequently needed to consider the different views (i.e., expectations towards value creation and value distribution) and interests (i.e., competition, value capture) of the involved actors (Adner, 2017, p. 43).

Consequently, while they are not congruent, the definitions of innovation ecosystems summarized in Table 15 point out specific aspects considered by innovation ecosystems (cf. Granstrand and

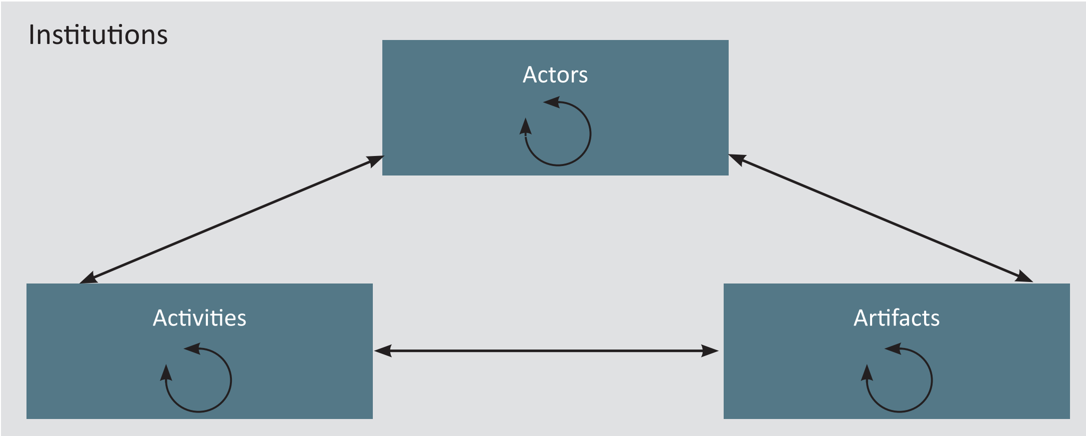



**Figure 16:** Defining elements of innovation ecosystems as proposed by Granstrand and Holgersson (2020, p. 7). Relations within entity types (circled arrows) indicate complementary or substitute relations (e.g., between multiple actors or artifacts). Arrows between elements indicate factors such as externalities, transformative relations, ownership, or usage rights.

Holgersson (2020)). However, in contrast to Granstrand and Holgersson[1] a slightly different set of elements that can be used to characterize innovation ecosystems is proposed in this thesis. These elements include (1) an ecosystem value proposition, (2) the involvement of multiple actors, (3) ecosystem activities, (4) ecosystem relations, (5) alignment structure, (6) assets and artefacts as well as (7) the focal company or platform an innovation is centered around.

**Table 16:** Summary of common elements present in definitions of innovation ecosystems

| | Characteristic elements | | | | | | |
|---|---|---|---|---|---|---|---|
| **Author** | **Ecosystem value proposition** | **(Multiple) actors** | **Activities** | **Relations** | **Alignment structure** | **Assets or artifacts** | **Focal company or platform** |
| Adner (2006) | ✓[2] | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ |
| Jackson (2011) | ✗ | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ |
| Autio and Thomas (2014) | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ |
| Adner (2017) | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ |

Table 16 continues on next page

[1] Granstrand and Holgersson (2020) suggested using actors, activities, artifacts, co-evolution/co-specialization, collaboration/complements, competition/substitutes and institutions to characterize the definitions of innovation ecosystems.

[2] Adner (2006) mentioned a synthesis of offerings to create customer value.

Table 16 continued from previous page

| | **Characteristic elements** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Author** | **Ecosystem value proposition** | **(Multiple) actors** | **Activities** | **Relations** | **Alignment structure** | **Assests or artifacts** | **Focal company or platform** |
| Ritala and Almpanopoulou (2017) | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ |
| Smorodinskaya et al. (2017) | ✗[1] | ✓ | ✓ | ✓ | ✓[2] | ✓ | ✗ |
| Reynolds and Uygun (2018) | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ |
| Walrave et al. (2018) | ✓[3] | ✓ | ✓[4] | ✓ | ✗ | ✗ | ✗ |
| Granstrand and Holgersson (2020) | ✓[5] | ✓ | ✓ | ✓ | ✗ | ✓ | (✓[5]) |

Based on the definitions of innovation ecosystems provided in Table 15, common and different aspects can be highlighted. Using definitions and the ecosystem characteristics described above, Table 16 provides an overview of the authors' perceptions of the topic. As shown in Table 16, authors tended to include actors, activities, and relations in their definitions of ecosystems. At the same time, alignment structure, assets, artifacts, and a focal company were rarely mentioned. Interestingly, despite the focus in innovation ecosystems on creating (joint) value, not all authors included a common ecosystem value proposition in their definition. This is curious as, for instance, Adner (2012, p. 4) ascertained that, in innovation ecosystems, *"[...] the success of a value proposition depends on creating an alignment of partners who must work together in order to transform a winning idea to a market success."* To further explore this aspect, the following sections include a review of the literature on creating value in the innovation ecosystem.

[1] Smorodinskaya et al. (2017) did not explicitly described the creation of ecosystem values.

[2] Smorodinskaya et al. (2017) describes innovation ecosystems as tailored organizational spaces.

[3] Walrave et al. (2018) mentioned path-breaking innovations developed and commercialized by multiple actors.

[4] Walrave et al. (2018) described co-creation activities.

[5] Granstrand and Holgersson (2020) mentioned the innovative performance of a single actor or a population of actors.

### 4.2.2 Value creation in innovation ecosystems

Adner (2017, p. 44), who proposed that researchers should describe innovation ecosystems per "structure" argued that they were characterized by a central ecosystem value proposition as well as the actor's respective activities, positions, and links. This is also reflected in the description given by Autio and Thomas (2014, p. 208), who argued that innovation ecosystems were typically not defined by a specific product, but were rather a *"[...] coherent set of interrelated technologies and associated organizational competences that glue a variety of participants together to co-produce a set of offerings for different user groups and uses."* Consequently, the creation of value in ecosystems depended on a set of complementary offerings from interdependent actors that contributed to the value a customer could receive (Kapoor, 2018, p. 5). Similarly, Almpanopoulou et al. (2019, p. 6357) characterized innovation ecosystems as *"[...] built around new technologies, ideas, and innovations and their supporting actors and structures."* Consequently, following Adner's definition of innovation ecosystems, the actor's contributions, positions, and links play crucial roles with regard to an ecosystem's structure (Adner, 2017, p. 44). This is particularly relevant, as performance in innovation ecosystems tends to be rooted in complementarity and innovation (Adner, 2006; Thomas and Autio, 2012; Adner and Kapoor, 2010). In addition, while concerns about rivals, consumers, or competencies were still considered as highly relevant, strategies and actions in the context of innovation ecosystems needed to account for interdependencies (Adner, 2012, p. 225). The following section presents a review of central aspects of value creation structures in innovation ecosystems to address the outlined issues.

#### a) Structures for value creation in innovation ecosystems

One prominent attempt to describe the value creation structure in innovation ecosystems was made and later refined by Adner in a series of publications (cf. Adner (2006, 2012); Adner and Kapoor (2016b, 2010, 2016a); Adner (2017)). The concept Adner (2012, pp. 84-85) subsequently called the *"value blueprint"* (compare Figure 17) was developed to explain the creation of value in innovation ecosystems. In doing so, Adner and Kapoor (2010, p. 309) highlighted the roles of different suppliers, companies providing complements, and the customer in the context of innovation ecosystems. However, while Figure 17 illustrates the fact that a focal company represents a major element in an innovation ecosystem, Adner (2017) proposed that researchers should take on a holistic view. Adner (2017, p. 55) particularly highlighted the aspect that innovation ecosystems were centered around *"[...]the focal value proposition, not a focal firm; and in terms of elements that need to be brought into alignment, thus excluding those that are already in place and can be expected to stay put."* In addition, Adner (2012, pp. 85-86) crucially highlighted that, even when multiple elements in the value blueprint were located in the same company, they need to be considered separately. This consideration could help in narrow the view of individual elements in a *"value blueprint."* Moreover, it implies that distinct efforts may be required to align individual elements in a single company (Adner, 2017, p. 55).

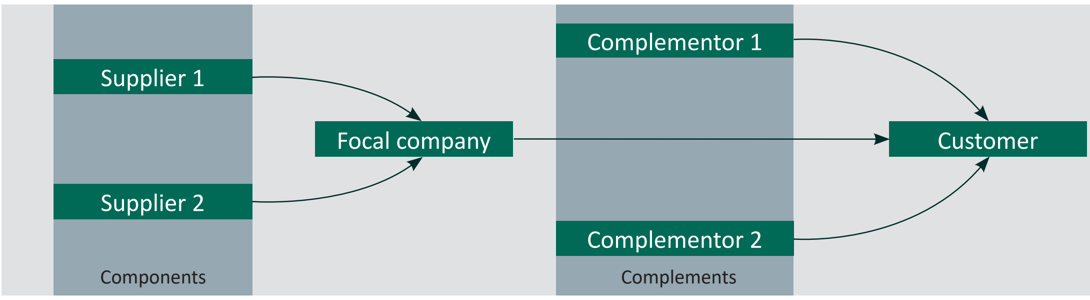



**Figure 17:** Innovation ecosystem as proposed by Adner and Kapoor (2010, p. 309)

It has to be noted that Adner and Kapoor's concept of the *"value blueprint,"* as depicted in Figure 17, shows only one level of suppliers and complementors. Adner and Kapoor (2010, p. 310) highlighted the fact that *"[...] this structure can be extended forward and backward along the activity chain to include higher-tiered actors [...]"*.[1] This is a particularly relevant consideration, as considering the locations and relations of companies that provide complements outside a direct path to the customer is one of the hallmarks of the *"value blueprint"* (Adner, 2012, p. 87). Adner (2012, pp. 85-86) then introduced the following elements when constructing value blueprints: (1) end customers and the respective value they are offered, (2) inputs of suppliers, (3) intermediaries between a focal company and the end-customer, (4) companies providing complements for each intermediary as well as (5) ecosystem risks of co-innovation/adoption for involved actors, and (6) offering viable solutions where risks might hinder co-innovation/adoption.

Interestingly, the role of complementors has gained particular relevance in the recent literature. For instance, Jacobides et al. (2018) emphasized the role of "non generic" complementarities both in consumption and production. In a similar vein, Adner and Liebermann (2021) pointed out three approaches in which complements could act as disruptions: *"Commodization," "adjacent entry,"* and *"value inversion."* When *"commodization"* occurs, a strategic change could shift the focus of differentiation from the company producing an ecosystem's core offers to the complementor. This could take place if entry barriers to complements are reduced, if complementors manage to drive differentiation, or if complementors achieve a position in which they are perceived as a *"guarantor of quality"* by customers (Adner and Liebermann, 2021, p. 6). When *"adjacent entries"* occur, complementors enter an ecosystem as direct rivals with regard to an ecosystem's core offer. By being rooted in the ecosystem, these complementors differ from traditional competitors in an ecosystem because their assets are typically associated with incumbent companies (Adner and Liebermann, 2021, p. 7). In the scenario of *"value inversion,"* complements become "too good." Thereby improving complement values does not increase but decrease the value of a focal offering in an ecosystem (Adner and Liebermann, 2021, p. 8).

Overall, the concept of *"value blueprint"* might serve to systematically consider relevant actors, their offered complements and components, as well as their positions and relations in an innovation ecosystem.

[1] See Adner (2012, p. 87) for an example of a generic value blueprint that maps actors and their relations to subsequently illustrate an innovation ecosystem.

## b) Risks and bottlenecks in innovation ecosystems

Adner (2006, p. 106) highlighted three factors that could potentially lead to the failure of innovation ecosystems. These factors are (1) technical challenges in independent innovations, (2) difficulties in coordinating innovation throughout a system, as well as (3) the too late emergence of the necessary market to support the investments (Adner, 2006, p. 106). Therefore, in the context of ecosystems, not only the focal actors' value but also all the elements required to demonstrate an ecosystem value need to be considered holistically (Adner, 2012, p. 149). In that regard, distinguishing between the individual actors' positions and roles in the ecosystem is crucial (Autio and Thomas, 2014, p. 206). For instance, looking at the basic concept of a *"value blueprint"* (compare, for example, with Figure 17), Adner and Kapoor (2010, p. 328) proposed to differentiate between roles located upstream (i.e., suppliers) and roles located downstream (i.e., companies offering complements, customers) in the ecosystem. This aspect bears particular relevance, as the position of a company relative to other ecosystem actors directly affects its ability to create value (i.e., upstream actors tended to face more component-related challenges while downstream complementors influenced the overall delivered value) (Adner and Kapoor, 2010, p. 307).

Consequently, Adner and Kapoor (2010, p. 310) acknowledged the existence of ecosystem-bottlenecks which they described as an uneven distribution of challenges between roles in an innovation ecosystem. Thereby, an actor's position in an ecosystem is believed to determine the type of bottleneck that may arise (Adner and Kapoor, 2010, p. 310). Furthermore, Adner and Kapoor (2010, p. 310) proposed that *"[...] whereas upstream component challenges limit value creation by constraining the focal firm's ability to produce its product, downstream complement challenges limit value creation by constraining the customer's ability to derive full benefit from consuming the focal firm's product."* Based on their described understanding of bottlenecks' potential effects, Figure 18 provides a framework of the outlined challenges that actors in an ecosystem might face. While actors are likely to experience a baseline amount of internal innovation challenges, external challenges might add even more production and consumption constraints.

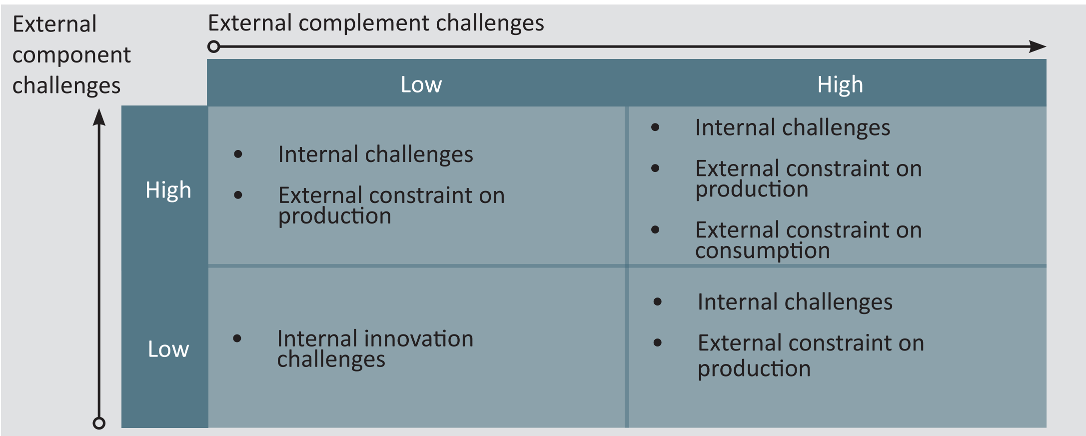



**Figure 18:** Framework of ecosystem challenges for innovators adapted from Adner and Kapoor (2010, p. 310)

Collaborations in ecosystems rely arguably on different types of complex relations and dynamic balances (Russel and Smorodinskaya, 2018, p. 116). These authors pointed out that the collaboration among actors in an ecosystem did not explicitly rule out the possibility that these actors competed within and outside of an ecosystem. This insight is particularly important, as not all ecosystem descriptions explicitly consider competition as a relevant factor.[1] In addition, ecosystem actors need to consider risks and dependencies that go hand in hand with intensive collaboration and co-innovation (compare, for example, with Adner (2012, pp. 47-49) and Adner and Feiler (2019, p. 124)). In that regard, Adner and Feiler (2019, p. 109) argued that since actors *"[...] increasingly rely on partners to contribute to a collective effort, the success of the collective effort becomes reliant on successful execution by a growing number of individual partners."* Adner (2012, p. 49) had previously highlighted the relevance of considering all involved actors in an ecosystem with regard to what he called *"adoption chains."* Notably, if one necessary type of actor in an *"adoption chain"* faces a disadvantage when adopting a specific innovation, this type of actor is likely to break the adoption chain and subsequently prevent the innovation from being offered to a potential end user (Adner, 2012, p. 49). Therefore, the misalignment of one type of actor could hinder the establishment of an ecosystem's value proposition. To avoid this situation, Adner (2012, p. 77) proposed to address these disadvantaged adoption chain links before launching an innovation. Naturally, this undertaking can become more difficult as the number of involved actors increases, as intermediaries are often positioned between the innovation and a customer in an ecosystem (Adner, 2006, p. 103). Typically, innovations further upstream require the adoption of a high number of intermediaries before substantial volumes of sales can be made (Adner, 2006, p. 103). Adner (2006, p. 103) then concluded that as *"[...] the number of intermediaries increases, so does the uncertainty surrounding market success."*

### 4.2.3 Role of technologies for creating value in innovation ecosystems

Several researchers have emphasized the relation between business environments and technologies. For example, Tushman and Anderson (1986, pp. 439, 463) found that technological discontinuities and uncertainty in environmental conditions were linked (e.g., through enhancing or destroying competencies). Gulati et al. (2000, p. 213) proposed that applying a network-perspective can help to understand the impact of disruptive technologies on the competitive landscape of industries over time. This perspective could be especially beneficial in that it helps researchers to understand why companies get locked in or out of dominant designs (Gulati et al., 2000, p. 213). Adomavicius et al. (2007, p. 185) also noted that the innovation and evolution of individual technologies could not be considered in isolation. According to these authors, understanding the evolution of technology requires focusing on systems of interrelated technologies and interdependent technological changes in these systems (Adomavicius et al., 2007, p. 185).

However, while the relevance of viewing technologies in the context of the business environment has been recognized, the recent literature has emphasized the role of technologies in the specific

[1] For instance, Moore (1996) underlined the role of competitors in an ecosystem, while Adner (cf. Adner and Kapoor (2010) or Adner (2012)) focused on individual innovations and did not explicitly consider competitors in the *"value blueprint"* concept.

context of innovation ecosystems. For instance, Xu et al. (2018, p. 208) underlined the fact that *"[...] innovation ecosystems require specific attention when faced with fast-developing emerging industries that closely link science, technology, and business."* This seems to be the case, as the technological configuration of an ecosystem results from the combined technological design choices made by all companies participating in an ecosystem (Luo, 2018, p. 132). For this reason, focal companies in an innovation ecosystem need to consider the external environment of the ecosystem when faced with high degrees of technological change in order to establish both internal alignment and external viability (Walrave et al., 2018, p. 111). Therefore, as proposed by Adomavicius et al. (2007, p. 186), using the ecosystem lens to investigate the evolution of technology can be helpful since it *"[...] provides a robust and comprehensive picture of innovation by considering multiple sources of influence."* Adner and Kapoor (2010) previously used the innovation ecosystem perspective to shed light on the companies' roles in providing complements and components. Specifically, Adner and Kapoor (2010, p. 328) argued that downstream complements were equally relevant and could be used to explain technological uncertainty, dominant designs (Utterback and Abernathy, 1975; Tushman and Anderson, 1986) or industry standards (Cusumano et al., 1992). One major factor in that regard is the aforementioned *"value blueprint"* of an ecosystem (see Figure 17). In particular, Adner and Kapoor (2010, pp. 326-327) found that being in the position of a technological leader was attractive when component challenges were high but was less attractive in case of high complement challenges. Specifically, companies that solved their technological execution challenges (i.e., upstream bottlenecks) at an early stage would need to wait for the companies providing complements to undertake co-innovation in order to overcome complement challenges (i.e., downstream bottlenecks) (Adner, 2012, p. 154). Only then would companies be in a position to demonstrate an effective ecosystem value proposition (Adner, 2012, p. 154). These findings indicate that a technology's performance needs to be considered in the context of its ecosystem (Adner and Kapoor, 2016a).

Especially regarding technological changes, companies could benefit from better understanding the interactions between innovation ecosystems for an "old" and , respectively, a "new", technology and how these interactions might influence competition and adoption on the market (Adner and Kapoor, 2016a, p. 627). The following two ecosystem influences could help to explain the differences between a technology's principal performance[1] and its realized performance (Adner and Kapoor, 2016a, p. 628):

- **Emergence challenge:** The ecosystem could hinder the realization of a "'new" technology's principle performance (e.g., through bottlenecks).

- **Extension opportunity:** Improvements in an ecosystem could enhance the performance of an "old" technology.

The impact that both an *"extension opportunity"* and an *"emergence challenge"* can have on the technological performance in ecosystems is illustrated in Figure 19. Depending on the level of extension opportunity and emergence challenge in an ecosystem, Adner and Kapoor (2016a, p. 629) proposed that researchers should differentiate between a baseline pace of substitution (Q1),

[1] Principal performance can be understood as the performance that could be technologically possible, but which does not take place due to shortcomings in the ecosystem.

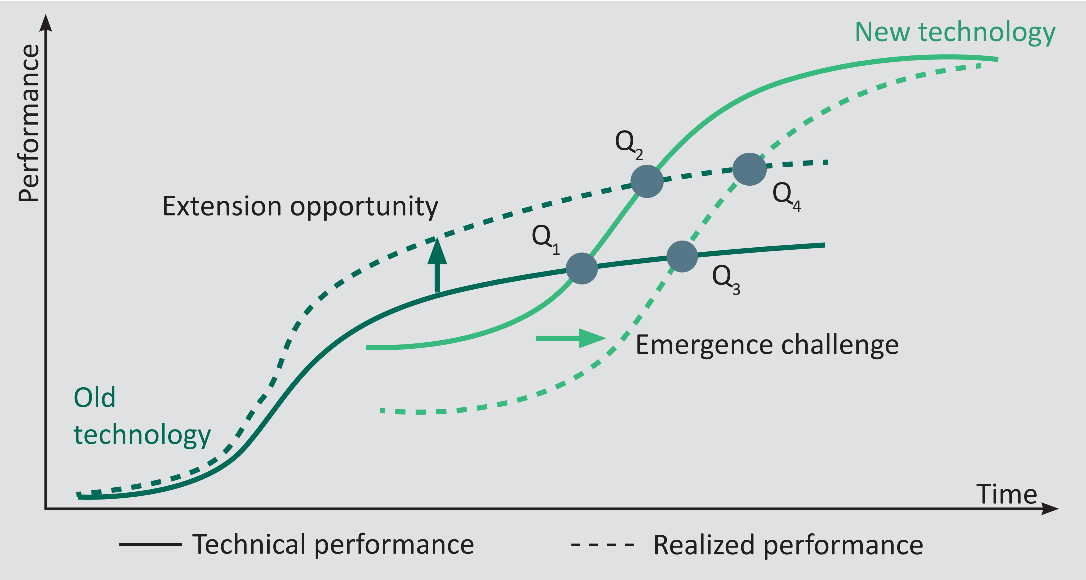



**Figure 19:** Influence of the ecosystem on the competition between an old and a new technology according to Adner and Kapoor (2016a, p. 629)

an intermediate pace of substitution (Q2, Q3), and a slow pace of substitution (Q4) (compare with Figure 19). This, in turn, would allow them to categorize the pace of technological substitution in an ecosystem using the framework illustrated in Figure 20. As shown in Figure 20, the baseline pace (i.e., the fastest pace) of substitution occurs when the old ecosystem will not be extended and the new ecosystem faces a low number of challenges during its emergence. If the current ecosystem can either be extended or the ecosystem of a new technology faces emergence challenges, the pace of substitution is likely to be slower than the baseline pace. The slowest pace of substitution will probably occur if both extension opportunities and emergence challenges take place (Adner and Kapoor, 2016a, p. 629). While an old ecosystem that holds back new technologies seems counterintuitive at first glance, Adner and Kapoor (2016a, p. 641) provided three specific modes of actions that support their claim:

- **Spillback:** By using *"spillbacks"* the initiatives that are developed to overcome emergence challenges of new technologies might result in solutions that allow individual actors to extend the use of old technologies.
- **Last gasp:** In *"last gasp"* efforts, individual actors try to capture value from an old technology while other companies shift towards a new technology.
- **Last resort:** In *"last resort"* undertakings, multiple actors across the ecosystem (competitors, suppliers, companies providing complements, users) that were collectively unable to manage a new technology extend the performance of an old technology.

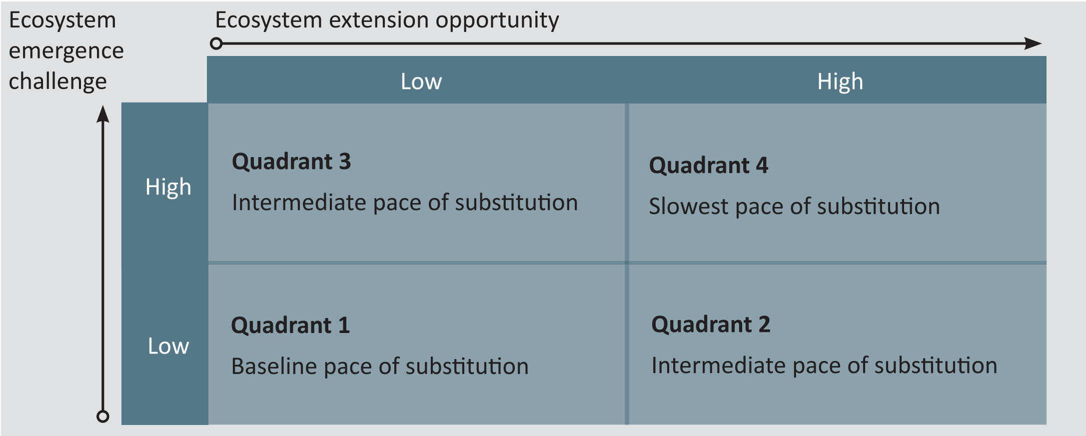



**Figure 20:** Framework used for analyzing the substitution of technologies according to Adner and Kapoor (2016a, p. 630)

Adner and Kapoor (2016a, p. 628) also proposed that researchers should see *"[...] substitution not as a competition between a new technology and an old technology, but rather as a competition between a new technology's ecosystem and an old technology's ecosystem."* As mentioned previously when desribing the concept of *"value blueprint,"* in a system where individual elements depend on each other, the weakest element acts as a bottleneck that hinders the realization of performance (Adner and Kapoor, 2016a, p. 642). This has a crucial implication for the realization of technology performance in ecosystems. Concretely, that the theoretically achievable performance of a technology in an ecosystem will only be truly achieved if the focal technology itself serves as the bottleneck (Adner and Kapoor, 2016a, p. 642). In addition, Adner and Kapoor (2016a, p. 643) noted that when new technologies temporarily face difficulties emerging in ecosystems and have limited opportunities to extend an existing ecosystem, industries might face stagnation (see Figures 19 and 20). In this situation, policymakers could intervene to overcome this challenge more quickly.

Looking at the role of technologies in ecosystems highlights that value creation, and its respective structures, are not a static construct. Instead, as described in the following section, to understand the value generated by the ecosystem, its respective evolution, governance, and strategies need to be considered dynamically.

## 4.3 Emergence and evolution of ecosystems

Moore (1996, p. 58) noted that merely creating ecosystems was not enough to achieve financial success. Instead, ecosystems need to be introduced and adequately developed. In particular, as in the ecosystem logic, not only individual companies but also whole ecosystems engaged in competition (Moore, 1996, p. 162). In order to determine how ecosystems might emerge and evolve to remain competitive, several aspects mentioned in literature are addressed in this section:

First, an overview of the general principles of business ecosystem evolution is presented. Second, the emergence and development in the specific context of innovation ecosystems are investigated in greater detail.

### 4.3.1 General overview of the evolution of ecosystems

#### a) Co-evolution of actors in the ecosystem life cycle

Several authors have emphasized that business ecosystems evolved through different stages of growth (cf. Moore (1993, 1996); Rong et al. (2015); Rong and Shi (2015)). However, while these authors have not used congruent terminology, they described similar aspects of ecosystem evolution. For instance, as summarized in Table 17, Moore (1993, p. 76) proposed four distinct stages of business ecosystem evolution: (1) birth, (2) expansion, (3), leadership, and (4) self renewal.

**Table 17:** Stages of business ecosystem evolution as described by Moore (1993, p. 77) and Moore (1996, pp. 64 ff.)

| Stage | Leadership challenges | Cooperative challenges | Competitive challenges |
|---|---|---|---|
| **Birth (Pioneering)** | Value | Define value proposition around a *"seed innovation"* together with customers and suppliers | Protect ideas from actors aiming for similar offers<br><br>Bind critical customers, suppliers and channels |
| **Expansion** | Critical mass | Cooperate with partners and suppliers to scale up<br><br>Introduce offer and strive for market coverage | Aim for market dominance and establish *"de facto"* standard (e.g., through dominating critical markets or tying up key market segments, lead customers, lead suppliers and important channels) |
| **Leadership (Authority)** | Lead co-evolution | Rally suppliers and customers behind a common vision to ensure collaboration of suppliers and customers to further improve the *"complete offer"* | Maintain influence on other ecosystem actors (including critical customers and suppliers) |
| **Self Renewal (Death)** | Continuous performance improvement | Collaborate with innovators to introduce new ideas | Maintain high entry barriers to prevent innovators from introducing alternative ecosystems<br><br>Aim for high switching costs to increase time available to improve own products and services using new ideas |

Similarly, Rong and Shi (2015, p. 137) provided an overview of different stages in business ecosystems using (1) products, (2) core companies, (3) partner networks, and (4) general ecosystem aspects as key indicators. As illustrated in Figure 21, Rong and Shi (2015, p. 139) differentiated between six states of evolution, spanning the emergence, convergence, consolidation, and renewal of ecosystems. Moreover, Rong and Shi (2015, p. 137) described distinct characteristics for each proposed key indicator that might be used to determine the current phase of an ecosystem (compare with Figure 21). Although Rong and Shi (2015) used different terms to describe the

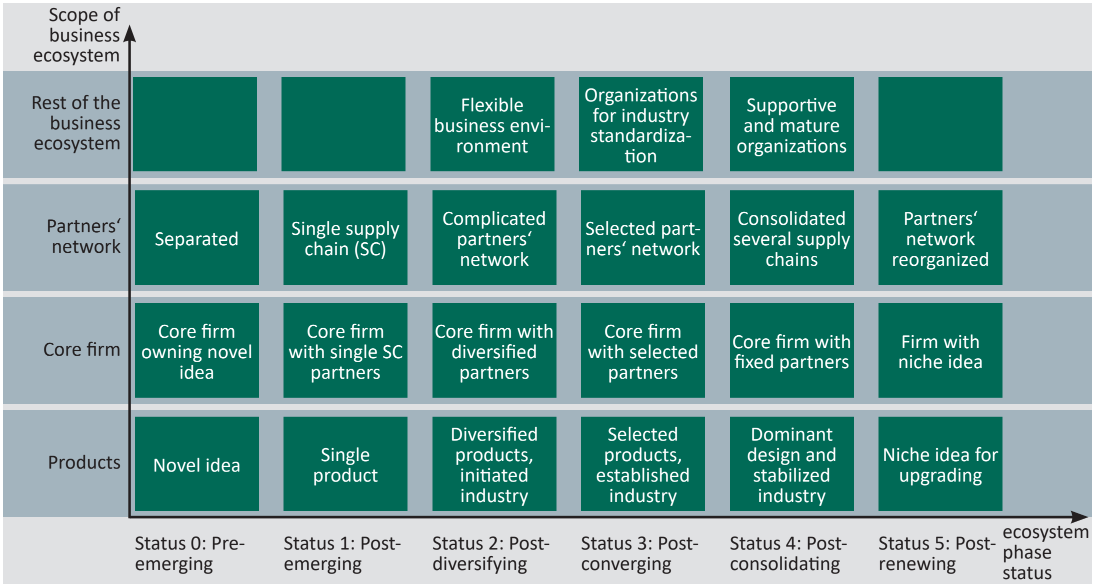



**Figure 21:** Phases and phase-starting/ending-states in the business ecosystem life cycle according to Rong and Shi (2015, p. 139)

evolution of business ecosystems than Moore (1993, 1996), the phases arguably describe similar aspects in the development of ecosystems.

Moore (1998, p. 168) made a crucial statement when he argued that revolutionary advances in creating value for customers, shaping markets, offering new products or processes, or transforming the companies' capabilities required the complementary evolution of other actors - and their respective capabilities - as a support function. Moore referred to this behaviour as *"co-evolution."* In addition, Moore (1998, pp. 170-171) stated that high-technology companies in particular would carry out partnering activities to facilitate co-evolution among suppliers, customers, and companies that provide complementary offers. This would allow them to establish and expand new business ecosystems and market segments as well as to secure investments in core contributions made by the ecosystem actors (Moore, 1998, p. 170).

When an ecosystem is in its early stages, co-evolving companies need to focus on satisfying customers and build up a network of partners and suppliers (Moore, 1996, pp. 77, 124). Thereby, the state of an ecosystem's value proposition mirrors the phase of the overall ecosystem. In that regard, he proposed that, in early ecosystem stages, customers could be addressed with *"precursor* *products"* that were acceptable for customers but did not yet comprehensively address their needs. These precursor products represented an early form of an ecosystem's value proposition that could subsequently be expanded and developed (Moore, 1996, p. 124). As shown in Figure 22, Moore (1996, p. 260) argued that the value generated by an ecosystem evolved gradually in the shape of an S-curve. Thereby, the partner network evolves during the life cycle of an ecosystem until it eventually needs to be reorganized when ecosystem renewal initiatives are introduced (Rong and Shi, 2015, p. 139). Business ecosystems would thereby co-evolve and expand until - typically in the leadership phase - a stable *"ecosystem architecture"*[1] emerges that lays the foundation for dominant designs (Moore, 1996, p. 79).

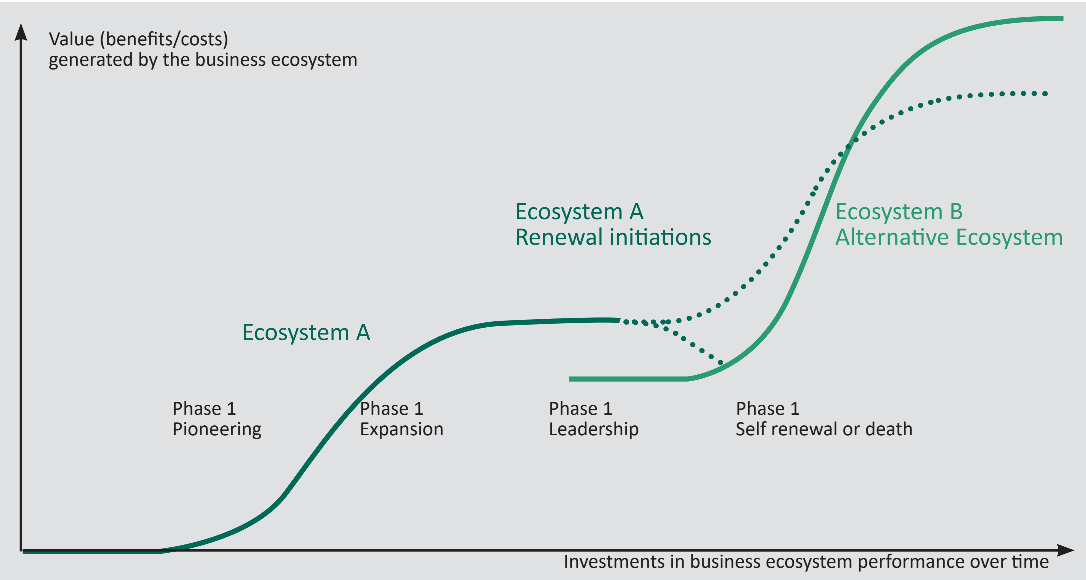



**Figure 22:** Value created by an ecosystem over time based on considerations by Moore (1996, p. 260)

As shown in Figure 22, in later phases ecosystems either enter the *"self renewal"* or *"death"* phase while alternative ecosystems based on different underlying ideas might emerge (Moore, 1996, p. 260). Moore (1996, p. 231) highlighted two principal scenarios that lead to the described final states of business ecosystems: Either a continuous change, for instance, due to innovations or new ecosystems or a more radical change[2] due to sudden shifts in environmental conditions, such as changes in governmental regulation or customer behavior. Figure 23 provides an overview of relevant factors leading to either ecosystem *"self renewal"* or *"death."* As illustrated, both changes in environments and customer preferences, as well as the emergence of alternative ecosystems, could result in a situation where established ecosystems are not able to satisfy the needs of involved actors. These actors, in turn, might withdraw from the ecosystem. In that vein, Moore (1996, pp. 77-78) argued that one factor influencing the end state of an ecosystem could be its overall

[1] The concept of *"ecosystem architecture"* arguably bears similarities to the concept of *"value blueprint"* used by Adner (2012) to describe innovation ecosystems.

[2] Moore (1993, p. 81) describes radical changes as the *"equivalent of an earthquake."*

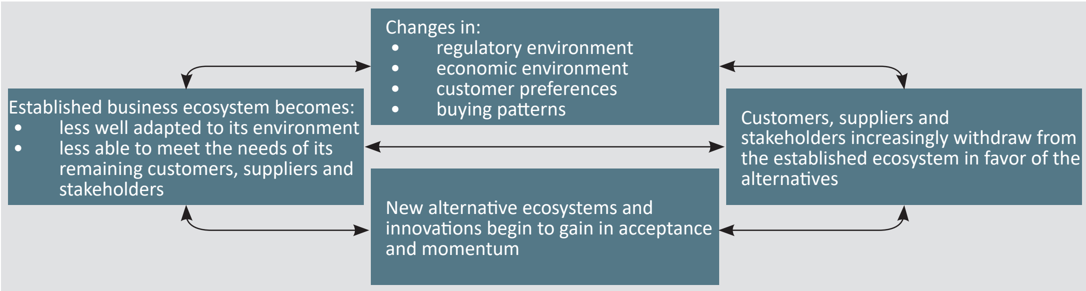



**Figure 23:** Self-supporting factors leading to either *"self renewal"* or *"death"* of business ecosystems (Moore, 1996, p. 232).

inertia. Particularly when business ecosystems failed to renew themselves, they were vulnerable to outside actors who attempted to establish alternative ecosystems, subsequently taking business away from the current ecosystem actors (Moore, 1996, pp. 77-78). A few years earlier, Moore (1993, p. 85) had noted that leading actors in mature business ecosystems *"[...] sometimes have no choice but to undertake profound structural and cultural changes."* These changes could also impact an ecosystem's governance as well as the roles the individual actors fulfill.

## b) Relevance of ecosystem roles and governance for ecosystem evolution

Various aspects of governance and the respective roles to enact governance can be seen as central pillars of ecosystem emergence and evolution. This is especially because ecosystems were characterized by a *"shared logic"* grounded in legitimacy as well as meaning and by systems that could be used to govern and coordinate the activities of participants (Thomas and Autio, 2014, pp. 8-11). These systems, meanwhile, consisted of regulatory elements and normative elements (Thomas and Autio, 2014, pp. 8-9). Moore (1996, pp. 124-126) had previously highlighted the importance of leading actors to ensure the ongoing improvement of the ecosystem. The role of these ecosystem leaders was characterized by (1) a high bargaining power (e.g., through the control of a critical component that other ecosystem actors require), (2) the actors' contributions to the overall ecosystem performance, and (3) investments of other ecosystem players acting as followers (Moore, 1993, p. 81). These leading actors were particularly relevant in the *"expansion"* and *"leadership"* phase of the ecosystem evolution process (Moore, 1993, p. 81). When governed by an *"ecosystem leader"*[1] (Moore, 1996, p. 191), several different types of actors take on distinct roles and perform specific activities to ensure the overall function of an ecosystem. Jacobides et al. (2018, p. 2260) elaborated upon this point by emphasizing that, in order to coordinate different types of complementarities and generate value, ecosystems required *"[...] coordination that cannot be dealt with in markets, but which also does not require the fiat and authority structure of a*

[1] The terminology used in different publications to describe an ecosystem leader is not congruent. According to Dedehayir et al. (2018, p. 22), similar terms in the literature to refer to an *"ecosystem leader"* (in the sense of Moore (1993)), are *"keystone actors"* (Iansiti and Levien, 2004a), *"hub"* companies (Iyer et al., 2006) and *"platform leaders"* (Cusumano and Gawer, 2002) as well as *"ecosystem champions"* (Dattee et al., 2018).

*central actor."* They proposed the idea that one hallmark of ecosystems was that actors in an ecosystem still were able to yield - at least residual - control over their assets and claims (Jacobides et al., 2018, p. 2266). Consequently, one factor that distinguishes ecosystems from traditional sets of actors (e.g., supply networks) is that central *"hub"* companies had limited influence and lacked hierarchical control (Jacobides et al., 2018, p. 2266). Therefore, while Jacobides et al. (2018, pp. 2266-2267) acknowledged that *"hub"* companies often set standards, rules, or interfaces, ecosystems still relied on partly distributed decision-making processes. Moreover, the evolution of ecosystems, including their respective structures and the actors' positions, might not be governed by a leading actor and instead depended on constraints and opportunities rooted in exogenous structures (Shipilov and Gawer, 2020).

Iansiti and Levien (2004a, p. 75), tried to clarify the different roles and activities in an ecosystem by proposing a taxonomy of network/ecosystem strategies. As summarized in Table 18, they differentiated between (1) keystone actors, (2) classical dominators, (3) hub landlords, and (4) niche players. The focus of these individual ecosystem roles differs largely: Keystone organizations, as described by Iansiti and Levien (2004b, p. 73), while lacking in physical presence, improved the overall health of the ecosystem, noting that they provided *"[...] a stable and predictable set of common assets."* These authors further specified that keystone actors needed to (1) create value in the ecosystem and subsequently (2) share this value with other ecosystem actors. While also lacking in physical presence, niche players contributed to the ecosystem using a focused set of capabilities. Classical dominators, in contrast, exerted a substantial presence in the ecosystem, created and captured large parts of the ecosystem value, and subsequently wielded considerable control in the ecosystem. Lastly, hub landlords were described as lacking in physical presence and as creating little value for the ecosystem while trying to capture the value generated by other actors (Iansiti and Levien, 2004a, p. 75).

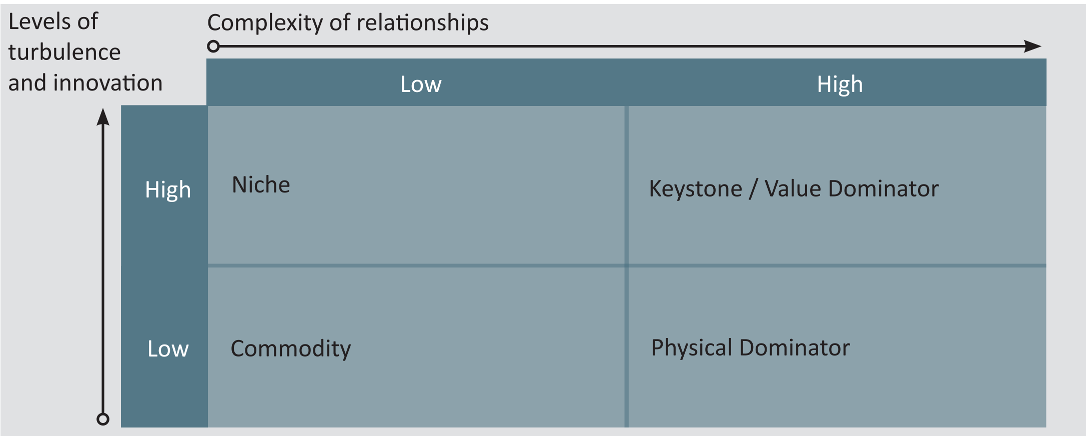



**Figure 24:** Business ecosystem strategies according to Iansiti and Levien (2004a)

Moreover, the ecosystem strategies outlined in Table 18 can be characterized by the complexity of the relations and the individual level of innovation and turbulence (Iansiti and Levien, 2004b, p. 75). As shown in Figure 24, in particular, keystone actors were critical in cases of high degrees of innovation that relied on complex relationships in an ecosystem.

**Table 18:** Overview of business ecosystem strategies according to (Iansiti and Levien, 2004a, p. 75)

| Strategy | Characteristics | Presence | Value creation | Value capture | Focus and Ccallenges |
|---|---|---|---|---|---|
| **Keystone** | • actively improves the overall health of the ecosystem<br>• benefits the sustained performance of the firm | • generally low physical presence relative to its impact<br>• occupies relatively few nodes | • leaves vast majority of value creation to network<br>• internally created value is shared widely | • shares value widely throughout network<br>• balances sharing of value with value capture in selected areas | • focus on creating platforms and sharing solutions to problems throughout the network.<br>• sustain value creation while balancing value extraction and sharing is a significant challenge.<br>• deciding which areas to selectively dominate is an additional challenge. |
| **Classical Dominator** | • integrates vertically or horizontally<br>• manages and controls large parts of its network | • high physical presence<br>• occupies most nodes | • directly responsible for large parts of value creation | • captures large parts of the created value | • main focus lies on control and ownership<br>• defines, ownes, and directs most of what the network does |
| **Value Dominator** (Hub Landlord) | • extracts as much value as possible from its network<br>• does not directly control the network | • low physical presence<br>• occupies few nodes | • creates little to no value<br>• relies on the rest of the network for value creation | • capture most value for themselves | • refuse to control their networks while relying on them as their only source of value<br>• extract significant amounts of value from networks that they put their existence at risk<br>• strategy fundamentally inconsistent |
| **Niche player** | • develops specialized capabilities<br>• capabilities as differentiator from other firms in the network | • individual niche players have very low physical presence<br>• constitute the bulk of ecosystems where they are allowed to thrive | • collectively create large parts of the value in a healthy ecosystem | • capture large parts of the value they created | • focused on specializing in areas where they have developed or can develop capabilities<br>• leverage the services provided by keystones in their ecosystem |

### 4.3.2 Specific aspects of the emergence and evolution of innovation ecosystems

While descriptions of ecosystem evolution outlined in the previous section were largely provided in the generic context of (business) ecosystems, the basic principles arguably hold true for innovation ecosystems. Therefore, in this work it is assumed that the literature on specific characteristics of innovation ecosystems represents an extension of the existing ecosystem literature rather than forming a distinct area of research. Consequently, in the following section, specific details regarding the emergence and development of innovation ecosystems are presented.

#### a) Factors for the emergence of innovation ecosystems

The early phases of innovation ecosystems bear particular relevance for their later forms (Dedehayir et al., 2018, p. 22). This is the case, because the early stages of innovation ecosystems tend to be similar to the front end of innovation, encompassing the activities that enable the transition of an innovation from a discovery to a commercialized product (Dedehayir et al., 2018, p. 25). Interestingly, however, the literature disagrees as to whether innovation ecosystems can be actively designed and implemented (i.e., introduced top-down) or emerge from the bottom-up. For instance, Tsujimoto et al. (2018, p. 55) argued that innovation ecosystems pursued the goal of providing offerings (products or services) through a *"[...] historically self-organized or managerially designed multilayer social network [...]"* that consists of *"[...] actors that have different attributes, decision principles, and beliefs."* One factor that could support the emergence of ecosystems is the co-existence of varying types of complementarities (Jacobides et al., 2018, p. 2260). In that regard, Jacobides et al. (2018, p. 2263) subsequently argued that ecosystems do not "emerge" spontaneously but are the *"[...] result of deliberate experimentation and engineering from different parties."* In contrast, Smorodinskaya et al. (2017, p. 5248) stated that innovation ecosystems cannot be introduced on purpose. Instead, they emerge from *"innovation-conducive environments"* through the collaboration of actors in a network (Smorodinskaya et al., 2017, p. 5248) which, in turn, were motivated by markets (Russel and Smorodinskaya, 2018, p. 125). Moreover, Dattee et al. (2018) proposed that companies should take a more deliberate approach toward the creation of innovation ecosystems. They found that companies that *"play the ecosystem game"* would coordinate the emergence of an increasingly clearer *"value blueprint"* (Dattee et al., 2018, p. 490). Specifically, they proposed that ecosystem actors would (1) keep open the range of possible options by delaying the commitment of their resources while (2) taking initiatives in advance to avoid unwanted future states before the respective blueprint for the ecosystem manifested itself. Thereby, the authors argued, companies would enact dynamic control to simultaneously influence the aspects of value creation and value capture in the ecosystem (Dattee et al., 2018, p. 490). However, the literature states that the emergence of innovation ecosystems is likely to face several, often complex, barriers.

In that regard, as illustrated in Figure 25, Almpanopoulou et al. (2019, p. 6361) distinguished distinct barriers that blocked the emergence of innovation ecosystems. In particular, actors tended to struggle to identify options that would enable the emergence of ecosystems (Almpanopoulou

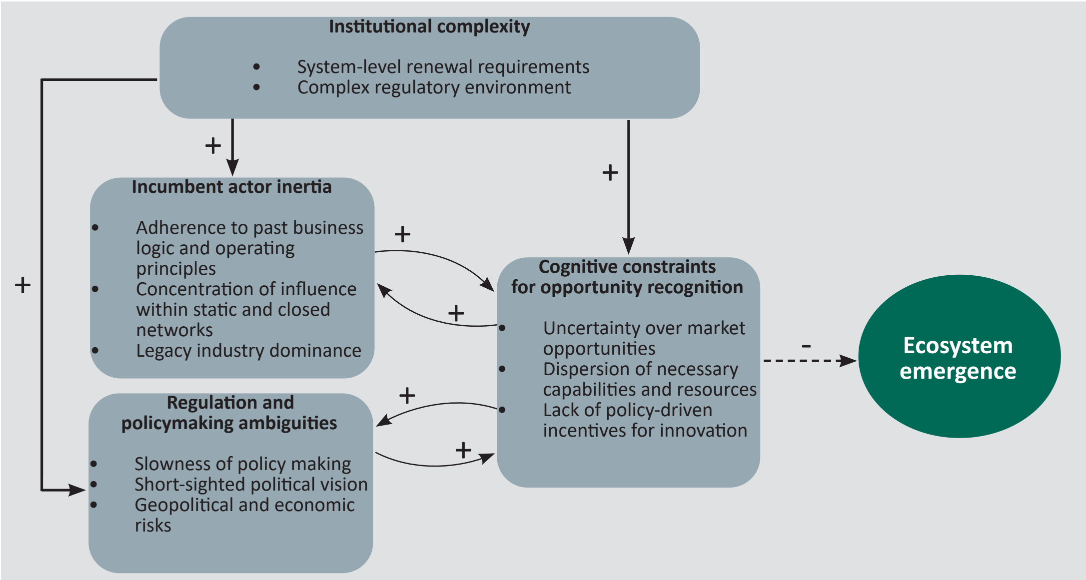



**Figure 25:** Forces that counteract the emergence of innovation ecosystems as proposed by Almpanopoulou et al. (2019, p. 6361)

et al., 2019, p. 6359). As shown in Figure 25, uncertain market opportunities, dispersed capabilities, and a lack of policy-driven incentives were major factors that kept companies from recognizing opportunities that could lead to the emergence of ecosystems (Almpanopoulou et al., 2019, p. 6361). These *"cognitive constraints for opportunity recognition"* were then positively reinforced by *"incumbent actor inertia," "regulation and policy making ambiguities,"* as well as institutional complexity. Referring to institutional theory[1] Almpanopoulou et al. (2019, p. 6364) proposed that *"incumbent actor inertia"* and *"cognitive constraints for opportunity recognition"* were tightly linked with the *"[...] dimensions of regulative, normative, and cognitive legitimacy."* Subsequently, Almpanopoulou et al. (2019, p. 6364) argued that *"[...] different dimensions of legitimacy seem to be an important pre-condition for ecosystem emergence."* Understanding institutional forces and legitimacy can indicate the context in which ecosystems emerge and, in turn, may help to avoid emergence barriers (Almpanopoulou et al., 2019, p. 6359). Moreover, the generation of innovation ecosystems is not a static event, but rather a process with multiple phases (Dedehayir et al., 2018, p. 26). It is typically in the early phases of ecosystem evolution when partnerships are forged and actors - often from different industries - are encouraged to join an ecosystem (Dedehayir et al., 2018, pp. 22-23). These initial activities are carried out to create a network of actors that works towards a common goal (Dedehayir et al., 2018, pp. 22-23). This also requires establishing a shared vision and enhancing the ecosystem's core product by encouraging complementarities. One particular critical aspect at this stage is the need to overcome the mutual dependencies of actors with regard to creating ecosystem value (Dattee et al., 2018, p. 467). At the core of this issue lies the fact that the actor's value proposition often yields little value in isolation (Dattee et al., 2018, p. 467). Thus, single actors have little incentive to begin contributing to a common ecosystem goal. To solve this *"chicken and egg"* problem, Dattee et al. (2018, p. 467) suggested

[1]See, for example, Dacin and Goodstein (2002) for further details on institutional theory.

the involvement of ecosystem leader that could take on the role of a *"keystone"*, as described by Iansiti and Levien (2004b), and could foster the introduction of an attractive *"value blueprint."*

Specifically, Dedehayir et al. (2018, p. 22) proposed four relevant groups of roles that are relevant for the generation of innovation ecosystems: (1) *"leadership roles"*, (2) *"direct value creation roles"*, (3) *"value creation support roles"* and (4) *"entrepreneurial ecosystem roles."* A summary on the roles and respective activities is presented in Table 19.

**Table 19:** Roles in the generation of innovation ecosystems according to Dedehayir et al. (2018)

| Group | Role | Activities |
|---|---|---|
| **Leadership roles** | Ecosystem governance | Initiates, maintains, and develops ecosystem functionality by:<br>• Designs roles of ecosystem actors<br>• Coordinates internal and external interactions<br>• Orchestrates resource flows among partners |
| | Forging partnerships | Creates a network by:<br>• Attracting and gathering relevant partners<br>• Establishing links and alliances with companies owning various resources from different industries<br>• Creating collaboration among parties in alliances<br>• Stimulating complementary investments and providing opportunities to create niches |
| | Platform management | Provides technical basis for market to function by:<br>• Designing and building a platform<br>• Opening platform, data, and infrastructure to<br>– establish a community of users<br>– enhance value from producers<br>• Orchestrating complementor innovations to align with the platform |
| | Value management | Creates and captures value by:<br>• Bundling offerings and supplied components<br>• Stimulating value appropriation for all producers and the end-user |
| | Dominator | Conducts mergers and acquisitions in related fields |
| **Direct value creation roles** | Supplier | Delivers key component offering by supplying materials, technologies, and services, to be used by others in the ecosystem |
| | Assembler | Provides products and services by:<br>• Assembling components, materials, and services<br>• Processing information, supplied by others in the ecosystem |
| | Complementor | Delivers key complementary offering by:<br>• Attaining compatibility with the platform<br>• Utilizing the design of the ecosystem's other offerings<br>• Meeting customer specifications |
| | User | Contributes to value creation by:<br>• Defining a problem or need<br>• Developing ideas based on product data provided by ecosystem leader<br>• Engaging in transaction and purchasing of offering<br>• Integrating key complementarities and using the product or service |
| **Value creation support roles** | Expert | Supports primary value creators by:<br>• Generating knowledge from research (basic and applied)<br>• Providing consultation, expertise, and advice<br>• Encouraging technology transfer and commercialization |

Table 19 continues on next page

Table 19 continued from previous page

| | | |
|---|---|---|
| | Champion | Supports ecosystem construction by:<br>• Building connections and alliances between actors<br>• Interacting between partners and sub-groups<br>• Providing access to markets (local and nonlocal) |
| **Entrepreneurial ecosystem roles** | Entrepreneur | Starts new venture around a vision by:<br>• Co-locating in a region with others (agglomeration economies)<br>• Setting up focused network of staff, suppliers, customers, and complementors<br>• Coordinating collaboration between research and commercialization partners |
| | Sponsor | Supports new venture creation by:<br>• Providing resources for entrepreneurs<br>• Financing low-income markets<br>• Purchasing and co-developing offerings of companies<br>• Linking entrepreneurs to other ecosystem actors |
| | Regulator | Supports entrepreneurial activity and opening avenues for ecosystem emergence by:<br>• Providing economic and political reform<br>• Loosening regulatory restrictions |

As shown in Table 19, Dedehayir et al. (2018, p. 23) found that companies taking on leadership roles were crucial for the emergence of ecosystems, as they ensured that (1) a critical mass is attained and (2) collaborations deliver holistic value. Looking at roles for direct value creation, Dedehayir et al. (2018, p. 24) proposed that the roles of the supplier, assembler, and complementor will probably be established shortly before the ecosystem genesis. Interestingly, they emphasized the crucial importance of building ecosystem relationships. Therefore, besides ecosystem leaders, this task could also be accomplished by ecosystem experts and champions (Dedehayir et al., 2018, p. 24). Moreover, they also highlighted the interdependencies between roles. Dedehayir et al. (2018, p. 24) proposed that entrepreneurial roles *"[...] may be assumed in response to the partnership forging activities of the ecosystem leader, or as a result of seeing opportunities to commercialize discoveries and inventions of experts."* Dedehayir et al. (2018, p. 24) than argued that *"[...] the entrepreneur will establish a purposeful network of internal (e.g. staff and experts) and external collaborators (e.g. suppliers, customers, and complementors)."* Moreover, entrepreneurial actors could act as intermediaries between actors performing research and actors pursuing the commercialization of technologies (Dedehayir et al., 2018, p. 24). Each of the roles identified by Dedehayir et al. (2018, p. 22) becomes relevant in different stages of the ecosystem's generation and fulfills specific activities. Dedehayir et al. (2018, p. 26) proposed three concrete stages (1) preparation, (2) formation, and (3) operation (compare with Figure 26). As shown in Figure 26, in each of the stages, different goals were relevant, leading to different activities that were then addressed by specific types of actors. In the preparation stage, the ecosystem leader begins to set up the ecosystem by deciphering roles, linking partners, and building platforms according to the users' needs. In later stages, ecosystem leaders would shift towards coordinating interactions, fostering collaboration, as well as orchestrating resource flows and companies providing complementing offers. It is in these later stages that dominators could also integrate actors. Dedehayir et al. (2018, p. 26) underlined the relevance of value support roles in

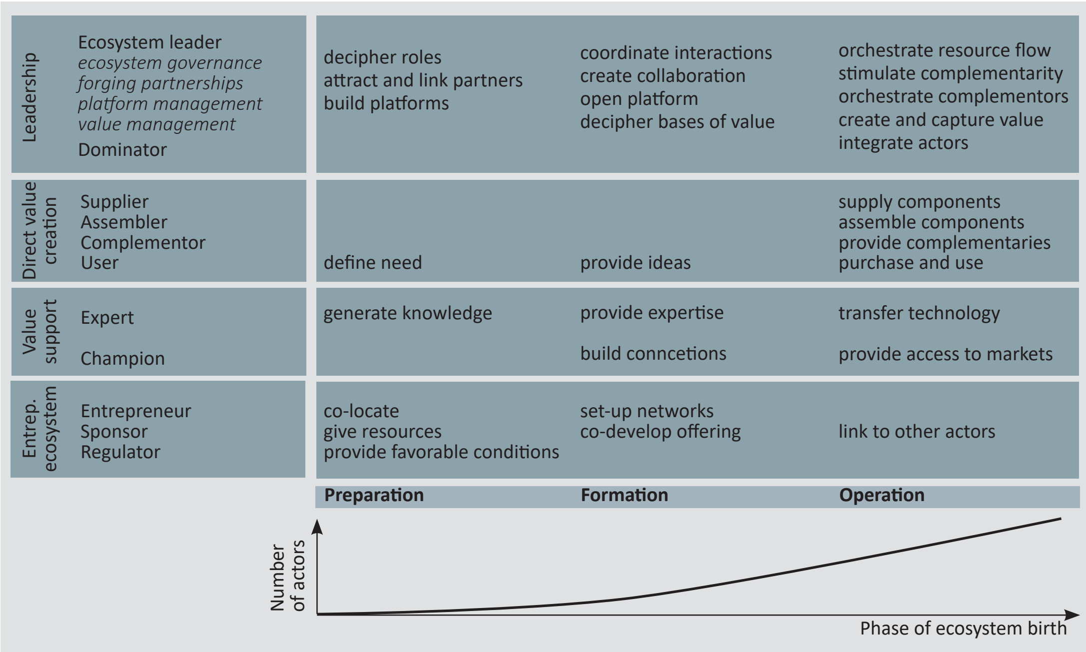



**Figure 26:** Roles and activities during the generation of innovation ecosystems according to Dedehayir et al. (2018, p. 26)

providing technological expertise, building connections, and enabling market access. Moreover, they argued that, while entrepreneurial ecosystem actors would co-locate, co-develop, and act to set up networks and link authors, that potential customers and users in the ecosystem would participate by defining needs and providing ideas. Interestingly, Dedehayir et al. (2018, p. 26) noted that suppliers, assemblers, and companies providing complementing offers would only start to participate in the ecosystem once it had entered its operational stage.

### b) Role of strategy and governance for innovation ecosystem evolution

Dedehayir et al. (2018, p. 19) emphasized the fact that themes such as organizational strategies for value creation, value capture, and ecosystem leadership, value blueprints, and the structure of ecosystems were closely related to the evolution of the innovation ecosystems. Accordingly, Luo (2018, p. 132) understood an innovation ecosystem's evolvability as *"[...] its inherent ability to generate value-creation variations in the technology configuration of the ecosystem's final products."* A cohesive strategy in that regard required choosing an opportunity environment, seizing opportunities, and creating viable networks among multiple business ecosystems (Moore, 1996, p. 16) and thus required a comprehensive understanding of an ecosystem as well as its respective dynamics (Adner, 2006, p. 106). Autio and Thomas (2014, p. 223) also emphasized the fact that strategies in innovation ecosystems were developed to support: (1) the creation of the ecosystem, (2) the coordination of the ecosystem, (3) the adjustment of business models to exploit an ecosystem's externalities, as well as (4) the creation of control strategies for appropriating value. These aspects underline others that are related to the ecosystem level, such as the creation and control of the ecosystem, as well as constructs that are typically associated with individual actors, such as business models. However, the abilities of individual ecosystem actors to pursue ecosystem strategies and the benefits they receive from doing so tend to differ. For instance, companies pursuing an ecosystem strategy were faced with a dilemma, since they could move in two principal directions (Adner, 2006, p. 106): On the one hand, they could try to maneuver themselves into the role of ecosystem leadership/orchestrator, which tended to consume massive amounts of resources/investments over a substantial time period. On the other hand, they could pursue strategies that were less aggressive but potentially more uncertain regarding which potential ecosystem leaders to follow, the scope of leaders' commitment, and the ability to fend off competitors. Moreover, companies that were able to lead an ecosystem could also influence its development to match their strengths (Adner, 2006, p. 106). This is particularly relevant, as ecosystem leaders would usually benefit from an established and functioning *"value blueprint"* (Adner, 2012, p. 117). Thereby, Adner (2017, p. 47) pointed out a critical difference between traditional strategies and ecosystem strategies: While companies competed with each other in conventional concepts of strategy, different ecosystems and thus ecosystem participants engaged in competition in the ecosystem concept of strategy. One particular aspect with regard to ecosystem strategies, according to Adner (2017, p. 47) was the alignment between individual ecosystem actors:

> *"Ecosystem strategy is defined by the way in which a focal firm approaches the alignment of partners and secures its role in a competitive ecosystem."*

This statement highlights (1) the role of consistency in the actors' strategies and the subsequent convergence of their actions, (2) the alignment of partners (i.e., the focal actors' ability to bring their partners in positions and roles that fit their ecosystem strategy), (3) the individual roles of actors in contributing to a value proposition and (4) the competitiveness of the overall ecosystem (Adner, 2017, pp. 47-49). Consistency could help increase the likelihood that the ecosystem actors' actions would be convergent, while failing to identify inconsistencies might have negative consequences for the ecosystems (Adner, 2017, p. 47). Adner (2017, p. 47) also proposed that the alignment of ecosystem actors needed to be viewed in the context of the focal actors' strategies and their abilities *"[...] to bring its partners into the positions and roles that its ecosystem strategy envisions."* Like Moore (1996, p. 16), Adner (2017, p. 47) highlighted two crucial steps that needed to be taken to align actors: First, gaps needed to be identified and, second, conditions to close gaps needed to be established (e.g., by allocating resources or changes in strategies). Moreover, innovation ecosystems relied on a clear vision and shared ecosystem values to foster the actors' participation in the co-creation of ecosystem value, as well as encouraging actors to share knowledge and establish connections (Ketonen-Oksi and Valkokari, 2019, p. 25).

Performing the outlined steps was reported as a challenging undertaking in the literature. For instance, Adner (2012, p. 194) acknowledged the difficulties faced when attempting to get the ecosystem partners' agreement/commitment as well as to align them to deliver a specific value proposition. Establishing this alignment could be difficult because the actors' business models might not be suited for the potential future states of innovation ecosystems (Ketonen-Oksi and Valkokari, 2019, p. 33). Consequently, Ketonen-Oksi and Valkokari (2019, p. 33) emphasized that

*"[...] participating in and facilitating collaborative innovation in ecosystems calls for a new kind of agility that, in some cases, requires companies to be willing to even kill their current business model(s) to survive within the evolving ecosystem.* Adner (2012, p. 194) had previously outlined several principles that could be applied to build successful ecosystems piecemeal and address these issues:

- **Minimum viable footprint:** The minimal configuration of elements that can create a specific commercial value.
- **Staged expansion:** Adner emphasized considering the order in which elements can be added to a *minimum viable footprint* to ensure that each element benefits from the already installed system, while increasing the potential for value creation for elements that will be added later.
- **Ecosystem carryover:** Adner (2012, p. 194) described this as *"[...] the process of leveraging elements that were developed in the construction of one ecosystem to enable the construction of a second ecosystem."*

Similarly, as summarized in Table 20, Autio and Thomas (2014, pp. 221-222) proposed a number of key aspects to be considered when planning for the creation and appropriation of value in innovation ecosystems.

**Table 20:** Key aspects for the creation and appropriation of value in innovation ecosystems according to Autio and Thomas (2014, pp. 221-222)

| Aspect | Relevance and potential implications for creation and appropriation of Value |
|---|---|
| **Control mechanisms** | Enable companies to influence ecosystems evolution, e.g.:<br>• shared platforms (e.g. hardware platform) (Cusumano and Gawer, 2002),<br>• critical assets (Teece, 1986, 1998) such as important but scarce resources<br>• pre-emptive alliances (Teece, 2009) that may allow for strong position of control in the ecosystem, following Autio and Thomas (2014, p. 221), especially when they prevent competitors from accessing to critical assets |
| **Migration of control** | As a result of ecosystem evolution, control mechanisms may shift to other places in the ecosystem. This holds the potential to undermine the position of companies. To avoid negative impacts, companies need to anticipate and prepare for ecosystem evolution. |
| **Value creation dynamics** | Properties of the creation and delivery of value as well as the respective relationships in the innovation ecosystem influence the companies' choices of positioning in the innovation ecosystem as well as value appropriation. Aspects to consider regarding the dynamics of value creation include:<br>• Type of value (e.g., services, manufactured goods, intangible assets)<br>• Distribution of value processes (e.g., sequential distribution along the value chain, parallel and horizontal distribution) |
| **Value externalities** | Innovation ecosystems benefit from incentives and structures for complementary innovation. According to Autio and Thomas (2014, pp. 221-222), this is due to value externalities (direct as well as indirect network effects) that positively influence the creation of value in innovation ecosystems. |

Autio and Thomas (2014, pp. 221-222) emphasized the roles of (1) control mechanisms that could help companies enact influence in an ecosystem, (2) the migration of control to other positions in the ecosystem, (3) dynamics of value creation as well as (4) value externalities, such as network effects that support complementary innovation. Ecosystem governance could thereby be enacted by defining interfaces, standards, engagement rules, and processes (Jacobides et al., 2018, p. 2260). Moreover, these authors underlined the role of modularity - particularly in the context of technology governance. Modularity could allow for the production of interdependent components by different actors and the coordination of individual ecosystem actors that faced dependencies mutually (Jacobides et al., 2018, p. 2260).

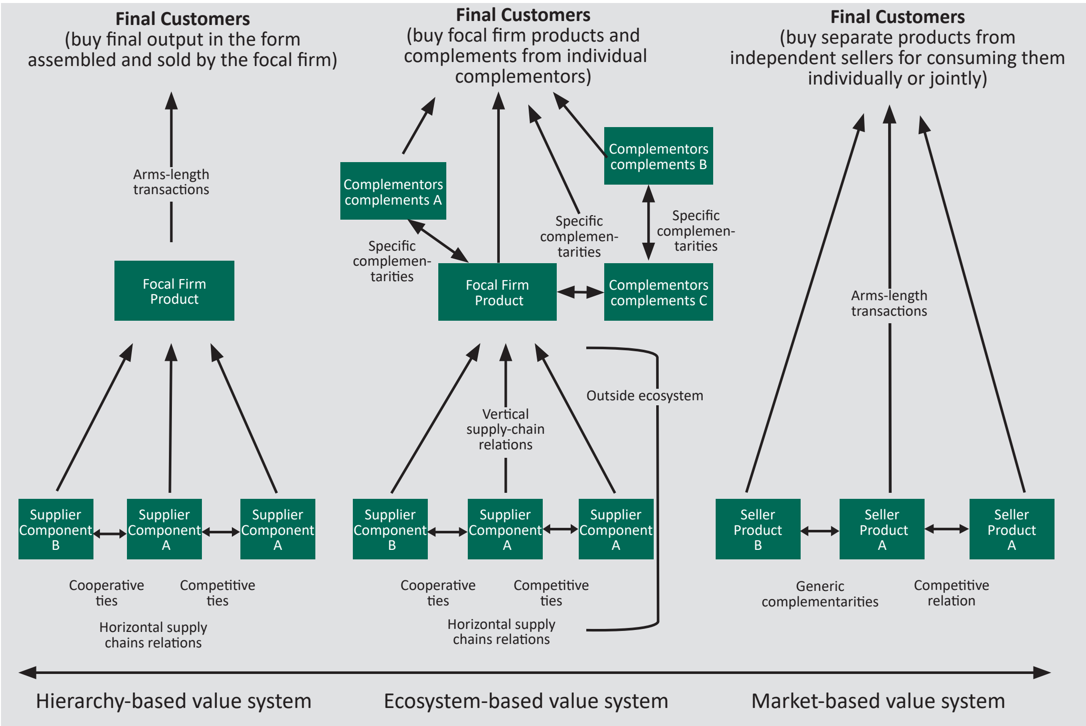



**Figure 27:** Comparison of value system structures (Jacobides et al., 2018, p. 2261)

Interestingly, the idea of control as described by Autio and Thomas (2014, pp. 221-222) might have a substantial impact on the exact form of an ecosystem's *"value blueprint"* (Adner, 2012). As illustrated in Figure 27, they distinguished between different levels of control in value systems that subsequently could be (1) hierarchy-based, (2) ecosystem-based, or (3) market-based. The construct Jacobides et al. (2018, p. 2261) labeled as an *"Ecosystem-based value system"* is strikingly similar to the concept of an innovation ecosystem's *"value blueprint"* (Adner, 2012). This underlines the related nature of an ecosystem's structure and its governance that, in turn, could impact the business models of individual ecosystem actors.

As highlighted in this chapter, business models can be considered to be relevant in the context of ecosystems (cf. Autio and Thomas (2014); Ketonen-Oksi and Valkokari (2019)). In the next section the relations of ecosystems and business models are described in greater detail.

## 4.4 Relations of ecosystems and business models

Recent publications have drawn links between the concepts of business models and ecosystems. However, while business models tended to focus on organizations, ecosystems provided a specific view of environments (Demil et al., 2018, p. 1219). To explore this relationship, conceptual similarities are outlined in this following section, and the literature relating both topics is summarized.

Already in the early phases of research on business ecosystems, Moore (1996, p. 240) argued that these ecosystems were determined by a set of underlying assumptions. Besides assumptions on environmental conditions, Moore (1996, p. 240) explicitly named assumptions about (1) customers, (2) about concrete offerings, (3) the actors and activities to create a certain offering as well as (4) how to generate revenues from an offering. Moore (1996, p. 240) referred to these assumptions as the ecosystem's business model. Although Moore used the term business model to describe the overall ecosystem, this highlights similarities between the concepts. In that vein, Schallmo and Brecht (2010, p. 5) argued that business models would exist on different levels, ranging from industry business models to company business models. Interestingly, Thomas and Autio (2012, p. 17) adopted this idea and - referring to Osterwalder and Pigneur (2010) - described the concept of an ecosystem model as *"[...] the rationale of how an ecosystem creates, delivers and captures value."*

However, while the connection between business models and ecosystems is present in the literature on business ecosystems, it has been more intensively discussed in the specific context of innovation ecosystems. In that regard, Adner (2017, p. 51), a vocal advocate of the innovation ecosystem, proposed that a *"[...] successful ecosystem is composed of multiple firms acting in concert—an ecosystem strategy can be thought of as one that takes partner firms' business model to be as critical to address as the focal firm's."* This statement contrasts with the view on business models, which typically place a focus on individual companies (cf. Osterwalder and Pigneur (2010); Zott and Amit (2010)). The view comes as no surprise, as, according to Anggraeni et al. (2007, p. 3), using relationships with customers, partners, or competitors effectively requires an understanding of interconnected business models as well as the factors and mechanisms that govern the respective networks. An examination of both the literature on innovation ecosystems and business models reveals similarities between the concepts. For instance, Adner (2017, p. 43), highlighted four basic elements that characterize ecosystems: (1) activities (i.e., discrete actions to establish a value proposition), (2) actors (i.e., entities that undertake activities), (3) positions that determine the flow of activities as well as (4) links that *"specify transfers across actors"* (i.e., material, information, influence).[1] Similarly, Granstrand and Holgersson (2020, p. 7) highlighted key aspects of innovation ecosystems as (1) actors, (2) activities, and (3) artifacts in their definition. The descriptions of ecosystem elements provided by Adner (2017, p. 43) and Granstrand and Holgersson (2020, p. 7), are reflected in the common understanding of business models comprising of *"content"*, *"structure"* and *"governance"* (Amit and Zott, 2001) and the relations of individual elements (Santos et al., 2009). Several authors have emphasized the elements of *"value proposition"*, *"value creation"*,

[1] Interestingly, Adner (2017, p. 43) emphasizes the fact that partners in an ecosystem do not necessarily need to have a connection to a focal ecosystem actor - an idea that supports his concept of a "value blueprint" which could be extended as necessary (Adner, 2012, p. 87).

*"value distribution"* and *"value capture"* in the context of ecosystems (see, for example, Adner (2017, p. 43) and Thomas and Autio (2012, p. 17)). These mirror the common elements and terminology used in the field of business models (cf. Remane et al. (2017); Clauss (2017)). The similarities between the outlined descriptions of innovation ecosystems and business models also become evident when one examines the approaches taken to describe business models. For instance, Amit and Zott (2012, p. 42) defined business models by emphasizing an *"activity system"* that could serve market needs by linking customers, partners, and vendors. In contrast, Berglund and Sandström (2013, p. 276) saw business models as high-level descriptions of ways value could be created, delivered, and appropriated that spanned company boundaries. These similarities serve to underline the implicit link between both concepts further.

Consequently, Thomas and Autio (2012, p. 17) argued that an *"[...] ecosystem model is analogous to that of the business model; however the key difference is that while the business model applies at the level of the focal firm, the ecosystem model applies at the level of the network."* Therefore, the concept of an ecosystem model can be applied in an approach enabling an ecosystem participant to consider the ecosystem as a whole (Thomas and Autio, 2012, p. 17). In contrast, the business model offers an approach for considering individual actors. (Thomas and Autio, 2012, p. 17). Unsurprisingly, Dattee et al. (2018, p. 469) concluded that *"[...] the literature has seen the move to the ecosystem model as a form of business model innovation, for which companies have surprisingly good visibility on what to do and how to get there."* One particularly direct angle that combines both the literature on ecosystems (e.g., Iansiti and Levien (2004b)) and on innovation ecosystems (e.g., Adner and Kapoor (2010, 2016a)), as well as the implicitly connected ecosystem literature, with aspects of business models (Zott and Amit, 2010) was provided by Talmar et al. (2018, p. 2). In their approach to model ecosystems, they proposed using concrete constructs on both the ecosystem level and the actor level. Table 21 provides an overview on the principal constructs proposed by Talmar et al. (2018).[1]

**Table 21:** Constructs for modeling ecosystems as proposed by Talmar et al. (2018)

| | Ecosystem level | Actor level | |
|---|---|---|---|
| **Constructs** | • Ecosystem value proposition<br>• User segments<br>• Actors | • Resources<br>• Activities<br>• Value addition | • Value capture<br>• Dependence<br>• Risk |

Talmar et al. (2018, p. 1)[2] further proposed that companies should combine their constructs in an ecosystem model that connects both the ecosystem level and the actor level, thus, highlighting interactions *"[...]both within and between actors."* As illustrated in Figure 28, the model allows the characterization of ecosystems by viewing ecosystem level constructs and actor level constructs as if they are centered around a joint ecosystem value proposition. It shows how different actors might both add value and capture value regarding this value proposition by applying resources and performing activities. Furthermore, it illustrates how an ecosystem's value proposition could be

[1]See Talmar et al. (2018) for details on the constructs.

[2]Talmar et al. (2018) partly based their argument on previous publications by Adner (2012) and Nambisan and Sawhney (2011).

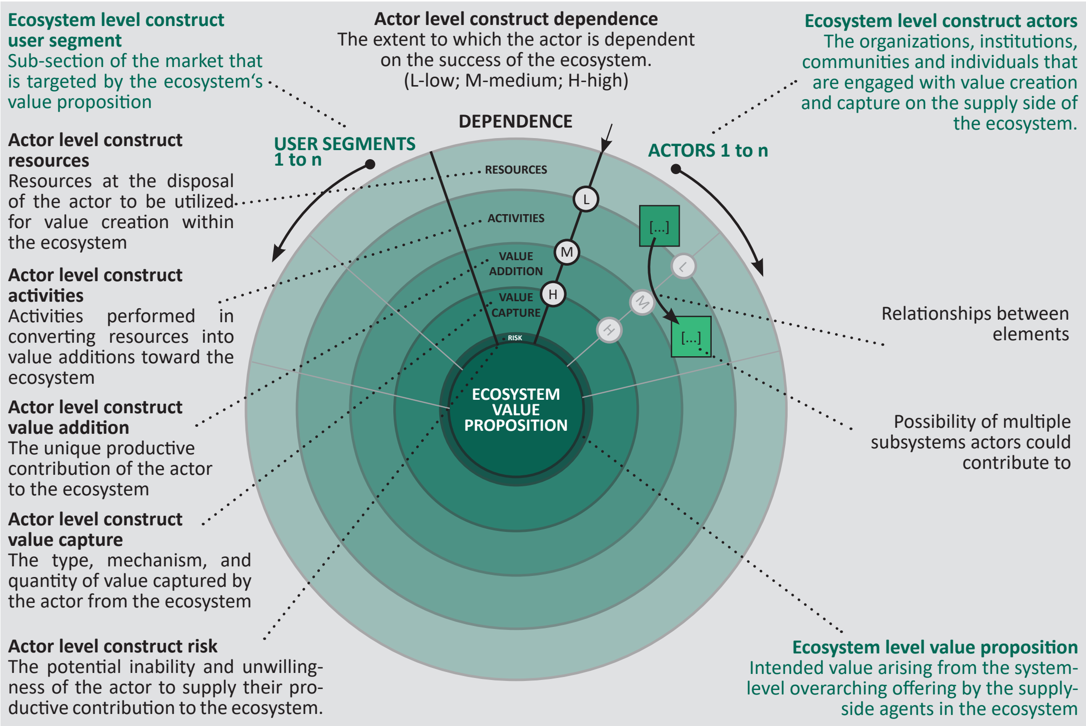



**Figure 28:** The Ecosystem Pie Model according to Talmar et al. (2018, p. 2)

relevant for the individual user segments . Moreover, while the *"Ecosystem Pie Model"* proposed by Talmar et al. (2018, p. 4) represents ecosystem-level and actor-level properties, it also captures relationships that *"[...] transcend the immediate vicinity of any actor in a value chain."* Talmar et al. (2018, p. 4) differentiated between two levels of relationships in their model: On the one hand, *"intra-actor relationships"* predominantly take place within a certain ecosystem actor. On the other hand, *"inter-actor relationships"* are typically situated between different ecosystem actors. Relevant inter-actor relationships identified by Talmar et al. (2018, pp. 4-5) in the literature were: (1) the integration of individual value additions at the end-user, (2) sharing and recombining resources to enhance the individual actor's ability to create value, (3) a boundary-spanning combination of activities with other actors (4) mutual influences on value capture among actors (5) the individual actors' risks that influenced activities of other actors resulting in mutual influences regarding how much actors are able to add and capture value in the ecosystem. In addition, (Talmar et al., 2018, p. 4) attempted to illustrate how intra-actor constructs relate. As shown in Figure 29, the arrangement of constructs on the actor level shows striking similarities to typical conceptions of business models (compare, for example, with Schallmo and Brecht (2010, p. 5)). One could argue that *"resources and activities"* are tightly related to the value creation aspect of business models. Moreover, an individual actor's *"value addition"* to an overall *"ecosystem value proposition"* on the ecosystem level could be interpreted as the *"value proposition"* on the actor level. However, while some constructs directly relate to the business model concept (e.g., value capture), others are not typically represented in descriptions of the single actor's business models (i.e., dependencies and risks). Nonetheless, Talmar et al.'s *"Ecosystem Pie Model"* provides a direct link between

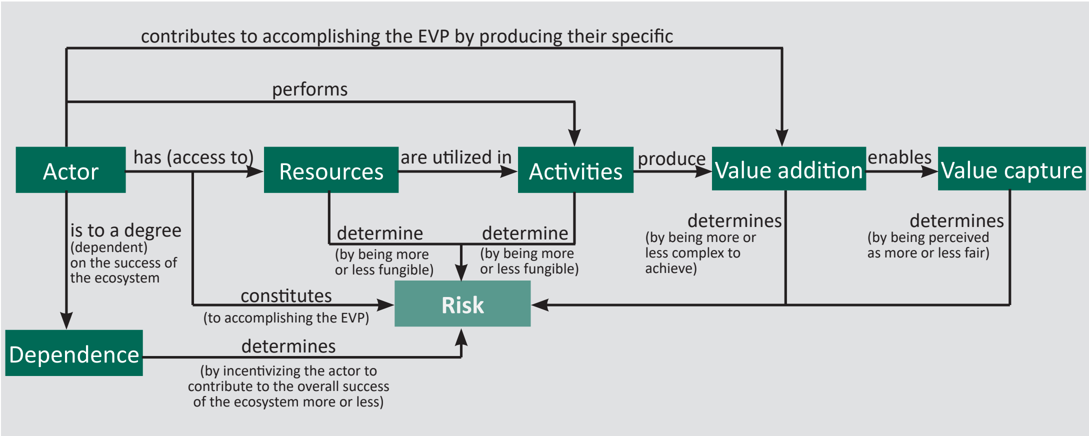



**Figure 29:** Intra-actor relationships of constructs according to Talmar et al. (2018, p. 4)

the concepts of business models and ecosystems. The model proposed by Talmar et al. (2018, pp. 4-5) also provides a structured approach that can be taken to consider individual aspects on the ecosystem and actor levels and how they relate to each other. This is especially fruitful since, according to Jacobides et al. (2018, p. 2260), ecosystem-based value systems need significant coordination due to their structures, which arise from different types of complementarities (compare with Figure 27).

Based on the concepts outlined above, it can be concluded that a number of researchers began to either implicitly or explicitly highlight the relations between innovation ecosystems and business models (cf. Adner and Kapoor (2010); Adner (2017); Demil et al. (2018); Talmar et al. (2018); Jacobides et al. (2018); Granstrand and Holgersson (2020)). However, the relationship between business models and ecosystems is not fully understood and thus needs further exploration.

## 4.5 Summary

In this chapter a basic overview of different ecosystem concepts was provided. While a homogeneous understanding on ecosystems still needs to emerge, the literature includes descriptions of several distinct concepts, such as business ecosystems (Moore, 1996), platform ecosystems (Cusumano and Gawer, 2002), and innovation ecosystems (Adner, 2006). However, due to following reasons, ecosystems centered around innovations (Adner and Kapoor, 2010; Adner, 2012, 2017) represent a particularly viable construct for this thesis work: First, innovation-centered ecosystems allow for the consideration of a value creation architecture consisting of complements and components (Jacobides et al., 2018; Kapoor, 2018) in a *"value blueprint"* (Adner, 2012). Second, innovation-centered ecosystems show remarkable conceptual similarities to business models (Adner, 2017; Demil et al., 2018; Talmar et al., 2018). This, in principle, makes them a suitable environment for considering the alignment of business models towards an ecosystem's value proposition (Adner, 2017; Talmar et al., 2018). However, innovation-centered ecosystems can not be used to explicitly consider aspects relevant for this thesis work. One major aspect in that regard is the role of competition. Therefore, the understanding of ecosystems used in this thesis is based on the innovation ecosystem construct (Adner and Kapoor, 2010; Adner, 2012, 2017), but also combines aspects related to the structure and governance of ecosystems as described by Jacobides et al. (2018), as well as fundamental elements of ecosystems, such as the roles of stakeholders and competitors, which are addressed in publications by Moore (1993, 1996). Consequently, while changes in business models are made to select, align, or influence their environments, the literature on ecosystems provides an overarching concept that can be applied to consider the alignment of individual business models towards ecosystems' value propositions. Therefore, the obtained insights provide a sound basis for a detailed investigation on the changes in business models in the context of their environment.

# 5 Literature review combining business model change and ecosystems

The concept of business models (see Chapter 3) and ecosystems (see Chapter 4) are distinctly similar and overlap in their thematical foci. This provides the starting point for a systematic review of the literature, combining the aspects of changes in business models and their respective ecosystems.[1] In this chapter, first, the purpose of conducting a thorough literature review is explicated (see Chapter 5.1), and the methodology used is described (see Chapter 5.2). Then, a descriptive overview on findings and the obtained qualitative results are presented (see Chapters 5.3 and 5.4). The end of the chapter presents a summary with a conceptual *"a priori"* construct that is used for subsequent empirical inquiries (see Chapter 5.5).

## 5.1 Purpose of the literature review

In the following sections, the purpose of conducting the literature review at hand is described. First, the relevance of the literature review for this thesis work is clarified. Second, guided by research question one, the focus and conceptual starting point of the review are summarized.

### 5.1.1 Relevance of the literature review for this thesis work

Webster and Watson (2002, p. 13) stated that reviewing the previously published, relevant literature is an integral component of any academic work, as it allows the researcher to create a solid foundation for further investigations. Due to the increasing scope and complexity of many research fields, it is also necessary to thoroughly analyze the literature (Fettke, 2006, p. 257). On the one hand, if a complete overview of a particular research field is not available, Fettke (2006) identified the possibility of unnecessarily duplicating efforts and neglecting relevant findings. On the other hand, he stated that due to the steadily growing literature in a given field, new theoretical questions needed to be addressed (Fettke, 2006, p. 257). Therefore, literature reviews can be helpful to understand the topic at hand and improve the research projects results as they

[1]An early version of this chapter was presented by the author of this thesis at the ISPIM Innovation Conference in Florence, Italy (see Rachinger et al. (2019)). However, for this chapter, the findings presented by Rachinger et al. (2019) were heavily revised. Therefore, this chapter represents an original contribution.

guide through the collection and analysis of data and support the development as well as the testing of theory (vom Brocke et al., 2015, p. 206).

Denyer and Tranfield (2009, p. 677) argued that literature reviews are beneficial in the area of management, as *"[...] researchers tend to ask and to address a steady flow of questions rather than integrate and build coherent knowledge stocks or seek further understanding of particular phenomena."* As outlined in previous chapters, the lack of clear terminology and proliferation of definitions in both the field of business models (see Chapter 3) and ecosystems (see Chapter 4) serve as vivid examples of the described tendency. The literature on business models and ecosystems suffers from the use of inhomogeneous terminology and the fragmented knowledge about both the individual topics and their relations. Therefore, exploring factors that influence the connection between business models (and their respective change) and ecosystem concepts requires a thorough investigation of relevant literature. The benefits of performing a review are two-fold: First, when reviews provide consistent and robust results, the review's outcome can be applied to different contexts (Denyer and Tranfield, 2009, pp. 671-672). Second, if the review delivers incongruent findings or reveals gaps in the existing knowledge, it can identify relevant questions for future research (Mertens and Holzner, 1992; Fettke, 2006; Webster and Watson, 2002; Denyer and Tranfield, 2009).

### 5.1.2 Focus and conceptual starting point of the literature review

Literature reviews need to be reproducible and thus require a comprehensive collection of data.[1] Consequently, systematic literature reviews must be based on a specific, well-formulated research question (Counsell, 1997, p. 381) to analyze the relevant work and distill findings (Teuteberg and Wittstruck, 2010, p. 1003). According to Counsell (1997, pp. 384-385), formulating this question guides the literature review by (1) defining which articles to include in the review, (2) applying a suitable search strategy to identify articles, and (3) determining which data need to be extracted from the identified articles. As outlined in Chapters 3 and 4, business models, business model change, and ecosystems show conceptual similarities and thematic overlaps. For instance, Gassmann et al. (2011) argued that business models would evolve from ecosystems. Thus, both constructs would be subject to interdependencies and constant change (Gassmann et al., 2011). Saebi (2015, p. 145) also argued that *"[...] business models need to be in a continuous flux, responding to opportunities and threats in the firm's external environment."* In that regard, business models could be changed to either (1) influence their surrounding ecosystem (through business model innovation) or (2) to establish alignment between a business model and its ecosystem

[1] This idea is reflected in the works of several authors. For instance, Fink (2020, p. 6) considered a research literature review as *"[...] a systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners."* Similarly, Denyer and Tranfield (2009, p. 671) describe a systematic review as *"[...] a specific methodology that locates existing studies, selects and evaluates contributions, analyzes and synthesizes data, and reports the evidence in such a way that allows reasonably clear contributions to be reached about what is and is not known."* According to Fink (2005, p. 3), also *"[...] a research literature review is a systematic, explicit and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners."*

(through business model evolution or adaptation) (Saebi, 2015, pp. 150-151) as well as to select a specific environment (Demil et al., 2018, p. 1213). Again, types of business model changes and the capacities needed to undertake change are contingent on the environmental dynamics in the environments surrounding the business models (Saebi, 2015, p. 161). Talmar et al. (2018, pp. 2-4) then implicitly linked business models as a specific type of actor construct with ecosystems as an overarching concept. This provides a link to the idea that, particularly in innovation ecosystems, multiple companies - and thereby implicitly their respective business models - need to be aligned to provide a joint ecosystem value proposition (Adner, 2017; Talmar et al., 2018). Therefore, this literature review was performed to answer the following research question (also see Chapter 1):

**Research Question 1:**
What are relevant issues in the literature addressing changes in business models in combination with ecosystems?

As outlined in Chapter 4.4, the described similarities are particularly present when examining business models and innovation ecosystems. Consequently, this thesis work relied heavily on the innovation ecosystem construct to characterize ecosystems. However, as argued in Chapter 4, the innovation ecosystem is firmly rooted in earlier characterizations of business ecosystems (Moore, 1996). Therefore, in this thesis work, key aspects of ecosystems as defined by Moore, such as the influence of governmental agencies, stakeholders, quasi-regulatory organizations, and competing organizations are combined with aspects identified by Adner and Kapoor (2010).

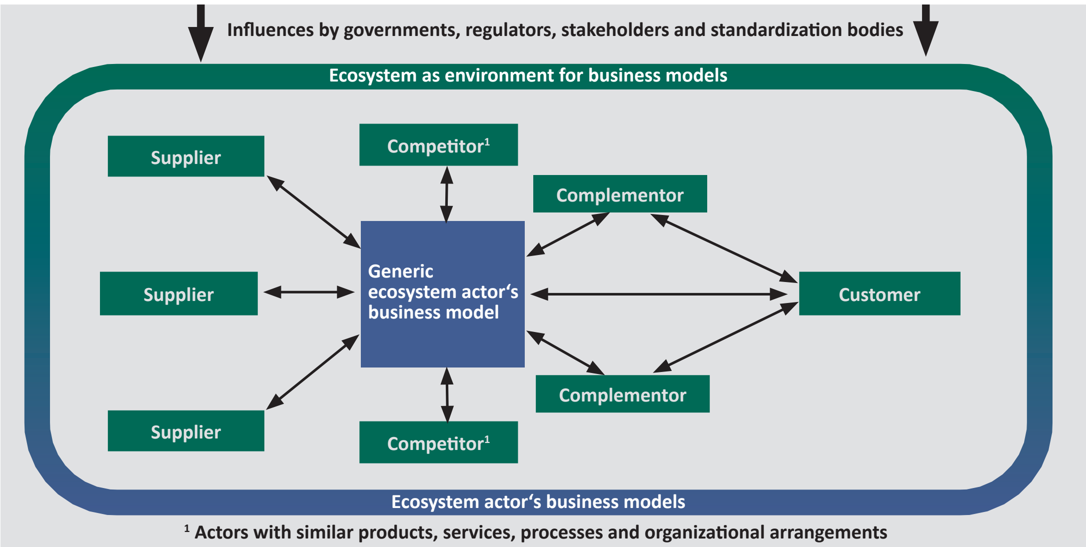



**Figure 30:** Conceptual frame used to illustrate relevant factors of business model innovation with regard to the actor's environment (Saebi, 2015; Foss and Saebi, 2017) in the context of ecosystems (Moore, 1996; Adner and Kapoor, 2010; Jacobides et al., 2018; Talmar et al., 2018) (personal illustration)

The inclusion of competitors represents a slight deviation from Adner's concept of ecosystems, which strongly emphasizes the actors involved in establishing a joint value proposition. Specifically, Adner (2017, p. 43) suggested considering individual elements that perform activities in support of an ecosystem value proposition rather than whole companies. While Adner and Kapoor (2010) did not explicitly include competitors in their concept of the *"value blueprint,"* he later acknowledged the influence of competition within and across ecosystems regarding how value was created, distributed, and captured (Adner, 2017, p. 49). Similar ideas also can be found in the literature on business models. For instance, Magretta (2002, p. 89) argued that business models need to be paired with aspects of strategy, as they do not explicitly consider competitors themselves. However, despite the fact that Adner (2017, p. 43) only vaguely defined the actors' overall competitive relations, Granstrand and Holgersson (2020) provided insights into common themes in the literature and indicated that aspects such as competition, collaboration, or co-evolution could play significant roles in ecosystems. To answer Research Question 1, it was deemed necessary to include aspects related to competition in the models, as the literature on business models emphasizes such aspects (compare, for example, Velu (2016, p. 134)).

The review results are subsequently categorized according to the construct illustrated in Figure 30, which forms a conceptual starting point for this review, enabling readers to understand the mutual relations of business model innovation in the context of ecosystems. The conceptual framework shown in Figure 30 does not comprehensively cover the individual actors and their positions and roles in an ecosystem. Instead, it illustrates the interdependencies between ecosystem aspects and the focal actors' business models on a generic level. This presents a starting point to consider the factors needed to align the involved actors' business models in the context of their ecosystems.

## 5.2 Applied research methodology

Authors presenting procedures for conducting systematic literature reviews typically describe a number of concrete steps divided into distinct phases. While the exact number of and labels for individual steps and phases tend to vary, the principle procedure is largely congruent across authors (see, e.g., Cooper (1988), Denyer and Tranfield (2009) Randolph (2009), vom Brocke et al. (2015), Onwuegbuzie and Frels (2016), or Fink (2020)). This literature review was conducted following the steps proposed by Denyer and Tranfield (2009) and Fink (2020). As illustrated in Figure 31, first, guided by a concrete research question, databases were selected and search terms defined. Based thereon, data was collected, screened, and analyzed. While analyzing relevant articles, this thesis relied on aspects of a structuring content analysis as proposed by Mayring and Fenzl (2014). This was done since articles gathered in a systematic literature review can provide both quantitative and qualitative insights (Onwuegbuzie and Frels, 2016, p. 50). The applied procedure, illustrated in Figure 31, is in line with descriptions by Tranfield et al. (2003, p. 218), who proposed to perform literature reviews in two stages: First, a *"descriptive analysis"* was conducted using a simple set of categories. Second, a *"thematic analysis"* was carried out to outline the current state of knowledge in the investigated field. A descriptive summary of relevant articles is presented in Chapter 5.3. The qualitative results of the literature review are summarized

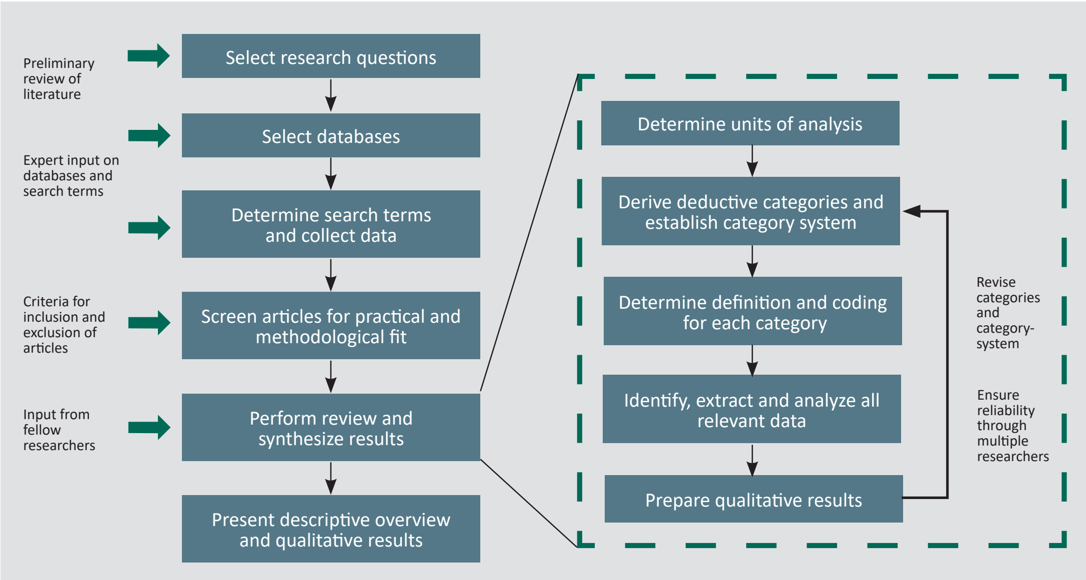



**Figure 31:** Overview of the adopted process for the literature review. The process combines steps for conducting a research literature review according to Denyer and Tranfield (2009) and Fink (2020) (left-hand side) with the logic of a structuring content analysis by Mayring and Fenzl (2014) (right-hand side)

in Chapter 5.4. Detailed information for each step performed, as illustrated in Figure 31, is provided in the following sections.

### 5.2.1 Selection of databases

The global scientific community publishes vast numbers of papers across scientific areas (Chadegani et al., 2013, p. 18). Therefore, scientific databases must be carefully selected to perform a literature review both efficiently and objectively (Chadegani et al., 2013, p. 18). The two most comprehensive online sources of data currently available are the *"Web of Science"* (WoS) search engine and the *"Scopus"* database (Chadegani et al., 2013, p. 18). In 2018, Scopus covered more than 23700 peer-reviewed journals from 5000 publishers (Elsevier, 2018). WoS includes more than 21000 journals, books, and conference proceedings, also providing an extensive database (Clarivate, 2020). However, upon closer inspection, both show slight differences. While WoS has a good coverage that goes back several decades, Scopus emphasizes more recent articles (Chadegani et al., 2013, p. 24). A further aspect when choosing a data source for literature reviews is the functionality (e.g., features, search operators allowed, specific search fields) as well as the algorithms for performing searches (vom Brocke et al., 2015, p. 210). For this thesis work, both WoS and Scopus were used for data collection to ensure a comprehensive coverage of articles with respect to the research question.

### 5.2.2 Determination of search terms and data collection

#### a) Search terms

According to Webster and Watson (2002, p. 16), literature reviews are typically centered around specific concepts. Guided by the review's research question, concepts for this review were the *changes in business models* and *ecosystems*. Systematic searches require the identification of relevant search terms (Tranfield et al., 2003, p. 215). These search terms are usually (1) built from a preliminary scoping study and (2) discussed by the review team (Tranfield et al., 2003, p. 215). Identifying search terms for the study at hand was challenging, since the terminology for these used concepts has not been uniformly defined (see Chapters 3 and 4). As highlighted by vom Brocke et al. (2015, p. 206), when phenomena are described using different terms, relevant articles for a specific topic might be overlooked.

Following the recommendations of Denyer and Tranfield (2009, pp. 684-685) and vom Brocke et al. (2015, p. 215), these issues were considered during this review by performing a small number of pilot (preliminary) searches for data to help identify and select appropriate search terms (vom Brocke et al., 2015, p. 215). These pilot searches used search terms obtained from previous reviews performed by Müller (2014) (in the area of business model change) and Järvi and Kortelainen (2017) (in the area of ecosystems). It has to be noted that initial scoping studies revealed a lack of literature that explicitly combined the topics of ecosystems and changes in the actor's business models. This made it necessary to broaden the scope of search terms used to cover a wider array of constructs that described the companies' environments.[1] Search terms were selected by considering that, despite differences in their specific focus, several constructs cited in the strategy literature (e.g., strategic networks or alliances) could be used to describe the companies' environments (Kapoor, 2018). This approach was deemed suitable, as recent studies (e.g., Shipilov and Gawer (2020)) have begun to bridge the ecosystem perspective with other concepts. Moreover, as stated in Chapter 4 (see Table 9), several researchers have described ecosystems as a type of network.

In the process, search terms were combined using Boolean operators (e.g., AND, OR, NOT) (Fink, 2020, p. 22). These operators proved useful for specifying a precise search field and limiting the total number of articles yielded by a specific search. However, combining search terms to obtain a suitable number of articles represented a challenging task. Applying an overly narrow search field might leave relevant articles unfound, while applying an overly broad search field can deliver an overwhelming number of (possibly not relevant) articles (compare Fink (2020, p. 22) and vom Brocke et al. (2015, p. 217)). As pointed out by vom Brocke et al. (2015, p. 217) *"[...] researchers must weigh coverage against decreasing returns on the investment of time"*. Therefore, the following steps were followed to derive the final set of search terms:

[1] Search terms associated with only loosely related constructs (e.g., value chain, social network theory) were deliberately not included.

- In the first step, searches were performed in both Scopus and WoS using multiple search terms for each individual field. Search terms covering a field were combined with an "OR" Boolean operator. Search terms for each individual field were added and removed iteratively. Terms that did not significantly impact the overall number of obtained results were removed from search queries. This step is also recommended by vom Brocke et al. (2015, p. 215), who suggested performing test-searches in databases to get a feeling for a topic and to refine the search strategy.

- After the individual searches for both topics yielded satisfactory results, the results for both search fields were combined with an "AND" Boolean operator in a second step. This step was also recommended by vom Brocke et al. (2015, p. 215), ) to help gain an understanding of the feasibility (e.g., number of articles) and relevance (e.g., development of the investigated field) of the review.

- In a third step, the results were discussed with colleagues and the supervisor of this thesis. Based on the obtained feedback, the search terms were adjusted and, if necessary, the process was repeated. This step is recommended by Denyer and Tranfield (2009, p. 682) and Fink (2020, p. 6), who proposed involving experts in the review process.

**Table 22:** Applied search terms for the fields of business model innovation and business ecosystems.

| **Search terms - business model change** | | **Search terms - business ecosystems** | |
|---|---|---|---|
| **Business model ...** | **Business model ...** | **... ecosystem** | **... network** |
| • ... innovation | • ... reinvention | • Business ... | • Business ... |
| • ... evolution | • ... flexibility | • Innovation ... | • Value ... |
| • ... reconfiguration | • ... disruption | • Cluster ... | |
| **... business model** | **Others:** | **Others:** | |
| • Disruptive ... | • Strategic innovation | • Strategic alliance | |
| • Dynamic ... | • Value innovation | • Strategic partnership | |
| • Flexible ... | | • (Inter-) connected organization | |

Table 22 provides detailed information about the search terms used, which resulted from this process. To account for variations in search terms (e.g., combinations of applied search terms, different spellings in American or British English, or singular/plural forms), several variants of the described search terms were used.

## b) Collection

As outlined, the search terms illustrated in Table 22 were applied using "OR" as well as "AND" operators following the procedure described above. The search conventions used in WoS as opposed to Scopus differed (Denyer and Tranfield, 2009, p. 684). In Scopus, the search was performed by examining the *"Title, Abstract and Keywords."* In WoS - due to the slightly different filtering possibilities - the search was performed by focusing on the data for the *"Title"* and *"Topic"* of each article. The search was limited to peer-reviewed scientific journal articles. Therefore, working papers, conference proceedings, and books were excluded from further analysis. Only articles in the English language were considered.

Two series of data searches were performed. An initial search in Scopus and WoS was performed in November 2018 (see Rachinger et al. (2019)). This initial search yielded 175 articles from Scopus and 112 articles from WoS. In February 2020, the search was repeated to account for articles published after the initial search yielding additional 95 articles from Scopus and 69 articles from WoS. Overall, a total number of 382 articles were identified in both searches. After removing duplicates (i.e., articles identified in both WoS and Scopus; articles identified in both search iterations due to unavoidable overlaps in search periods), the investigation yielded a total of 307 potentially relevant articles. All identified articles were carefully documented and referenced in an Excel database for further analysis.

### 5.2.3 Screening of articles for relevance

Figure 32 provides an overview of the process used to search for and select relevant articles. As suggested by vom Brocke et al. (2015, p. 218), the screening process was justified by applying predefined criteria.

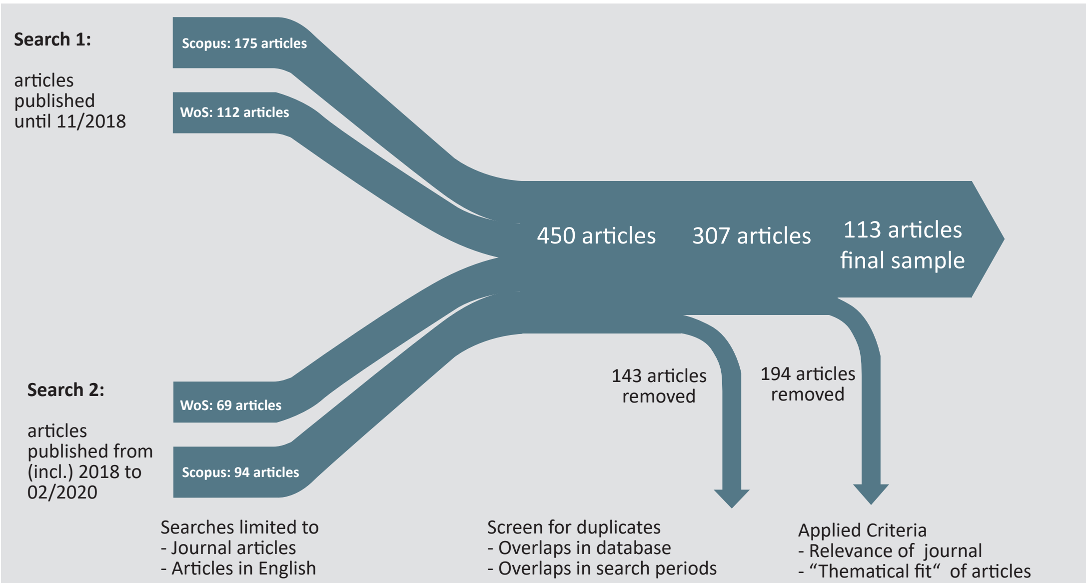



**Figure 32:** Sankey diagram showing the identification of relevant articles from obtained search results. (The search was performed in two rounds using both Scopus and WoS). The final sample of 113 articles was subsequently used for further analysis.

Following the recommendations of Tranfield et al. (2003, p. 215), only *"[...] studies that meet all the inclusion criteria specified in the review protocol and which manifest none of the exclusion criteria [...]"* were included in the review. Explicit criteria for exclusion and inclusion were formulated before screening the material (Randolph, 2009, p. 6). The following criteria were applied:

- **Criterion 1:** While applying the described search strategy, the focus of the review was placed on scientific articles. This effectively excluded non-scientific publications (e.g., editorials, comments), which might be subjective or biased (Fink, 2020, p. 14).

- **Criterion 2:** The journals in which the identified peer-reviewed articles were published were screened for their thematic fit and overall quality (Fink, 2020, p. 14). This was done for each journal individually (i.e., not applying predefined selections of journals, such as journals covering a specific field).

- **Criterion 3:** Titles and abstracts of the remaining articles were screened for thematic fit. Guided by Research Question 1 (see Randolph (2009, p. 6)), articles that did not address both the topics of business model innovation and aspects of business environments were excluded from the analysis. Two researchers performed this step to improve the reliability of the process (Fink, 2020, p. 156).

- **Criterion 4:** After filtering the results to identify relevant articles based on the abstracts, step 3 was repeated by the author using the full texts of the remaining articles.

After removing the duplicates from the initial dataset, predefined criteria were applied to obtain a final selection of 113 articles. As recommended by Randolph (2009, p. 6), the process of data collection and data screening was carefully documented in an Excel spreadsheet. This also included recording detailed information about decisions made and specifying arguments for the exclusion or inclusion of articles (Denyer and Tranfield, 2009, p. 684). The documentation subsequently helped to establish confidence in the obtained results (vom Brocke et al., 2015, p. 217). The final selection of 113 relevant articles ultimately formed the basis for the data analysis and interpretation of the topic (Fink, 2020, p. 14).

## 5.3 Descriptive overview of relevant articles

Following the suggestions of Tranfield et al. (2003, pp. 216-217), *"general information"* (e.g., title, author, year of publication) as well as *"specific information"* (e.g., methods and details) were extracted from relevant articles to generate a review of the investigated field. Information about the year of publication as well as the publication journal was directly extracted from Scopus and WoS. In addition, articles were read to identify key[1] aspects, such as their research approaches, empirical settings, thematic foci, and the exact approaches taken to describe business model change and the surrounding ecosystems. (Tranfield et al., 2003, pp. 216-217)

The data analysis showed that the first relevant publications combining both investigated concepts were published in the early 2000s. One possible explanation for this could be that the business models concept was introduced via a number of influential publications in the area (e.g., Amit and Zott (2001), Chesbrough and Rosenbloom (2002)). The ecosystem perspective also became increasingly popular beginning in the 1990s and continuing into the 2000s (e.g., due to publications by Moore (1993), Iansiti and Levien (2004b), and (Adner, 2006)). In the following years, the results show the ongoing interest in the research field with a notable increase observed in the number of publications appearing in 2015 and onwards (see Figure 33).

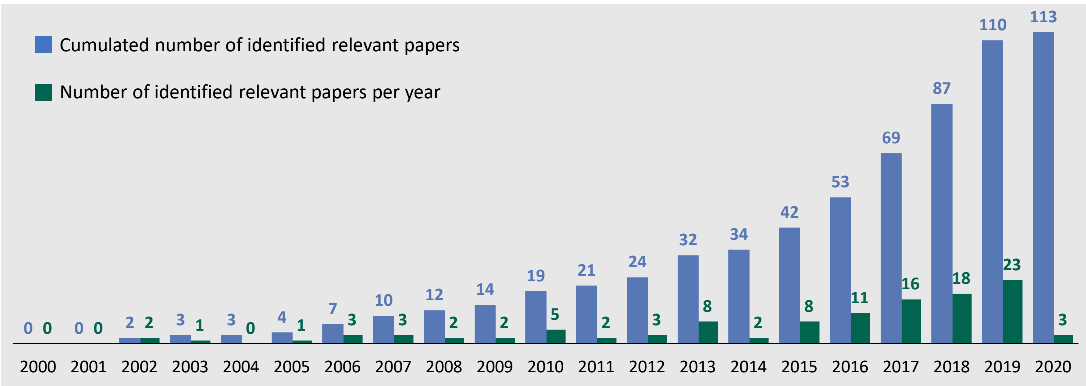



**Figure 33:** Overview of the total and yearly number of relevant papers (personal illustration)

Interestingly, this topic was primarily discussed in a small number of journals. Six journals contained at least four publications on the topic, accounting for 36 out of the total of 113 articles (approximately 32%). When extending the view to the journals that include at least two relevant publications, we see that a total of 17 journals account for 64 out of the 113 publications (approximately 56%), including more than half of the relevant literature. An overview of relevant journals identified in the investigation is provided in Figure 34.

Furthermore, as expected, the research field relied to a large degree on qualitative investigations (61 articles; approximately 54%) followed by conceptual papers that accounted for roughly a quarter

[1] In case multiple aspects in a certain area were identified in a paper, the dominant aspect was used for the analysis

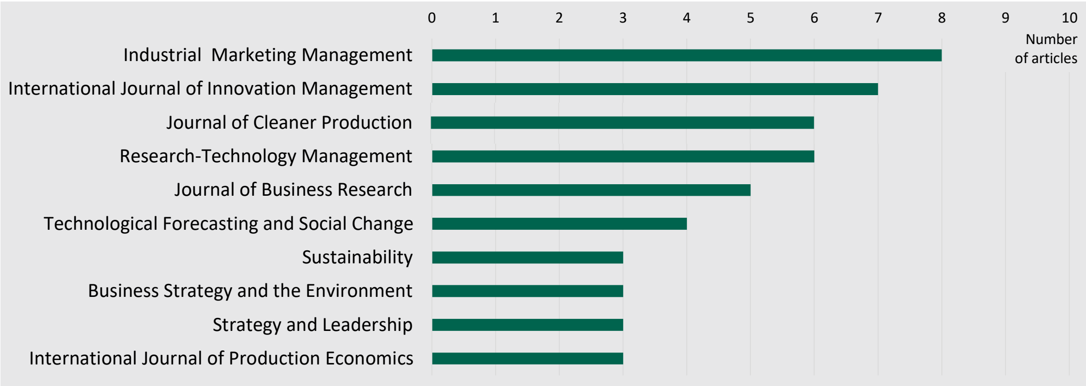



**Figure 34:** Overview in journals including more than two relevant articles on the topic. (personal illustration)

of all relevant articles (30 articles; approximately 25%). Only a small fraction of the relevant articles consisted of quantitative investigations (17 articles; approximately 15%) and literature reviews (6 articles; approximately 5%). Figure 35 presents an overview of research approaches taken in relevant articles. When examining the empirical settings investigated in relevant articles,

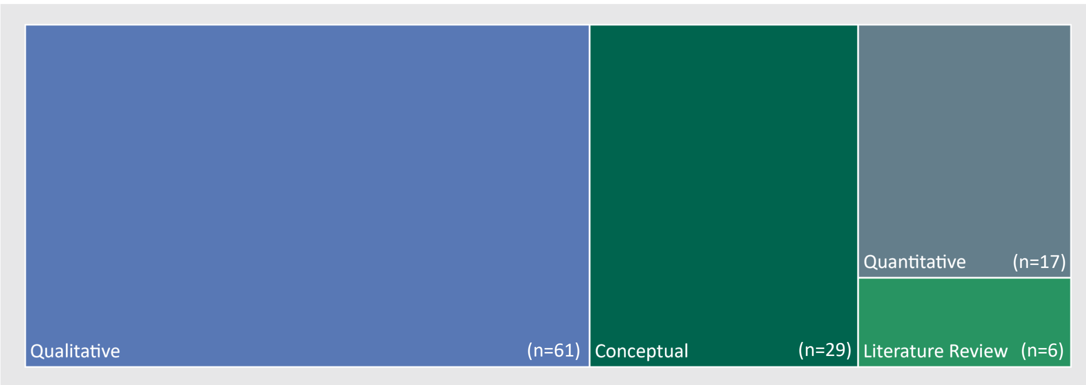
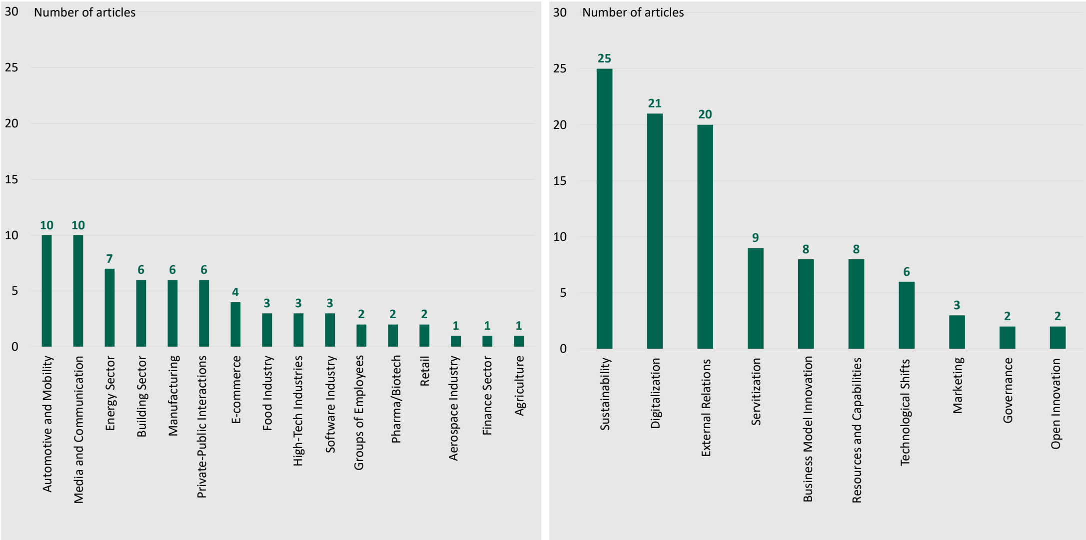



**Figure 35:** Treemap illustrating the applied key research approaches in the investigated literature. (personal illustration)

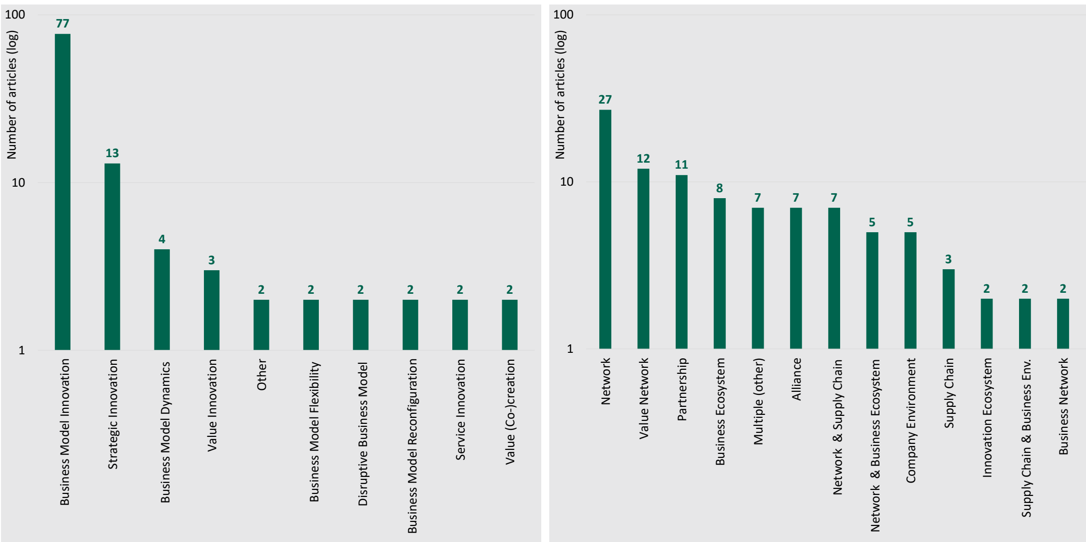
we see that studies were predominantly conducted in the contexts of the automotive, media, and energy sectors. To a small degree, studies also placed a focus on the building sector or on manufacturing companies. This highlights the relevance of this thesis work, in which actors were considered from the automotive-, energy-, and infrastructure sectors (i.e., sectors containing actors potentially relevant for the xEVs ecosystem). The most frequently identified thematic focus was *"sustainability."* This insight is also reflected in the journals identified articles were published. Specifically, some of the journals containing articles that were relevant for this review placed a clear focus on sustainability topics (e.g., *"Journal of Cleaner Production"*, *"Sustainability"*). An overview of relevant characterisitics identified in the literature is presented in Figure 36.




(a) - Overview of articles concentrating on a distinct setting

(b) - Overview of articles with a distinct thematical focus

**Figure 36:** Characterization of the investigated literature. Articles without a clear empirical setting (i.e., no or, respectively, several empirical settings) were not included. Similarly, articles with no clear or multiple thematic focal areas were not included.




(a) - Relevant (used in $\geq$ 2 articles) concepts for business model change (logarithmic scale)

(b) - Relevant (used in $\geq$ 2 articles) concepts for company environments (logarithmic scale)

**Figure 37:** Overview of the key concepts used for the topics of *business model change* and *ecosystem* in reviewed articles. If a combination of multiple concepts was identified, the key concept was used. If no key concept could be clearly identified, the respective combination of concepts was added as a separate category.

In addition, key concepts used in relevant articles to describe the areas of *"business model change"* as well as *"ecosystem"* were investigated. The vast majority (77 articles) used the term *"business model innovation"* with other notabel concepts being *"strategic innovation," "business model dynamics,"* and *"value innovation."* Surprisingly, many of the investigated articles described the business ecosystem as a form of network (i.e., strategic network, value network) or as partnerships. Remarkably, only two of the investigated articles combined the concepts of business model change and innovation ecosystem. These results serve to further highlight the relevance of this review. An overview of identified key concepts is presented in Figure 37.

Based on the descriptive overview of the investigated articles, the next section provides an in depth investigation of qualitative insights regarding potentially relevant factors for changing business models in ecosystems.

## 5.4 Qualitative results of the review

In this section, the results of the analysis and interpretation of the investigated relevant articles are presented. As noted by vom Brocke et al. (2015, p. 206), the interpretation represents the major challenge of reviews, particularly since, as pointed out by Denyer and Tranfield (2009, p. 685), a *"[...] synthesis needs to go beyond mere description by recasting the information into a new or different arrangement and developing knowledge that is not apparent the individual studies in isolation."* This specifically applies to the field of management and organization, where measuring constructs is a difficult undertaking that requires the consideration of specific contexts (Denyer and Tranfield, 2009, p. 682).

To synthesize the qualitative results, a structuring content analysis as described by Mayring and Fenzl (2014, pp. 97 ff.) was performed. The results of this analysis subsequently guide the category selection and material evaluation. During this process, the qualitative nature of the investigated field (see Section 5.3) was taken into consideration. Figure 31 illustrates the applied process as well its integration into the literature review process. For the analysis, the process described by Mayring and Fenzl (2014) together with aspects mentioned by Gioia et al. (2012) were used to form categories and evaluate material. First, following the process of a structuring content analysis as described by Mayring and Fenzl (2014, p. 97), an initial deductive category system was developed based on the literature. This initial system was used to identify, extract, and analyze data from the final selection of articles. Second, after this first round of analysis, the system of categories was revised. If necessary, the deductive coding system was extended using inductive coding. As described by Mayring and Fenzl (2014), after the first round of coding and the completion of the coding system, the same researcher repeated the coding procedure to ensure intra-coder reliability. Third, using the revised coding system, all articles were analyzed again, adhering to the process illustrated in Figure 31. Moreover, as recommended in the literature, multiple researchers were involved in the process of checking the codes to ensure their reliability (Randolph, 2009; Mayring and Fenzl, 2014; Fink, 2020). An overview of the final system of categories formed and the categorization of the respective articles is provided in Table 23. These categories were formed to justify the articles' contributions and connect the review results with the main theme of this thesis work (Tranfield et al., 2003, p. 219). Specifically, the results of the review are compared with the conceptual considerations regarding the mutual dependencies of business model change and ecosystems illustrated in Figure 30.

**Table 23:** Overview of identified themes regarding changing business models in ecosystems in investigated articles

| Aggregate Dimensions | Second-order Themes | Articles Addressing Identified Themes |
|---|---|---|
| **Role of ecosystem properties for changing business models** | Role of ecosystem governance for changing business models | Meier et al. (2011), Prince et al. (2014), Hammarfjord and Roxenhall (2016), Oshri et al. (2016), Velu (2016), Forkmann et al. (2017), Fehrer et al. (2018), Dellyana et al. (2018), Nardelli and Rajala (2018), Rong et al. (2018), Spieth and Meissner (2018), To et al. (2018), Wu et al. (2018) |
| | Role of ecosystem architecture for changing business models | Buur et al. (2013), Minarelli et al. (2015), Bouncken and Friedrich (2016a), Dellyana et al. (2016), Hammarfjord and Roxenhall (2016), Forkmann et al. (2017), Dellyana et al. (2018), Fjeldstad and Snow (2018), Liu and Bell (2019), Rachinger et al. (2019), Reinhardt et al. (2019), Rong et al. (2018), Su et al. (2020), Vedel and Servais (2019), Monios and Bergqvist (2020) |
| | Role of business model change barriers in ecosystems | Matthyssens et al. (2006), Berglund and Sandström (2013), Burton et al. (2016), Zhao et al. (2016), Sarasini and Linder (2018), Diaz Lopez et al. (2019) |
| | Role of ecosystem risks and uncertainties for changing business models | Chesbrough and Schwartz (2007), Giesen et al. (2010), Bouncken and Friedrich (2016b), Velu (2016), Evans et al. (2017), Mansour and Barandas (2017), Brillinger (2018), Ganguly and Euchner (2018), Mütterlein and Kunz (2018), Zhao et al. (2018), Yang et al. (2019) |
| | Influence of ecosystem relationship properties for changing business models | Szekely and Strebel (2013), Bouncken and Friedrich (2016a), Oshri et al. (2016), Autio et al. (2018), Dellyana et al. (2018), Forkmann et al. (2017), Spieth and Meissner (2018), Liu and Bell (2019) |
| **Relations between changes in business models and ecosystems** | Role of communication and knowledge about ecosystem for changing business models | Berghman et al. (2006), Chesbrough (2007b), Lindgren et al. (2010), Lee et al. (2010), Mason and Mouzas (2012), Berglund and Sandström (2013), Buur et al. (2013), Guo et al. (2013), Katzy et al. (2013), Prince et al. (2014), Karlsson et al. (2017), Fehrer et al. (2018), Dellyana et al. (2018), Nailer and Buttriss (2020), Nardelli and Rajala (2018), Rong et al. (2018), Spieth et al. (2019), Liu and Bell (2019), Vorraber and Müller (2019) |

Table 23 continues on next page

Table 23 continued from previous page

| Aggregate Dimensions | 2nd Order Themes | Articles addressing identified themes |
|---|---|---|
| | Role of ecosystem stakeholders for changing business models | Role of ecosystem stakeholders for changing business models (General): Segers (2016), Jiao and Evans (2016), Rong et al. (2018), Hamelink and Opdenakker (2019), Yang et al. (2019)<br><br>Role of ecosystem stakeholders for sustainable changing business models: Goyal et al. (2014), Bocken et al. (2015), Bolton and Hannon (2016), Sarasini and Linder (2018), Nußholz et al. (2019) |
| | Role of ecosystem actors' resources and capabilities for changing business models | Matthyssens et al. (2006), Calia et al. (2007), Rajala and Westerlund (2008), Shelton (2009), Giesen et al. (2010), Lindgren et al. (2010), Wu et al. (2010), Gebauer et al. (2012), Halme and Korpela (2013), Katzy et al. (2013), Wang et al. (2015), Bolton and Hannon (2016), Hammarfjord and Roxenhall (2016), Ayala et al. (2017), Karlsson et al. (2017), Edralin et al. (2018), Dellyana et al. (2018), Fehrer et al. (2018), Fjeldstad and Snow (2018), Spieth and Meissner (2018) |
| | Role of knowledge transfer for changing business models in ecosystems | Kadama (2002), Chesbrough and Schwartz (2007), Mason and Leek (2008), Roxenhall (2013), Forkmann et al. (2017), Wadin et al. (2017), Spieth and Meissner (2018), Mazzucchelli et al. (2019) |
| | Influence of business model change on ecosystem actors and architecture | Mason and Leek (2008), Shelton (2009), Lindgren et al. (2010), Park (2011), Burton et al. (2016), Velu (2016), Karlsson et al. (2017), Fehrer et al. (2018), Rong et al. (2018), Wang et al. (2018), Hamelink and Opdenakker (2019) |
| | Role of actor culture for changing business models in ecosystems | Mason and Mouzas (2012), Hammarfjord and Roxenhall (2016), Bourdon and Jaouen (2016), Breuer and Lüdeke-Freund (2017), Spieth and Meissner (2018) |
| **Role of technologies for ecosystems and business model change** | Changes in business models to market technologies | Koen et al. (2010), Wu et al. (2010), Mason and Mouzas (2012), Pynnönen et al. (2012), Simmons et al. (2013), Arnold et al. (2016), Wadin et al. (2017), Sarasini and Linder (2018), Monios and Bergqvist (2020) |
| | Business model change to access ecosystem resources and capabilities for new technologies | Jablonski (2015), Mayangsari and Novani (2015), Ogilvie (2015), Arnold et al. (2016), Shalender (2018) |

Table 23 continues on next page

Table 23 continued from previous page

| Aggregate Dimensions | 2nd Order Themes | Articles addressing identified themes |
|---|---|---|
| | Technologies as enabler or driver of business model changes in ecosystems | Ginsburg (2002), MacInnes (2005), Chapman (2006), de Reuver et al. (2009), Shelton (2009), Guo et al. (2013), Brenner (2018), Rong et al. (2018), Shalender (2018), Kohtamäki et al. (2019), Valtanen et al. (2019), Leminen et al. (2020) |
| **Strategic behavior and interactions of ecosystem actors** | Co-evolution of ecosystem and business model | Co-evolution of ecosystem and business models (General): Matthyssens et al. (2006), Chesbrough (2007b), Lindgren et al. (2010), Simmons et al. (2013), Prince et al. (2014), Ogilvie (2015), Yderfält and Roxenhall (2017), Dellyana et al. (2018), Fehrer et al. (2018), Fjeldstad and Snow (2018), Nailer and Buttriss (2020), Nardelli and Rajala (2018), Rong et al. (2018), Sarasini and Linder (2018), Spieth and Meissner (2018), Su et al. (2020)<br><br>Co-evolution of ecosystem and sustainable business models: Szekely and Strebel (2013), Bolton and Hannon (2016), Baldassarre et al. (2017), Wadin et al. (2017), Brennan and Tennant (2018), Gallo et al. (2018), Diaz Lopez et al. (2019), Vorraber and Müller (2019) |
| | Roles of Co-opetition, Competition, and Collaboration for changing business models in ecosystems | Giesen et al. (2007), Park (2011), Velu (2016), Minarelli et al. (2015), Karlsson et al. (2017), Dellyana et al. (2018), Fjeldstad and Snow (2018), Nardelli and Rajala (2018), To et al. (2018), Monios and Bergqvist (2020) |

The following section is organized to reflect the dimensions of the category system in order to establish a framework to compare new and previous findings (Randolph, 2009, p. 2). However, due to the interrelated nature of ecosystem aspects and business model aspects, it was not always possible to clearly distinguish between the investigated constructs.

### 5.4.1 Role of ecosystem properties for business model changes

In the following section, relevant aspects are described regarding the role of ecosystem properties in changing business models identified in the literature. The section is structured by sub-headings using the identified dimensions summarized in Table 23. Consequently, the aspects are pesented that are related to ecosystem governance, ecosystem architecture, barriers to business model change, the roles of risks and uncertainties, and properties of ecosystem relations.

### a) Role of ecosystem governance for business model change

To et al. (2018, p. 793) investigated the impact of the business context on business model innovation and found five contextual antecedents: (1) value creation networks, (2) the behavior of actors, (3) governance and rules, as well as (4) complexity of innovations and (5) technological mastery. The following aspects found in the investigated literature partly reflect To et al.'s insights.

**Ecosystem architecture and governance:**
The literature indicated that an ecosystem's architecture (see also Section 5.4.1 Subsection b) is related to its respective governance. For instance, networks that were centrally governed had a *"narrow viewpoint"* (Dellyana et al., 2016, p. 209). These networks tended to re-configure products and services, leading to a low (incremental) level of business model innovation as well as stagnant value creation and value delivery (Dellyana et al., 2016, p. 209). In particular, focal companies needed to manage the flow of values by managing communication, transparency of information, and the implementation of business models (see also Section 5.4.2 Subsection a). As a result, this study showed that the dynamic governance of networks can enable business model innovation. In contrast, the dynamic behavior of companies in the network (e.g., through contributing resources and capabilities or actively participating in interactions) was shown to increase the involvement of actors in business model innovation processes, ultimately resulting in rearranged network ties and configurations (Dellyana et al., 2018, p. 216). Rong et al. (2018, p. 238) highlighted the relations between an ecosystem's structure and governance by differentiating between product-based and platform-based ecosystems. They proposed that ecosystems based on products tended to be organized by focal companies that subsequently outsourced parts of their value creation and organized a *"supply-chain based ecosystem"* (Rong et al., 2018, p. 238). In particular, in product-based ecosystems, adjusting business models through outsourcing could reduce the outsourcing companies' influences and lead to a more democratic ecosystem (Rong et al., 2018, p. 238). Furthermore, while focal companies still were important actors in the platform-based ecosystem, they tended to wield less influence when the ecosystem relied on democratic interactions of platform partners (Rong et al., 2018, p. 238). While focal companies were only rarely able to dictate business models directly, they had strong influence by setting a common vision to *"[...] unite other stakeholders around the value creation and appropriation concepts that they have identified [...]"* leading to business model experimentation and the subsequent development of a scalable business model (Rong et al., 2018, p. 240). However, the resulting business model depended on the market demand, the stakeholders' actual commitment towards a proposed model for creating and appropriating value, and the focal companies' ultimate influence (Rong et al., 2018, p. 240). Furthermore, Rong et al. (2018, p. 242) highlighted the fact that, in platform-based ecosystems (in contrast to product-based ecosystems), focal companies often relied on a higher number of stakeholders and faced a high level of complexity. This complexity tended to require *"[...] more formal structures, agreements, processes and channels of communication [...]"* which subsequently limited flexibility. Interestingly, these authors proposed that this reduced flexibility and the subsequent longer reaction time could destabilize the incumbent companies' business models (Rong et al., 2018, p. 242).

**Impact of actor properties on ecosystem architecture and goverance:**
Fehrer et al. (2018, p. 556) suggested that various actors - including, but not limited to, the platform business - influenced the governance of platform ecosystems. They highlighted the versatile ecosystem actors' involvement in value co-creation in platform business models and the need for institutions to support positive ecosystem behavior. The authors indicated that actors were connected in an adaptive architecture and that system governance for symbiotic sharing and collaborating was subsequently influenced by all actors in the platform ecosystem. However, while actors could use platforms to establish connections, growth usually took place in the platform's surrounding ecosystem (Fehrer et al., 2018, p. 556). Furthermore, Fehrer et al. (2018, p. 561) highlighted the need to facilitate non-hierarchical collaboration practices *"[...] rather than trying to manage all entities in the collaboration process."* In the context of strategic innovation networks, Prince et al. (2014, pp. 124-125) found that neutral entities with limited power could orchestrate networks if these actors obtained legitimacy. These hub entities may balance competing interests and values to achieve strategic goals (Prince et al., 2014, pp. 124-125). Similarly, Wu et al. (2018, p. 29) found that different forms of legitimacy (regulative legitimacy, normative legitimacy, and cognitive legitimacy) for business model innovation were rooted in interactions with actors in the value network (e.g., partners, stakeholders), while Velu (2016, p. 124) proposed that a relation existed between companies' dominance in an ecosystem and their tendency to change their business models. In specific terms, less dominant companies engaged in co-opetition relations to protect their business models and performed a low degree of business model innovation. Dominant companies, in contrast, pursued revolutionary business model innovation, but at a later stage than less dominant companies (Velu, 2016, p. 124). One interesting point raised by Hammarfjord and Roxenhall (2016, p. 1750037-2) was that networks that performed strategic innovations (a form of business model innovation) tended to be created and financially supported by actors outside the network. They further noted that (1) pooling resources and (2) enabling the provision of more complicated products (compared to what individual actors could provide) could act as incentives for strategic innovation networks (Hammarfjord and Roxenhall, 2016, p. 1750037-2). In contrast, Nardelli and Rajala (2018, p. 45) proposed that processes for business model innovation were triggered by client organizations and were driven by the requirements of client organizations and end users (e.g., cost competitiveness, service quality). Furthermore, business model innovation tends to be accompanied by a commitment from the client organizations' management (Nardelli and Rajala, 2018, p. 45). The literature also suggested that governance was relevant when changes occured in an ecosystem's architecture. For instance, Meier et al. (2011, p. 271) emphasized the impact of corporate governance when performing activities involving mergers and acquisitions (M&A) to pursue strategic innovation. Moreover, business model innovation by involving additional actors (e.g., providing services or outsourcing activities) was found to have an impact on governance mechanisms, particularly with respect to manufacturing companies (Forkmann et al., 2017, p. 153).

**Formalization, goals and measures for ecosystem governance:**
Another critical point in the literature was the goals and measures used to encourage collaboration among multiple actors and their contractual formalization. With regard to strategic innovation through outsourcing, Oshri et al. (2016, p. 204) underlined the central role of relations between contractual and relational governance for strategic innovation. Moreover, in the context of value nets, necessary aspects for business model innovation (e.g., sharing of resources, communication behavior) tended to be contractually arranged (Dellyana et al., 2018, p. 216). In that regard,

Spieth and Meissner (2018, p. 1850042-15) highlighted difficulties (e.g., contractual challenges) that accompanied governing business model innovation in the context of alliances. These authors described that a major obstacle was unclear business model innovation objectives and the subsequent difficulties in formulating performance goals and measures upfront. They also highlighted the need to understand and balance the expectations of involved partners, striving to achieve an overall optimum when innovating business models in alliances (Spieth and Meissner, 2018, p. 1850042-15).

## b) Role of ecosystem architecture for changing business models

**Relations of ecosystem architecture and business models:**
The findings above indicate that the ecosystems' architecture and governance are related factors that both impact the involved business models. Business models, thereby, have a central role in business environments, as they provide the platform for the actors' interactions with their network (Dellyana et al., 2018, pp. 214-216). For instance, Fjeldstad and Snow (2018, p. 34) argued that *"[...] effective organizations constantly align the elements of their business model to the environment in which they are operating."* Fjeldstad and Snow (2018, p. 37) also emphasized the fact that business model innovation can be supported (or even be triggered) by a company's ecosystem by making *"[...] business models viable and offer firms new arenas, structures, and processes for business model experimentation."* Su et al. (2020, p. 414) also found that trial-and-error approaches could be used to adjust business models in response to environmental changes. These results are echoed by Spieth et al. (2019, p. 277), who proposed that the innovation of the value architecture[1] encompasses the business partners of relevant companies as well as the value capture mechanism in an industrial network.

In that vein, Rong et al. (2018, p. 234) proposed that *"scalability,"* *"flexibility,"* and *"extensibility"* were capabilities that enabled development of business models in the context of business ecosystems. Moreover, Rong et al. (2018, p. 234) argued that the *"[...] structure of the business ecosystem (product based, platform based, or combinations of both) influenced the potential impact that these capabilities can have on business model development."* Rong et al. (2018, p. 235) further ascertained that *"[...] a business model is the outcome of an aggregated set of relevant activities of a company, which take place and evolve out of the ecosystem in which the firm operates."* Consequently, they argued that, as the ecosystem of a business model evolves, it impacts its ability to be flexible (Rong et al., 2018, p. 243). In addition, the type and orientation of a specific industry and actor's positions in the industry value chain could influence the ability of technology-driven business model innovation (Rachinger et al., 2019). Vedel and Servais (2019, p. 1236) also underlined the role of the network structure for value innovation. Specifically, Vedel and Servais (2019, p. 1236) noted that *"[...] value innovation is contingent on the fit between the actors involved in the entry node, not on the fulfilment of the needs of a focal actor."* Involving multiple stakeholders and adopting a network-centric business model design could be beneficial to demonstrate an overall feasible business (Reinhardt et al., 2019, pp. 432-443).

[1] Spieth et al. (2019, p. 277) investigated innovations of value architecture and proposed that this aspect included the *"[...] innovation of an industrial network's core competences, its internal value creation activities, its external value creation activities, and the (value) distribution to the targeted customers."*

**Ecosystem actors' roles and activities:**
Networks and their individual actors (e.g., customers, financial investors, network-collaborators) were found to be key factors for business model innovation (Liu and Bell, 2019, p. 515). In that regard, Buur et al. (2013, p. 70) emphasized the importance of considering individual actor's roles and their relations in the context of their network when undertaking business model innovation. This aspect could be particularly relevant in the context of new technologies, as key actors are likely to change roles while new roles might emerge (Monios and Bergqvist, 2020, p. 7). For instance, Dellyana et al. (2016, p. 209) highlighted differences regarding how specific types of networks (vertical value net, horizontal value net, and multidimensional value networks) differed in their business models (particularly in the creation, delivery, and capture of value). These findings agree with those of Minarelli et al. (2015, pp. 48-49) who proposed that business model innovation depended more on *"[...] horizontal collaboration, size of the firm and business models adopted by other firms within their network [...]"* than on a focal actor's individual innovation strategy. Moreover, companies could be able to capture value from new *"value chain architectures"* by, for example, increased revenues, reduced costs or generally higher returns on investments (Bouncken and Friedrich, 2016a, p. 3585).

**Approaches to align business models and ecosystems:**
Giesen et al. (2010, p. 17) highlighted the relevance of choosing appropriate business models for an environmental context (economic environment, market opportunities) as well as aligning internal factors towards desired changes. This indicated that it is important to consider ecosystem properties when changing business models. In particular, recurring changes in business environments require companies (i.e., manufacturers) to constantly adjust the composition of their offerings in order to stay competitive (e.g., by readjusting services or product-based components of their value propositions) (Hammarfjord and Roxenhall, 2016, p. 1750037-1). Possible approaches that could be taken to address this issue could be to (1) realize innovation potentials by focusing on neglected areas of the value chain or to (2) involve third parties to add value using technologies, or new business approaches (Chapman, 2006, p. 35). A different approach that has been taken by central companies is to develop network structures/architectures in order to respond to markets more effectively, thus increasing business model flexibility (Mason and Mouzas, 2012, p. 1348). Furthermore, Mason and Mouzas (2012, p. 1348) argued that the flexibility of business models depended on the companies' positions and activities within a network, as well as the business model's architecture and focus. Interestingly, Mason and Mouzas (2012, p. 1362) noted that the flexibility of business models was related to the technological complexity of the sourced supplies. While sourcing commodity products was associated with a high degree of flexibility, technologically complex products tend to offer little flexibility (Mason and Mouzas, 2012).

### c) Role of business model change barriers in ecosystems

The findings of the literature review indicated that a company's surrounding ecosystem could represent a barrier to changing business models. For instance, Diaz Lopez et al. (2019, p. 29) underlined the role of technical barriers on the supply side and market barriers on the demand side. Sarasini and Linder (2018, p. 25) identified several sources of business model inertia: (1)

formal institutional arrangements, (2) inertia through company-level structures, and (3) inertia through structures spanning multiple companies. The authors remarked that especially (2) and (3) would arise as business models stabilized and solidified (Sarasini and Linder, 2018, p. 25). To overcome these barriers to business model innovation Sarasini and Linder (2018, p. 25) proposed to link *"[...] practice and experimentation with the formation of new interfirm networks and new institutional arrangements."* They emphasized experiments involving new regulatory structures and corporate politics. Similarly, Matthyssens et al. (2006, p. 751) revealed that actors faced *"industry recipes"* that could prevent the creation and realization of *"value innovation."* In a similar vein, Zhao et al. (2016, p. 260) proposed to take a (project-based) integrated design approach to address fragmented industry structures and the lack of collaboration within supply chains. Furthermore, they highlighted the role of communication and early feedback (Zhao et al., 2016, p. 260). Burton et al. (2016, p. 39) also argued that the value creation and value capture of service innovation activities might be limited by conflicts that create relational tensions. If unaddressed, these conflicts could reduce the value for all involved actors, which required actors - particularly in the manufacturing sector - to be aware of and respond to tensions (Burton et al., 2016, p. 39). Furthermore, to avoid roadblocks that hinder business model innovation, the incentives that can be used with both friendly and more hostile actors must be understood (Berglund and Sandström, 2013, p. 281). The successful innovation of business models of focal companies needs to align the interests of key actors in the companies' ecosystems with intended changes (Berglund and Sandström, 2013, p. 281).

### d) Role of risks and uncertainties in the ecosystem for changing business models

**Sources of risks and uncertainties:**
The investigated literature also indicated the relevance of risks and uncertainties when changing business models in the context of ecosystems. One possible reason for this could be that companies have relied to an increasing degree on external partners to (1) create innovations, (2) bring innovations to the market, and (3) generate financial benefit from innovations (Mütterlein and Kunz, 2018, p. 176). Chesbrough and Schwartz (2007, p. 56) pointed out the need to carefully manage core capabilities when engaging in business models that involved co-development activities of products and services. These activities required extensive strategic analyses due to the risks involved (Chesbrough and Schwartz, 2007, p. 56). Interestingly, Velu (2016, p. 124) noted that engaging in partnerships with third-party actors *"[...] reduces survival of new firms as the degree of business model innovation increases."* Evans et al. (2017, p. 605) also suggested that considering the behavior of network members towards sustainability[1] represented a substantial source of business model complexity, while Brillinger (2018, p. 1840005-1) remarked that value creation *"[...] in complex and dynamic value networks with a multitude of different actors leads to a higher level of uncertainty and a larger number of risks."* Moreover, breakthrough innovations (i.e., innovations that open up new revenue streams) required innovations in business models in addition to changes in products or offerings, leading to inherent uncertainties due to the potential changes

[1] The three sustainability dimensions according to the triple bottom line are ecological-, economic-, and social sustainability.

in (or addition of) channels, partnerships, customers, revenue models, as well as technologies (Ganguly and Euchner, 2018, p. 27).

**Addressing risks for changing business models in ecosystems:**
An essential aspect of changing business models in the context of ecosystems was identifying and addressing relevant risks that stood in the way of profitable and sustainable[1] business models (Brillinger, 2018, p. 1840005-1). One way to achieve this goal would be to adapt business models to support organizations and help them to manage uncertainties in their business environments (Giesen et al., 2010, p. 22). Consequently, successful business model innovations should match the pace and flexibility of start-ups while utilizing existing capabilities, resources, and assets (Giesen et al., 2010, p. 22).

Another approach cited by Mansour and Barandas (2017, p. 305) can be performed by companies with an *"advanced"* business model. These companies could use their business model as an adaptive platform, whereby key suppliers and customers are engaged in relationships to share both technological and business risks (Mansour and Barandas, 2017, p. 305). In addition, conducting *"business experiments"* could be a useful tool to reduce risks (Ganguly and Euchner, 2018, p. 27). Bouncken and Friedrich (2016b, p. 5201) also suggested that suppliers could *"[...] combine dissimilar value elements in joint value architectures by reducing the opportunism risks and appropriating the increased (joint) value."* A joint architecture could improve the convergence of targets while reducing competition, resulting in high levels of creation and appropriation of value (Bouncken and Friedrich, 2016b, p. 5201). Another aspect was raised by Yang et al. (2019, p. 14), who emphasized the positive impact of governmental support in reducing risks. This support could, in turn, enable innovation leadership and appropriate risk management (Yang et al., 2019, p. 14). Furthermore, Zhao et al. (2018, p. 1224) found that extending single-actor business models could minimize risks while maximizing opportunities.

## e) Influence of ecosystem relationship properties for business model changes

The ecosystem actor's relationship properties might substantially impact the involved business models, as business model innovation typically relies upon connected actors (e.g., distributors, customer companies) (Forkmann et al., 2017, p. 156). For this reason, actors need to appropriately manage their relations and distribution networks when extending the customer bases (Forkmann et al., 2017, p. 156). Moreover, failures in (entrepreneurial) ecosystems were often related to interactions between participants and the structures of the ecosystems (Autio et al., 2018, p. 91). In part, it is the role of policymakers to support interactions in ecosystems, consequently facilitating knowledge transfer as well as business model experimentation (Autio et al., 2018, p. 91). Liu and Bell (2019, p. 529) found that to be *"[...] successful in experimenting and developing a new business model, the firm requires strong networks that allow it grow into the new model."* Similarly, Spieth and Meissner (2018, p. 1850042-19) emphasized (1) dynamic, (2) architectural, and (3) relational dimensions when performing business model innovation in the context of alliances. The dynamic

[1] I.e., economically sustainable, in contrast to other aspects of sustainability, such as ecological or social.

aspect of relations might require the use of shared structures to bridge conflicts and different transaction speeds as well as shared standards, targets, and performance measures. Business model innovation in alliances could increase the individual actor's financial performance (Bouncken and Friedrich, 2016a, p. 3590), but long durations of alliance relations reduced companies' ability to capture value (Bouncken and Friedrich, 2016a, p. 3590). In addition, Szekely and Strebel (2013, pp. 475-476) differentiated between partnerships for incremental strategic innovation (often involving single issues and a small number of companies) and partnerships for radical strategic innovation that were typically based on deeper partnerships involving different groups of stakeholder groups. Oshri et al. (2016, p. 203) also suggested that *"[...] high-quality relationships between clients and suppliers may indeed help achieve strategic innovation through outsourcing."* However, these authors suggested that the positive effect of outsourcing depends on relational governance, which is, in turn, impacted by the specific outsourcing contract.

### Summary of relevant ecosystem properties for changing business models

Insights obtained from the literature review indicate that an ecosystem's properties have a substantial influence on actor's ability to change their business models. Specifically, an ecosystem can be seen as a proving ground for business models (Fjeldstad and Snow, 2018). The investigated categories are summarized in Figure 38.

As shown, the major factors identified with regard to changes in associated business models were (1) an ecosystem's governance and architecture, (2) barriers to changing business models, (3) risks and uncertainties, as well as (4) the ecosystem actors' relationship properties. Relevant aspects identified regarding ecosystem governance were the clarity of objectives (Meier et al., 2011; Dellyana et al., 2016, 2018) and goals (Spieth and Meissner, 2018) as well as the actors' roles (Prince et al., 2014) for changing business models. Factors stemming from an ecosystem's architecture included its structures and processes (Fjeldstad and Snow, 2018), which could provide a basis for the evolution of (new) business models (Rong et al., 2018), specific actor's roles (Buur et al., 2013; Liu and Bell, 2019) in their ecosystem, their individual activities (Monios and Bergqvist, 2020), as well as the actors' fit within the network (Vedel and Servais, 2019). This, in turn, required the alignment of the actors' business models with regard to ecosystem-specific properties (Giesen et al., 2010). However, ecosystem actors may face change barriers, such as ecosystem-related business model inertia (Sarasini and Linder, 2018), established industry recipes (Matthyssens et al., 2006), or technical barriers (Diaz Lopez et al., 2019). These barriers could be overcome by integrated design approaches and improved communication (Zhao et al., 2016), addressing relational tensions (Burton et al., 2016), and considering and aligning the interests of involved actors (Berglund and Sandström, 2013). In addition, ecosystems could be sources of risks and uncertainties rooted in the need to coordinate ecosystem actors (Mütterlein and Kunz, 2018), in managing capabilities when performing co-innovation (Chesbrough, 2007a), as well as in the complexity and risks associated with the number of involved actors (Brillinger, 2018).

Addressing risks in changing business models in an ecosystem context was crucial (Brillinger, 2018) and could be accomplished by using adaptable business models (Giesen et al., 2010), business

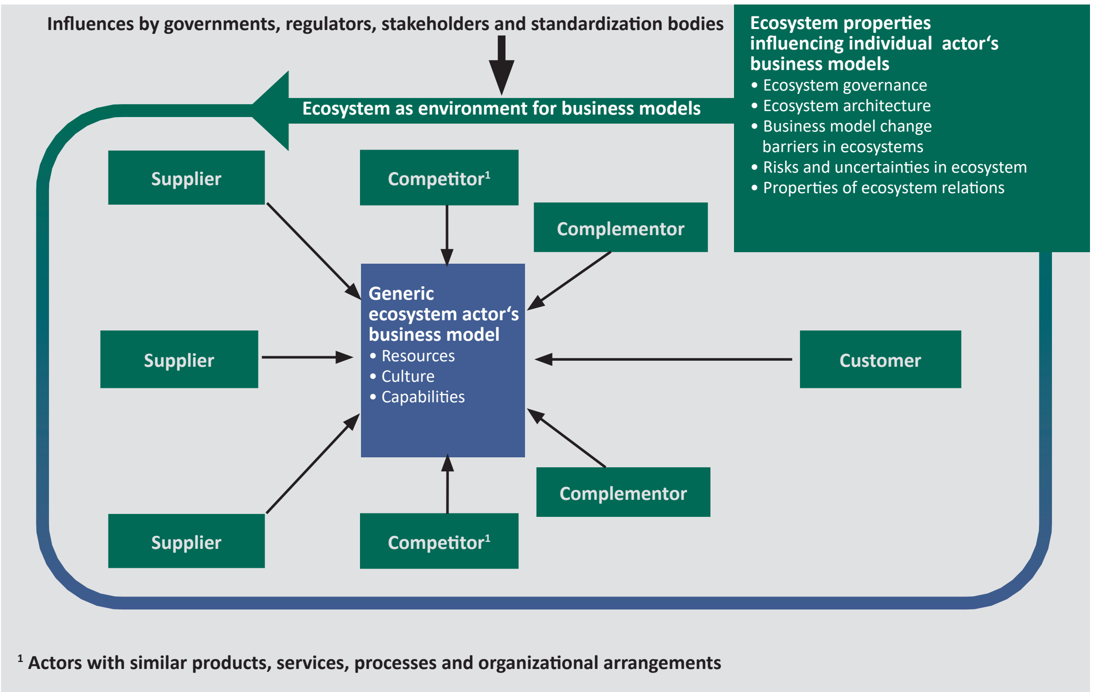



**Figure 38:** Overview of the identified factors for changing business models in the context of ecosystems. Personal illustration based on insights from the literature (Moore, 1996; Adner and Kapoor, 2010; Jacobides et al., 2018; Talmar et al., 2018). The basic framework was extended based on the findings from the literature review regarding ecosystem aspects that are relevant to changing business models.

experiments (Ganguly and Euchner, 2018), or platform moves (Mansour and Barandas, 2017). Furthermore, relationship properties were a crucial ecosystem aspect that influenced changes in business models (Autio et al., 2018). Interactions could be facilitated by regulators (Autio et al., 2018) and could, in turn, facilitate business experiments, subsequently reducing risks associated with new business models (Liu and Bell, 2019). In addition, shared structures could help to avoid conflicts and counteract differences in transaction speeds (Spieth and Meissner, 2018).

### 5.4.2 Role of changes in actors' business models for ecosystems

In the following section, relevant aspects of the role changes in the actors' business models regarding ecosystems are described. Again, the section's structure mirrors the identified dimensions summarized in Table 23. Consequently, aspects related to communication and knowledge about an ecosystem, ecosystem stakeholders, the role of resources and capabilities, ecosystem relations, and knowledge transfer, as well as the ecosystems' architectures and actors' culture are presented.

#### a) Role of communication and ecosystem knowledge for changing business models

**Role of communication in ecosystems for changing business models:**
Since companies are not in full control of their environments, Berglund and Sandström (2013, p. 274) found that *"[...] the systemic and boundary-spanning nature of business models imply that firms are forced to act under conditions of interdependence and restricted freedom."* This, in turn, highlights the need to find solutions that enable those involved to shared knowledge, provide stable networks, and ensure trust regarding the appropriation of value and the alignment of the actors' diverse interests (Berglund and Sandström, 2013, p. 274). Facilitating communication among ecosystem partners could be highly beneficial, allowing partners, e.g., to formulate a scalable business model before executing it (Rong et al., 2018, p. 240). Moreover, demonstrating scalability in terms of creating and appropriating value for the involved stakeholders could be beneficial, as this eventually supported working relations in networks (Rong et al., 2018, p. 240). The review results indicated that the role of dialogue could be crucial as a means of hub companies to orchestrate diverse strategic innovation networks (Prince et al., 2014, p. 122). Concretely, Prince et al. (2014, p. 124) proposed a strategy where a *"[...] hub actor defines content and basic assumptions of what dialogues are permitted as well as who is invited to participate."* As a result, by controlling dialogues and selecting partners that were open for a specific innovation (i.e., partners that perceive innovation as a non-disruptive solution to industry challenges), hub actors could align network actors towards strategic innovations (Prince et al., 2014, p. 124). Similarly, intense information exchange, as well as diffusing risk among the partners, could have positive effects on suppliers creating value with new customers and ultimately stimulating (joint) innovation (Berghman et al., 2006, p. 970). Furthermore, Mason and Mouzas (2012, p. 1341) found that companies need to effectively promote communication among network actors to utilize resources from their business network. Communication could support innovative solutions, thereby allowing them to address changing customer requirements (Mason and Mouzas, 2012, p. 1341). Liu and Bell (2019, p. 530) later argued in favor of using the information provided by customers to meet their requirements. They suggested extending companies' value networks to finance innovations of products and business models as well as to use opportunities to collaborate (Liu and Bell, 2019, p. 530). Similarly, Nardelli and Rajala (2018, p. 48) supported the constant involvement of multiple actors in business model innovation which would allow them to improve their understanding of requirements and adjust their business models accordingly. Establishing cross-disciplinary communication was especially essential when companies needed to collaborate with external actors to innovate parts of their value propositions (i.e., services, products), business concepts, or business models (Buur et al., 2013, p. 55). Another aspect related to communication

and knowledge that can promote business model innovation is managerial ties, particularly when business model innovation is performed while value networks are redefined (e.g., through the introduction of new business partners like suppliers or vendors) (Guo et al., 2013, p. 453). In addition, contracts, partnerships, and the overall flow of information and money could be influenced by utilizing business model learning potentials (Dellyana et al., 2018, p. 216).

**Role of ecosystem knowledge:**
Spieth et al. (2019, p. 276) acknowledged that business models embedded in networks relied on *"[...] network level value creation processes and business exchange patterns that are not clearly aligned."* In a similar vein, Chesbrough (2007b, p. 59) made a crucial point, arguing that relationships could be turned into co-development partnerships by *"[...] assessing others' business models, understanding one's own business needs and the degree of their alignment with one's own business model."* This implicitly highlights the role of knowledge in (1) value propositions (knowledge about demand and earnings), as well as in (2) value deployment (in terms of positioning a company within its network to expand its value as well as value appropriation) (Lee et al., 2010, p. 20). Consequently, identifying the requirements of the ecosystem actors was identified as an essential task to establish a viable *"business model ecosystem"* (Vorraber and Müller, 2019, p. 2). Ecosystems have the potential to support the development of business models, which then requires focal companies to understand their environments in terms of numbers and types of customers and the overall market demand (Rong et al., 2018, p. 235). Subsequently, the impact of a focal company on other actors could be explored by viewing business models not as a company-centric construct but rather as part of a business network (Mason and Mouzas, 2012, p. 1344). In this way, networks can contribute to the integration of market knowledge into business models. This could be a fruitful approach, since this understanding is a prerequisite for making investments in terms of capacity and supply (Rong et al., 2018, p. 235). Lindgren et al. (2010, p. 131) highlighted the necessity of considering the customers' value chains holistically (starting at the producer up to the end-user) to reveal hidden potentials and subsequently trigger the development of network-based business models. Furthermore, focal companies needed to understand their business ecosystems and their associated stakeholders in order to interact with other actors that contributed to their business models appropriately (Rong et al., 2018, p. 243). This finding underlines the role of business ecosystems in building sustainable[1] business models as it identifies opportunities for value creation and subsequently establishes strategies that allow companies to appropriate value (Rong et al., 2018, p. 244). Similarly, Nailer and Buttriss (2020, p. 678) argued that business models would influence companies' abilities to identify appropriate partners and develop relations to support their activities with resources. This was particularly relevant, as selecting appropriate partners was strategical influential (Karlsson et al., 2017, p. 2933). The capabilities of actors acting as intermediaries can support identifying and performing matchmaking between collaboration partners as well as managing innovation processes between suppliers and customers of innovations (Katzy et al., 2013, p. 306). The described results of this review also apply to platform business models, which rely on the knowledge of a company's potential to collaborate, its technological interfaces, and its knowledge of how to leverage relationships in networks (Fehrer et al., 2018, p. 547).

[1] The word sustainable here is meant not in the ecological sense but in terms of longevity.

## b) Role of ecosystem stakeholders for changing business models

The literature also indicated that stakeholders play a substantial role in the process of changing business models. For instance, a business models can create and appropriate value only as a result of an iterative interaction between the stakeholders in an ecosystem (Rong et al., 2018, p. 235). The authors also emphasized the role of (1) network effects among stakeholders, (2) the role of ecosystems in fostering the development of business models, as well as (3) uncertainties regarding market demand of new technologies, which could hinder investments in capacity or supply (Rong et al., 2018, p. 235). Unsurprisingly, the review revealed that companies need to investigate their surrounding business ecosystem - including relevant stakeholders - to recognize how interactions among actors could benefit business models and how the value can be shared (Rong et al., 2018, p. 236). Focal companies might also consider increasing the number of ecosystem partners to expand their business models and add value streams to ultimately increase their overall economic feasibility (Rong et al., 2018, p. 236).

**Role of legislative and governmental stakeholders:**
Governmental influences were identified as a potentially relevant factor regarding technology-based business models (Jiao and Evans, 2016, p. 348). These influences could have a substantial impact on the application of new technologies and hold the potential to catalyze business models built around new technologies[1] (Jiao and Evans, 2016, p. 348). However, the literature on the effect of governments on business models was still fragmented. For instance, Segers (2016, p. 136), argued that new *"[...] disruptive business models are introduced faster than the ability to fit these new business models into existing regulatory frameworks and/or the fast-growing competition [...]"* from cheaper products. Along these lines, Hamelink and Opdenakker (2019, p. 125) noted that *"[...] legislations can hinder a "true new" value proposition [...]"*. In a similar vein, Yang et al. (2019, p. 14) found that governmental projects can *"[...] engage consumers as business ecosystem partners."* They argued that one crucial point was that the governments could create new business models by supporting the introduction of new business ecosystems. These authors stated that governments could take one concrete action towards establishing new ecosystems by promoting trust in a common undertaking and, in turn, fostering the ecosystem participation of actors. They added that this particularly applied to companies entering an ecosystem at a later stage, as these latecomers faced significant risks in creating business models. Yang et al. (2019, p. 15) remarked that governments supporting these latecomers could increase the number of ecosystem participants, subsequently fostering innovation-opportunities.

The role of governments has been strongly emphasized in the literature in the context of sustainability. For instance, Goyal et al. (2014, pp. 35-36) emphasized the fact that *"[...] the significant role of the government in the growth and entry of the social enterprises having socio-economic business model."* Similarly, Nußholz et al. (2019, pp. 308-309) pointed out the potential impact of policies to overcome resource barriers and to promote the use of resource-efficient processes in business models. However, changing business models alone will not be enough to accomplish system change. Unsurprisingly, authors have underlined the need to make changes in change

[1] Jiao and Evans (2016, p. 348) explicitly named governmental influences as a catalyst for business model reconfiguration towards EVs.

market structures as well as to carry out political and regulatory reforms (Bolton and Hannon, 2016, p. 1740). Consequently, changing business models to support sustainability requires the understanding of synergies as well as the alignment of involved systems (Bolton and Hannon, 2016, p. 1740). Moreover, using policy to promote sustainable business models might have a limited impact (Sarasini and Linder, 2018, p. 26). To address this issue, Bocken et al. (2015, p. 74) proposed using *"value mapping"* to *"[...] consider and align multiple types of value generated, missed, and destroyed for different stakeholders, including value for society and environment, before thinking about new opportunities to generate new economic value."* They argued that this approach could be used to consider stakeholders (including their potential added values in the ecosystem and how to interact with them) as well as innovation barriers when redesigning business models (e.g., existing mental models or physical infrastructure) (Bocken et al., 2015, pp. 75-76).

### c) Role of ecosystem actors' resources and capabilities for changing business models

Network-based business models potentially provide high levels of innovation as they tend to enable access to a large variety of ideas and competencies as well as to technologies, products, markets, and industries in a network (Lindgren et al., 2010, p. 134). This is particularly relevant, as individual actors often lack the necessary resources to innovate in areas that require substantial investments as well as high levels of knowledge and expertise (Karlsson et al., 2017, p. 2932).

**Changing business models to integrate other actors' resources and capabilities:**
Business model innovation presents an attractive option, as it typically requires low amounts of resources but holds the potential to overcome resource scarcities (Halme and Korpela, 2013, p. 13). The resources required to stay competitive may be provided by a company's innovation network (Calia et al., 2007, p. 426). This idea was further emphasized by Edralin et al. (2018, p. 78), who proposed that *"[...] resource constraints can be overcome through a business model that leverages off collaboration and partnerships [...]"* and Shelton (2009, p. 44), who claimed that integrated innovation requires *" [...] partners that complement your current resource base and expand your value offering."* Specifically, Shelton (2009, p. 43) considered building up resources within a company to be too sluggish and expensive and proposed that companies should engage in partnerships to overcome resource constraints. Lindgren et al. (2010, p. 130) also suggested that, in addition to trying to improve their core competencies on an individual level, actors need to be *"[...] more open to network-based innovation, particularly when the core knowledge and competencies needed to improve their performance are not available in-house."* Attractive external sources of competence could be, for instance, research institutions, competitors, consultants, as well as customers and suppliers (Lindgren et al., 2010, p. 130). More specifically, Fjeldstad and Snow (2018, p. 36) argued that companies *"[...] increasingly work with their customers, suppliers, and partners when altering the elements of their business models."* Moreover, Fehrer et al. (2018, p. 561) highlighted the fact that with business model designs that allowed *"[...] for flexibly accessing resources and knowledge from various actors, instead of building up knowledge for each problem within a focal firm, redundancies can be reduced within the entire set of activities."* Similarly, Nußholz et al. (2019, pp. 308-314) proposed that companies should perform business

model innovation to (1) establish partnerships for accessing physical resources (e.g., by moving beyond a company's value chain position), (2) develop capabilities and technologies, as well as (3) identify and perform marketing to selected customers (Nußholz et al., 2019, pp. 308, 314). With regard to sustainability transitions, Bolton and Hannon (2016, p. 1740) suggested that business model managers or entrepreneurs could *"[...] act as system builders by entering into partnerships to draw on resources, such as finance and technical expertise, and construct a seamless web of technological, political, economic and social components."* However, the exact form of ecosystem-oriented business model change made to overcome a lack of resources and capabilities largely differed. For instance, Spieth and Meissner (2018, p. 1850042-1) noted a tendency that incumbents relied on resources from alliance partners, specifically when incumbents entered new business segments where they lacked the necessary resources and expertise (Spieth and Meissner, 2018, pp. 1850042-1-1850042-2). A potential result of this resource-sharing in alliances could be that changes to a shared business model could occur, where the involved actors jointly commercialized an alliance's results (Spieth and Meissner, 2018, pp. 1850042-1-1850042-2). Another example was provided by Ayala et al. (2017, pp. 550, 551) who proposed that companies should collaborate with service suppliers to extend capabilities when performing business model innovations towards product-service solutions. However, business model innovation often requires actors to rearrange their network configurations and ties (Dellyana et al., 2018, p. 216). One possible reason for this could be that business model innovation relies on collaborations with external actors to a larger degree than *"service product innovations"* or *"service process innovations"* (Wang et al., 2015, p. 1378). This, in turn, has its roots in the nature of business model innovation.

**Capabilities for integrating actors in business models:**
Wang et al. (2015, p. 1378) strongly argued that *"[...] business model innovation is the most radical and complex innovation and it is often beyond the capability of one single organization."* As a consequence, business model innovation tends to require the coordinated involvement of multiple parties (Wang et al., 2015, p. 1378). Therefore, when attempting to access external resources and capabilities, it can be challenging to establish a fit between a business model and its environment. Specifically, Bolton and Hannon (2016, p. 1740) highlighted that a main challenge was to *"[...] align content, structure and governance of the business model with the evolving socio-technical context, incorporating dynamic changes to regime structures (e.g. energy markets and utility business practices) and the political framework within which decisions are made."* This indicates that accessing resources from ecosystem actors might require specific capabilities. Nonetheless, integrating actors in business models might yield substantial benefits. For instance, Hammarfjord and Roxenhall (2016, p. 1750037-2), found that by *"[...] pooling resources, companies participating in strategic innovation networks can produce and deliver more complicated products than they can individually."* However, integrating actors - and their respective resources and capabilities - into business models depended on multiple factors and could present companies with substantial difficulties. One root cause for difficulties with regards to integrating actors could be differences in whether the capabilities for business models were developed internally or obtained from external sources (Rajala and Westerlund, 2008, p. 71).

The literature contains information about the specific capabilities necessary for integrating actors and their respective resources and capabilities in business models. For instance, Katzy et al. (2013, p. 302) found that *"[...] matching complementary resources of the network partner and integrating* *them into a coordinated innovation process is an important capability."* Thereby, companies could use complementary assets from strategic partners to establish a value network that is integrated into local infrastructure, subsequently articulating an attractive value proposition (Wu et al., 2010, p. 51). Moreover, Giesen et al. (2010, p. 24) highlighted the role of global integration in accessing capabilities that support business model innovation, while Matthyssens et al. (2006, p. 760) argued that value innovations required from actors (value innovators) *"[...] new competencies or the synergistic collaboration among network partners to which parts of the new offering are outsourced."* In a similar vein, Lindgren et al. (2010, p. 130) found that, as companies were increasingly tied together, they emphasized the need to adjust their business models and capabilities to meet other actors' requirements and subsequently to *"[...] support their partners' core competences so as to create a new and joint platform for collaboration and innovation."* Furthermore, Gebauer et al. (2012, p. 57), in the context of strategic innovation, suggested that companies *"[...] should not only manage the accumulation of external knowledge, but also adapt their combinative capabilities (systematisation, coordination, and socialisation of knowledge) in order to succeed."*

### d) Role of ecosystem relations for knowledge transfer when changing business models

**Role of knowledge sharing in ecosystems:**
As outlined above, individual actors often lack sufficient internal expertise. Consequently, as business models tend to span a focal actor's boundaries, accessing knowledge and learning from ecosystem partners could be a major driver for innovation (Spieth and Meissner, 2018, p. 1850042-16). The business model could potentially be utilized to establish relations between actors and to facilitate the transfer of knowledge and capabilities. This idea was propagated by Mason and Leek (2008, p. 774) who argued that dynamic business models could be used to identify and link key actors as well as to foster the *"[...] identification and specification of appropriate knowledge types and knowledge transfer mechanisms for different actors, in different contexts."* Co-development relationships could also represent a key factor for business model innovation (Chesbrough and Schwartz, 2007, p. 55). However, depending on a specific context, the character of the relationships varies (Chesbrough and Schwartz, 2007, p. 55). Kadama (2002, p. 289) further underlined the value of knowledge transfer by arguing that community-based innovations that transcended a focal actor's organization could *"[...] provide new value to many customers through knowledge within the community and the innovation of competence."* However, one crucial aspect is that company spanning knowledge transfer in the context of business model change can be seen as a complex undertaking that is subject to a multitude of influences.

**Influences on knowledge transfer and business models change in ecosystems:**
One major aspect in that regard is the role played by business model mechanisms for knowledge conversion when undertaking business model reconfiguration (Forkmann et al., 2017, p. 160-161), especially, as the transfer of knowledge between actors relies on multiple factors. In that regard, Roxenhall (2013, pp. 1350002-16-1350002-17) pointed out the complexity of appropriately guiding and managing a substantial number of individual members of strategic innovation networks. This might have a severe impact on business models in an ecosystem, as it fostered knowledge transfer

and, as a consequence, enabled innovation (Roxenhall, 2013, pp. 1350002-16-1350002-17). Similarly, the individual actors' reasons for sharing knowledge effectively were frequently reported as a critical aspect (Mazzucchelli et al., 2019, p. 242). Moreover, companies could benefit from removing conflicting assets when performing joint business model innovation (Wadin et al., 2017). In that respect, Wadin et al. (2017) proposed that companies should use a cooperative process of business model innovation to maximize learning effects, subsequently suggesting that they should perform business model innovation as separate entities (e.g., joint ventures). Thereby, these separate entities would be better able to focus on common interests and avoid conflicts (Wadin et al., 2017). Challenges to establishing knowledge transfer included (1) being able to identify companies with complementing capabilities, as well as (2) being open and willing to learn (Spieth and Meissner, 2018, p. 1850042-16). The best learning results could be achieved when partners had a cooperative learning intent - a situation referred to as *"cooperative business model innovation"* (Wadin et al., 2017). Ayala et al. (2017, p. 551) also found that the dynamic of knowledge sharing depended on (1) the type of collaboration and (2) wether the focus of business model innovation was on services or products. They highlighted the fact that designs that were driven by suppliers[1] allowed for more fast-paced innovations of business models, since these designs involved less knowledge sharing with suppliers and required no new capabilities with regard to services (Ayala et al., 2017, p. 551). However, they also noted that this option had its downfalls, such as dependence on suppliers and difficulties in supplier selection (Ayala et al., 2017, p. 551).

Companies might also have incentives to actively transfer knowledge to ecosystem partners when changing their business models. For instance, Forkmann et al. (2017, p. 163) argued that in order to reconfigure business models towards services, companies *"[...] not only need to focus on the processes and mechanisms under their direct control, but also need to mobilize and assist other involved actors in their complementary infusion and defusion processes through knowledge conversion mechanisms, e.g. training, provision of service manuals, or joint problem solving, and through governance mechanisms, e.g. monitoring systems, accreditation schemes, or detailed contractual arrangements."*

### e) Influence of business model change on ecosystem actors and ecosystem architecture

Business models can have substantial impacts on ecosystem actors and, consequently, on the overall structure of an ecosystem. One key aspect is rooted in the boundary-spanning nature of business models, namely, their ability to connect competing firms and establish relations (e.g., co-opetition relations) (Velu, 2016, p. 133). Interestingly, changes in business models were seen as related to an ecosystem's architecture. For instance, Hamelink and Opdenakker (2019) argued that business model innovation that involved complementarities in introducing an innovative value proposition could lead to an increased number of partnerships and customer segments as well as additional channels. Velu (2016, p. 134) had argued earlier that this broader concept of business model sheds light on how *"[...] coopetition might shape industry structure and business*

[1] Specifically, Ayala et al. (2017) differentiated between supplier driven *"black box designs"* - in contrast to *"white box designs"* where designs were driven by buyers.

*model evolution."* Fehrer et al. (2018, p. 561) supported this argument, noting that business models (and thus their respective value creation processes) were shifting towards more open networks[1] that relied on value processes performed by versatile actors. However, the literature review results that addressed the influence of business model change activities on ecosystem actors and structures contained a broad and fragmented array of topics. For instance, Mason and Leek (2008, p. 774) found that companies could use dynamic business models to *"[...] develop and manage supply networks, which reduce their operating costs and maximize their effectiveness in the marketplace."* Similarly, business model innovation might be used to introduce public-private networks (Karlsson et al., 2017, p. 2925) and could also play a role in creating and evolving a new industry (Park, 2011, p. 144). Concretely, Park (2011, p. 145) argued that a *"[...] new business model innovation can erode existing value chains and build strong ecosystems that are tightly embedded in business models."* Service innovations, which often went hand in hand with new business models, often also required new partnership types, novel value networks, and new possibilities to commercialize capabilities (Shelton, 2009, p. 44). Consequently, Wang et al. (2018, pp. 19-20) found that business model innovation can result in a shift of ecosystem role over an ecosystem's lifecycle. These studies indicated that adjustments in the interactions among network-partners could eventually lead to tensions - for instance, when actors expanded their capabilities into areas that had been previously occupied by other actors (Burton et al., 2016, p. 39). Moreover, dominant companies are expected to experience only a low degree of change with regard to their network-based business models (Lindgren et al., 2010, p. 130). Less dominant, small companies, in contrast, tended to consider more radical changes to their business models (Lindgren et al., 2010, p. 130).

### f) Role of actor culture for changing business models in ecosystems

In addition to the aforementioned aspects, the results of the literature review indicated that cultural aspects substantially influenced the relations among members involved in business model innovation in alliances described by Spieth and Meissner (2018, p. 1850042-11). These authors noted that one particular challenge was to overcome resistance to innovations involving partners. Concretely, Spieth and Meissner (2018, p. 1850042-16) underlined the role of (1) *"risk tolerance"*, (1) *"courage for radical innovation"*, as well as the (3) *"willingness to embark on new paths"* and proposed that business model innovation could benefit from a culture that supported risk taking and experimentation. Hammarfjord and Roxenhall (2016, p. 1750037-25) also underlined the role of (1) network commitment, (2) a potential expectation gap, (3) shared values, as well as the (4) density and (5) size of ego networks. Breuer and Lüdeke-Freund (2017, p. 1750028-1) also noted that innovation based on values could facilitate developing networks and business models and concluded that innovation management might benefit from norms and values as a *"[...] common ground for deriving new and possibly co-evolving business models."* Another aspect raised by Mason and Mouzas (2012, p. 1363) was the impact of individual country cultures on business models as well as the technological culture of actor groups (e.g., customers, employees), which play a role when changing business models using technologies (Bourdon and Jaouen, 2016, p. 72).

[1] Fehrer et al. (2018, p. 561) differentiated among three different business model design logics: (1) *"firm-centered networks"*, (2) *"solution networks"* and (3) *"open networks"*.

These authors indicated that training of the involved actors and facilitating the gradual evolution of the value architecture (resources, processes) and the value proposition could support successful transitions (Bourdon and Jaouen, 2016, p. 72).

### Summary on influences of business model changes on ecosystems

The review results indicate that the actors' business model changes impact their surrounding ecosystems in multiple, complex, and intertwined ways. As summarized in Figure 39, these factors can be roughly grouped into the categories of (1) communication and general ecosystem knowledge[1], (2) ecosystem stakeholders, (3) resources and capabilities, (4) relations and knowledge transfer, (5) actors and ecosystem architecture, as well as (6) cultural aspects. The relevance

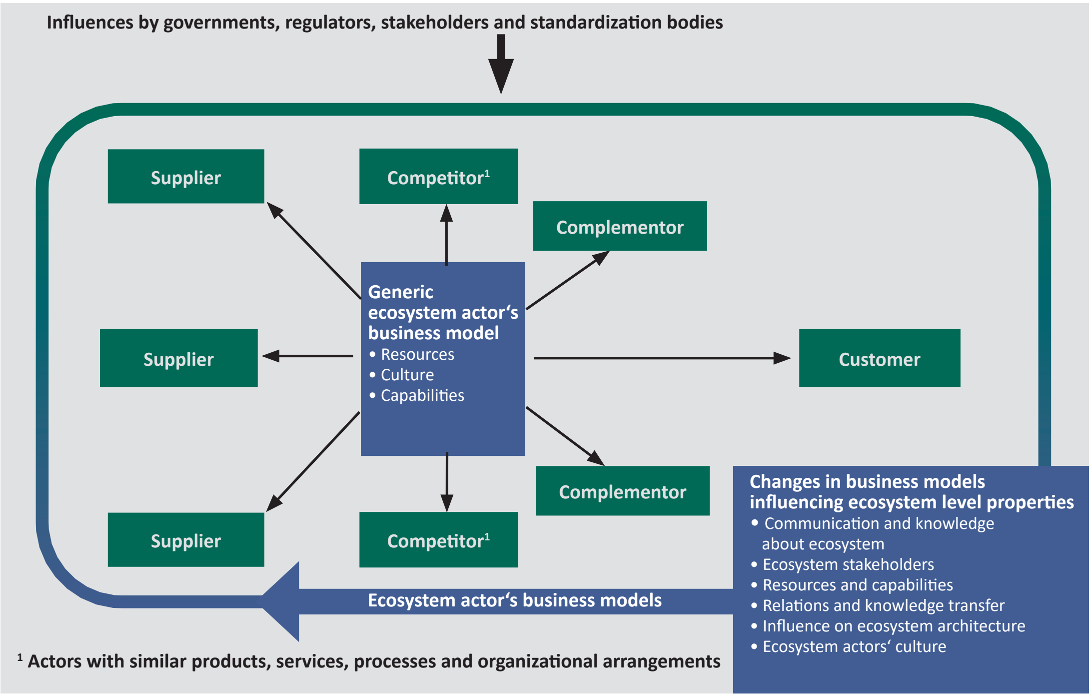



**Figure 39:** Overview of the identified factors for changing business models in the context of ecosystems. Personal illustration based on insights from the literature (Moore, 1996; Adner and Kapoor, 2010; Jacobides et al., 2018; Talmar et al., 2018). The basic framework was extended based on the findings from the literature review regarding the influences of business models on the ecosystem.

of communication becomes particularly clear when considering boundary-spanning aspects of business models in the context of an environment, which inevitably impose restrictions on a focal actor (Berglund and Sandström, 2013). In that regard, communication might support companies in identifying said restrictions. However, the aspect of communication can not be viewed in

[1] Ecosystem knowledge in this case refers to knowledge *about* the surrounding ecosystem.

isolation, as, for example, the ability to shape conversations among actors was influenced by several factors, such as an actor's role (Prince et al., 2014). Moreover, other studies suggested that communication could help companies fulfilling customer demands (Nardelli and Rajala, 2018; Liu and Bell, 2019). Another identified factor in that regard was knowledge about business models surrounding ecosystem as it, for instance, allowed companies to better align their business models with their respective environments (Chesbrough and Schwartz, 2007). Having knowledge about elements such as value propositions in terms of demand and earnings, possible ways of how to deploy values (Lee et al., 2010; Rong et al., 2018) as well as requirements to introduce a viable *"business model ecosystem"* were identified as particularly important (Vorraber and Müller, 2019). An appropriate understanding of an ecosystem and its stakeholders could subsequently support interactions (Rong et al., 2018). Several authors noted that identifying relevant actors and building relations represented a challenging task (Rong et al., 2018; Nailer and Buttriss, 2020), which could be supported by intermediaries (Katzy et al., 2013). Stakeholders in an ecosystem were also mentioned as influencing business models substantially (Rong et al., 2018). Authors argued that companies should holistically consider an ecosystem's stakeholders when aligning values and interactions as well as innovation barriers in an ecosystem when redesigning business models (Bocken et al., 2015; Bolton and Hannon, 2016). One particularly relevant aspect pointed out by several actors was the influences wielded by governmental and regulatory stakeholders, which could both facilitate (Jiao and Evans, 2016; Yang et al., 2019) or hinder (Segers, 2016; Hamelink and Opdenakker, 2019) changes in business models in an ecosystem.

Another crucial factor for individual actors that performed business model innovation in the context of ecosystems was the ability to access the resources and capabilities of other ecosystem actors. This could be an attractive way for individual actors to overcome scarcities or expand on resources and capabilities (Halme and Korpela, 2013; Karlsson et al., 2017; Edralin et al., 2018) at a rapid pace (Shelton, 2009) while avoiding redundancies (Fehrer et al., 2018). Moreover, accessing resources and capabilities from ecosystem partners by changing business models can be considered as a complex undertaking which might require specific capabilities of its own. The role of knowledge transfer between actors was identified as related to the aspect of accessing resources. Business models were mentioned as being able to support the identification of - as well as relationship building between - relevant actors and defining appropriate knowledge types and mechanisms to transfer and convert knowledge (Mason and Leek, 2008; Forkmann et al., 2017). Consequently, innovation activities that transcended focal actors' organizations could enable innovation and new customer value. Influences on the ability to use business models to access knowledge included the complexity of transferring knowledge, which required the appropriate management of actors and interactions (Roxenhall, 2013), and the identification of suitable companies for knowledge transfer (Spieth and Meissner, 2018), as well as the maintenance of its overall pace and dependencies between actors (Ayala et al., 2017).

Business model activities were also reported as having an impact on external actors and their surrounding ecosystem architecture. Influences included establishing industry-shaping co-opetition relations (Velu, 2016), introducing and managing different kinds of networks (Mason and Leek, 2008; Karlsson et al., 2017) and shifting ecosystem roles over an ecosystem's lifecycle (Wang et al., 2018).

A multitude of cultural aspects underpinned the described influences on business model changes in the context of ecosystems. These included the actors' norms and values (Hammarfjord and Roxenhall, 2016; Breuer and Lüdeke-Freund, 2017), their level of commitment, as well as their stance towards technologies (Bourdon and Jaouen, 2016). These aspects also played a role in, for instance, overcoming resistance to innovations conducted by multiple companies (Spieth and Meissner, 2018).

### 5.4.3 Role of technologies for ecosystems and business model change

In the following section, relevant aspects regarding the role of technologies in ecosystems and involved business models are described. Again, the structure of the section mirrors the identified dimensions summarized in Table 23. Consequently, aspects are presented with regard to changes in business models to market technologies, changes in business models to access resources and capabilities for technologies, as well as the role of technologies as enablers/drivers of business models.

#### a) Changes in business models to market technologies

New technologies might require individual actors to change business models to bring them to the market. Sarasini and Linder (2018, pp. 25-26) proposed that a dynamic[1] view of the innovation of business models was well-suited to considering experimentation, the commercialization of technology and might be able to act as a cornerstone in co-evolution processes (also compare Section 5.4.4). Alliances between actors could consequently support business models' development to disseminate technologies (Wadin et al., 2017). As outlined above, innovations of business models typically involved changes in relationships (e.g., number or intensity of relations) (Arnold et al., 2016, p. 1640015-12). Therefore, marketing technological innovations required good communication and collaboration with customers, ideally in long-term relations (Arnold et al., 2016, p. 1640015-12). However, disruptive product innovations could destabilize existing business models and market structures (Simmons et al., 2013, p. 751). Pynnönen et al. (2012, p. 1250022-15) also highlighted the role of continuous (and often iterative) business model innovation to develop technologies supporting the requirements of current and emerging customers. This process was especially relevant when changes in enabling technologies, preferences of customers, or infrastructure occurred (Pynnönen et al., 2012, p. 1250022-15). On the other hand, incumbent companies that were able to provide *"breakthrough technology innovation"* might fail to perform business model innovation involving changes in market spaces (Koen et al., 2010, p. 48). Again, literature review results on the topic were fragmented. For instance, the entry timing of companies could play a major role when changing business models in ecosystems to market technologies. This was indicated by Wu et al. (2010, p. 51) who proposed that *"[...] latecomer firms, though*

[1]Sarasini and Linder differentiated between a static and a dynamic view on business model innovation. The static view allows insights to be gained regarding different types of business model innovations (Sarasini and Linder, 2018, p. 25, 26).

*disadvantaged in technological capabilities and market resources, can successfully introduce disruptive technologies from advanced economies into emerging economies through secondary business-model innovations."* Another aspect highlighted by Mason and Mouzas (2012, p. 1363) was that focal companies may enact an influence in their upstream network to (1) identify and (2) influence technological innovations through supplier interactions, subsequently generating product innovations that would open up business opportunities and drive market change. Furthermore, costs for technological obsolescence could influence industry business models[1] (Monios and Bergqvist, 2020, p. 1).

### b) Business model change to access ecosystem resources and capabilites for new technologies

The continued growth of a business segment centered around a novel technology[2] required focal actors to have both a vision for the overall ecosystem as well as collaborations with competing as well as complementing propositions. However, due to the evolution of individual sectors, finding a suitable strategic positioning and value proposition can represent a challenge, as the resources and capabilities of related actors in a company's network needed to be considered (Shalender, 2018, pp. 78-79). Changing business models could be particularly relevant when accessing resources and capabilities that subsequently can be used for new technologies. For example, Ogilvie (2015, p. 25) concluded that *"[...] focus of product-service ecosystems isn't on radical new technologies but rather on new combinations of technologies and services that create value in new ways [...]"* underlining the fact that *"[...] these new combinations require diverse sets of technical and operational capabilities—combinations not often found within the bounds of a single firm."* Similarly, Shelton (2009, p. 38) highlighted the *"[...] need to fuse technology and business model innovation by organizing and leveraging the appropriate resources."* Furthermore, Mayangsari and Novani (2015, p. 320) emphasized the role of co-creation of value in the context of new technologies[3] due to the involved actors' individual resources. Companies developing business models subsequently need to consider the benefits of related actors and use them to their advantage (Shalender, 2018, pp. 78-79), while robust partnerships could support the enhancement of value propositions (Shelton, 2009, p. 38). Arnold et al. (2016, p. 1640015-13) also found that companies in the electrical engineering sector that pursued new technological directions (digitalization) *"[...] show remarkable distinctions in terms of partner networks as well as cost structure."* Companies pursuing new technological avenues might require suitable development partners, industry partners, as well as research institutions (Arnold et al., 2016, p. 1640015-13). Jablonski (2015, p. 929) supported this argument suggesting that *"[...] the network enables the implementation of joint initiatives of companies embedded in the network aimed to create new technologies."* Consequently, value exchanges between companies can create new offerings (e.g., products or services) Jablonski (2015, p. 929).

[1] Monios and Bergqvist (2020, p. 1) predicted substantial changes in heavy-duty transport operations (e.g., due to environmental benefits), including a shift away from ownership-based business models.

[2] Shalender (2018, pp. 78-79) used the example of electric vehicles and their respective ecosystems.

[3] Mayangsari and Novani (2015, p. 320) used the example of smart cities.

### c) Technologies as enabler/driver of business model change in ecosystems

Proprietary technological knowledge could provide focal companies with a considerable influence (Rong et al., 2018, p. 240). This particularly applies to product-based ecosystems. While this influence could increase focal companies' flexibility with regards to their business models, it also can put other actors in a position of disadvantage (Rong et al., 2018, p. 240). Economic environments and disruptive technologies can cause companies to reevaluate their business models (Ginsburg, 2002, p. 45). New technologies might require companies to radically change their business models to align with their environments (Brenner, 2018, p. 17). Chapman (2006, p. 36) then characterized the relation between technology and industry business models as follows: *"Technology can be a catalyst – both to drive innovation as well as to enable it. It can play a vital part in new products, services, channels, market-entry strategies, operational transformation and industry-altering business models. Technology can even enable other innovation enablers such as collaboration."* In turn, the initial focus of new technology development often lies on technological and environmental problems (MacInnes, 2005, p. 17). Only later, developers tended to investigate obstacles in developing a viable business model (MacInnes, 2005, p. 17). Nonetheless, technologies could have a substantial impact on both business models and business environments. For instance, Guo et al. (2013, p. 451) emphasized that rapid *"[...] advances in technologies have enabled firms to fundamentally change the ways they do business, in particular, the ways they reshape their boundary-spanning business networks."* Similarly, findings by de Reuver et al. (2009, p. 1) suggested that *"[...] technological and market-related forces are the most important drivers of business model dynamics, while regulation plays only a minor role."* Furthermore, de Reuver et al. (2009, p. 1) pointed out several differences in the type of companies: While start-ups, where business models often are in their early stages, perceived a strong influence of technology and market-related drivers, the effects were less pronounced in larger, established companies. Subsequently, de Reuver et al. (2009, p. 10) concluded that *"[...] when developing new services and products and their underlying business models, companies need to be aware of the role technology and market forces play in the first phase of business model development."* Moreover, technological developments[1] could affect the actors' business models directly as well as other ecosystem actors that needed to realign their business models (Kohtamäki et al., 2019, p. 380). Consequently, Leminen et al. (2020, p. 299) differentiated between technology[2]-related company-specific business model innovation (taking place from the inside-out), and systemic (connected) business model innovation (taking place from the outside-in). The degree of innovation in both cases could range from incremental to radical (Leminen et al., 2020, p. 299).

[1] Kohtamäki et al. (2019, p. 380) specifically looked at the context of digitalization.

[2] Leminen et al. (2020, p. 299) performed investigations in the context of industrial Internet of Things.

### Summary of relevant aspects of technologies for changing business models in ecosystems

An overview of the identified aspects is provided in Figure 40. Relevant aspects with regard to technologies identified when reviewing the literature and combining changes in business models and ecosystem aspects were changes in business models to (1) market technologies, (2) technologies as

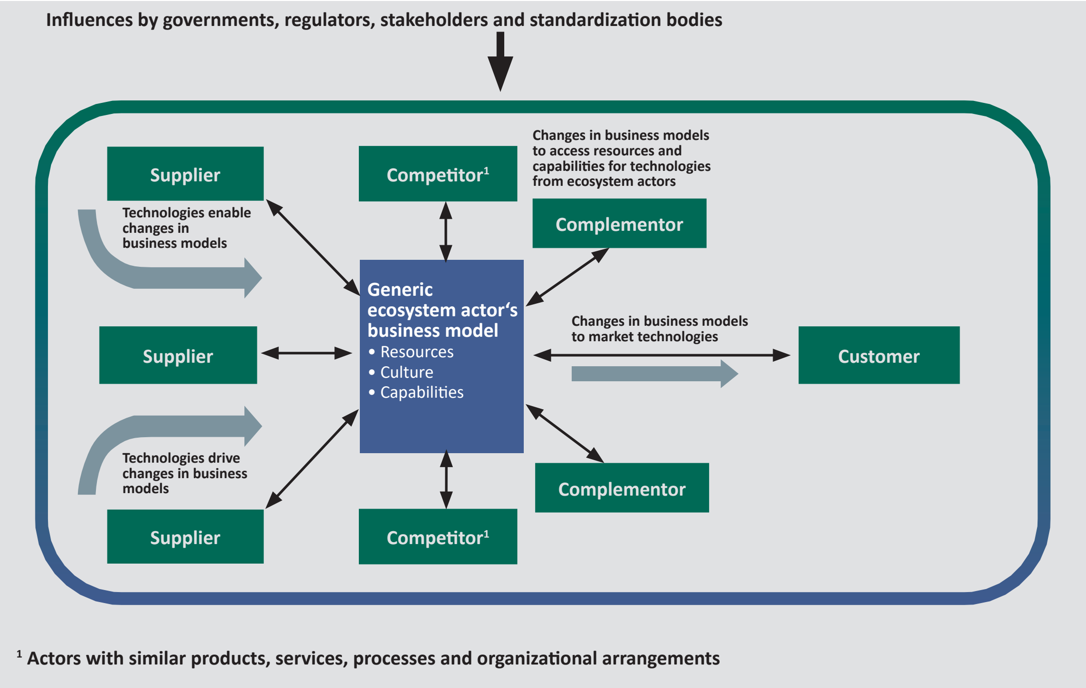



**Figure 40:** Overview of the identified factors needed to change business models in the context of ecosystems. Personal illustration based on insights from literature (Moore, 1996; Adner and Kapoor, 2010; Jacobides et al., 2018; Talmar et al., 2018). The basic framework was extended based on the findings regarding the roles of technology identified in the literature review results.

enablers or drivers of changes in actors' business models, as well as (3) changes in business models to access resources and capabilities from ecosystem actors that are necessary for technologies. Performing ecosystem-based business model changes could be instrumental in bringing technologies to the market (Wadin et al., 2017; Sarasini and Linder, 2018). Relevant factors were identified as interactions with customers (Arnold et al., 2016), the degree of technological innovations (Koen et al., 2010; Simmons et al., 2013), entry timing (Wu et al., 2010), as well as the actors' influence (Mason and Mouzas, 2012) and costs for becoming obsolete (Monios and Bergqvist, 2020). As outlined previously, changing business models represents an attractive option that can be taken to access resources and capabilities (see Section 5.4.2). This particularly holds true in the context of technologies, as technologies often required new capabilities that actors did not possess (Ogilvie, 2015). Business models needed to be aligned in the context of the ecosystem to enable mutual benefits (Shalender, 2018) and to co-create new technologies (Mayangsari and Novani, 2015;

Jablonski, 2015; Arnold et al., 2016). Consequently, technologies could either directly or indirectly result in changes in business models as well as their respective ecosystems (de Reuver et al., 2009; Kohtamäki et al., 2019).

### 5.4.4 Role of actors' strategic behavior for changes of business models in ecosystems

#### a) Co-evolution of ecosystem and business models

**Business models as vehicles for co-evolution:**
Creating and delivering value increasingly involved collaboration in co-production networks encompassing a focal company and its surrounding ecosystem actors (Fjeldstad and Snow, 2018, p. 34). Fehrer et al. (2018, pp. 561-562) highlighted the existence of mutual influences between business models and their ecosystem, arguing that *"[...] logic and structure of platform business models illustrate that value is cocreated through shaping and re-shaping institutional arrangements and at the same time being shaped by these institutional arrangements."* Dellyana et al. (2018, p. 211) also found a *"[...] two-way relationship between the actor's network, business model and business model innovation dimensions."* The review results indicate that the external orientation in an ecosystem relies both on changes in the environment and the participation of stakeholders when innovating business models (Nardelli and Rajala, 2018, p. 38).

Furthermore, business model innovation can be induced and formed by interactions with users (Yderfält and Roxenhall, 2017, p. 20). This implies that business model innovation can be seen as the outcome of co-evolutionary processes between companies and their respective business environments (Su et al., 2020, p. 399). Moreover, Nardelli and Rajala (2018, p. 38) suggested that *"[...] business model innovation entails interorganisational collaboration across different phases of the innovation process."* Consequently, successful innovations in networks require changes in the focal companies' business models to adapt them to the overall network-level business models (Lindgren et al., 2010, p. 130) and establish a deep integration of these models in companies' network relations (Matthyssens et al., 2006, p. 752). This, in turn, relied on the commitment and cooperation of external actors (e.g., suppliers) (Matthyssens et al., 2006, p. 752). Thereby, business model innovation could serve to examine options for creating *"value chain networks"*, value proposition, and for building relationships between users and producers.

**Drivers for co-evolution of business models and ecosystems:**
Due to the rising amount of tightly integrated "ecosystem-based business models," companies increasingly need to cooperate with partners along the whole value chain (Ogilvie, 2015, p. 26). In doing so, Ogilvie (2015, p. 26) argued that multiple companies engaging in collaboration *"[...] can be more capable than one, as they act both in their mutual interest and each in its own self-interest."* Co-development partnerships are crucial to establishing alignment between the focal companies' business models and the business models of co-development partners (Chesbrough, 2007b, p. 57). This idea is also reflected in the findings of Prince et al. (2014, pp. 109-110), who

indicated that actors performing collaborative innovation in strategic innovation networks would *"[...] serve their own interests whilst paradoxically wanting to serve the collectivity of the network."* In turn, this can create a win-win situation, as focal companies often seek out actors to satisfy their resource needs while other actors aimed to realize value fitting their business model (Nailer and Buttriss, 2020, p. 680). Driven by anticipated and/or realized value, actors then change their business models to address the common interests in their ecosystem (Nailer and Buttriss, 2020, p. 680). According to Nailer and Buttriss (2020, p. 680), this *"[...] value anticipation/realisation mechanism therefore operates across all actors interacting through connected business models, functioning as the glue in their relationships as each seeks to realise anticipated value."* Moreover, Chesbrough (2007b, p. 57) highlighted the role of the complementarity of aligned business models, which could benefit all involved partners. As a result, realized benefits might explain the dynamics of the actors' relations in a network (Nailer and Buttriss, 2020, p. 680).

**Boundary conditions for co-evolution of business models and ecosystems:**
Performing joint business model innovation had several advantages, such as sharing of (1) costs, (2) risks, and (3) knowledge (Spieth and Meissner, 2018, p. 1850042-19). However, utilizing this potential could require a high degree of flexibility and the adaption of established processes (Spieth and Meissner, 2018, pp. 1850042-11-1850042-14). Rigid structures of partners involved in the undertaking may slow down or even hinder business model innovation (Spieth and Meissner, 2018, p. 1850042-14). As described above (see Section 5.4.2-a), communication and ecosystem knowledge play major roles when companies change business models in the context of their ecosystems. Specifically, Nardelli and Rajala (2018, p, 49) ascertained that interacting and connecting business model with stakeholders, internal units as well as outsourced providers can help to *"[...] understand and monitor their needs and expectations better over time, thereby being able to develop their business model accordingly."* This also applies when supporting the co-evolution of multiple actors, since focal companies need to communicate with partners in the ecosystem to conceive scalable business models before executing them (Rong et al., 2018, p. 240).

Interestingly, interactions between business models and their environments might lead to convergences between both constructs. This can occur when initially different business models[1] (1) reflected changes in the business environment, (2) evolved alongside, and (3) were supported by the prevailing business ecosystem (Rong et al., 2018, p. 238). Companies could subsequently profit from business model flexibility to incrementally adjust value creation and appropriation, react to internal and external changes, and include new partners (Rong et al., 2018, p. 240). The co-evolutionary adoptions between business models and their ecosystems, therefore, support the idea that business models undergo evolutionary development enacting influence on - as well as being influenced by - their environmental contexts (Simmons et al., 2013, p. 751).

**Co-evolution of the ecosystem and sustainable business models:**
Much of the literature addressed the topic of co-evolution between business models and their surrounding ecosystems in the context of environmental sustainability. For instance, Bolton and Hannon (2016, p. 1740), argued that business model innovation would likely be insufficient to effect transitions to sustainability. In contrast, content, structure, and governance of business

[1] Rong et al. (2018, p. 238) differentiated between product-based, platform-based, and hybrid business models.

models need to be aligned with an evolving societal/technological context as well as with political decision-making (Bolton and Hannon, 2016, p. 1740). Similarly, Baldassarre et al. (2017, p. 183) underlined the relevance of involving customers when introducing sustainable value propositions, which, in turn, might lead to changes in a company's stakeholder network and context. As highlighted by Gallo et al. (2018, p. 911) and Szekely and Strebel (2013, pp. 475-476), partners played a major role in the transition process towards sustainability. This particularly applies in cases where the scope of innovation increased, which resulted in the involvement of more stakeholders as well as more intense partnerships (Szekely and Strebel, 2013, p. 476). Consequently, sustainable innovation ecosystems required the development of business models, networks, as well as products, services, and processes (Diaz Lopez et al., 2019, p. 29). Supply-side measures would consequently be reflected in the supply chain and internal processes as well as partly the value proposition (Diaz Lopez et al., 2019, p. 29). As a result, the success of measures depends on a company's ability to form new coalitions with external actors (Diaz Lopez et al., 2019, p. 29). According to Vorraber and Müller (2019, p. 2), establishing sustainable business models also required them *"[...] to know and represent the values of the actors and how they are met in the overall context of the business network."* In turn, *"network centric business model innovation"* needs to balance economic and environmental values when establishing sustainable supply networks, as situational logics might both enable or hinder sustainable value creation (Brennan and Tennant, 2018, p. 621). Interestingly, Brennan and Tennant (2018, p. 621) noted that *"network-centric business models"* were not necessarily characterized by complementary logics and shared values.

### b) Role of competition and co-opetition and collaboration for changing business models in ecosystems

The review provided rich evidence of the co-evolution of business models and ecosystems. However, few insights were gained regarding the aspects of collaboration, competition, and co-opetition. This might represent a finding in itself, as it gives an indication of the focus of the researchers. The outlined topics when changing business models in the context of their ecosystem included the following:

**Role of co-opetition for changing business models in ecosystems:**
A company's customer base can influence both competition and cooperation, leading companies to innovate their business model (either evolutionary or revolutionary) and subsequently engage in co-opetition (Velu, 2016, p. 125). Co-opetition represents a vital element of business models as it holds the potential to influence both industry structure as well as the evolution of involved business models (Velu, 2016, pp. 133-134). The degree of business model change depended on the influence and timing of actors (Velu, 2016, p. 133). Less dominant actors tended to engage in co-opetition relations to demonstrate low degrees of business model change at an early stage as a defensive move (Velu, 2016, p. 133). Dominant actors, however, were potentially able to engage in co-opetition relations to realize revolutionary business models with a high degree of assertiveness (Velu, 2016, p. 133). Co-opetition could also reportedly encourage business model

innovation (Minarelli et al., 2015, p. 33). Moreover, avoiding to engage in co-opetition relations might put companies at a severe risk[1] (Monios and Bergqvist, 2020, p. 8).

**Role of competition for changing business models in ecosystems:**
Giesen et al. (2007, p. 37) argued that successful strategies to innovate business models emphasized *"[...] a strong fit between the competitive landscape for a particular industry and the organization's strengths, shortcomings and characteristics such as age and size."* Thereby, competitors can motivate business model innovation (Dellyana et al., 2018, p. 209). This, in turn, required innovating actors to enter relations to demonstrate a specific value, subsequently resulting in the formation of strategic networks (Dellyana et al., 2018, p. 209). In turn, companies might use business model innovation to change the competition in a market (Park, 2011, p. 144). In doing so, changing business models could establish competitive advantages and overcome disadvantages (Park, 2011, p. 144). Thereby, To et al. (2018, p. 791) ascertained that business model innovation could support the introduction of *"[...] overarching value propositions to compete for whole markets."*

**Role of collaboration for changing business models in ecosystems:**
Creating value in business models required companies to consider a focal company, its interactions, and its surrounding business ecosystem (Nardelli and Rajala, 2018, p. 49). Specifically, Nardelli and Rajala (2018, p. 49) pointed out that business model innovation *"[...] entails interorganisational collaboration across different phases of the innovation process."* New concepts of business models increasingly relied on collaboration both inside and beyond organizations (Fjeldstad and Snow, 2018, p. 37). In cooperations between actors with different expertise, even minor changes in business models might result in high degrees of value creation (Dellyana et al., 2018, p. 216). Consequently, companies could benefit from building up *"collaborative capabilities"* (Dellyana et al., 2018, p. 216). Furthermore, companies might profit from establishing *"collaborative capabilities"* - however, these capabilities could be especially beneficial in industries with diffused, complex, and growing knowledge bases (Fjeldstad and Snow, 2018, pp. 37-38). Particularly older companies could benefit from performing business model innovation that utilize "network plays", such as external collaborations and partnerships (Giesen et al., 2007, p. 27). Companies could also benefit from mechanisms for developing long-term relations when performing adaptions to the partners or customer relations involved in a business model (Karlsson et al., 2017, p. 2931).

### Summary of strategic behavior among ecosystem actors for changing business models

The types of interactions relevant for changes in business models in the context of their ecosystems identified in the review presented a nuanced view of the actor's competitive behavior. Specifically, the described interactions ranged from (1) co-evolution (Matthyssens et al., 2006; Fjeldstad and Snow, 2018; Su et al., 2020) to (2) competition (Giesen et al., 2007), (3) co-opetition

[1] Monios and Bergqvist (2020, p. 8), who investigated new technological trends in the automotive industry, proposed that manufacturers face the option of either engaging in competition with their current customers or, over the long run, risking the survival of their companies.

(Velu, 2016), and (4) collaboration (Dellyana et al., 2018; Fjeldstad and Snow, 2018; Nardelli and Rajala, 2018). An attempt to integrate the results into the context of business model changes and ecosystems is provided in Figure 41. The results show a clear focus on the co-evolution of business models and their ecosystems and indicate that the co-evolution of the actors' business models with their environment (Fjeldstad and Snow, 2018) and the involved mutual influences between both constructs (Dellyana et al., 2018; Fehrer et al., 2018; Nardelli and Rajala, 2018) were major strategic concerns. Business model change can thereby be seen as a result of co-

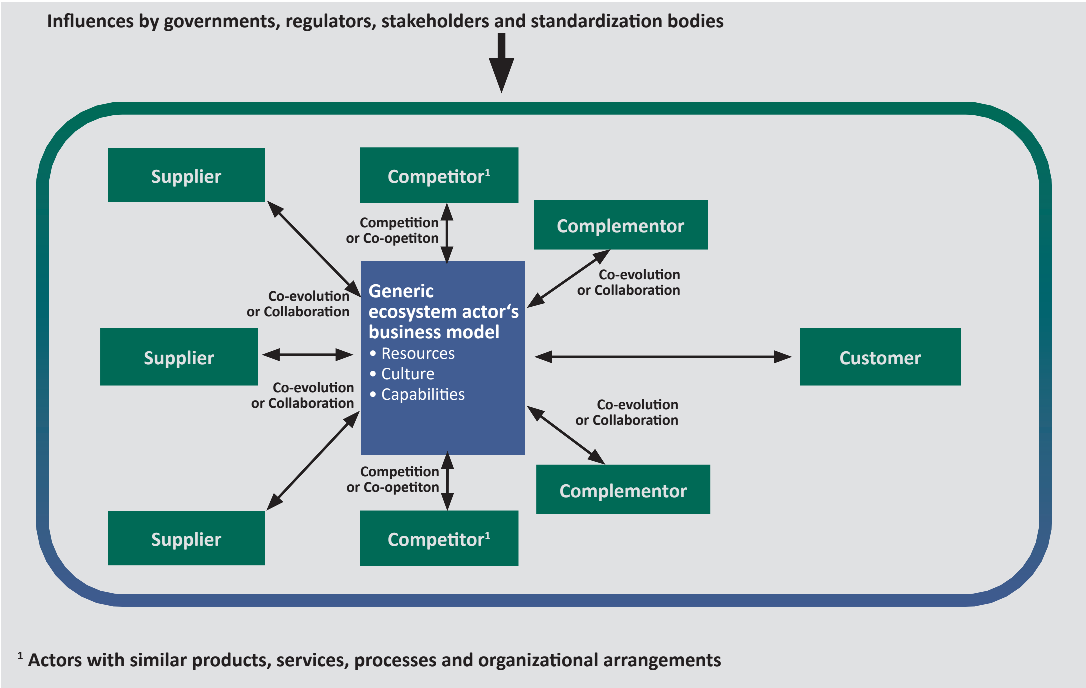



**Figure 41:** Overview of the identified factors for changing business models in the context of ecosystems. Personal illustration based on insights from literature (Moore, 1996; Adner and Kapoor, 2010; Jacobides et al., 2018; Talmar et al., 2018). The basic framework was extended based on the findings regarding strategic aspects for changing business models in ecosystems.

evolutionary processes between companies and their environments (Su et al., 2020) which could benefit from integration into their surrounding networks (Matthyssens et al., 2006). Co-evolution of business models with their environments could provide several benefits, such as establishing alignment between individual ecosystem actors (Chesbrough and Schwartz, 2007) or increasing the overall outcome of involved actors (Prince et al., 2014; Ogilvie, 2015; Nailer and Buttriss, 2020). However, changes in business models that spanned an individual actors' boundaries required flexibility (Spieth and Meissner, 2018), a good understanding of the involved actors' expectations (Nardelli and Rajala, 2018), as well as communication to ensure that the resulting business models were beneficial for involved actors and scalable (Rong et al., 2018).

## 5.5 Summary

After performing the literature review, the results are summarized in this chapter, ultimately placing them into the context of the established ecosystem conceptualizations presented in Figure 30 at the beginning of the chapter. The review revealed mutual influences between business models and

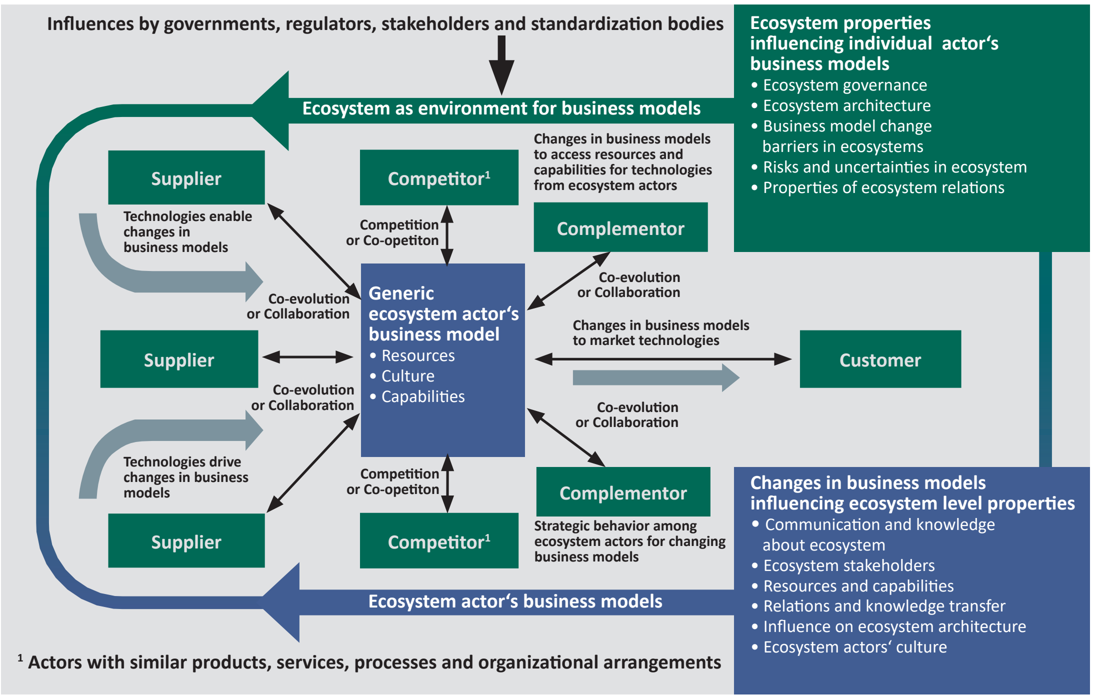



**Figure 42:** Overview of the identified factors for changing business models in the context of ecosystems. Personal illustration based on insights from literature (Moore, 1996; Adner and Kapoor, 2010; Jacobides et al., 2018; Talmar et al., 2018). The basic framework was extended based on the results from the literature review.

their respective environments (see Figure 42). On the one hand, ecosystem properties such as governance, ecosystem architecture, barriers for changing business models, as well as risks and properties of ecosystem relations were identified to influence actors' business models. On the other hand, changes in business models could influence ecosystem properties. Relevant factors identified were the actor's ability to communicate and gain knowledge about their surrounding ecosystems and the stakeholders they needed to address when changing the business model. Influenced by their culture, companies making changes to their business models were reportedly able to influence an ecosystem's architecture. One particularly relevant aspect for changing business models was the resources and capabilities a focal company had at its disposal, as well as its ability to access resources and capabilities from other ecosystem actors. A crucial finding was that relations with ecosystem actors allowed for the transfer of knowledge. This applied in particular to capabilities and resources relevant for new technologies. Moreover, technologies were stated to play a major role in the interplay between ecosystems and business models, as they could act as both drivers or enablers of business models. In turn, changes in business models could be necessary to bring technologies to the market. Another factor that could affect both business models and ecosystems was the individual actor's stance towards co-evolution, co-opetition, competition, and collaboration. Consequently, the actors' strategic behavior could influence how they approached other ecosystem actors, potentially influencing their business model change activities. The resulting conceptual framework outlined in Figure 42 thereby graphically summarizes the individual results, as well as their presumed relationships (Miles and Huberman, 1994, p. 18). In line with Miles and Huberman (1994, p. 18) the framework *"[...] specifies who and what will and will not be studied."* Thus the obtained framework acts as an *"a priori"* construct (Eisenhardt, 1989) for the subsequent empirical investigations conducted in this thesis work. Therefore, the literature review acted as an embedded study that guided subsequent research (Onwuegbuzie and Frels, 2016, p. 49).

# Part III

# Empirical Research

# 6 Overview of the ecosystem for electric and electrified vehicles

Developments with regard to new automotive technologies and their respective ecosystems have gained substantial attention in the last years. For instance, Knupfer et al. (2017, p. 8) argued that the potential of e-mobility to disrupt the automotive industry stems from four self-reinforcing megatrends: (1) autonomous, (2) shared, (3) connected, and (4) electrified. Electrifying vehicles could reduce emissions related to transport and the vehicles' overall environmental impact (Figenbaum et al., 2015, p. 29). In particular, the electric vehicles' specific characteristics, such as their low local emissions and their energy efficiency, made them an attractive alternative to conventional vehicles (Figenbaum et al., 2015, p. 29). Thus, based on the pace of implementation and the development of involved technologies, electric mobility might have a substantial impact in the near future (Abdelkafi et al., 2013, p. 1340003-2).

The chapter is structured as follows: First, in Section 6.1 the understanding of xEVs in this thesis is described in detail. Second, Section 6.2 gives an overview of the xEV ecosystem. Based on this overview, in Section 6.3, changes in propulsion technologies, as well as the respective ecosystem structures and business models, are described.

## 6.1 Understanding of electric and electrified vehicles in this thesis

Despite the increasing relevance of the topic, a common understanding of what constitutes electric mobility is yet to emerge (Abdelkafi et al., 2013, p. 1340003-4). A possible reason for this was mentioned by Abdelkafi et al. (2013, p. 1340003-4) who stated that electric mobility *"[...] involves a number of different technologies that enable the distribution and storage of electricity, in addition to energy generation and communication management."* One approach taken to characterize electric mobility was provided by Helbig et al. (2017, p. 45) who used the term to summarize multiple alternative powertrain technologies, such as BEVs, hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV), range extenders (REX), as well as fuel cell electric vehicles (FCEVs) under one umbrella. In that regard, Hardman et al. (2013, p. 15449) argued that vehicles powered by fuel cells and pure battery-electric vehicles were *"[...] both variations of EVs, sharing many parts."* Nonetheless, both types of vehicles represent competing technologies with a high potential for disruption (Hardman et al., 2013, p. 15449), subsequently making them attractive objects for further investigation. Adopting the understanding used by Helbig et al. (2017, p. 45), in this thesis, the term xEVs will be used to address both purely electric vehicles (e.g., BEVs) as well as electrified vehicles (e.g., PHEVs, FCEVs).

## 6.2 The ecosystem for electric and electrified vehicles

### 6.2.1 Influences on the ecosystem for electric and electrified vehicles

Recent studies on the topic showed the potential impact of xEVs. However, a clear path forward is not yet clear. For instance, Knupfer et al. (2017, p. 8) ascertained that while *"[...] e-mobility is likely to be highly disruptive, significant uncertainty exists about the timing of EV adoption and how quickly, or not, that will ramp up."* This might be the case, as xEVs are subject to a multitude of factors. These factors influence how attractive it is for actors to enter the xEV ecosystem as well as how they choose a concrete form of the business model to engage in ecosystem activities. As summarized in Table 24, recent studies described the influences towards - and effects of - xEVs (see, for example, Knupfer et al. (2017); Helbig et al. (2017); Mosquet et al. (2020)).

**Table 24:** Overview of influencing factors on xEVs (Knupfer et al., 2017; Mosquet et al., 2020)

| Influence | Description of influence |
|---|---|
| **Batteries and Range** | • Increasing vehicle ranges: Larger installed battery packs help to overcome the customers' range anxiety (Knupfer et al., 2017, pp. 11-12).<br>• Battery improvements: Improvements in batteries lead to declining battery prices and higher driving ranges - subsequently making xEVs more attractive to customers. (Mosquet et al., 2020, p. 3)<br>• Battery costs: Decreasing prices of battery packs potentially enable price parity between electric and conventional vehicles for selected applications in the next years (Knupfer et al., 2017, pp. 11-12). However, while battery costs are beginning to decline, they still represent a barrier for achieving profitability (Knupfer et al., 2017, p. 13). |
| **Infrastructure** | • Improvements in the scale of charging infrastructure due to collaborations among multiple OEMs as well as governmental influences (Knupfer et al., 2017, pp. 11-12). |
| **Megatrends** | • Increased urbanization and subsequent changes in vehicle usage as well as concerns regarding air quality (Knupfer et al., 2017, pp. 11-12). |

Table 24 continues on next page

Table 24 continued from previous page

| Influence | Description of influence |
|---|---|
| **Governments** | • Governmental regulatory emission targets: OEMs likely face a trade-off decision between complying with emission standards by offering more green vehicles or absorbing fees for not complying with set regulatory standards (Knupfer et al., 2017, pp. 11-12). Tighter regulations regarding local vehicle emissions consequently push OEMs to increase their xEV production in order to meet their emission goals (Mosquet et al., 2020, p. 3).<br>• Government incentives: Incentives for xEVs provided by governments result in lower total costs of ownership for consumers (Mosquet et al., 2020, p. 3). |
| **Competing technologies** | • Currently, improvements and extensions of conventional ICE technology (e.g., mild hybrids) are still - at least in part - well suited to comply with current regulatory regimes. However, adhering to established technologies is likely to result in a sizeable gap with regard to future regulatory targets. (Knupfer et al., 2017, p. 13) |
| **Capital requirements** | • Several simultaneous technological shifts in the automotive industry (e.g., connectivity, autonomous driving, shared mobility) puts automotive companies under financial strain. In addition, vehicles relying on ICE technology currently present a higher potential for short-term revenues as compared to pure EVs (Knupfer et al., 2017, p. 13). |
| **Incongruent supply/demand** | • Automotive companies face a mismatch between supply and demand. This particularly is reflected in a lack of EV models addressing price sensitive markets. (Knupfer et al., 2017, p. 13) |

Table 24 shows that relevant drivers for xEVs included (1) the development of batteries to lower the costs of vehicles and (2) the accelerating effect of regulations (Helbig et al., 2017, p. 45) as well as (3) faster than anticipated improvements in key technologies (e.g., affected batteries, vehicle ranges and infrastructure), all of which were a driving force for xEVs (Knupfer et al., 2017, pp. 11-12). Similarly, Wu et al. (2019, pp. 3, 5) expected that xEV deployment would begin to accelerate, driven by policy and regulations, as well as increasing customer demand. This demand, in turn, was influenced by factors such as the driving range, costs, or availability of infrastructure, which, in part, depended on the ongoing investments of automotive original equipment manufacturers (OEMs) in xEV-technologies (Wu et al., 2019). Consequently, dominant factors in favor of xEVs were governmental influences and policies that pushed the diffusion of emergent technologies required for xEVs (Priessner et al., 2018, p. 701). Regulations that took effect in 2020 put OEMs at risk of substantial fines for not meeting emission-lowering targets (Mosquet et al., 2020, p. 6). This led established automotive OEMs to recognize xEVs as an essential element with regard to complying with targets for emissions and fuel economy while conventional vehicles were expected to remain an integral part of most OEMs' strategies Knupfer et al. (2017, p. 6). As a result, OEMs needed to balance xEV-sales to meet regulatory requirements with costs for xEVs (e.g., battery packs) and profits from conventional vehicles (Knupfer et al., 2017, p. 6).

However, as summarized in Table 24, actors that tried to introduce xEVs also faced several challenges. These challenges included (1) demonstrating further reductions in battery costs,

(2) the availability of multiple technologies, (3) intense capital requirements as well as (4) a supply/demand mismatch for new automotive technologies that required new solutions as well as more agile approaches from OEMs (Knupfer et al., 2017, p. 13). Another factor was the long delivery times for xEVs, which were due to the supply chain, which was stated to still be in a state of flux (see Figure 47 in Section 6.3.2) (Kässer et al., 2019, p. 32). Moreover, as pointed out by Jiao and Evans (2016, p. 348), the economic viability of xEVs largely faced a "hen and egg" type of problem, as *"[...] battery manufactures await EVs to achieve a critical mass adoption by customers while the uptake of EVs requires cost reduction in batteries."* Overall, it can be concluded that OEMs needed to bring more xEVs to the market to meet both regulatory requirements as well as customer demands (Kässer et al., 2019, p. 30). Consequently, regulations were also expected to lead regions such as Europe away from powertrains dominantly relying on internal combustion engines (ICE) towards a more balanced mix of vehicle electrification (Mosquet et al., 2020, p. 6).

### 6.2.2 Expected market development of electric and electrified vehicles

Despite the described concerns and barriers, the xEV segment began to grow, resulting in an annual global growth in light EV sales in the years 2014 to 2018 close to 60% (Hertzke et al., 2019, p. 86). Driven by customer demand and regulatory targets, established OEMs began to ramp up production and launched a wide variety of xEVs into the market (compare Wu et al. (2019, p. 12) and Hertzke et al. (2019, p. 70)). Ultimately, with more than 20% of all customers considering an electric vehicle, 1.3 million sold in 2017, and a forecast of 3 million sold in 2020, electric vehicles are gaining traction (Hertzke et al., 2019, p. 70). However, sales growth has still not been on par with industry expectations (Priessner et al., 2018, p. 701), and the overall penetration rate of xEVs remains low (see Figure 43). Recent developments as well as forecasts of vehicle sales and market shares are illustrated in Figure 44 and Figure 45. Until the year 2030, Wu et al. (2019, p. 4) predicted a market share of purely electric vehicles of around 20%, while Mosquet et al. (2020, p. 4) estimated that the market share of all xEVs would be as high as 50%. While both Wu et al. (2019, p. 4) and Mosquet et al. (2020, p. 4) forecast an increase of xEV market share up until 2030, sales of conventional vehicles were expected to decline. Figure 45 illustrates the fact that regulations will initially be the primary sales driver. However, after a first regulatory push, the total cost of ownership (TCO) and customer preferences will likely determine the sales of xEVs. Specifically, depending on vehicle type and specific regions, Mosquet et al. (2020, p. 5) expected a tipping point of the BEVs' five-year TCO around 2022 to 2023. Wu et al. (2019, p. 2) also recently presumed that the market for BEVs would reach its tipping point in 2022, with the cost of ownership of xEV expectedly being on the same level as conventional combustion-engine-powered vehicles (Wu et al., 2019, p. 2).

Ultimately, the adoption curve of xEVs is arguably determined by their overall attractiveness to specific markets and, in turn, depends on (1) vehicles TCOs (including vehicle-costs), (2) driven distances as well as (3) fuel costs (gasoline and electricity) (Mosquet et al., 2020, p. 5). Further influences on the attractiveness of xEVs could be their higher perceived enjoyment and objective usability (Müller, 2019, p. 11). In addition, psychological as well as socio-demographic aspects

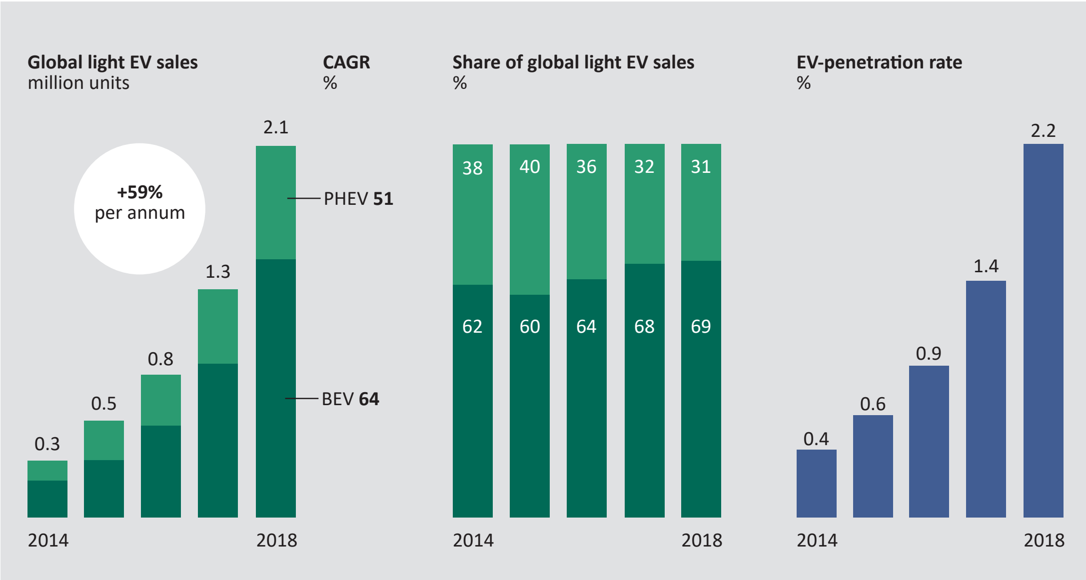



**Figure 43:** Overview of the development of the EV market by Hertzke et al. (2019, p. 86). Data show a substantial growth in the EVs compound annual growth rate (CAGR) of almost 60 % and - although on a low absolute level - an overall increasing penetration rate of EVs.

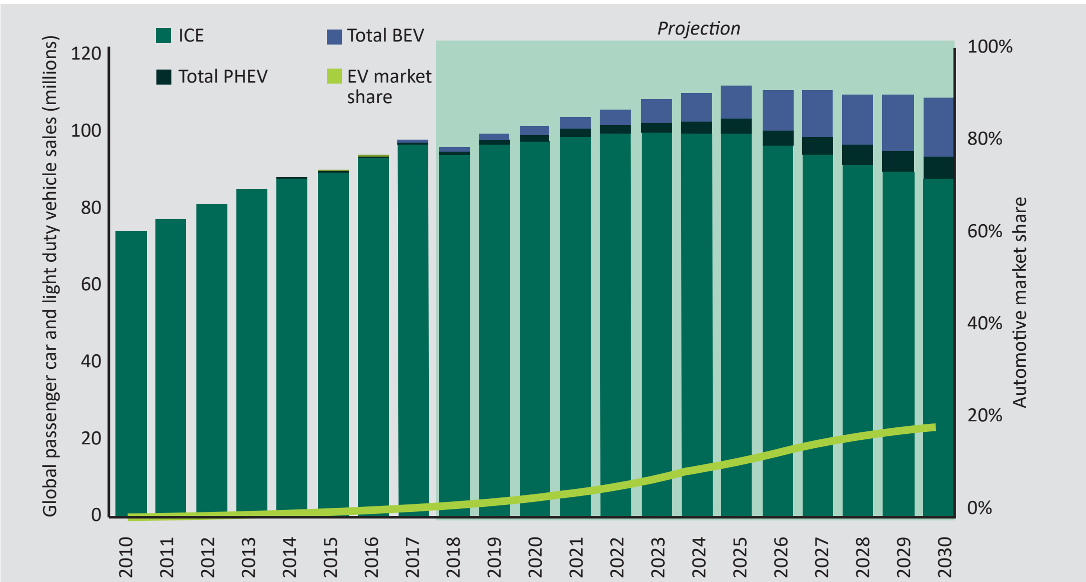



**Figure 44:** Predicted number of global passenger and light duty vehicle sales (Wu et al., 2019, p. 4)

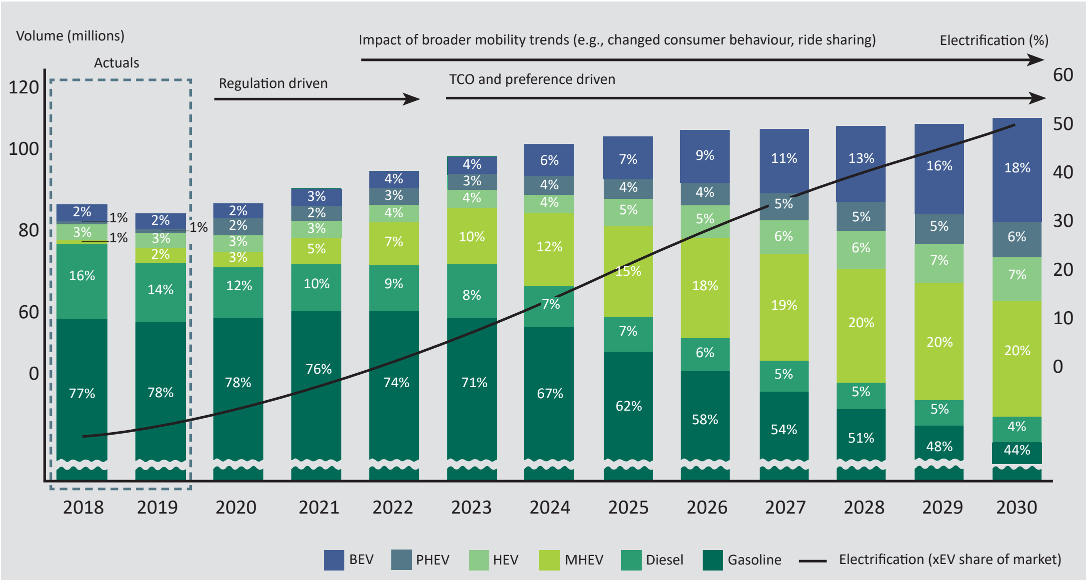



**Figure 45:** Forecast for global vehicle sales (Mosquet et al., 2020, p. 4)

were reported to influence the adoption of xEVs (e.g., pro-environmental or pro-technological attitudes) (Priessner et al., 2018, p. 701).

## 6.3 Changes in technologies, ecosystems and business models for electric and electrified vehicles

This section provides an overview of technologies in the xEV ecosystem, the impact of technologies on the structure of the established automotive ecosystem, and actors' business models.

### 6.3.1 Multiple propulsion technologies in the ecosystem

The xEV ecosystem finds itself in competition with the ecosystem centered around conventional vehicles (Abdelkafi et al., 2013, p. 1340003-5). Specifically, Abdelkafi et al. (2013, p. 1340003-5) recognized the circumstance that *"[...] electric cars are competing against conventional cars and have to fulfill the expectations of users, who are accustomed with the qualities of the old technology and may not easily settle for a new technology with a lower performance."*

Moreover, xEVs comprise a large number of subsystems that - taken individually - are in different areas of the technology cycle (Abdelkafi et al., 2013, p. 1340003-6). One example of this are electric motors, which have been used in various applications for over a century. Consequently, multiple technologies potentially relevant for use in xEVs exist, and a dominant technology is yet to emerge. (Abdelkafi et al., 2013, pp. 1340003-6-1340003-7) For instance, Hardman et al. (2013) pointed out that fuel cell powered and purely battery powered vehicles - although related in used technologies and components - were competing for similar markets and could be disruptive with regards to the mass market served by conventional vehicles as well as to one another.

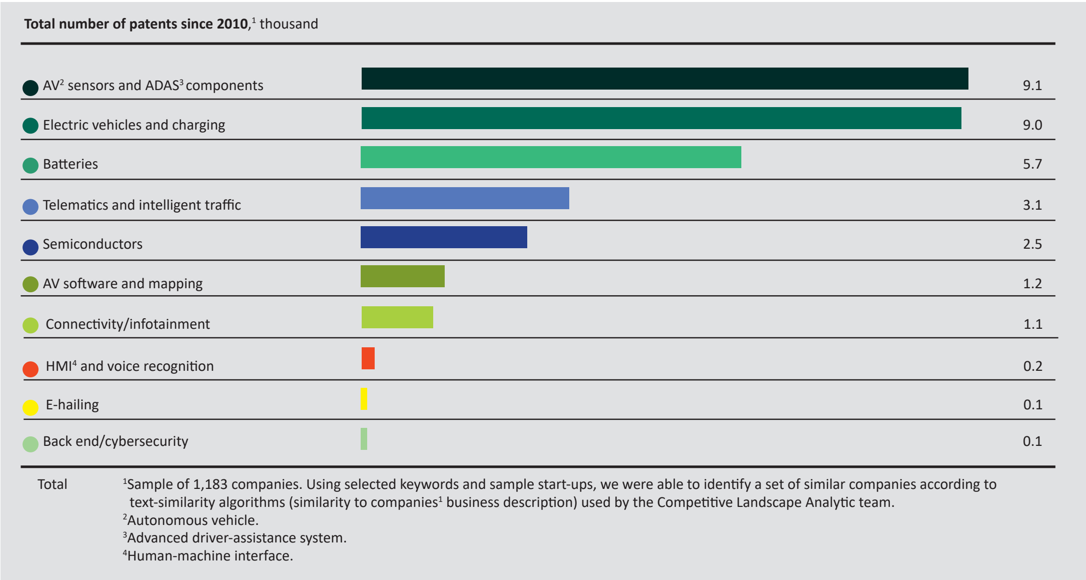



**Figure 46:** Development efforts in the automotive sector indicated by number of patents (Holland-Letz et al., 2019, p. 21).

Major factors in that regard were the distinct types of infrastructure for each technology, the potential to use them in different ways, and the high likelihood that they would be manufactured from different companies (Hardman et al., 2013, p. 15449). To shed light on technological developments, Holland-Letz et al. (2019, p. 21) investigated the number and type of relevant patents in the automotive sector from 2010 to 2019. As shown in Figure 46, development efforts in the period from 2010-2019 were largely focused on technologies for electrification of vehicles as well as autonomous driving. Combined, technologies for xEVs (charging and batteries) take a leading position.

### 6.3.2 Changing ecosystem structures for electric and electrified vehicles

By committing to xEVs, established OEMs face new competitors from *"regionally advantaged OEMs"*, new entrants (e.g., start-ups), as well as non-automotive players (Wu et al., 2019, p. 12). For instance, Wu et al. (2019, p. 2) predicted that, around 2030, a part of today's incumbent OEMs would be out of business while the surviving OEMs might face significant changes to their existing business models.

In that regard, electric mobility brings about opportunities for upcoming technologies that are either completely new or have been adapted from other sectors and, therefore, are new to the automotive industry (Abdelkafi et al., 2013, p. 1340003-6). For instance, considering that batteries are expected to represent between 25% and 40% of a BEV's value, OEMs face the decision to either buy batteries or to build their own capacities for battery production to control larger parts of value creation (Helbig et al., 2017, p. 46). Moreover, cooperations formed to share financial burdens in core areas with large investments will become a dominant success factor (Kässer et al., 2019, p. 34). Interestingly, Kässer et al. (2019, p. 33) proposed that, as traditional value chains between suppliers and OEMs begin to dissolve and new entrants, governments, and regulations increase in relevance, these cooperations will lead to a handful of global ecosystems centered around a small number of leading actors. In that regard, Hertzke et al. (2019, p. 70) underlined that because governments are reducing their subsidies towards xEVs, sustaining a growth path of electrification is likely to require massive amounts of manufacturing gains. This is particularly interesting since, as highlighted by Abdelkafi et al. (2013, p. 1340003-4), electric mobility depended on a multitude of actors *"[...] such as car manufacturers, energy providers, and communication companies."* Traditionally, manufacturers have represented a large part of the value chain. However, xEVs are believed to require the involvement of additional actors (e.g., for electric machines or batteries), leading to increased outsourcing activities and a subsequent loss of control as well as learning abilities (Abdelkafi et al., 2013, p. 1340003-5). Moreover, as automotive OEMs continue to outsource value creation, they find themselves needing to reconsider what constitutes their core competencies - in particular as the current core competencies (e.g., engine technology) might decline in relevance (Abdelkafi et al., 2013, pp. 1340003-23-1340003-24). Simultaneously, these developments could also open up opportunities for new competitors (Abdelkafi et al., 2013, p. 1340003-5). Mosquet et al. (2020, p. 13) predicted that electrification in the automotive sector is likely to reshape value chains in the next years (see also Figure 47). As a consequence, the increasingly rapid growth of the xEV segment will likely have a substantial impact on major actors in the ecosystem, such as OEMs, suppliers, and governments (on the national, regional as well as local levels) (Mosquet et al., 2020, p. 12). According to Hertzke et al. (2019, p. 86) the global xEV industry expands at a fast pace as xEV volumes start to offer substantial profit opportunities for well-positioned suppliers and other upstream players while reducing the profit margins of traditional OEMs. In addition, new incumbents and suppliers entering the market together with OEMs that followed different sourcing strategies for components of their electrified drivetrains led to a recalibration of the value chain for powertrains (Hertzke et al., 2019, p. 86). As illustrated in Figure 47, as new players entered into the downstream regions of the ecosystem, established automotive Tier 2 and Tier 1 actors tended to move towards central positions that had typically been occupied by established OEMs. These actors, for instance, evolved towards Tier 0.5 suppliers (e.g., by providing complete vehicle systems and chassis) while simultaneously integrating backwards (e.g., by entering new areas of competences, such as batteries or electronics). Established automotive OEMs faced new competitors with regard to xEVs, and reacted by performing backward integration activities (e.g., for xEV components) (Kässer et al., 2019, p. 33). In the past, automotive OEMs shifted from performing value-adding operations largely in-house towards relying on suppliers and managing complex networks (Abdelkafi et al., 2013, p. 1340003-23). As xEVs became more widely accepted, Abdelkafi et al. (2013, p. 1340003-23) predicted that this trend would likely continue leading automotive OEMs to *"[...] give up even more of their internal value chain in favor of their supply chain network."* However, while understanding the introduction of xEVs as a product seems to be

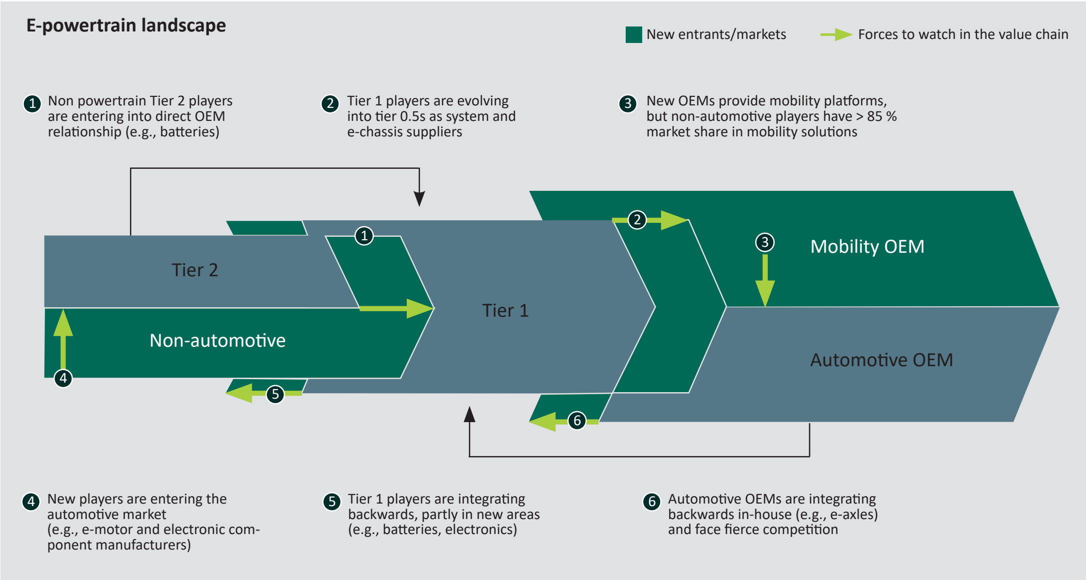



**Figure 47:** Changes in the value chain for e-powertrains according to Kässer et al. (2019, p. 33).

a key aspect, it does not provide a complete picture of the creation of value centered around xEVs. For instance, Walrave et al. (2018, p. 104) argued that while automotive OEMs could integrate the entire vertical value chain for electric vehicles, from the perspective of the end-user *"[...] no matter how advanced the car is, a sustainable mobility experience [...] is only achieved when the users can also conveniently charge it, for instance, via the infrastructure provided by local grid companies."* As a consequence, grid companies are considered to be critical actors for creating an attractive ecosystem value proposition for end users, despite the fact that they have no direct relationship with the value chain required to manufacture vehicles.

### 6.3.3 Business models for electric and electrified vehicles

As noted before, the sales of xEVs are expected to grow substantially, which will likely be a driving force towards business model innovation. In particular, Knupfer et al. (2017, p. 21) noted that *[...] to serve this larger set of potential EV buyers while maintaining profitability, automakers will need to experiment with and deploy new business models."* In that regard, Abdelkafi et al. (2013, p. 1340003-9) recognized that developing innovative business models could be a critical factor for the success of technologies in early stages in their life cycle. The development of adequate business models could particularly help to generate profits from new technologies (Abdelkafi et al., 2013, p. 1340003-31). Specifically, looking at electric mobility, Abdelkafi et al. (2013, p. 1340003-20) distinguished between business models that focused directly on electric vehicles and business models that provide services in the area of electric vehicles. Abdelkafi et al. (2013, p. 1340003-33) further stated that electric mobility would challenge automotive OEMs as well as the whole value network. Concretely, Abdelkafi et al. (2013, p. 1340003-33) suggested:

> *"The new technology will lead to established actors leaving the industry and new players coming into the business. The suppliers of the conventional engine parts may go out of the industry, while opening the way for the suppliers of the electric machine and battery to do more businesses. Consequently, to stay in the industry, traditional suppliers need to adapt their business models radically; in particular they should come up with totally different value propositions."*

Consequently, key actors are likely to change their roles and business models, while new roles, such as network operators or asset managers, might gain relevance with the uptake of xEVs (Monios and Bergqvist, 2020, p. 7). As pointed out by Knupfer et al. (2017, p. 21), in contrast to traditional purchase prices or lease rates, the financial cornerstone of business models centered around xEVs will be the total costs of ownership. In that regard, the aspect that certain patterns of business models - such as a low-touch approach[1] - are linked to the life cycle, and therefore the costs of a technology (Abdelkafi et al., 2013, p. 1340003-20) need to be taken into consideration. This implied that automotive OEMs could shift away from bringing xEVs to the market as a product and focus more on offering electric mobility as a package or a service (Knupfer et al., 2017, p. 21). In addition, a novel business model approach could likely provide a better fit with specific xEV characteristics (Knupfer et al., 2017, p. 21).

Along that line, Mosquet et al. (2020, p. 12) predicted that OEMs and suppliers would need to reinvent their business models, invest in new technologies, and shift their capabilities. Interestingly, Mosquet et al. indicated that the need to adapt is not limited to established actors from the automotive sector. Instead, it will also impact electric utilities, which face additional strain on their infrastructure as the demand for battery charging increases (Mosquet et al., 2020, p. 13). Abdelkafi et al. (2013, p. 1340003-6) stated that an effective, sustainable and profitable use of energy in electric vehicles could be achieved through their integration in energy supply systems, such as smart grids. This is crucial, as breakthrough innovations require complementary innovations to create value for customers (Adner, 2006, p. 98). Concurrently, the most dominant infrastructure-solutions for xEV charging are (1) home charging with approximately two-thirds of charging, (2) public charging, and (3) highway fast charging, which is necessary to promote xEV adoption (Mosquet et al., 2020, p. 13).

Moreover, Helbig et al. (2017) proposed that, by 2025, two additional business models could potentially be relevant for future automotive OEMs: (1) acting as producer of *"white label"* components and vehicles[2] as well as (2) providers of mobility services relying on the usage of data. Interestingly, Bohnsack et al. (2014, p. 298) identified a tendency, whereby incumbent OEMs stayed rather close to the established business models they used to target their existing customers. A possible reason for this behavior was the established OEMs' ability to leverage their substantial revenue streams, existing complementary assets, and value networks (with the exception of specific components, such as batteries) (Bohnsack et al., 2014, p. 298). In particular, Bohnsack et al. highlighted the fact that the established OEMs' existing dealer network could play a central role in

[1] The low-touch approach was described as offering cheap versions of high-end products or services (Abdelkafi et al., 2013, p. 1340003-20).

[2] Helbig et al. (2017, p. 22) described *"white label"* products as *"[...] unbranded products that are marketed by other players."*

delivering novel value propositions centered around xEVs. Along these lines, Knupfer et al. (2017, p. 21) underlined the relevance of new business models to introduce xEVs to a larger customer base while ensuring profitability.

## 6.4 Summary

Looking at recent developments in the automotive industry, several technological, political, and societal developments put established companies under a substantial amount of pressure (Knupfer et al., 2017; Mosquet et al., 2020). While xEV uptake is currently at a low level, forecasts indicate a massive uptake of xEVs and their respective ecosystem in the future (Wu et al., 2019; Hertzke et al., 2019; Mosquet et al., 2020). Thereby, the ecosystem is confronted with multiple potential technologies (Holland-Letz et al., 2019) in varying stages of their life cycles (Abdelkafi et al., 2013). Consequently, the number and types of involved actors, as well as the overall architecture of the xEV ecosystem, are likely to undergo substantial changes (Wu et al., 2019; Kässer et al., 2019). In turn, actors in the xEV ecosystem will probably need to adapt their business models (Abdelkafi et al., 2013; Helbig et al., 2017; Mosquet et al., 2020). Summarizing the aspects laid out above, the xEV ecosystem may experience a radically different ecosystem composition and involved actors' business models as compared to the established automotive ecosystem.

In the following chapter, the empirical study and the obtained insights from multiple ecosystem actors are laid out. These insights serve as a basis to understand which factors play roles in the xEV ecosystem and provide a starting point for investigations on why actors (1) participate in the ecosystem, (2) how they interact to create value, (3) how they adjust their business model, and (4) how they align their business models to be able to add value towards the xEV ecosystems' value propositions.

# 7 Empirical research strategy

As shown in the literature review in Chapter 5, few studies have explicitly addressed business models in the context of ecosystems. Due to the lack of research combining both concepts and in line with the research approach and philosophy described in Chapter 1, a qualitative research approach was taken to explore the topic further. Qualitative research refers to investigations in which findings are derived by means other than statistics or quantification (Strauss and Corbin, 1998, pp. 10-11). A major advantage of qualitative research is that it offers the potential to collect more in-depth data as compared to quantitative research (Ang, 2014, pp. 205-206). Moreover, qualitative research designs are well-suited to exploring areas where research is lacking as well as to study phenomena using a *"holistic and comprehensive"* approach (Corbin and Strauss, 2015, p. 5). In this research, xEVs were taken as an example to explore the role of business models in the context of ecosystems centered technological innovations. Guided by the literature and the research questions, the configuration of the methodological tools used was carefully selected to fit the research objectives. Subsequently, multiple actors in the innovation ecosystem for xEVs were studied to answer the following research questions (see Chapter 1):

**Research Question 2:**
What influences do ecosystem actors perceive that encourage them to participate in an ecosystem centered around novel technologies?

**Research Question 3:**
How do ecosystem actors interact to create value in an ecosystem centered around novel technologies?

**Research Question 4:**
How can actors participating in an ecosystem centered around novel technologies align their individual business models to contribute to a joint ecosystem value proposition?

**Sub-Question 1:**
How does participating in an ecosystem centered around novel technologies influence the individual actors' business models?

**Sub-Question 2:**
How do individual ecosystem actors change their business models when participating in an ecosystem centered around a novel technology?

As proposed by Gehman et al. (2017, p. 14), the research approach was customized to fit the given research context. Thereby, the applied approach took dependencies of single elements of the research process into consideration (Flick, 2017, p. 123). Figure 48 illustrates the empirical research conducted in the course of this thesis work. The process can be divided into three distinct phases: (1) preparation, (2) exploration, as well as (3) saturation and maturation.

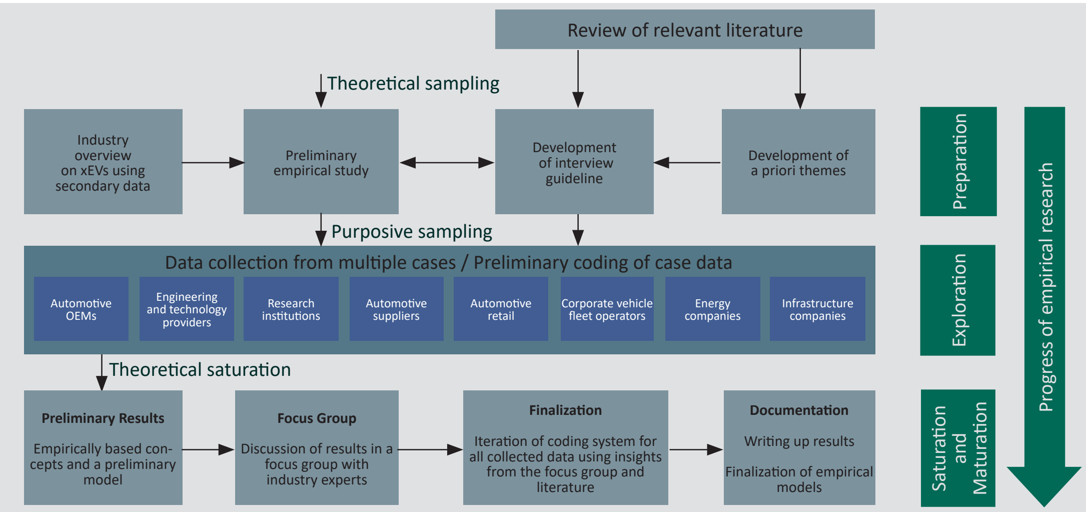



**Figure 48:** Applied empirical research process (personal illustration)

First, in the preparation phase, (1) *"a priori"* themes were derived from literature, (2) an preliminary empirical study was conducted, and (3) an overview of the industry was gained using secondary data. This served to sharpen the focus for the main study. Second, in the main study, different types of ecosystem actors were investigated by performing 46 semi-structured expert interviews in a total of 27 embedded case studies. Third, in the saturation and maturation phase, the obtained results were used to derive preliminary concepts. These concepts were used as input for a focus group held with experts in the automotive industry that helped to refine and finalize the obtained insights. The remaining chapter is structured based on the elements shown in Figure 48 and provides detailed information about the conducted research process.

## 7.1 Preparation phase

In the preparation phase, based on secondary data, a basic overview of the xEV topic was established (see Chapter 6). A preliminary study relying on semi-structured interviews with informants from the automotive sector was also conducted. In the preliminary study, theoretical sampling[1] as described by (Strauss and Corbin, 1998, p. 73) was applied to identify relevant actors in the innovation ecosystem for xEVs. Theoretical sampling was chosen since it is well-suited for studying unexplored issues from multiple angles (Corbin and Strauss, 2015, p. 137). An overview of the informants from the preliminary study can be found in Appendix A.1. A total of eight interviews were conducted in six different companies from the automotive sector. The interviews were conducted from 2015 till 2017 as part of thesis work for two master's theses[2]. These interviews were carried out to improve the understanding of the relation between the investigated companies' technologies and their business models in the context of an ecosystem centered around a specific technological innovation. Based on suggestions by Flick and von Kardorf (2005, p. 106) and Yin (2009, p. 61), the information obtained through the preliminary study was used to refine the subsequent research, providing valuable insights on the topic:

- Informants cited actors providing complementary solutions (e.g., charging of xEVs) as bottlenecks in the innovation ecosystem for xEVs (see Adner and Kapoor (2010)).

- Actors participating in the xEV ecosystem reported that shifting power relations and changing business partners were necessary to demonstrate value based on xEVs. These changes impacted actors both upstream and downstream of OEMs.

Insights from the preliminary study consequently helped to sharpen the focus of the main investigation. Specifically, the research focus was extended to include both upstream suppliers and downstream companies that provided complementary offers in the xEV ecosystem. Moreover, the obtained insights were used to refine the interview guideline for the main study.

## 7.2 Exploration phase

In the exploration phase, a multiple case study design was adopted that integrated elements of the approaches proposed by Eisenhardt (1989), Yin (2009), and Gioia et al. (2012) (see Figure 48). The chosen approach was deemed suitable as, according to Eisenhardt and Graebner (2007, p. 27), multiple case designs *"[...] create more robust theory because the propositions are more deeply grounded in varied empirical evidence."* Using multiple case designs also allows for a more appropriate level of construct abstraction, thus leading to more accurately delineated relationships

[1] Strauss and Corbin (1998, p. 73) describe theoretical sampling as an approach based on *"[...] emerging concepts, with the aim being to explore the dimensional range or varied conditions along which the properties of concepts vary [...]"*.

[2] One master's thesis was written by the author of this dissertation. A second follow-up master's thesis was supervised by the author of this dissertation. All collected data were re-evaluated for this dissertation.

and more precise definitions (Eisenhardt and Graebner, 2007, p. 27). Multiple case designs also represent a fruitful approach for this topic since they are well-suited for investigations on topics that are still in their early stages (Eisenhardt, 1989, p. 548). In the following sections, the selection of cases and collection of respective data are described in detail.

### 7.2.1 Data collection strategy

In accordance with Eisenhardt (1989) and Yin (2009), data from multiple case studies were collected and analyzed (see Table 25). Based on a thorough review of relevant literature (see Chapter 5), a framework of influencing factors on business model change in the context of ecosystems was established. This framework subsequently served as an *"a priori"* construct for the main study of this thesis and was instrumental in shaping the design of the study (Eisenhardt, 1989, p. 536). Following the suggestion of Miles and Huberman (1994), *"a priori"* constructs allow to formulate a provisional list of codes before conducting field research (see Chapter 5). The use of provisional codes is well-suited to case study research, as it allows the development of theoretical propositions that subsequently guide the collection as well as analysis of data (Yin, 2009, p. 18). This could improve the empirical grounding of emergent theory (Eisenhardt, 1989, p. 536). Following the suggestion of Yin (2009, p. 106), this thesis work relied largely on data from interviews, as they are *"[...] essential sources of case study information."* In the following section, the development of the interview guidelines, the role of respondents for this study, and the pursued interview strategy are described.

#### a) Interview guideline

The *"a priori"* construct developed through a systematic review of literature (see Chapter 5) was used as a guideline to formulate questions for the main study described in this thesis. This allowed for a more concrete investigation of this topic (Eisenhardt, 1989, p. 536). In addition, as recommended by Corbin and Strauss (2015, p. 34), findings[1] from the preliminary study conducted by the author as well as one of the author's master students were taken into consideration while creating the interview guideline. Overall, the interview guideline's form and structure oriented on several previous theses conducted at the "Institute of General Management and Organisation" at Graz University of Technology (Fellner, 2010; Müller, 2014; Wipfler, 2018). Interviews were conceptualized as semi-structured expert interviews and relied on open questions on the topic. Thereby, respondents were questioned using, *"how"* and *"why"* questions, as these provided a flexibility that is unmatched by more structured forms of investigation (Ang, 2014, pp. 205-206). Before using the questionnaire in the field, an extensive round of feedback was collected from several fellow researchers, the thesis supervisor, and researchers from other research institutions and taken into consideration to refine the interview guideline. As suggested by Eisenhardt (1989,

[1] Findings from the preliminary study helped to sharpen the focus of questions on business models and their respective environments. The findings were also used to improve the overall structure of the interview guideline.

p. 539) and Corbin and Strauss (2015, p. 137), the interview guideline was further improved during the process of collecting and analyzing data using insights from the field. Interview questions were refined, and further questions were added as new concepts or themes emerged during the field study (Eisenhardt, 1989, p. 539). Following the suggestion of Eisenhardt (1989, p. 539), these changes were considered as legitimate in the context of theory-building research, since the author of this thesis was *"[...] trying to understand each case individually and in as much depth as is feasible."* In a similar vein, Gioia et al. (2012, p. 19) argued that in interpretative research to uncover and develop new concepts *"[...] interview questions must change with the progression of the research."* The final version of the interview guideline can be found in Appendix A.1.

### b) Investigators and interview approach

Using interviews in case studies requires researchers to operate on two levels simultaneously, as they need to (1) question the interview partners to collect relevant research data while (2) avoiding agitating the interview partner in such a way as to prevent further questions (Yin, 2009, pp. 106-107). According to Flick and von Kardorf (2005, p. 143), the interviewer in a semi-structured interview has to decide when and in what sequence to ask questions during the interview. Furthermore, the interviewer needs to be vigilant regarding which questions to skip (e.g., if they have already been implicitly answered) and when to probe deeper (Flick and von Kardorf, 2005, p. 143). Following the suggestions by Eisenhardt (1989, p. 538), multiple investigators were present in selected instances when conducting the semi-structured interviews for this thesis work. The investigators were the author of this thesis, and three master's students.[1] According to Eisenhardt (1989, p. 538), the use of multiple investigators has two key advantages: First, they increase the study's creative potential by offering complementary insights, and subsequently adding to the richness of data. Second, they increase the chance of finding novel insights in data by applying different perspectives. Furthermore, multiple investigators increase the confidence in the obtained findings (Eisenhardt, 1989, p. 538). However, as emphasized by Yin (2009, p. 53) interviewers need to be prepared for and practiced in conducting interviews. The necessary practice was obtained through the author's active involvement in various research projects based on qualitative data. In addition, before each interview, the relevant company data were screened to be aware of company-specific factors.

### c) Criteria for informants

As suggested by Eisenhardt and Graebner (2007, p. 28), this thesis includes data from *"[...] numerous and highly knowledgeable informants who view the focal phenomena from diverse perspectives."* Consequently, this serves to limit the bias of interview data. Furthermore, the basic assumptions of Gioia et al. (2012, p. 17) were followed, namely, that (1) *" [...] the organizational world is socially constructed [...]"* and (2) respondents *"[...] constructing their organizational realities are*

[1]With the exception of two interviews in the preliminary study, the author of this thesis was present at all interviews conducted in the process of data collection.

*"knowledgeable agents"[1] [...]"* able to explain *"[...] thoughts, intentions, and actions."* Therefore, in contrast to other types of interviews, the respondent in an expert interview is not the focal point of the investigation (Flick and von Kardorf, 2005, p. 139). Instead, informants in expert interviews are of interest due to their specific knowledge about the investigated area (Flick and von Kardorf, 2005, p. 139). Where applicable, the author of this thesis followed the suggestions by Eisenhardt and Graebner (2007, p. 28) and collected interview data relying on informants from (1) different hierarchical levels, (2) different functional areas, groups, and geographies, (3) other relevant organizations and outside observers. In addition, the following criteria formulated by Morse (1994, p. 228) were taken into consideration when selecting informants: First, respondents should have experience in and knowledge about the topic in order to be able to answer the interview questions. Second, respondents should be able to reflect upon and articulate their understanding. Third, respondents should be willing to participate in the study as well as have enough time to cover the prepared interview guideline.

### 7.2.2 Identification of relevant cases and preliminary analysis

Based on the insights from the preliminary study, the focus of data collection was sharpened. Thereby, the selection became more specific as the research progressed (Corbin and Strauss, 2015, p. 137). Subsequently, purposive sampling as described by Flick (2017, p. 155) was used to determine the cases included in the main study. The applied procedure agrees with that proposed by Yin (2009, p. 62) who emphasized that a *"[...] case study design can be modified by new information or the discovery of new data during data collection."* Moreover, as proposed by Corbin and Strauss (2015, p. 153), when selecting relevant cases, the individual context of each case was taken into consideration, as it plays a major role for empirical investigations to explain *"[...] action-interaction within a background of conditions and anticipated consequences."* Specifically, the following selection criteria were applied in the main study described in this thesis:

- First, companies needed to be actors in the ecosystem for xEVs themselves or directly affected by these actors.

- Second, due to the early stage of the xEV ecosystem (see Section 6.4 and Draschbacher et al. (2020)), the data collection was carried out to cover actors and address their relevant roles in the generation of innovation ecosystems as proposed by Dedehayir et al. (2018).

- Third, as proposed by Yin (2009) and in accordance with the recent literature on innovation ecosystems (e.g., Adner (2012); Talmar et al. (2018); Jacobides et al. (2018)), the research focused on individual organizational units within companies that provided added value for an overall ecosystem value proposition centered around xEVs.

- Fourth, only companies with a corporate or business unit headquarter located in Austria or Germany were considered. On the one hand, this allowed for better access to informants, reduced potential language barriers, and benefited the collection of additional information about

[1] Emphasis by original author

investigated companies, if needed. On the other hand, this covered countries that simultaneously had a strong xEV industry and market.[1]

## a) Collection of case data

Considering the findings from the preliminary study and insights on relevant ecosystem roles provided by Dedehayir et al. (2018), both companies upstream and downstream of OEMs were deemed as relevant with respect to the investigated topic. Using the set selection criteria, data from multiple types of actors were gathered. Although the collected cases do not constitute a representative sample in a statistical sense, sufficient data on actors in the innovation ecosystem for xEVs could be obtained. In addition, relying on the perspectives of multiple actors adds richness to the analysis (Eisenhardt, 1989, p. 538). Following the recommendation of Yin (2009, p. 53), this thesis work was designed to include at least two cases for each type of actor in the final sample. After selecting relevant actors in the xEV ecosystem for the analysis, companies were screened for informants using professional networking platforms (i.e., LinkedIn, Xing) as well as the personal contacts of the author and those of the thesis supervisor. The selection of companies and individual informants was guided by the previously defined criteria (i.e., criteria towards actors, criteria towards informants). Potential informants were subsequently contacted and provided with a short summary of the research project. If they agreed to participate, data were gathered using the data collection strategy described above. Data for the main study were collected from December 2018 to September 2019. All interviews were recorded and transcribed in full to establish a solid base for further analysis. Table 25 provides a summary of all investigated cases[2]. Figure 49 provides an overview of the investigated cases, the types of respective actors, and their positions in the ecosystem.

**Table 25:** Overview of all investigated cases.

| Case category | Abbre-viation | Position in ecosystem | Assumption about Ecosystem Roles according to Dedehayir et al. (2018) | Embedded cases | Interviews (per category) |
|---|---|---|---|---|---|
| Automotive OEMs | OEM | Central | Leadership roles | 4 Cases | 6 Interviews |
| Engineering and technology providers | ETP | Upstream | Value creation support | 2 Cases | 9 Interviews |
| Research institutions | RI | Upstream | Value creation support | 2 Cases | 2 Interviews |

Table 25 continues on next page

[1]Only a small number of countries simultaneously have a strong EV industry and EV market. Specifically, the only countries having both a notable industry and market for xEVs are China, the United States, Germany and Japan. (Hertzke et al., 2019, p. 87)

[2]Cases from the preliminary study were included, as they added substantial value to the insights of the research project.

Table 25 continued from previous page

| Case category | Abbre-viation | Position in ecosystem | Assumption about ecosystem roles according to Dedehayir et al. (2018) | Embedded cases | Interviews (per category) |
|---|---|---|---|---|---|
| Suppliers *(established automotive)* | SUP | Upstream | Direct value creation | 4 Cases | 12 Interviews |
| Suppliers *(focused technology)* | SUP | Upstream | Entrepreneurial role | 2 Cases | 3 Interviews |
| Automotive retail | RET | Downstream | Direct value creation | 2 Cases | 2 Interviews |
| Corporate vehicle fleet operators | FO | Downstream | Direct value creation | 2 Cases | 2 Interviews |
| Energy companies *(electric energy)* | EC | Downstream | Direct value creation | 3 Cases | 4 Interviews |
| Energy companies *(petrol energy)* | EC | Downstream | Direct value creation | 2 Cases | 2 Interviews |
| Infrastructure companies | INF | Downstream | Direct value creation | 4 Cases | 4 Interviews |
| **Total** | | | | **27 Cases** | **46 Interviews** |

An exact overview of all interviews conducted for this thesis work is provided in the Appendix A.1. In total, the database comprised more than 44 hours of interview material[1]. The shortest interview was conducted with informant MS36 and took 37 min; the longest interview was conducted with informant MS38 and took 2 hours and 22 minutes[2].

### b) Preliminary inductive coding of case material

As proposed by Strauss and Corbin (1998, pp. 10-11), collected data was used to perform a qualitative interpretative analysis aiming at *"[...] discovering concepts and relationships in raw data and then organizing these into a theoretical explanation scheme."* This procedure of interpreting, organizing, conceptualizing, reducing, elaborating, and relating data to find categories with distinct dimensions and properties is often referred to as *"coding"* (Strauss and Corbin, 1998, p. 12). The coding procedure was performed considering individual sense-bearing phrases using the software

[1] The duration of conversations with interview partners PS6, PS7 and PS8 was not documented. The total amount of conducted interview time, therefore, is higher.

[2] This interview was conducted in two sessions, since the questionnaire could not be completed in the first appointment.

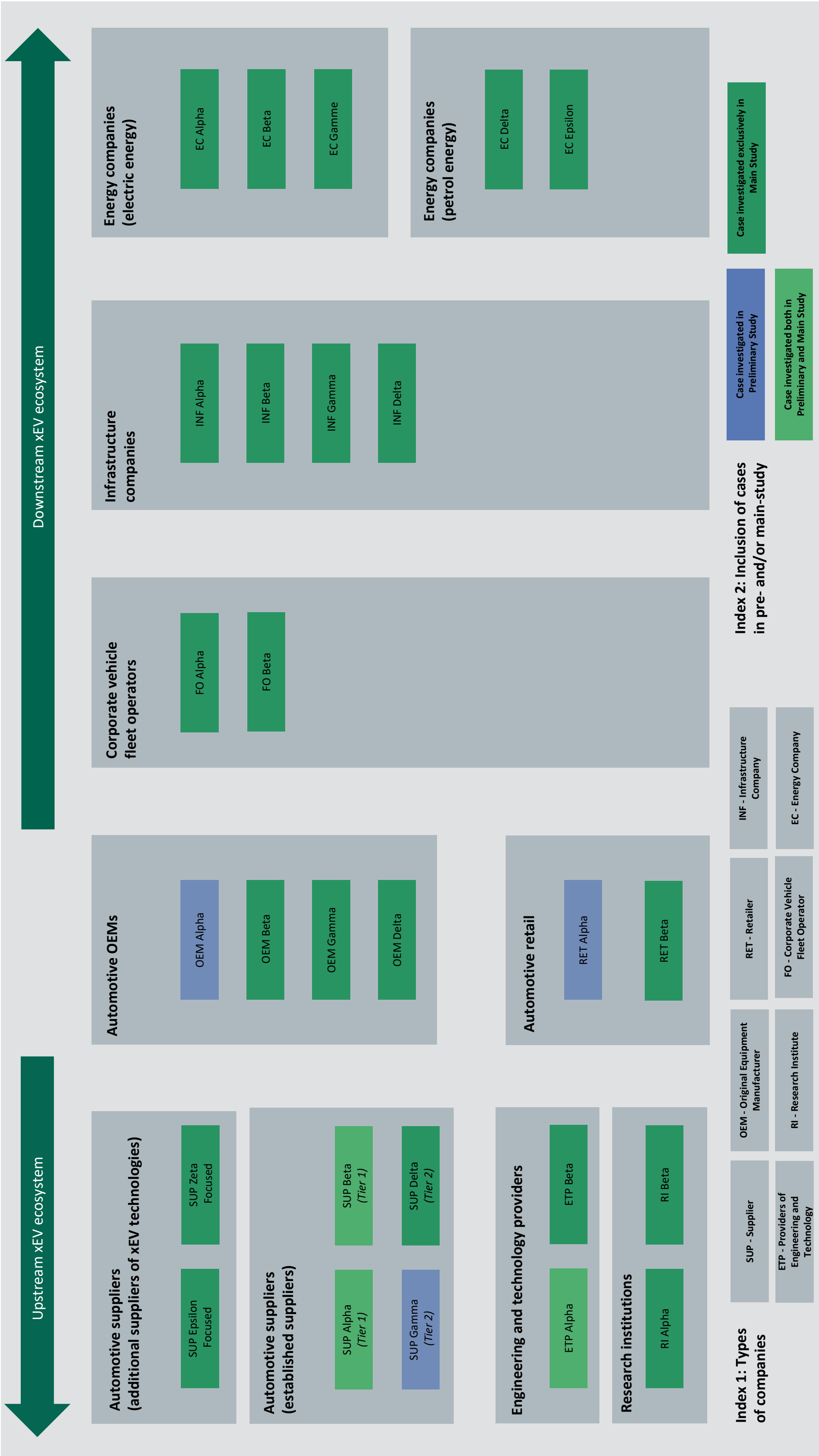



**Figure 49:** Graphical representation of the investigated cases (personal illustration).

MAXQDA2018. As suggested by Eisenhardt (1989, p. 536), guided by the research questions, and with reference to the literature, potentially important aspects were identified (i.e., findings reflecting *"a priori"* constructs; see Chapter 5) while proposed relations between variables were initially avoided. In the process of collecting data, several preliminary coding iterations were performed based on the gathered data. In the first round of analyses, collected material was coded close to the original text (Flick and von Kardorf, 2005, p. 259). In this step, coding was supported by provisional codes derived from the literature (Miles and Huberman, 1994). During the ongoing process of data collection and data analysis, additional concepts emerged, requiring resorting and integration of codes in an *"[...] interplay between researchers and data [...]"* (Strauss and Corbin, 1998, p. 13). In subsequent coding iterations, initial codes were aggregated to more abstract categories (see Flick and von Kardorf (2005, p. 259) and Muckel (2007, pp. 217-218)). In addition, a structuring logic proposed by Gioia et al. (2012) was used to evaluate and display relevant findings in first- and second-order categories. A category was considered saturated when no new properties, dimensions, conditions, actions/interactions, or consequences emerged from the data (Strauss and Corbin, 1998, p. 136).

## 7.3 Saturation and maturation

Naturally, opportunities to include additional data are always available, which, in turn, require criteria to stop data collection (Flick and von Kardorf, 2005, p. 103). The criterion considered to stop data collection used for the empirical study was *"theoretical saturation"* (Eisenhardt, 1989, p. 545). Thereby, when examining the amount of knowledge gained from additional cases, no new themes, properties, or dimensions emerge when all possible variability has been accounted for in the analysis (compare with Strauss and Corbin (1998, p. 158) and Flick and von Kardorf (2005, p. 103)). In the course of this thesis work, saturation was reached, and the data collection stopped after gathering data on 27 cases from a total of 46 conducted interviews (see Table 25 and Figure 49). Moreover, because a range between four to ten cases is typically deemed as sufficient (Eisenhardt, 1989, p. 545), the collected case data for this thesis work were deemed sufficient to answer the posed research questions. As illustrated in the overview of the research process in Figure 48, the results were summarized, and a preliminary model of the obtained results was established. This subsequently formed the input for a focus group in which the intermediate results were presented and discussed. Then, insights from the focus group were used to refine the obtained insights from the case studies. Based thereon, several iterations of cycling back and forth between material and literature were performed to refine and - if necessary, re-code - the results obtained when exploring the topic. The following sections provide detailed information about the subsequent steps taken.

### 7.3.1 Focus group

In this thesis work, the multiple-case study's intermediate results were used as input for a focus group with industry experts. In the focus group, qualitative data from a homogenous group of people were collected by means of a focused group discussion (Krueger and Casey, 2015, p. 16). Conducting a focus group after completing the collection of case data thereby supported the interpretation of the insights obtained thus far (Krueger and Casey, 2015, p. 14); consequently this interpretation was used in a triangulation context *"[...] to elicit participants' interpretations of results from earlier studies."* The chosen approach was deemed particularly fruitful, as focus groups (1) rely on a specific group dynamic (Caillaud and Flick, 2017, p. 158), (2) allow participants to reveal their perspectives in different ways as compared to interview settings (Bryman, 2016, p. 520), and (3) are well-suited to test ideas (Krueger and Casey, 2015, p. 22).

### a) Focus group participants

As outlined by Smithson (2008, p. 357), organizing focus groups that consist of an appropriate number and mix of people can be challenging. The organization of the focus group for this thesis work was supported by the Styrian automotive cluster organization *"ACStyria"* and took place as a side event of the annual Austrian automotive fair *"AutoContact19"*[1]. Potential participants were contacted in advance by the management of the *"ACStyria."* Furthermore, invitations were handed out to participants of the fair on the day of the focus group. In total, eleven managers from the automotive industry participated. The duration of the focus group was 43 minutes. Table 26 provides an overview of the focus group participants.

**Table 26:** Overview of the participants in the focus group

| Participant Nr. | Type of Company | Technological Focus | Position of Participant |
|---|---|---|---|
| 1 | Regional Cluster | Focus automotive | Area manger |
| 2 | Supplier A | Measurement dystems | Business development |
| 3 | Supplier B | Electronics | Manager external relations |
| 4 | Supplier C | Electronics | n.a. |
| 5 | Supplier D | Metal technology | Business strategy |
| 6 | Supplier E | Electric cComponents | Managing director |
| 7 | Supplier F | Plastic components | Key account manager |
| 8 | Supplier G | Multiple / electric platforms | Area director |
| 9 | Engineering provider | Engineering | n.a. |
| 10 | Research institution | Additive manufacturing | Researcher |
| 11 | Automotive retail | - | Managing director |

For further considerations, the conducted focus group as a whole was considered as the unit of analysis instead of the individuals within the group (Smithson, 2008, p. 359).

[1]For further information see: https://autocontact.at/ac/

### b) Focus group data collection and analysis

After a short presentation of preliminary research findings, the author of this thesis took on a moderator's role and facilitated the discussion among participants (Smithson, 2008, p. 359). This was crucial as Ang (2014, p. 206) pointed out that in focus groups *"[...] interactions and the ability to allow conversations to evolve also opens up an avenue for participants to build on each other's comments and ideas, potentially creating synergies from the discussions and perhaps stepping onto a new line of inquiry."* Consequently, group dynamics were actively encouraged to explore issues from the participants' viewpoints (Smithson, 2008, p. 367). The focus group's results were analyzed in the course of iterating the preliminary coding system established in the exploration phase. Obtained results were analyzed separately and subsequently used to refine and triangulate the previously collected empirical data (Caillaud and Flick, 2017, p. 168).

## 7.3.2 Iteration of coding system and final data analysis

The data analysis forms the core of developing theory from case studies (Eisenhardt, 1989, p. 539). However, Eisenhardt described data analysis as a challenging and not fully codified process. As described in Chapter 7.2, the preliminary coding of the gathered material was performed during the exploration phase. Based on this coding, as well as on insights from the conducted focus group and additional literature on the topic, the coding system was iterated to establish a high degree of confidence in the results. Therefore, this data analysis deviates from the basic idea of Grounded Theory (Glaser and Strauss, 1967; Corbin and Strauss, 1990; Strauss and Corbin, 1998; Charmaz, 2006; Corbin and Strauss, 2015). Instead, the approach applied for data analysis relies on a more pragmatic understanding of case study research (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Yin, 2009; Gioia et al., 2012).

### a) Applied data analysis approach

Based on the preliminary first- and second-order categories established in the exploration phase, an extensive literature search[1] was again performed. Using the gained insights from a systematic review, the focus group as well as the preliminary coding system, a process of cycling back and forth between themes emerging from the data analysis and literature was performed. Specifically, the following combination of techniques was applied to analyze the data (Corbin and Strauss, 2015, pp. 87-99):

[1] In this update, the systematic literature review originally conducted in 2018 was updated to include relevant literature published until 2020. See Chapter 5 for more detailed information about the literature review process.

- *"Constant comparisons"* as well as *"theoretical comparisons"* were performed to heighten the researchers' awareness of properties and dimensions in the data (Corbin and Strauss, 2015, pp. 93-95).
- A *"Flip-Flop Technique"* was applied to identify contrasts or extremes and highlight significant features (Corbin and Strauss, 2015, p. 97).
- The *"Waving the Red Flag"*-approach was used to reduce biases. Thereby, researchers critically consider passages or memos for signals (e.g., words, sentences) in order to question self-evident insights (Muckel, 2007).

Following the recommendations of the *"Grounded Theory Methodology,"* the identified categories remained open to change during the coding process (Muckel, 2007, p. 215). Furthermore, constant comparisons between categories were performed to identify similarities and relations among the data (Muckel, 2007, p. 215). As in the exploration phase, categories were aggregated using a structuring logic described by Gioia et al. (2012). This helped to investigate identified phenomena on a higher level of abstraction (Muckel, 2007, p. 218).

Again, as in the exploration phase, the coding procedure was performed using the software MAXQDA2018. The process of data structuring was accompanied by checking for intercoder agreement between the author of this thesis and two fellow researchers (Gioia et al., 2012, p. 22). The process of coding was carefully documented and could be repeated, in principle.

### b) Abstraction and presentation of results

The vast body of collected material required taking an efficient approach toward the abstraction and presentation of the obtained results. To stay within reasonable spatial constraints while presenting relevant findings, no complete narratives for each individual case are presented. This decision is supported by Eisenhardt and Graebner (2007, p. 29), who argued that *"[...] presenting a relatively complete and unbroken narrative of each case is infeasible for multiple case research, particularly as the number of cases increases."* Subsequently, results are structured along the following dimensions:

- First, results are categorized according to the respective research questions.
- Second, results are categorized according to the types of investigated actors and their respective positions in the ecosystem (upstream, downstream, central).
- Third, results are categorized into the main categories for each research question identified during the coding process.

For each of the three outlined dimensions, a short *"Case Vignette"* highlighting core issues is presented in a tabular form (Miles and Huberman, 1994, p. 81). All descriptions can be found in Appendix A.3. This approach follows that of Eisenhardt (1989, p. 540) who suggested to *"[...] select categories or dimensions, and then to look for within-group similarities coupled with intergroup differences."* The chosen approach enabled the researcher to become familiar with each case, making it easier to draw the subsequent comparisons between cases (Eisenhardt, 1989, p. 540). Moreover, as highlighted by Eisenhardt (1989, p. 540), the applied approach thereby *"[...] allows the unique patterns of each case to emerge before investigators push to generalize patterns across cases."* Consequently, individual case results were further aggregated to be able to analyze and present the obtained results. However, to ensure appropriate rigor and empirical grounding, the aggregated results are complemented by original quotes from the conducted interviews (Eisenhardt and Graebner, 2007, p. 29).

## 7.4 Quality criteria

Unlike the criteria used in quantitative research, the quality criteria for qualitative research are disputed (Bortz and Döring, 2007a, p. 106). In principle, two main approaches exist for using criteria in qualitative research (Bortz and Döring, 2007a, p. 107): First, researchers can orient themselves toward criteria relevant for quantitative research, such as *"objectivity," "reliability,"* and (internal and external) *"validity."* Second, researchers might develop their own quality criteria based on the logic of their individual qualitative studies. This, however, has led to a plethora of individual catalogs of criteria for qualitative research, which, in turn, has prevented the emergence of a standardized catalog of criteria (Bortz and Döring, 2007a, p. 107). One popular catalog was proposed by Lincoln and Guba (1985, p. 290) who suggested to use *"truth value," "applicability," "consistency,"* and *"neutrality"* to ensure what they coined the *"trustworthiness"* of qualitative research. For this research, the aspects of reliability, validity, and objectivity[1] were considered as relevant criteria, as they represent common aspects of judging the quality of research designs (Lincoln and Guba, 1985; Bortz and Döring, 2007a; Yin, 2009; Flick, 2009, 2017). Moreover, as described below, they are closely related to criteria proposed by Lincoln and Guba (1985) and Schou et al. (2012). Table 27 provides an overview of the measures used to address relevant quality criteria.

**Table 27:** Overview of measures used in this thesis work to address relevant quality criteria.

| Measures | Construct validity | External validity | Internal validity | Reliability | Objectivity |
|---|---|---|---|---|---|
| Using multiple sources of evidence | ✓ | ✗ | ✗ | ✗ | ✗ |
| Gathering feedback on results in a focus group | ✓ | ✗ | ✗ | ✗ | ✗ |
| Providing *"thick descriptions"* of material | ✗ | ✓ | ✗ | ✗ | ✗ |

Table 27 continues on next page

[1] Objectivity was considered as a criterion, although its applicability in qualitative research disputed - particularly when adopting an interpretivist stance (Madill et al., 2000; Flick, 2009).

Table 27 continued from previous page

| Measures | Construct validity | External validity | Internal validity | Reliability | Objectivity |
|---|---|---|---|---|---|
| Performing regular Peer debriefings | ✗ | ✗ | ✓ | ✗ | ✗ |
| Replications across multiple cases | ✗ | ✓ | ✗ | ✗ | ✗ |
| Argumentation of case/informant selection and context description | ✗ | ✓ | ✗ | ✓ | ✗ |
| Argumentation of methodology selection and detailed methodology description | ✗ | ✗ | ✓ | ✗ | ✗ |
| Careful documentation of research process and data collection | ✗ | ✗ | ✓ | ✓ | ✓ |
| Triangulation (methods, informants, researchers) | ✗ | ✗ | ✓ | ✓ | ✓ |
| Separating gathered data and interpretation | ✗ | ✗ | ✗ | ✓ | ✗ |
| Tightly linking interpretation and data through appropriate quotes | ✗ | ✗ | ✗ | ✗ | ✓ |

In addition, for the research at hand, the obtained results were checked for their logical coherence and parsimoniousness (Eisenhardt, 1989, p. 532). A detailed description of the individual criteria and how they were considered is provided in the following section.

## 7.4.1 Validity

According to Flick (2009, p. 387), the validity in qualitative research can be *"[...] summarized as a question of whether the researchers see what they think they see."* Both the generation of data as well as the inferences drawn from data are relevant issues with regards to validity. Specifically, the following aspects were taken into consideration:

### a) Construct validity:

Construct validity considers the suitability of measures used to study a certain subject (Yin, 2009, p. 41). By following the recommendations of Yin (2009, p. 41) construct validity was ensured by relying on multiple sources of evidence (i.e., multiple cases, multiple informants) and gathering feedback on the preliminary results in a focus group.

### b) External validity:

External validity roughly translates to the criterion of *"applicability"* proposed by Lincoln and Guba (1985, p. 290) as well as the criterion of *"transferability"* used in the qualitative social sciences (Bortz and Döring, 2007a, p. 109). In general terms, external validity considers the generalizability of a study (Yin, 2009, p. 43). It has to be noted that external validity represents a limitation of case study research (Yin, 2009, p. 43). However, the external validity of a study can be increased through (direct) replications of case studies and/or multiple case designs as well as the use of *"thick descriptions"* of contexts and objects of investigation (Lincoln and Guba, 1985, p. 301). Following the suggestions of Schou et al. (2012, p. 2090), the selection of informants, as well as informants' context, was argued and described in detail. Moreover, the findings of this research might allow for analytical generalization (Treharne and Riggs, 2015, p. 63). Analytical generalization thereby refers to *"[...] the process of generalizing from some data to an extant theory rather than generalizing from some data to the population, as is attempted in statistical generalization."* For the empirical context presented in this thesis, it can be assumed that, since the emergence of xEVs is not a local but rather a global phenomenon and the majority of investigated companies act globally, the empirical insights gathered from companies in Austria and Germany could, in principle, be applied to similar geographic regions. Moreover, innovation ecosystems, business models, and technologies are closely related topics (Teece, 2010; Adner and Kapoor, 2016a) that bear relevance in many different areas. Subsequently, it can be assumed that the obtained findings can, to some extent, be applied to other ecosystems centered around a technological innovation and the involved actors' business models. The transferability of obtained results could thereby depend on the structure of respective ecosystems - particularly with regard to similarities in the ecosystem's actor structure and the corresponding availability of component values and complementary offers (Adner, 2017; Jacobides et al., 2018; Kapoor, 2018). Moreover, results might be well-suited to be transferred whenever actors face similar *"rules of the game"* in terms of regulators, standardization bodies, laws, social behavior, and business ethics (Teece, 2007, p. 1323).

### c) Internal validity:

Internal validity corresponds to the criteria of *"truth value"* as proposed by Lincoln and Guba (1985, p. 290) as well as *"credibility"* in the qualitative social sciences (Bortz and Döring, 2007a, p. 109). Lincoln and Guba (1985, p. 290) defined it as *"[...] the extent to which variations in an outcome (dependent) variable can be attributed to controlled variation in an independent variable."* Consequently, as emphasized by Puch (2013, p. 322) internal validity *"[...] refers to the internal logic and consistency of the research."* Overall, the criterion is disputed in qualitative research. On the one hand, Eisenhardt (1989, p. 545), emphasized that internal validity, generalizability, and overall theory building from case studies could be improved by tying emergent theory to literature. Yin (2009, p. 43), on the other hand, argued that it does not apply to descriptive or exploratory investigations. According to Yin (2009, p. 43), internal validity would instead apply to explanatory studies or studies that investigate causal relations. This idea was further underlined by Puch (2013, p. 322). In this thesis work, the criterion has limited relevance due to the descriptive and exploratory nature of the performed research. However, despite its disputed relevance, elemental aspects proposed in the literature were considered to strengthen the internal validity of qualitative research. Thereby, as summarized by Bortz and Döring (2007a, p. 109), concrete arguments for the chosen methodology, as well as a detailed description of the performed methods, were provided (see Chapter 1 for arguments that support the use of this research approach and this chapter for the applied methodology). Furthermore, as recommended by Schou et al. (2012, p. 2090), the research process was carefully documented, and triangulation in terms of methods, researchers, and informants was applied. In addition, as proposed by Lincoln and Guba (1985, p. 301), the study was regularly discussed with external colleagues (peer debriefing).

### 7.4.2 Reliability

Reliability in research contexts is understood as the independent repeatability of a study (Albers et al., 2007, p. 375). As highlighted by Bortz and Döring (2007a, p. 109) this is closely related to the criterion of *"consistency"* as proposed by Lincoln and Guba (1985, p. 290) and *"dependability"* as used in the qualitative social sciences. For qualitative research, reliability can be ensured by considering the following aspects (Flick, 2009, p. 387): First, by explicating data collection to allow a differentiation between the gathered data and the interpretation of data. Second, by explicating applied procedures for collecting data. In this thesis work, the criterion was ensured by presenting the collected data and interpreting the data separately. In addition, a detailed documentation of the data collection process is provided in this chapter. Thereby, the applied criteria for selecting relevant cases and suitable informants (Flick, 2017, p. 492) are described in detail. Consequently, the process could - in principle - be repeated. In addition, as reliability can be further improved by documenting a research process (Flick, 2009, p. 387), case data were stored, and collected materials were documented in a case database. As suggested by Schou et al. (2012), the reliability was further increased by supporting the interpretation of data with quotes and drawing conclusions that are supported by individual findings. Furthermore, as proposed by Lincoln and Guba (1985, pp. 301 ff.), the reliability of this research was strengthened by performing triangulation between partly overlapping methods (i.e., interview-based case studies, focus group), as well as by involving multiple researchers in the data analysis.

### 7.4.3 Objectivity

Objectivity is closely related to the criterion of *"neutrality"* as proposed by Lincoln and Guba (1985, p. 290) as well as *"confirmability"* as used in the social sciences (Bortz and Döring, 2007a, p. 110). Objectivity in qualitative research can be understood as the consistency of meaning between independent researchers investigating the same data (Flick, 2009, p. 387). The objectivity of this research was ensured by carefully documenting the applied methodological procedure (Bortz and Döring, 2007b, p. 326). In addition, following the recommendations of Flick (2017, p. 499), objectivity was ensured by involving multiple researchers in conducting interviews and analyzing interview data. Any inconsistencies were discussed until a consensus had been reached.

# 8 Research results

In the following sections, the results of the empirical study are presented. Although the investigated groups of companies were involved in similar areas, as described in Chapter 7, the research strategy considered data from a broad range of different types of cases.[1] Presented data are roughly categorized according to the case-actors' positions in the xEV ecosystem. Consequently, the results are presented for central ecosystem actors (i.e., automotive OEMs) as well as for companies upstream and downstream of these actors.

The data collection was carried out focusing on the elements of investigated actors that contributed to an overall ecosystem value proposition (see Chapter 4) centered around xEVs. As a result, individual divisions within a company were treated separately if they contributed in substantially different ways to an overall ecosystem value. However, applying a strict classification scheme was not fully possible due to their individual characteristics and different levels of embeddedness in multiple business relations. Examples in the data are FO Alpha and INF Alpha. Although both investigated cases operated under the same corporate roof, one acted as the dedicated operator of a corporate vehicle fleet while the other coordinated public infrastructure for electric charging. Other examples were investigated suppliers, which can be roughly characterized as follows: (1) Tier 1 suppliers (SUP Alpha, SUP Beta), (2) Tier 2 suppliers (SUP Gamma, SUP Delta), as well as (3) suppliers for a narrow spectrum of xEV technologies (SUP Epsilon, SUP Zeta). ETP Alpha and ETP Beta also followed different approaches in their business model. Furthermore, as summarized in Chapter 7, energy companies with a background in electrical energy as well as with an affiliation to petrol energy were investigated separately. Moreover, while they generally had similar aims, infrastructure companies took vastly different approaches: INF Alpha took on a coordinating role, INF Gamma and INF Delta focused on tailored charging solutions (private and corporate charging). At the same time, INF Beta acted as an enabler for corporate customers and installed public charging infrastructure.

Figure 50 provides an overview of the themes identified in the data. As illustrated, the insights build upon one another. First, in Section 8.1, data on influences to enter the xEV ecosystem are summarized to answer research question two. Second, in Section 8.2, data on interactions of ecosystem actors to create value based on xEVs are presented. Third, data on influences on the business models (Section 8.3) and respective business model changes (Section 8.4) of actors in the xEV ecosystem are presented.

[1] The designations of investigated cases are presented in Chapter 7 - Figure 49. A detailed overview of all collected data is provided in Appendix A.1.

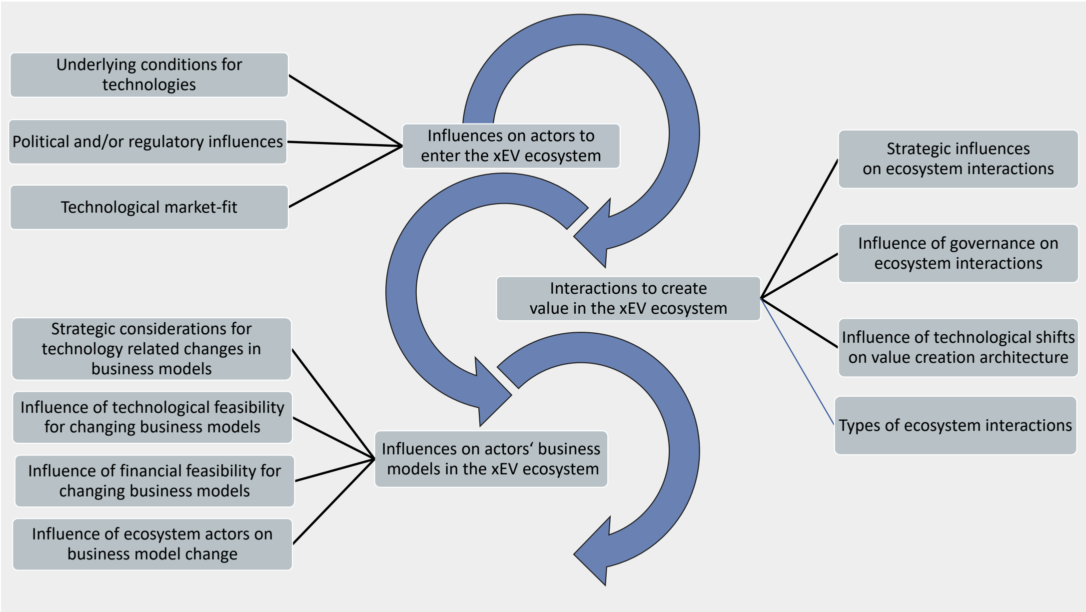



**Figure 50:** Overview of identified themes in collected data

## 8.1 Influences encouraging actors to participate in the ecosystem

### 8.1.1 Introduction and overview

This section summarizes the collected data on influences that affected the investigated ecosystem actors, encouraging them to enter the xEV ecosystem (see research question two in Section 1.2). After analyzing the collected data, common themes among the actors emerged. Figure 51 gives an overview of identified themes. A case-based description of the investigated aspects is provided in Appendix A.3. Overall, the data indicate that underlying conditions for xEVs, political and regulatory influences, as well as the ability of xEV technologies to address markets were dominant factors for the investigated actors. However, the concrete form of identified influences differed depending on the type of investigated actors as well as the actor's position in the ecosystem. The subsequent analysis is structured on the basis of the actors' positions in the ecosystem. Detailed information about each cases is presented according to the themes identified in the data.

### 8.1.2 Results for central ecosystem actors

**Underlying conditions for technologies:**
Technologies for xEVs show properties that could enable the use of more sustainable vehicle operations. However, technologies for xEVs were also perceived as having several limitations -

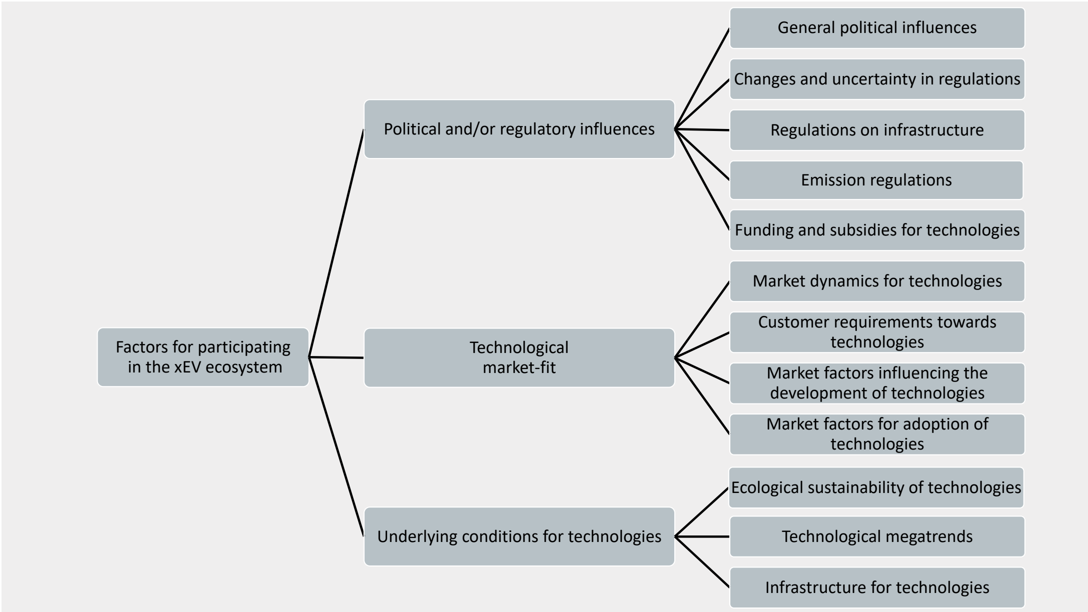



**Figure 51:** Overview of themes regarding research question two in collected data

predominantly in terms of the vehicle range. In addition to investigating new technologies for xEVs, OEMs saw the need to address this issue by providing holistic mobility solutions and improving infrastructure (e.g., electric charging, hydrogen).

**Political and/or regulatory influences:**
OEMs perceived substantial political and regulatory influences (especially regulations on $CO_2$ emissions) that encouraged them to enter the xEV ecosystem and investigate respective technologies. Informants in OEM Alpha noted that these regulations acted as accelerators for the OEMs initiatives. However, the influences differed in individual regions, and possible changes in regulations prevented OEMs from committing resources at a large scale. In addition to direct regulatory influences, OEMs also perceived influences on their customers (e.g., incentives for operating xEVs). Incentives for xEVs favored business customers (e.g., operators of corporate vehicle fleets). Informants in OEMs perceived a lack of support from regulators as well as regulatory obstacles that blocked the development of xEV infrastructure (e.g., electric charging, hydrogen).

**Technological market fit:**
Corporate customers represented a substantial xEV market segment. However, private customers were seen as a relevant market that OEMs could not fully serve at the moment (e.g., due to a lack of complementary offers and technological limitations). As a result, OEMs were in need of solutions to make xEVs more attractive to a broader audience while limiting the technological and financial risks. Subsequently, informants in OEMs said they were taking multiple technological approaches (e.g., PHEVs, FCEVs, BEVs) simultaneously.

The findings are underlined by exemplary direct quotes provided by informants in investigated OEMs, as summarized in Table 28.

**Table 28:** Notable quotes provided by informants from central ecosystem actors regarding the influences that encouraged them to enter the ecosystem for xEV technologies. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS22<br>00h 11min 45s -<br>00h 12min 03s | OEM Beta on influences to enter the ecosystem | *"Yes, that's, well, my perception is, that it is purely political and economic pressure - without that, we wouldn't run into it so quickly because there are also many, many risks in it."* (adjusted for better readability) |
| MS23<br>00h 24min 19s -<br>00h 24min 36s | OEM Beta on the role of complements for entering the ecosystem | *"But if the government now politically promotes electric mobility, but [...] does not establish the entire infrastructure, over which we have no influence, in a timely manner, then that is indeed a major problem."* (adjusted for better readability) |
| MS25<br>00h 39min 10s -<br>00h 39min 53s | OEM Delta on factors related to markets when entering the ecosystem | *"I think this is due to political influencing factors. But ultimately these are market influencing factors. And then, of course, customer behavior itself. Because of course it's attractive to drive electric cars. It's also, I'd say, en vogue, so market developments have driven every OEM to develop electric cars. And, of course, because the topic will have great potential in the future."* (adjusted for better readability) |

### 8.1.3 Results for upstream ecosystem actors

In this section, the influences to enter the xEV ecosystem as reported by upstream actors are presented. Consequently, the data reported by informants from suppliers, engineering and technology providers, as well as research institutions are summarized.

#### a) Collected empirical data regarding influences on suppliers

**Underlying conditions for technologies:**
Global megatrends (e.g., changes in user behavior) and the ecological sustainability of technology were frequently mentioned as influences by informants in suppliers. Furthermore, the availability of infrastructure to operate competing technologies for xEVs (electric charging, hydrogen) influenced the technologies' attractiveness. This, in turn, impacted the ecosystem's attractiveness. Cost reductions in new technologies (e.g., battery costs) were mentioned as further factors that promoted the shift towards electric propulsion technologies and made participating in the xEV ecosystem more attractive.

**Political and/or regulatory influences:**
Investigated suppliers unanimously stated governmental regulations and, in particular, $CO_2$ regula-

tions directed at automotive OEMs, citing these as major factors that encouraged them to enter the xEV ecosystem. From a regulatory perspective, the possibility of driving bans for conventional types of vehicles was mentioned by informants. In addition to the influences mentioned above, informants in suppliers specifically reported the impact of Asian countries that pushed the development and application of xEVs based on strategic considerations (e.g., establishing technological leadership for xEVs). Informants stated that Tier 1 suppliers were hesitant to fully commit to a new technology, since the continuity of the given regulatory regime was perceived as uncertain.

**Technological market fit:**
Suppliers (Tier 1, Tier 2) stated that their main objective was to support OEMs and to help them to introduce products that allowed them to meet their regulatory targets. However, uncertainties in market demands of vehicle (end-)customers - partly influenced by the availability of complementarities (e.g., infrastructure) - in combination with the lead times necessary to react to demand changes with new products were stated as obstacles that kept them from committing to technologies for electric propulsion. In contrast, smaller, more focused suppliers perceived a substantial potential for providing solutions to selected markets for xEV technologies.

Findings are underlined by exemplary direct quotes provided by informants in investigated suppliers, as summarized in Table 29.

**Table 29:** Notable quotes provided by informants from suppliers on influences that encouraged them to enter the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS4<br>00h 22min 01s - 00h 22min 21s | SUP Beta on the attractivity of electic mobility | *"I am of the opinion that e-mobility actually makes no sense. So if you look at it from an ecological point of view. It is becoming more and more accepted. But from my point of view, the hype about electromobility is already declining."* |
| MS4<br>00h 22min 21s - 00h 23min 17s | SUP Beta on regulations, technologies and infrastructure | *"It becomes difficult when individual countries operate special regulations, such as China, or Norway, and things are being promoted that do not really make sense from a European perspective. That is also one of the reasons why, in my opinion, the European OEMs are very cautious regarding electric mobility. They may well be driven by European policy on exhaust gas emissions to the point where they now have to do something towards e-mobility, but that is the only reason, in my view, or the main reason, that hydrogen technology has not yet reached that point. It would actually be possible from the vehicle-perspective, but we are still far away from having the infrastructure to operate it."* |
| MS6<br>00h 18min 17s - 00h 18min 28s | SUP Beta on the influence of volatile regulations | *"You calculate your business case with certain subsidies and then 3 years later they turn everything around again, and you have invested there and you are stuck there. So this aspect, for example, I think, is pretty much present in all these risk considerations."* (adjusted for better readability) |

Table 29 continues on next page

Table 29 continued from previous page

| Quote origin | Case and context | Quote |
|---|---|---|
| MS7<br>01h 07min 42s -<br>01h 08min 20s | SUP Beta on infrastructure for electric charging | *"What I think is a big challenge with increasing volume is the topic of infrastructure. For me it is far from solved. [...] If you look at it, what would it mean if all of a sudden there were only electric cars driving around in the city? What effect would that have on the infrastructure of energy providers? Charging infrastructure that does not exist today. And perhaps the expectations of end customers are often a bit odd."*(adjusted for better readability) |
| MS8<br>00h 27min 58s -<br>00h 28min 50s | SUP Beta on technological complexity and industry goals | *"The electric motor itself is not a Rocket Science, it is more the control of the power electronics and the interaction between the battery, or let's say energy storage, whether there is a battery or a fuel cell, it doesn't matter, and it ensures the driving dynamics. And of course it is also one of China's major strategic goals to be at the forefront of this field and to expand its role as, let's say, not only a manufacturer, but also increasingly as a developer. And when you look at the figures and you see that in many areas the Chinese state has already succeeded very, very well in implementing its industrial policy, yes."* |
| MS8<br>00h 40min 31s -<br>00h 41min 22s | SUP Beta on actors for infrastrucutre | *"We also know that the energy suppliers are not a particularly innovative industry. They have always been system maintainers and have changed [...] only since the European liberalisation of electricity and new things are beginning to happen, and they say they are thinking about new business models. But otherwise they are not particular drivers of innovation, also not regarding the business model. That the OEMS don't do this is obvious somehow, and they usually don't have the competence. They have a completely different business model, that would be something in addition, especially something that is very cost intensive, nobody really wants to put on that shoe."* (adjusted for better readability) |
| MS8<br>00h 45min 59s -<br>00h 46min 37s | SUP Beta on costs of technological leaps and the role of the regulator | *"[...] everything that has a higher, let's say, a higher level of technological development is always, always much more expensive than the existing system at the beginning. And that's exactly the issue: What are we willing to pay? As long as we don't charge for any harmful effects we do to the environment somewhere there, I still have a big gap and it will cost me twice as much, which no one is prepared to pay if they don't have to. And that is why it always needs the regulatory system. That's global."* (adjusted for better readability) |
| MS9<br>00h 14min 51s -<br>00h 15min 10s | SUP Delta about the political environment as driver for xEVs | *"Well, e-mobility is quite clearly driven by legislation. So, it is not that the customer is now necessarily going to come and say "I absolutely need an electric vehicle". But the political environment has changed so much that electric cars are suddenly a must.* |

Table 29 continues on next page

Table 29 continued from previous page

| Quote origin | Case and context | Quote |
|---|---|---|
| MS9<br>00h 16min 53s -<br>00h 17min 13s | SUP Delta about factors for entering the xEV ecosystem | *"When I see electromobility, it is of course due to external forces and drivers. This is not something that we wanted or somehow defined ourselves, but rather a reaction to changes in the market. New products, of course, are driven internally because you simply have good ideas. So that is both."* |
| MS11<br>00h 1min 53s -<br>00h 2min 58s | SUP Zeta about factors for entering the xEV ecosystem | *"So what I would discard a bit is the belief that it is somehow about sustainability and - quasi - green mobility. If you learn how automotive companies operate - they are as profit oriented as other players. They make their profits - if we look at Germany in the premium segment - with high-performance engines. [...] That means that the whole automotive industry is based on the conventional vehicles, or at least the conventional one is still based on the conventional vehicles. And why are we moving into electric mobility now? From my point of view the only reason are regulatory requirements, $CO_2$ legislation, that is 75 grams, 2025 that will come, 95 2021 and it goes on like this."* (adjusted for better readability) |
| MS11<br>00h 4min 23s -<br>00h 4min 53s | SUP Zeta about the influence of regulations on the ecosystem for xEVs | *"The automotive industry actually supports electromobility through the profits from conventional vehicles and operates electromobility based on $CO_2$ specifications that are defined by regulators. Against this background, I can see e-mobility and also the disruption and I believe that this is simply being pushed into the market step by step by regulatory means, and this is also creating the whole ecosystem."* |
| MS11<br>00h 9min 36s -<br>00h 9min 52s | SUP Zeta about infrastructure as limitation for xEVs | *"The real business case is not yet apparent there, and the big limitation of electric mobility [...] is actually the availability of charging infrastructure."* (adjusted for better readability) |

### b) Influences on engineering and technology companies

**Underlying conditions for technologies:**
Investigated actors acknowledged the need to offer technologies that enabled ecological sustainability. However, the overall environmental sustainability of new technological approaches (e.g., FCEVs, BEVs) was questioned. Investigated actors saw the limited availability of infrastructure (electric charging, hydrogen) as preventing its customers from adopting technologies on a large scale.

**Political and/or regulatory influences:**
A major influence that encouraged actors to participate in the xEV ecosystem was changes in regulations that affected the customers of companies providing engineering and technologies. Like suppliers, engineering and technology providers perceived a strategic push for xEV technologies in selected regions.

**Technological market fit:**
Due their its existing customers' need to shift their technologies, developing and providing technologies for xEVs was seen as an attractive market by engineering and technology providers. New OEMs with different technological requirements also needed engineering and technology providers to offer their solutions more quickly and more flexibly. However, the dominant technology for xEVs was not yet clear.

As before, these findings are underlined by an exemplary direct quote provided by an informant from an investigated engineering and technology provider, as shown in Table 30.

**Table 30:** Notable quote provided by an informant from a company offering engineering and technology solutions regarding influences to enter the ecosystem for xEV technologies. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS15<br>00h 22min 53s -<br>00h 23min 16s | ETP Alpha about regulatory influences on technologies | *"Of course, all these $CO_2$ emission limits and exhaust emission limits set by the legislator indirectly influence our business. Because then it is necessary to develop further in exactly this direction and then it falls back on us again."* (adjusted for better readability) |

## c) Influences on research institutions

**Underlying conditions for technologies:**
Informants in research institutions perceived a societal change towards more sustainable technologies (indicated, e.g., by the decreasing reputation of ICE vehicles). Overall, research institutions acknowledged the potential of technologies for xEVs to contribute to ecological sustainability. Furthermore, technological limitations (e.g., charging times, ranges) were stated as limitations that could be overcome by making technological improvements. Informants in research institutions also confirmed the existence of multiple technological solutions in the xEV ecosystem. The dominant solutions were estimated as largely depending on the technological feasibility of the required infrastructure (e.g., electric charging was described as more manageable than hydrogen fueling infrastructure).

**Political and/or regulatory influences:**
Research institutions saw regulatory influences on OEMs as primary drivers for developing and adapting xEV technologies in the ecosystem. Informants predicted that, as soon as OEMs committed to xEVs, the high volumes of vehicles produced and offered on the market - and the subsequent scale effects - would make the technology more attractive for additional actors.

**Technological market fit:**
Informants predicted that xEVs would be suitable for a large number of current vehicle use cases. However, the suitability depended on the fit between the technology used and the particular use case requirements. Informants believed that the overall low availability of vehicles was the reason

for the currently low application of xEVs. This, in turn, was thought to depend on the timing of technologies and vehicle costs.

Again, the findings are underlined by direct quotes provided by informants from research institutions, as summarized in Table 31.

**Table 31:** Notable quotes provided by informants in research institutions regarding influences that encouraged them to enter the ecosystem for xEV technologies. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS20<br>00h 07min 41s - 00h 08min 18s | RI Alpha on the role of legislation and muncipalities for entering the ecosystem | *"Everything that has to do with hybrid drive and electric drive and ultimately it also influences, perhaps indirectly, the municipalities, because perhaps for two reasons: on the one hand, the infrastructure is required, this means charging stations. But also due to other legislation, and maybe societal pressure, the air quality in the cities is definitely gaining attention and therefore driving bans for old technologies under some circumstances. So, that's quite a big arc that you can draw there."* |
| MS20<br>00h 44min 21s - 00h 44min 36s | RI Alpha on factors supporting xEVs | *"If the need is there and the customers pay for it, it will come. Yes, of course the municipalities have to provide for it and the public sector has to support it, etc. But if there are enough electric vehicles and people who pay for them, it will come."* |
| MS21<br>00h 10min 35s - 00h 11min 02s | RI Beta on the influence of requirements | *"Where we are influenced, of course, the market is classically the OEM, who, triggered by his customer, then actually dictates where the journey is going. Because the OEM says: okay, this is the battery, this is the volume that I allow, this is the additional weight that I allow, these are the safety requirements that I impose on myself, that I derive from the legal requirements, that's how you have to see it a bit."* |

### 8.1.4 Results for downstream ecosystem actors

In this section, the influences to enter the xEV ecosystem reported by downstream actors are described. Consequently, the data reported by informants in automotive retailers, corporate operators of vehicle fleets, companies in the energy sectors and infrastructure companies are presented.

#### a) Collected empirical data regarding influences on automotive retail

**Underlying conditions for technologies:**
Informants from automotive retailers perceived the availability of complementary solutions (electric charging infrastructure, charging technology) and vehicle batteries (range, costs) as factors that

made the xEV ecosystem less attractive. These factors were stated as being linked to the structure of the electrical energy grid as well as the availability of (electrical) energy for charging xEVs.

**Political and/or regulatory influences:**
Electric and electrified vehicles were perceived as being pushed by governmental regulations (especially $CO_2$ regulations geared towards OEMs) and incentives for xEV customers. However, the amount of governmental influence seemed to depend on the individual geographic regions. In addition, strict regulations regarding the charging infrastructure (e.g., for public and private charging) were referred to as hindering an xEV uptake.

**Technological market fit:**
According to informants from automotive retail, corporate customers mainly requested fully electric vehicles (e.g., vehicle fleet operators, partly due to governmental incentives for xEVs). While xEVs currently provide few incentives for customers (e.g., due to higher vehicle costs), regulations and changes in society are expected to impact their overall attractiveness (e.g., social status, the possibility of driving bans). Informants from automotive retailers emphasized the need to create an appealing value proposition around xEVs to ensure their overall success.

The obtained findings are underlined by a direct quote provided by an informant from an automotive retail company, as shown in Table 32.

**Table 32:** Notable quote provided by an informant from an automotive retail company on the influences that encouraged actors to enter the xEV ecosystem. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| PS8 (n.a.) | RET Alpha about corporate customers for xEVs | *"For private customers it is simply not an attractive option. Also corporate clients only adopted it since the introduction of tax benefits."* (adjusted for better readability) |

## b) Influences on corporate operators of vehicle fleets

**Underlying conditions for technologies:**
Informants from corporate operators of vehicle fleets saw the limited availability of public charging infrastructure and inhomogeneous charging standards as obstacles that prevented actors from entering the xEV ecosystem. However, due to the high predictability and well-known[1] use cases of vehicles in their companies, they were able to install their own private infrastructure for electric charging. Installing infrastructure for hydrogen was deemed as not yet feasible. The suitability of the current energy grid to charge xEVs was also investigated. According to informants from operators of corporate vehicle fleets, charging high numbers of xEVs could require substantial investments in the energy grid or intelligent/digital solutions to flatten load curves.

[1]Informants from corporate operators of vehicle fleets mentioned that the use cases for which they used xEVs were largely planned in advance and/or predictable.

**Political and/or regulatory influences:**
Informants from both investigated operators of corporate vehicle fleets perceived that political influences towards xEVs existed. FO Alpha had a close affiliation with governmental institutions, and a direct political influence was enacted through a shareholder. FO Beta perceived indirect political influences through the incentives for xEVs as well as the possibility of driving bans in urban areas. Furthermore, the informant in FO Beta reported a high level of managerial commitment to contribute to ecological sustainability with xEVs.

**Technological market fit:**
A major consideration for informants from the investigated vehicle fleet operators was the fit of the xEV's performance, assessed by examining its use cases, as well as the availability of complementary solutions (e.g., booking of infrastructure, electric charging). At the time of the interview, although the xEVs' TCOs were becoming more attractive (partly due to government incentives), they could not yet compete with conventional vehicles. However, price drops due to technological developments were expected. Furthermore, sustainable vehicle fleets were seen as a competitive advantage. Interestingly, informants mentioned that xEVs from vehicle brands with which the company was already familiar were easier to integrate into the company.

The findings are underlined by direct quotes provided by informants from corporate operators of vehicle fleets, as summarized in Table 33.

**Table 33:** Notable quotes provided by informants from research institutions regarding the influences that encouraged them to enter the ecosystem for xEV technologies. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS26<br>00h 20min 26s -<br>00h 20min 44s | FO Alpha | *"The problem used to be that every energy operator or energy supplier built up its own network. [...] You needed a card from them."* (adjusted for better readability) |
| MS27 20:22min<br>00h 08min 11s -<br>00h 08min 23s | FO Beta | *"We have actually mastered this challenge - range, durability, battery, vehicle quality - relatively well. One issue is still the availability of models."* |

## c) Influences on companies in the energy sector

**Underlying conditions for technologies:**
Informants from companies with a background in electrical energy (EC Alpha, EC Beta, EC Gamma) reported that their companies supported initiatives towards xEVs (predominantly electric charging infrastructure) to meet the corporate sustainability goals. Furthermore, the informants expected a significant increase in the xEV market share, leading them to extend their electric charging infrastructure and offer scalable solutions to both business customers (in business-to-business (B2B) relations) and private customers (in business-to-customer (B2C) relations). However, a number of hindrances were also mentioned: Not all current xEVs were able to fully utilize the

available infrastructure (e.g., some vehicles were not compatible with infrastructure.) In that regard, informants from companies from the electric energy sector highlighted the importance of digital solutions for transparent and intelligent charging. Informants from companies in the petrol energy sector (EC Delta, EC Epsilon) mentioned shareholder pressure to operate in more ecologically sustainable ways. However, they saw the current charging infrastructure as unfit to deal with high numbers of xEVs. Furthermore, they questioned the overall environmental sustainability of xEVs.

**Political and/or regulatory influences:**
Investigated energy companies unanimously saw xEVs as highly driven by political influences, and mainly the regulations on $CO_2$ emissions and financial incentives/funding for xEVs. However, regulations and political actors were also mentioned as hindrances. Installing public, and in part private infrastructure, were mentioned as being hindered by regulations (e.g., regulations towards infrastructure in residential buildings, regulations that affected the billing of charging operations, influences of municipalities that needed to grant access to public spaces to install infrastructure). Petrol-based energy companies estimated the potential impact of regulatory changes as high. For example, informants from EC Epsilon mentioned the possibility of an increase in taxes on electrical energy to compensate for electric charging costs.

**Technological market fit:**
Informants from energy companies indicated that multiple coexisting technologies existed for xEVs. However, the fit of these technologies depended on the use case in which they were applied. In addition, customers reportedly demanded solutions for electric charging. Interestingly, a large portion of demand came from business customers who were placed under pressure to meet their corporate sustainability requirements. Offers that addressed xEV operators were still seen as fragmented. Informants mentioned the need for involved technologies to mature as a prerequisite to provide attractive offers to customers. Energy companies from the petrol sector were mentioned as satisfying demands for more sustainable energy due to strategic considerations. Technological uncertainty (performance, unclear dominant technology) and the small market potential of xEVs – as compared to their potential in other areas – were stated as reasons to keep the investments in new technologies (e.g., hydrogen infrastructure, fuel cells) low.

The findings are underlined by direct quotes provided by informants from energy companies, as summarized in Table 34.

**Table 34:** Notable quotes provided by informants from energy companies regarding influences that encouraged actors to enter the ecosystem for xEV technologies. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS29<br>00h 16min 13s -<br>00h 16min 45s | EC Alpha on the role of emission regulations facilitating the entry of actors in the ecosystem | *"So, our expectation is that with 2020 this legal tightening at EU level with the $CO_2$ emissions will come. That is now also my subjective observation, very many manufacturers now also come out with new models - against this background - and between 2020 and 2022 a very big push will come."* (adjusted for better readability) |
| MS29<br>00h 24min 09s -<br>00h 24min 41s | EC Alpha on incongruent regulations | *"So very much in the establishment of the charging infrastructure. There are some obstacles and barriers to be removed. The way we see it, there are simply a lot of legal regulations that do not yet cover the topic of electric mobility, or only to a very limited extent. Basically, there is a great deal of uncertainty, which often extends to aspects regarding buildings."* (adjusted for better readability) |
| MS29<br>00h 33min 02s -<br>00h 34min 10s | EC Alpha on the roles of stakeholders and public interest | *"The energy suppliers are very much in the hands of the state. So, in comparison to other commercial enterprises, we are already very strong in business areas that do not directly have such strong, direct pressure on earnings, but where there is also the public interest. In the development of public charging infrastructure, there is already interest on the part of the owners to drive the matter forward and, I believe, here, in particular, there is an interest in really also driving innovations forward. So that is one, probably one of the main reasons why we dedicated ourselves to the topic very early on because the owners simply demanded it."* |
| MS30 43:22min<br>00h 43min 43s -<br>00h 44min 10s | EC Alpha on an expected shift in customer groups | *"The influence of end customers will also decline. [...] And in return, the requirements of large logistics companies, for example, will rise sharply. And they will be triggered again, via the back door of the policy of sustainability, sustainability reports, total $CO_2$ balance, etc. in the company. So there's something big, a big influencing factor coming at us, I think, in the future."* (adjusted for better readability) |

### d) Influences on companies involved in infrastructure

**Underlying conditions for technologies:**
Informants from companies that offered or enabled infrastructure solutions for xEVs stated that they were considering multiple technologies (e.g., electric charging, hydrogen). However, while still facing major obstacles (e.g., limitations of the energy grid), electric charging was currently perceived as the only feasible option. Substantial investments to overcome the limitations of the energy grid could in part be avoided by providing "intelligent" solutions for energy management.

**Political and/or regulatory influences:**
Informants from infrastructure companies perceived substantial political influence towards xEVs. This could occur through direct political intervention (INF Alpha) or indirectly (INF Beta, INF Gamma), for instance, through adjusted taxes or financial incentives. Only INF Delta saw itself as largely untouched by political influences while still acknowledging their overall effects.

**Technological market fit:**
Informants from infrastructure companies stated the need to ensure the technological and economic feasibility of their activities while also meeting customer requirements. In that regard, INF Alpha highlighted the need to offer customer-friendly solutions (e.g., through roaming and price transparency). Interestingly, INF Beta perceived the low pace of established companies in terms of offering charging solutions as a business opportunity.

The findings are underlined by direct quotes provided by informants from infrastructure companies, as summarized in Table 35.

**Table 35:** Notable quotes provided by informants from infrastructure companies on the influences that encouraged actors to enter the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS37<br>00h 08min 27s - 00h 09min 16s | INF Gamma about practical obstacles for providing private charging infrastructure | *"A major example for an obstacle is - that is solveable by technology - how do I install wallboxes in the garages of apartment buildings without massive investments or having to ask all residents. That is a regulatory issue that has a massive impact on electric mobility. "* |
| MS37<br>00h 28min 23s - 00h 28min 32s | INF Gamma about governmental influences on new technologies | *"When the public authorities want something to be pushed and provide funds for it, then the issue suddenly gets a boost. Of course that is what has happened here. Clearly, the issue of $CO_2$ neutrality, sustainability, the subsidies available in Austria for electric cars and wallboxes helps us, naturally."* |

### 8.1.5 Summary

Using the data collected from multiple actors – both upstream and downstream – a detailed understanding of the effects of the individual influences on the participation of individual ecosystem actors in the xEV ecosystem could be described. As summarized in Table 36, the data indicate how actors – both upstream and downstream – were either directly or indirectly influenced, encouraging them to enter the xEV ecosystem. The exact influences differed with regard to the positions of individual actors in the ecosystem. In support of the insights provided in Chapter 6, regulations that affect automotive OEMs, costs associated with xEV technologies, and the availability of technology complements represent major factors that influenced the individual actors' decisions and encouraged them to participate in the xEV ecosystem. Furthermore, the data indicate that, besides OEMs, multiple actors in the ecosystem were subject to either political or regulatory influences.

These results also show that the market fit for xEVs represents a fragmented picture depending on the customer groups (i.e., private and corporate customers), as multiple types of potential bottlenecks for xEVs were perceived (i.e., availability of vehicles and types of infrastructure). The actor's individual ability to overcome these bottlenecks significantly influenced their decision to enter the xEV ecosystem.

**Table 36:** Overview of empirical data gathered from investigated actors regarding influences that encouraged them to enter the xEV ecosystem.

| **Actors** | | **Underlying conditions for technologies** | | | **Political and/or regulatory influences** | | | | | **Technological market-fit** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | A3 | B1 | B2 | B3 | B4 | B5 | C1 | C2 | C3 | C4 |
| OEM | | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ |
| SUP | Tier 1 | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| SUP | Tier 2 | ✗ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ |
| SUP | Focus | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ |
| ETP | | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ |
| RI | | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |
| RET | | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ |
| FO | | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✓ |
| EC | electric | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ |
| EC | petrol | ✓ | ✗ | ✓ | ✗ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ |
| INF | | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |

**Legend**

| | | | | | |
|---|---|---|---|---|---|
| **A1** | Ecological sustainability of technologies | **A2** | Technological megatrends | **A3** | Infrastructure for technologies |
| **B1** | General political influences | **B2** | Changes and uncertainty in regulations | **B3** | Regulations on infrastructure |
| **B4** | Emission regulations | **B5** | Funding and subsidies for technologies | | |
| **C1** | Market dynamics for technologies | **C2** | Customer requirements towards technologies | **C3** | Market factors influencing the development of technologies |
| **C4** | Market factors for adoption of technologies | | | | |

## 8.2 Interactions for value creation in the ecosystem

### 8.2.1 Introduction and overview

In this section, an overview is presented of collected data regarding the interactions among the ecosystem actors in the xEV ecosystem (see research question three in Section 1.2). Again, the structure of the presented results mirrors the common themes that emerged during the analysis. Figure 52 gives an overview of these identified themes. A case-based description for the investigated aspects is provided in the appendix (see Chapter A.3). The results indicate

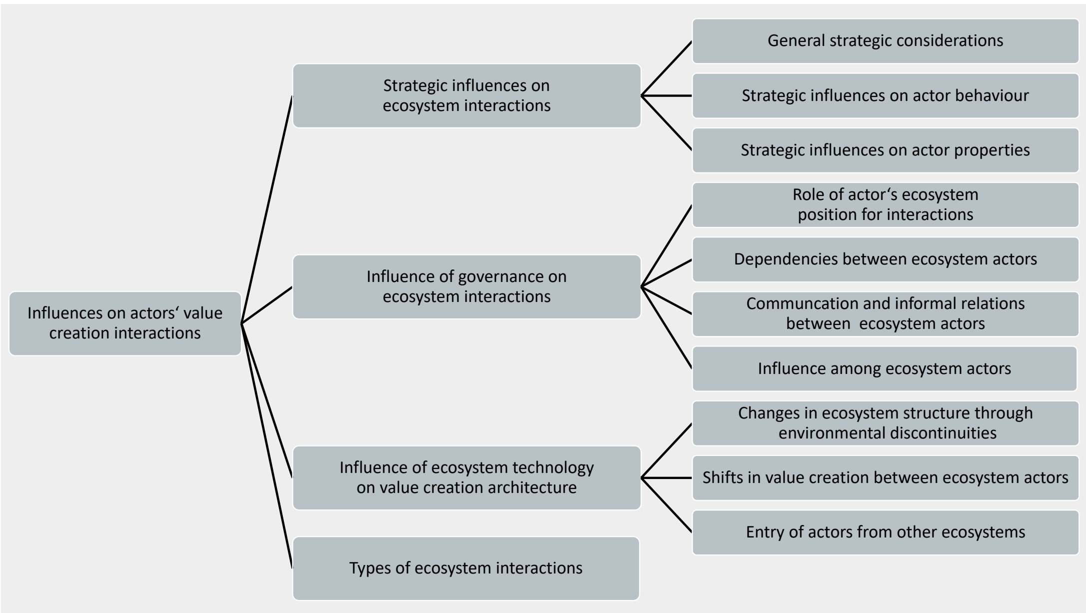



**Figure 52:** Overview of themes regarding research question three in collected data

that interactions with the ecosystem were guided by strategic considerations towards the actors' properties and behavior. Furthermore, the results underline the relevance of the governing factors with respect to ecosystem interactions, such as the actors' positions and roles in the ecosystem, actor interdependencies as well as communication and informal relations among actors in the xEV ecosystem. In addition, the results also suggest that the increased relevance of xEV technologies induced changes in the ecosystem's value creation architecture. This includes structural changes in the ecosystem, value creation shifts that occur between actors, and actors from multiple industries that enter the ecosystem to add value towards xEVs.

### 8.2.2 Results for central ecosystem actors

**Strategic influences on ecosystem interactions:**
OEMs have introduced xEVs in the past but were unable to generate profit in the undertaking. Informants stated the need to cooperate with actors in the ecosystem to increase the profit potential of xEVs. This finding is supported by the fact that OEMs at the time of data collection lacked technological capabilities in necessary technological areas, forcing them to rely on external actors to counteract their shortcomings. However, informants from OEMs stated their intentions to build up their own capabilities for xEVs. Furthermore, informants mentioned their intention to offer their technological components (e.g., powertrain components) to ecosystem actors to establish scale effects.

**Influence of governance on ecosystem interactions:**
Informants from OEMs stated that they were able to influence the technology development efforts of their partners in the upstream ecosystem. This was partly done by selecting and de-selecting suppliers, depending on the individual suppliers' fit with OEMs' requirements. OEMs relayed external influences (e.g., regulations, influences by share/stakeholders) on to their suppliers (see also Section 8.1) but tried to minimize their dependence on individual suppliers (e.g., by avoiding having only one supplier for a technology). Automotive OEMs influence was stated as being higher with smaller partners and in new cooperations. Informants from OEMs further stated that they increasingly required more flexible solutions from suppliers to cope with the changing requirements. Informants also mentioned the need to coordinate suppliers to ensure the function of the vehicle systems.

**Influence of ecosystem technology on value creation architecture:**
Informants from OEMs reported a competence shift away from OEMs as central ecosystem actors towards its suppliers in competence areas relevant for xEV technologies. As a result, informants stated that OEMs intensified collaborations with partners that had previously acted purely as suppliers. OEMs, as well as their suppliers, thereby triggered technological developments. The OEMs' increased need for technological flexibility was also stated as influencing its relations with engineering and technology providers. Actors seemed to be increasingly interdependent upon one another, which indicated a need to coordinate their activities. Interestingly, informants from OEMs mentioned a lack of initiative from energy companies to establish appropriate infrastructure for the electric charging of xEVs. As a result, OEMs deemed it necessary to pursue initiatives to improve electric charging infrastructure to be able to sell xEVs in high volumes. Informants stated that this was done primarily by creating separate actors for electric charging (e.g., through establishing joint ventures).

**Types of ecosystem interactions for technologies:**
Informants in OEMs generally stated that, due to a shift towards xEVs, their number of collaborations with ecosystem actors had increased. This allowed them to access new technologies (or components relevant for technologies) as well as to establish complementary offers (e.g., electrical energy and charging infrastructure for xEV charging). Furthermore, OEM Delta also mentioned its intentions to extend its scope and act as a supplier for other ecosystem participants.

**Table 37:** Notable quotes provided by informants from central ecosystem actors regarding the interactions needed to create value in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| PS6, PS7<br>n.a. | OEM Beta on building up capabilities for xEVs | *"The topic of drive technology in particular is an important point. We will not be using standard electric motors or standard batteries and will clearly ensure to be technologically capable in this area."* (adjusted for better readability) |
| MS22<br>00h 20min 00s - 00h 20min 36s | OEM Beta on changes in the ecosystem structure to enable complementary offers | *"Yes, the biggest risk is certainly the whole issue of infrastructure. Because of the whole infrastructure, on which we are also dependent, of course we can influence that, and we influence it as much as possible. So we also have joint ventures now with [name of Joint Venture], for example, or we are also looking for opportunities that, for example, with our [electric vehicle of the OEM] we also provide a card with which our customers have to pay the same price at all charging stations."* (adjusted for better readability) |
| MS22 26:22min<br>00h 26min 16s - 00h 26min 48s | OEM Beta on relations with its suppliers | *"It's more cooperative. So we learn from each other equally, so we, they are really partners for us, they are not just suppliers or something. It is often the case, quite honestly, that we have to learn from them. For example, [informant names several established Tier 1 suppliers] or other companies that used to be suppliers for us are now more like partners at the moment, because they have also invested a lot in technology."* (adjusted for better readability) |
| MS22<br>00h 33min 49s - 00h 34min 25s | OEM Beta on influences towards upstream suppliers | *"We have to prepare both sides for our future issues. And that is not only a huge task for us, but also for our partners. And clearly, through many cooperation deals, we can also tell them in which direction they want to go or have to go. We can only achieve something together if we both make major changes."* (adjusted for better readability) |
| MS24 15:26min<br>00h 14min 32s - 00h 15min 06s | OEM Gamma about the role of providers of engineering and technology | *"Another very important pillar is engineering service providers who help us deal flexibly with order changes, especially in the area of validation. That we can fall back on flexible resources outside the company, particularly when it comes to changes in the law, exhaust or emissions legislation, we have to ensure our product's validity. "* (adjusted for better readability) |
| MS25 52:26min<br>00h 07min 40s - 00h 07min 55s | OEM Delta on possible dependence from new actors entering the ecosystem | *"Now a young company, or a new, innovative company brings a technology, looks really great, but can you adjust to it now without becoming dependent on it?"* (adjusted for better readability) |

### 8.2.3 Results for upstream ecosystem actors

In this section, the data on the interactions of actors in the xEV ecosystem as reported by informants in upstream companies are presented. Consequently, the data reported by suppliers, engineering and technology providers, as well as research institutions are presented.

#### a) Data on interactions from the perspective of suppliers

**Strategic influences on ecosystem interactions:**
Informants from the investigated Tier 1 suppliers (SUP Alpha, SUP Beta) monitored their environments and the customer (mainly OEMs) requirements in order to adjust their competencies and technologies to make them an attractive partner for customers in terms of joint development efforts and sharing of development risks. Furthermore, informants from Tier 1 suppliers stated that they were more flexible in their production capacities than OEMs, making them attractive partners in collaborations. However, the long development times of products in combination with the end customers' uncertain acceptance were perceived as hindrances for xEV technologies. In addition, informants stated that the main decision criterion for customers was the product price. Investigated Tier 1 suppliers tried to keep the production of core elements in-house to demonstrate its added value while outsourcing non-core products. Informants from Tier 1 suppliers also considered options to bypass OEMs and deliver vehicles[1] directly to operators of vehicle fleets. Informants from the investigated Tier 2 suppliers (SUP Gamma, SUP Delta) also said that they observed market trends and were open to new technological approaches. However, changes in Tier 2 suppliers were estimated as having only a limited impact on the products for end customers. Finally, suppliers of focused technological solutions (SUP, Epsilon, SUP Zeta) also stated that they screened their environment for relevant factors as well as competitors and were in close contact with customers. However, informants indicated that they were selective about their cooperations and considered their technological capabilities, previous experiences, as well as strategic aspects. Simultaneously, the need to form cooperations to industrialize their technologies and manufacture high volumes of products was recognized. On the one hand, this was due to the fact that focused suppliers had limited manufacturing capacities. On the other hand, cooperations were seen as a means to accelerate market entries.

**Influence of governance on ecosystem interactions:**
Informants from Tier 1 suppliers stated that they depended heavily on the OEMs' commitment to technological directions. Established automotive OEMs were perceived as being influenced by additional OEMs entering the ecosystem that focused on xEVs. This led to accelerated technology development among ecosystem actors. In contrast to new OEMs that entered the ecosystem, established OEMs relied on their technological legacy (e.g., ICE technology) while they simultaneously also performed technological shifts. The suppliers' technological capabilities were perceived as a criterion in the OEMs' supplier selection process, which allowed them to influence the OEMs' decisions and technologies slightly. Suppliers, in turn, reported being able to

[1] For example as "white label" products.

largely select and influence their own suppliers further upstream. Informants from Tier 2 suppliers reported that they depended on established industry processes but also perceived the influences of customers and its network of partners. Quite in contrast to Tier 1 and Tier 2 suppliers, providers of focused technological solutions estimated their influence as substantial. However, in order to keep their offers of technological solutions flexible, the focused suppliers avoided investing in production capacities for high volumes and instead relied on licensed manufacturing of their products. Interestingly, informants from SUP Zeta mentioned that they cooperated with influential actors (e.g., operators of vehicle fleets) to increase their leverage to subsequently influence OEMs. SUP Zeta avoided forming exclusive partnerships to be able to increase the market share of the company's products and subsequently establish de facto standards.

**Influence of ecosystem technology on value creation architecture:**
Informants perceived the automotive industry as reluctant to innovate. However, the barriers that kept actors from entering the xEV ecosystem were estimated as lower than entry barriers with regard to ICE vehicles. This situation paved the way for new OEMs to enter the ecosystem, a process that required the support of established automotive suppliers in selected areas, such as engineering and manufacturing. In turn, these automotive suppliers started to rely on actors with engineering competencies (typically research institutions or engineering and technology providers) to be able to invest in development efforts outside their core competencies. Established actors from other industries (e.g., electronics, batteries) started to contribute their technological capabilities to xEV technologies. Furthermore, newly established actors (e.g., start-ups) also entered the ecosystem and provided specialized technological solutions for xEVs. These developments led to an overall increase in the number of actors in the xEV ecosystem and, as a result, a radically different supply structure for xEVs than for conventional vehicles. Informants reported that the established actors in the automotive industry performed M&A activities with these new ecosystem actors to extend their competencies in technological areas relevant to xEVs (e.g., battery, electronics). Since a part of the traditional value creation necessary for conventional vehicles is not necessary for xEVs (e.g., components such as electric motors are far less complex than ICEs), informants expected a shift in value creation between the established and new actors. Subsequently, informants predicted an overall consolidation of ecosystem actors. This result is supported by the perception that the OEMs who initially cooperated with ecosystem actors for xEV technologies showed tendencies to in-source value creation for xEVs. Furthermore, informants from suppliers predicted the increased relevance of actors that could provide complementary values for xEVs, such as electrical energy providers for vehicle charging.

**Types of ecosystem interactions for technologies:**
Suppliers for xEV technologies started to cooperate with new and established upstream actors (research institutions, suppliers, engineering and technology providers) as well as OEMs to develop competencies in technological areas relevant for xEVs. Informants stated, however, that suppliers needed partners that were able to supply components for new technologies in high volumes. This criterion was stated as excluding a number of actors from further cooperation. Focused suppliers notably did not commit to produce high volumes themselves but offered to support customers in the industrialization of their components or relied on external actors for manufacturing.

The findings are underlined by exemplary direct quotes from informants, as summarized in Table 38.

**Table 38:** Notable provided by informants from suppliers regarding the interactions in the ecosystem that create value for xEVs. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| PS2<br>00h 18min 56s -<br>00h 19min 32s | SUP Beta on the need to shift technologies | *"They say: Yes, if you want to continue to be a supplier to me, then you have to embrace these technologies and open up these technologies. That has a great impact. On the supplier side as well, of course. Yes, of course. [...] On the one hand they come with their own technologies. On the other hand, they are the ones who make these technologies possible in the first place."* (adjusted for better readability) |
| PS3<br>00h 15min 37s -<br>00h 15min 57s | SUP Gamma about influences in the ecosystem | *"Basically very open [towards change]. We would have to differentiate in individual cases. For example, changes to a product or a production process: Yes. However, we are still in the automotive sector - let's just say that we are restricted to a certain track, how such an approval process has to be carried out. We are not the only ones to determine this."* (adjusted for better readability) |
| MS1<br>00h 38min 42s<br>00h 39min 21s | Supplier Alpha on power relations in the upstream ecosystem | *"I'll put it this way, you can scale up I think, that what happens with ourselves in part in connection with our large customers - meaning the automotive and vehicle manufacturing industry. You can of course break it down a little bit to what happens to ourselves then as a very large Tier 1 supplier. [...] With the scale that we have, we take on a similar role, I guess, towards important suppliers. In terms of influence, demands that we make towards them. Similar to the situation we experience ourselves in with our customers."* |
| MS3<br>00h 14min 24s -<br>00h 14min 48s | SUP Beta on the role of capabilities in cooperations | *"You can work with partners where the gradient goes in the right direction. Where the partner knows at least as much or maybe even more in the area where you work together. [...] One works together with such a service provider where he has a lot to offer that the knowledge gradient points in the right direction."* (adjusted for better readability) |
| MS3<br>00h 20min 26s -<br>00h 20min 38s | SUP Alpha on the need to shift technologies | *"That you are the partner that the OEM goes to and says, here we have a need in 5 or in 7 years the SOP[1] should be...what kind of concept would you suggest? That is what we aim for.* |
| MS5<br>00h 29min 30s -<br>00h 30min 04s | SUP Beta about new OEMs entering the ecosystem | *"We then have a certain test and validation plan behind this technology carrier and for that we simply need some energy storage units, for that we need an energy converter, for that we simply need the elements that are important for that and often we cannot fall back on mass production products because they are new technologies that you can't get off the shelf. So here is the situation: Where do I get hardware from in time, a very important point in the whole network."* |

Table 38 continues on next page

[1]The abbreviation refers to the start of a production (SOP).

Table 38 continued from previous page

| Quote origin | Case and context | Quote |
|---|---|---|
| MS6<br>00h 44min 05s - 00h 44min 22s | SUP Beta about sharing risks with OEMs | *"Why does the customer come to us with such topics? Because he simply has someone with whom he can share the risk. This means he comes to us with a lot of business, or because of the incentive, because he says ok - I come to you and share the risk."* |
| MS7<br>00h 06min 15s - 00h 06min 52s | SUP Beta about new OEMs entering the ecosystem | *"Now that we see that many new players are pushing into the automotive industry, who actually have no experience with vehicles, but rather come from the service side, but are still thinking about building their own cars. We can help them to find the optimum in terms of costs and technology. At the end of the day, we make sure that the right technologies or dimensions are developed for their planned area of application - this means we support the vehicle specification."* (adjusted for better readability) |
| MS7<br>00h 17min 34s - 00h 17min 45s | SUP Beta about the influence of competitors in the automotive industry | *"I don't think it's a secret that - I think, OEMs wouldn't have moved so fast in this direction - the traditional OEMs wouldn't have moved so fast in this direction - if it had not been for actors like TESLA."* |
| MS7<br>00h 40min 38s - 00h 40min 46s | SUP Beta about the influence of competitiors in the automotive industry | *"Our biggest competitor is the OEM itself, because they usually make the decision whether to do it in-house or to hand it to another company."* |
| MS8<br>00h 11min 43s - 00h 12min 11s | SUP Beta about new OEMs entering the ecosystem | *"Electrification has simply added new customers. There are now new customer groups who say they don't even care about the ICE ballast, and a tradition as an OEM. They are now coming because of the lower entry barriers and say, "We want to develop an e-vehicle. And we want to bring it onto the market." That's mainly in Asia and very strongly driven in China. So there are just new players in the market."* |
| MS10<br>00h 39min 01s - 00h 39min 31s | SUP Gamma about influences in the ecosystem | *"We have been able to push the entire industry in this direction, that the acceptance is there and that we have been able to present the advantages transparently. That is point 1. Point 2: This is also confirmed by the fact that there are now some competitors who have very, very similar concepts to ours."* (adjusted for better readability) |
| MS11<br>00h 35min 21s - 00h 35min | SUP Zeta about the emergence of an ecosystem for xEVs | *"So if you're at the top level of the OEM, for example, then the topic is actually electromobility in general. So it's an innovation, and you can very well imagine how this cascade now extends down into the supplier structures [...]. There are the industries that have only just emerged based on this technological change at OEM level, and this also applies to the charging infrastructure, which was not yet in existence 5 to 10 years ago, it really began to develop and develop in a structured way about 5 years ago."* (adjusted for better readability) |

Table 38 continues on next page

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| Quote origin | Case and context | Quote |
|---|---|---|
| MS11<br>00h 38min 16s - 00h 38min 29s | SUP Zeta about the positioning of the company | *"So we are between T1 and T2 level, but we are also detached from it, because we do not only supply to OEMs, but also provide infrastructure."* (adjusted for better readability) |
| MS11<br>00h 44min 52s - 00h 45min 12s | SUP Zeta about the influence of xEVs on the ecosystem | *"So you have electric mobility as a big disruptive change with the whole supply chain for the vehicle itself. That is quite remarkable, so many of the established T1s are actually left out because they are not needed. You simply don't need a manufacturer of connecting rods or whatever for electric vehicles."* |
| MS12<br>00h 09min 19s - 00h 10min 59s | SUP Zeta about relevant stakeholders for electric charging technology | *"There was a change, for a long time the OEM was our most relevant stakeholder. And there is this chicken-and-egg problem, am I now concentrating on the charging infrastructure or am I concentrating on the component that is inside the vehicle? Our technology actually needs the OEM to integrate it into his vehicle. In this respect the OEM approach is still very important. But what is also decisive is the Tier 1, which supplies the OEM and which should be addressed to the same extent and you have to offer this value proposition to the OEM as well. This creates a "Triumvirate" between the OEM, the technology supplier and Tier 1. And it is often the case that the OEM says he needs a Tier 1 in order to be able to act at all, but at the same time the Tier 1 also says he needs the order from the OEM to be able to bear the development risk at all."* |

## b) Interactions of companies providing engineering and technologies

**Strategic influences on ecosystem interactions:**
Informants from ETP Alpha stated that they were developing technologies to fit their customers' specifications. ETP Alpha's customers benefited from technological solutions but also bore the associated market risks of the new technologies (e.g., investments in industrialization, uncertain market success). Since ETP Alpha did not manufacture large volumes of products/components based on its technologies, it was substantially more flexible in terms of its technological approaches than its customers. This allowed ETP Alpha to explore new technological solutions, subsequently building capabilities that its customers often did not possess. Furthermore, ETP Alpha's flexibility was stated as being an advantage in the current situation, as informants from ETP Alpha perceived that its customer requirements were becoming more volatile. Interestingly, informants in ETP Beta had a similar perception and stated that the development cycles were shortening while the cost pressure was increasing. According to ETP Beta, this led established actors in the automotive industry to outsource parts of their development efforts in order to reduce costs and maintain a high pace during individual development efforts.

**Influence of governance on ecosystem interactions:**
Informants from ETP Alpha described the company's capabilities as crucial factors (e.g., to be considered as a partner in cooperations). ETP Alpha began to develop new technologies and

increased its competencies in new technological areas in preparation for a potential market need to account for lead times in building capabilities. Subsequently, ETP Alpha was able to provide customers with data on the feasibility of new technologies and support its customers in shifting their capabilities (e.g., through training and joint development projects), subsequently influencing the technologies used by its customers. Furthermore, ETP Alpha also communicated its customers' requirements to suppliers, establishing a fit between the suppliers' capabilities and the customer requirements. The influence ETP Alpha could enact in the ecosystem partly depended on the size and type of actors. While ETP Alpha was able to carry out business relations with research institutions and smaller actors, the company had only limited influence over the principal directions of technological developments when dealing with larger component manufacturers. Informants from ETP Alpha stated the need to coordinate the individual actors' activities in joint development efforts. Information exchange and market intelligence relied on exchanges with customers (e.g., in joint projects). Informants from ETP Beta outlined a slightly different approach, whereby, besides R&D in selected areas, the company's competencies were largely directly developed in customer projects. Furthermore, informants from ETP Beta stated that they were restricted by the established processes in the automotive industry. Depending on the specific relation, ETP Beta acted as an enabler (e.g., for Tier 1 suppliers) while informants believed that their contribution – at least in principle – was considered as exchangeable by OEMs.

**Influence of ecosystem technology on value creation architecture:**
Informants from ETP Alpha recognized that a large number of actors were entering the xEV ecosystem. To expand its capabilities and capacities, ETP Alpha extended the number and intensity of its collaborations and performed M&A activities. Informants stated that, on their own, single actors in the industry value chain could not have all the necessary areas of competence to deal with the complexity of new technologies required for xEVs. However, ETP Alpha was able to contribute its technological capabilities at multiple points in the value chain. Subsequently, ETP Alpha was able to relay information and connect actors due to its relations with its suppliers and its customers. (For example, it could do this by pre-selecting suppliers for their customers.) This was especially relevant for xEV technologies, since ETP Alpha was also able to integrate and connect new actors from other industries that entered the ecosystem due to its knowledge of the automotive sectors and the technological capabilities. Informants from ETP Alpha stated that the whole industry needed to commit to the new technology to ensure its success. Currently, however, the number of suppliers for xEV core components was perceived as limited. Actual suppliers were perceived as struggling to establish scale effects. Like ETP Alpha, ETP Beta predicted that the uptake of xEVs would lead to a shift in the value creation architecture in the ecosystem. ETP Beta highlighted the fact that established actors would probably not be able to add value for xEVs in selected areas that are now covered by new actors originating from industries outside the automotive sector. Established actors that tried to contribute to xEVs were largely expected to either focus on using their remaining relevant capabilities in a different way or to shift their capabilities as a whole. ETP Beta stated that intense M&A activities were being carried out in the ecosystems. Informants assumed that this was in part due to the current ecosystem actors' efforts to shift their capabilities rapidly.

**Types of ecosystem interactions for technologies:**
ETP Alpha co-developed technologies with external partners (suppliers, customers, research institutions). However, partners for xEV technologies tended to be different actors than for ETP Alpha's other business areas. Suppliers of core components were highly relevant, since ETP Alpha integrated these components into modules and systems for its customers. Competition with suppliers was seen as low as they often acted as (development) partners for technologies. However, co-opetition could occur where involved actors had similar competencies. Informants from ETP Alpha also perceived an increase in the number of customers and an accompanying overall growing demand for xEV technologies. In contrast, ETP Beta offered resources and capabilities to customers that aimed to outsource engineering activities. Subsequently, while also relying on research institutions in selected areas, their activities were determined by their interactions with customers.

The findings are underlined using quotes from conducted interviews, as summarized in Table 46.

**Table 39:** Notable quotes provided by informants in engineering and technology providers regarding interactions in the ecosystem for xEV technologies. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS13<br>00h 04min 24s<br>00h 05min 03s | ETP Alpha about shifting competences in the ecosystem | *"Since the technologies are very, very new and the companies are not positioned in such a way that they also have this comprehensive knowledge, especially with the current OEMs or the classic OEMs who have made conventional drives so far, they simply need adequate support. Technologically, because they can't do it on their own and the second thing is, they don't have the capacity to provide the engineers that are needed to develop electrified vehicles. And that's where we're simply going to support them with engineering."* |
| MS13<br>00h 23min 40s<br>00h 24min 10s | ETP Alpha about information exchange in the ecosystem | *"Because of course we are not only having goods supplied by our partners, but they also provide us with information about market trends... so this is for sure. When we collect this information, it broadens our picture, of course we also talk to the customer, how they see it, but of course also from the supplier, what is technologically possible, what makes sense, we get this information strongly from the partners and thus they influence us technologically."* |
| MS13<br>00h 25min 23s<br>00h 26min 28s | ETP Alpha about development partnerships | *"Well, of course we have strong cooperations... in partnership with our customers, that we join forces, so partnerships are not only university partnerships but we also join alliances, so to speak, with OEMs and develop elements together, do joint research projects where there is not only one OEM but several actors because they are in a situation where they can't do everything on their own. [...] So you get together and look at it in an alliance, then you have a smaller investment to make and actually get a relatively large amount of input simply because you know that you have to disperse it a bit, yes."* (adjusted for better readability) |

Table 39 continues on next page

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| Quote origin | Case and context | Quote |
|---|---|---|
| MS14<br>00h 14min 51s - 00h 15min 08s | ETP Alpha about co-operations with other actors | *"It is normally always a cooperation, there is no other way. There are those where it's easy. If you don't have the same product. And when they both do engineering, we naturally have a certain competitive relationship."* (adjusted for better readability) |
| MS14<br>00h 40min 16s - 00h 41min 08 | ETP Alpha on buying capabilities and resources for technologies | *"You need acquisitions. You can't do it alone. And it's not possible because you can't build up the knowledge in the short time available. There are simply not that many people available. Then you actually have to buy them in the form of companies. Start-ups and companies like these, it's so logical - you can't cover the incredible range of technology. We struggle with our people to get along. That is the challenge. That you create the breadth of technology within the company. That is actually the main challenge."* (adjusted for better readability) |
| MS15<br>00h 32min 33 - 00h 32min 52s | ETP Alpha about communication of requirements | *"After all, the supplier does not always have full understanding of the final application or of the overall system. This means that the specifications that he actually has to comply with come from the customer and are passed on indirectly to the supplier via us."* (adjusted for better readability) |
| MS15<br>00h 42min 59s - 00h 43min 30s | ETP Alpha about customer requirements | *"I think you have to understand what the customer wants in principle. That is perhaps, I think that in the mobility sector it hasn't changed that much, because what the customer wants, what makes the customers tick, is still the OEMs, they tick the same, no matter what type of vehicle. I believe that little has changed there."* (adjusted for better readability) |
| MS15<br>00h 15min 14s - 00h 16min 09s | ETP Alpha about industrialization of its technologies | *"We can never directly demonstrate these cost targets, that's the risk of the customer pulling this up and then actually coming down with the costs. This is quite difficult for a new technology, because in the end you have to make sure that the customer builds up the supply chain. It's the same as in the automotive industry, in the classic one, where there are 20 manufacturers for each connecting rod and for each valve, who are under extreme cost pressure and can produce very cheaply. That's where you have to get to with a new technology, where there are perhaps new components, where there are not yet so many suppliers. And I believe that this is, in my view, a very big risk. You can't solve that overnight."* (adjusted for better readability) |
| MS15<br>00h 40min 02s - 00h 40min 31s | ETP Alpha about additional partners in the ecosystem for xEVs | *"I mean, through technology, of course, other partners have come into play. That is clear because they are completely different suppliers than those in our core business, but that is probably not something special either. If, as I said, I now start to develop battery vehicles or fuel cell vehicles and before that it was just internal combustion engines, then it is clear that I have new suppliers. In this respect, that has certainly changed."* (adjusted for better readability) |

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| Quote origin | Case and context | Quote |
|---|---|---|
| MS17<br>00h 34min 37s - 00h 35min 10s | ETP Alpha about information for strategic decisions | *"We provide the network as well, in fact. We offer to introduce customers to the industry, to introduce them to suppliers. We also offer studies on the state of the art of a technology - intellectual property, for example. So everything related to the topic where the customer wants more security or needs a decision basis for strategic decisions."* (adjusted for better readability) |
| MS18<br>00h 17min 55s - 00h 18min 08s | ETP Beta about its influence in partnerships | *"For Tier 1 we are in the role of an enabler, which means that we are very strong there, so now we are also very strong on these issues, very strong with the competence inside. As soon as it comes to the OEM, you are rather interchangeable."* (adjusted for better readability) |
| MS19<br>00h 32min 12s - 00h 32min 57s | ETP Beta about the effects of technological shifts in the industry | *"So if you have a look at it, many old ones are just falling away. That means that the companies that were around for years in the traditional topics are disappearing. These are also often companies that simply don't have the money or possibility to carry out this transformation. Many small companies, which are specialized, fall away. That means you can see that at the moment there is a turnaround in the industry. Everybody is trying to acquire something in order to be able to serve these topics quickly, and we are not exempt from that. There are companies that used to, let's say, grow naturally from the inside out, they no longer have the time. They suddenly buy companies."* (adjusted for better readability) |

### c) Interactions of research institutions

**Strategic influences on ecosystem interactions:**
Informants from investigated research institutions predicted that the current actors' competencies and capabilities in the automotive ecosystem would become less relevant for xEVs. They proposed that these actors could apply their competencies and capabilities in other areas.

**Influence of governance on ecosystem interactions:**
Informants from both investigated research institutions emphasized the dominant influence of automotive OEMs as central actors in the xEV ecosystem. However, while the OEMs' commitment towards technology was seen as a determining factor, OEMs themselves were heavily influenced by external factors (e.g., vehicle customers' requirements). Furthermore, influences from municipalities were mentioned (e.g., driving bans, support of charging infrastructure).

**Influence of ecosystem technology on value creation architecture:**
The relevance of new core-components for xEVs was perceived as having a major impact on the traditional ecosystem value creation architecture. Companies in the automotive sector started to shift their capabilities while new actors from other industries gained relevance for xEVs, taking on the role of suppliers for core components. Informants also perceived intense M&A activities where

actors that managed to adjust their competencies were acquired. Interestingly, both informants saw a substantial difference between competencies for xEVs between geographical regions. The potential for competition between OEMs and energy companies (e.g., as operators of vehicle fleets) was seen as low due to the OEMs' strong influence on vehicular technologies (e.g., electric charging).

**Types of ecosystem interactions for technologies:**
Companies in the automotive industry began to establish collaborations. This, in part, resulted in local[1] production capacities. Furthermore, informants in research institutions reported that relevant actors entered business relations to address the issue of charging infrastructure.

Again, the findings are underlined using quotes from the conducted interviews, as shown in Table 40.

**Table 40:** Notable quotes provided by informants from research institutions regarding the effects of interactions in the ecosystem for xEV technologies. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS20<br>00h 13min 58s -<br>00h 14min 23s | RI Alpha on new types of suppliers entering the xEV ecosystem | *'We can assume on the basis of - here we are again with the legislation - on the basis of the legislation that in a good 10 years almost every newly sold car will have a lithium-ion battery installed. So this is a huge market. And this is currently happening a bit alongside the vehicle manufacturers. These are new vehicle suppliers."* |
| MS21<br>00h 6min 15s -<br>00h 06min 25s | RI Beta about potential impacts in the ecosystem | When a *"[...] volume segment manufacturer flips the switch then this has a suction effect in the segment - up and down."* (adjusted for better readability) |
| MS21<br>00h 14min 48s<br>00h 14min 58s | RI Beta on the impact of xEVs on OEMs competences | *"Completely, or at least in part completely different technologies now become key-technologies. Think about the semiconductor or electronics industry."* (adjusted for better readability) |
| MS21<br>00h 17min 56s -<br>00h 18min 33s | RI Beta about the requirements for charging infrastructure in case of xEV mass production | *"The moment the OEMs have started to say that they are really going in the direction of mass production - to invest their energies - at that moment it was clear to everybody. [...] They need hundreds, thousands of sockets, preferably one for every car driver. Because they know they have to sell their vehicles now. Because they have to charge the vehicles as soon as this high-volume idea was really there - because they know they have to sell their vehicles somehow. Because they have to charge their vehicles somewhere. [...] As long as it was a complete niche vehicle, they could do what they wanted."* (adjusted for better readability) |

[1]In the same geographical region as OEMs other production capabilities.

### 8.2.4 Results for downstream ecosystem actors

In this section, the data on the interactions of actors in the xEV ecosystem as reported by informants from upstream companies are presented. Consequently, the data reported by informants from automotive retailers, corporate operators of vehicle fleets, companies in the energy sectors, and infrastructure companies are presented.

#### a) Interactions of automotive retailers

**Influence of governance on ecosystem interactions:**
Informants from automotive retail companies stated that they largely depended on their affiliated OEMs and had little to no influence on the OEMs' actions.

**Influence of ecosystem technology on value creation architecture:**
Informants from automotive retail companies perceived the relevance of charging infrastructure and electrical energy for customers as increasing.

**Types of ecosystem interactions for technologies:**
Informants from retailers mentioned that they tried to balance the disadvantages of xEVs through collaborations with rental companies. Energy companies that entered the market for xEVs were seen as a competitive threat. However, informants from automotive retail companies acknowledged the need to cooperate with companies from the energy sector for electric charging, indicating a co-opetition relation.

A relevant quote provided by an informant is presented in Table 41.

**Table 41:** Notable quote provided by an informant from an automotive retail company regarding interactions that create value in the xEV ecosystem. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS28<br>00h 29min 48s - 00h 30min 27s | RET Beta about collaborating with energy companies for electric charging | *"You have to provide the customer with charging solutions. This means that we cooperate with the energy suppliers, where you get a card. This is in the process of being standardized. [...] Without these other participants in the market, it would be difficult. But selling electric energy is a good business for them."* (adjusted for better readability) |

### b) Interactions of corporate operators of vehicle fleets

**Strategic influences on ecosystem interactions:**
Informants from FO Alpha clearly stated that collaborating with external providers for charging infrastructure was unattractive due to (1) high recurring costs and (2) dependence on external actors in their vehicle operations. However, informants from FO Alpha stated that the availability of external partners for service and maintenance was a prerequisite before making investments in xEVs. Informants from FO Beta underlined the need for governmental incentives to make xEVs an attractive option (see also Section 8.1).

**Influence of governance on ecosystem interactions:**
Before adopting xEVs on a large scale and making investments in infrastructure for electric charging, FO Alpha gathered information from actors that already operated substantial numbers of xEVs. This supported the integration of xEVs in FO Alpha's vehicle fleet. Similarly, FO Beta relied on proven technology from a limited number of suppliers to be able to scale up their xEV operations while minimizing the overall complexity of its xEV fleet. FO Beta was stated as being in a position to co-develop new technologies with OEMs. However, informants from FO Beta also recognized the OEMs' behavior as a hindrance for their xEV initiatives as the low availability of xEVs on the market represented a bottleneck for scaling up the share of xEVs in its vehicle fleet. Informants stated that energy companies played only a minor role in their xEV operations. Municipalities and their influence on the installation of charging infrastructure were considered as relevant factors.

**Influence of ecosystem technology on value creation architecture:**
Informants from fleet operators perceived that establishing sophisticated solutions for electric charging of xEVs was limited by the low xEV market share. This, in turn, was influenced by the fact that the OEMs currently provided only a small number of xEVs. Informants from FO Beta highlighted the need for regulatory changes to implement viable solutions for at-home charging.

**Types of ecosystem interactions for technologies:**
FO Alpha stated that it was cooperating with several providers of complementary solutions for the operation of xEVs in its fleet (e.g., booking software, operators of public infrastructure for electric charging). FO Beta highlighted the attractiveness of long-term partnerships while also stating that competition among xEV suppliers (i.e., OEMs offering xEVs) could provide benefits. However, due to the overall low number of xEVs on the market, the competition among suppliers was estimated to be rather low. FO Beta recognized the potential of cooperating with electrical energy companies.

Table 42 supports the presented insights with a relevant quote by one informant in FO Beta.

**Table 42:** Notable quote provided by an informant from a corporate operator of an xEV fleet regarding interactions to create value in the xEV ecosystem. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS27<br>00h 55min 38s - 00h 55min 49s | FO Beta on actors' uncertainty in the ecosystem | *"An illustrious group of companies is building up, all of which have a certain strategy but none of them knows exactly how it will work. There is a great deal of uncertainty in it."* |

## c) Interactions of companies from the energy sector

**Strategic influences on ecosystem interactions:**
Informants from electrical energy companies (EC Alpha, EC Beta, EC Gamma) perceived the market for xEVs and the respective technologies as developing towards maturity at a fast pace, which required their companies to adapt their activities. The volatility of the technological development of the xEV technologies and the involved market uncertainties required energy companies to demonstrate more flexibility than they needed in their regular business activities. Informants from EC Beta highlighted that the company tried to rapidly implement charging solutions to avoid competition with OEMs by outpacing them. Informants from petrol energy companies (EC Delta, EC Epsilon) were more reluctant to commit to new technologies than companies providing electrical energy. However, informants stated that they would monitor their environment and prepare for the gradual implementation of technological shifts.

**Influence of governance on ecosystem interactions:**
Informants from companies providing electrical energy saw their influence on OEMs as very limited. In turn, OEMs were stated as being in a comfortable position to determine specifications for xEVs and the respective charging infrastructure. EC Beta and EC Gamma managed to reduce their dependence on suppliers by introducing their own technological solutions for electric charging. Interestingly, electric energy companies started to intensify and formalize collaborations among one another. This increased their overall influence and enabled them to make xEVs more attractive for customers (e.g., through increased charging infrastructure coverage).

**Influence of ecosystem technology on value creation architecture:**
Informants from the electric energy providers saw that actors from multiple industries were beginning to add value to an ecosystem value proposition for xEVs (e.g., predominantly actors from the automotive sector and electrical energy providers). Informants from electrical energy providers saw options to realize mutual benefits using xEVs (e.g., improving charging infrastructure while creating vehicle-to-grid solutions). In turn, electrical energy providers also saw the possibility that OEMs provided energy for electric charging as a threat. Major shifts in the value creation architecture from the perspective of investigated electrical energy providers were stated to depend on the automotive OEMs' initiatives (price reductions of vehicles, technological improvements, offering high volumes of xEVs). Informants in companies for electrical energy stated to have

considered acting as operators of vehicle fleets to customers but decided against this option for strategic reasons (e.g., the dominance of automotive OEMs). Furthermore, informants from electrical energy providers highlighted that they intensified collaborations with other energy companies in the area of electric charging infrastructure. In addition, informants in electric energy providers stated that the number of their suppliers and companies that provided complementary offers has increased due to their initiatives towards charging infrastructure for xEVs. Similarly, informants from petrol companies expected a change in their energy supply infrastructure, while they also reported having broadened and intensified collaborations with other ecosystem actors to provide energy for xEVs. Furthermore, EC Delta was involved in the establishment of a dedicated company to address infrastructure solutions.

**Types of ecosystem interactions for technologies:**
Informants from electrical energy suppliers saw the potential for competition with the automotive sector in the area of electric charging infrastructure. They further reported that energy companies relied on a broad number of suppliers for specialized technologies of their own (established as well as additional suppliers for new technologies) and stated to perform co-development of technologies with selected suppliers. EC Gamma reportedly relied on suppliers to be able to focus on its core competencies. Competition among energy companies in the area of electric charging was seen as low. This is underlined by electrical energy providers that aligned their activities and collaborated in electric charging infrastructure. Informants from electrical energy companies stated that they acted as an enabler of xEV solutions for other actors. Informants from EC Epsilon further highlighted that the company relied on strategic partnerships with major actors (e.g., automotive OEMs) to explore and test new technologies.

Table 43 provides a summary of relevant quotes provided by informants that support the outlined insights.

**Table 43:** Notable quotes provided by informants from energy companies on interactions regarding xEV technologies. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS29<br>00h 48min 58s -<br>00h 49min 27s | EC Alpha on potential competition with OEMs | *"There are vehicle OEMs who are perhaps now completely reorganizing the value chain and supplying the energy for it, and that naturally influences us when such key players on the vehicle side perhaps offer not only the vehicle, but also the charging infrastructure and the necessary green electricity. And there are also initiatives and subsidiaries of these companies, and the strategy now seems to be going in that direction, so that does have an impact on us."* |
| MS31<br>00h 59min 49s -<br>01h 00min 17s | EC Delta on new competitors in the energy sector | The *"[...] OEMs see this business and want to get into this business. And the oil companies have missed this train. They're jumping on the hydrogen topic now because it's much closer to their core business. But as far as electric energy for driving is concerned, the German OEMs have missed it completely."* (adjusted for better readability) |

### d) Interactions of companies for infrastructure

As described previously, although similar in nature, investigated companies for xEV charging infrastructure showed largely different approaches:

**Strategic influences on ecosystem interactions:**
All investigated companies for electric charging infrastructure stated the intent to improve the charging infrastructure for xEVs. A dominant theme among investigated actors was their focus on customers (e.g., highlighting the importance of usability of charging solutions). One means to this end proposed by informants from INF Alpha was fostering the competition between multiple actors. Informants also underlined the relevance of norms and standards (i.e., for electric charging). Investments in technologies and the lead time to bring new charging solutions to the market were stated as being concerns for informants in investigated actors for infrastructure.

**Influence of governance on ecosystem interactions:**
Automotive OEMs were perceived as dominant actors for electric charging (e.g., due to their influence on industry norms and standards). However, informants from INF Beta stated that they could outmaneuver OEMs by introducing solutions at a rapid pace. Informants from INF Alpha coordinated actors for electric charging by setting specific criteria. INF Gamma and INF Delta stated the need to coordinate their suppliers actively. In that regard, informants from INF Gamma stated that they wielded substantial influence over suppliers by being affiliated with an automotive OEM. Overall, suppliers indicated that they influenced actors and encouraged the creation of infrastructure by introducing new technological solutions.

**Influence of ecosystem technology on value creation architecture:**
Informants stated that new actors providing solutions for electric charging were entering the xEV ecosystem. OEMs, however, were seen as reluctant to adapt their technological roadmaps while simultaneously in-sourcing activities that added value to the xEV ecosystem (e.g., electric charging infrastructure). One informant from INF Beta explicitly stated that cooperations with OEMs for electric charging were only feasible on a long-term basis. Cooperations with automotive suppliers were stated as being more attractive. Furthermore, informants mentioned the relevance of cooperating with actors from other industries (e.g., collaborations with energy companies to integrate vehicles into the energy grid). However, this was currently estimated as not being a pressing issue. Furthermore, informants from INF Beta perceived that, as the market for xEVs increased in attractiveness, actors began to differentiate and specialized.

**Types of ecosystem interactions for technologies:**
The type of interactions showed differences with regard to the investigated actors' specific approaches. INF Alpha took on a coordinating role and leased locations to operators of charging infrastructure. INF Beta provided solutions for charging infrastructure to B2B and B2C customers and faced competition by OEMs while also collaborating in selected areas. However, INF Beta cooperated with companies from the energy sector. INF Gamma, being affiliated with an OEM, perceived a low level of competition, which was stated as being due to the current high market potential of xEV charging. INF Delta coordinated its suppliers to develop and produce products and collaborated with B2B partners to gain market access.

Selected statements from informants in infrastructure companies are provided in Table 44.

**Table 44:** Notable quotes provided by informants from infrastructure companies on interactions in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS36 00h 21min 24s - 00h 21min 38s | INF Beta about collaboration and co-opetition | *"In the past, a lot of things were done together with competitors, because there was no market at all. Today you build your own partner network, specialize, internationalize, professionalize."* |
| MS36 00h 25min 50s - 00h 26min 24s | INF Beta about the influence of OEMs on electric charging | *"The OEM is insanely strong in its field. So it is calling the shots, clearly. It also tries to push the ISO[1] standard and the standardization so that it can scale. But you can work wonderfully around it, be ahead of it with speed. So yes, in the long run they have a very, very strong power and there's no getting around them. But you can counter it like a speedboat on the left and on the right, and then you can innovate a fair bit yourself."* (adjusted for better readability) |
| MS36 00h 26min 42s - 00h 27min 08s | INF Beta about collaborating with OEMs | *"We work with OEMs. I don't think that you really can push them into a technology or innovation, because they have their very, very rigid road map, and they stick to it. And it's incredibly difficult to take them along and influence them. So this is the monolith in the middle. They define the direction and you can only work around them, sometimes with them, but just very long term."* (adjusted for better readability) |
| MS38 00h 26min 23s - 00h 26min 54s | INF Delta in rivalries and differing paces in the value chain | *"Our main problem with us is that if you want to raise potential in your customer's value chain, you are not the only partner and you simply have so many stakeholders in there that rivalries can arise. Someone can't keep up the pace, in the worst case the customer himself, i.e. the one who initiates it, not the one who benefits from it, but our customer."* |

[1] Thias abbreviation refers to standards provided by the international organization for standardization (ISO).

### 8.2.5 Summary

Based on the results on factors that encourage actors to enter the xEV ecosystem presented in Section 8.1, this section reports the results of how actors in the ecosystem interacted to create value based on xEVs. Table 36 provides an overview on the mentioned influences.

**Table 45:** Overview of empirical data gathered from investigated actors regarding their interactions within the xEV ecosystem

| Actors | | Strategic influences on on ecosystem interactions | | | Influence of governance ecosystem interactions | | | Influence of ecosystem technology on value creation architecture | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | D1 | D2 | D3 | E1 | E2 | E3 | E4 | F1 | F2 | F3 |
| OEM | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| SUP | Tier 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| SUP | Tier 2 | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ |
| SUP | Focus | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ETP | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ |
| RI | | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ |
| RET | | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ |
| FO | | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ |
| EC | electric | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ |
| EC | petrol | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ |
| INF | | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Legend**

| | | | | | |
|---|---|---|---|---|---|
| **D1** | General strategic considerations | **D2** | Strategic influences on actor behavior | **D3** | Strategic influences on actor properties |
| **E1** | Role of actor's ecosystem position for interactions | **E2** | Dependencies between ecosystem actors | **E3** | Communcation and informal relations between ecosystem actors |
| **E4** | Influence among ecosystem actors | | | | |
| **F1** | Changes in ecosystem structure through environmental discontinuities | **F2** | Shifts in value creation between ecosystem actors | **F3** | Entry of actors from other ecosystems |

By examining the obtained results, an in-depth understanding of actors' interactions for xEVs can be derived. The data reveal stark differences between the actors upstream and downstream of OEMs. Established automotive OEMs used their influence to govern the upstream actors' behavior and supported their xEV initiatives. While established upstream actors, such as suppliers and engineering and technology providers, were influenced by the OEMs requirements regarding xEVs, they simultaneously needed to engage with new actors entering the xEV ecosystem. In particular, new actors that provide technological components for xEVs tended to require assistance from established actors in the automotive ecosystem to translate their contributions in a way that enabled them to create value towards xEVs. New suppliers for specific technologies also entered the ecosystem and tried to form industrialization partnerships in order to keep their technological flexibility while connecting the upstream technological approaches applied by major automotive actors (e.g., for electric charging) with the downstream complementary offers. In the downstream part of the ecosystem, governmental actors, automotive OEMs, and companies from the energy sector started to push infrastructure by either (1) establishing dedicated actors, (2) initiating activities to provide charging solutions themselves, or (3) coordinating activities to support the creation infrastructure undertaken by single actors.

# 8.3 Influences on business models in the ecosystem

## 8.3.1 Introduction and overview

This section presents insights obtained from data regarding the factors that the investigated actors perceived as influencing them and encouraging them to change their business models (see research question four in Section 1.2). Table 53 gives an overview of themes identified in the data. A case-based description for the investigated aspects is provided in the appendix (see Chapter A.3). Overall, results indicated that strategic considerations played a role for the informants. In addition,

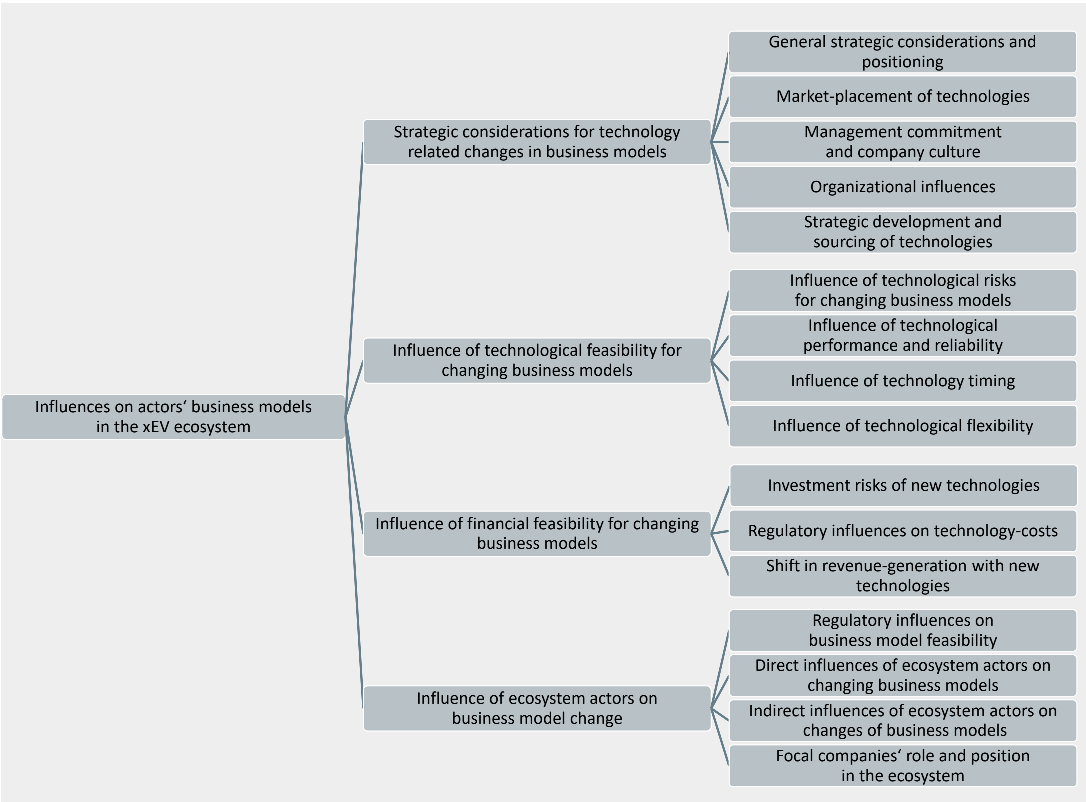


**Figure 53:** Overview of themes regarding research question four - sub-question one in the collected data

the data highlight the importance of technological and financial feasibility of new technological approaches as well as the influence of external actors on business models.

### 8.3.2 Results for central ecosystem actors

**Strategic considerations for technology related changes in business models:**
OEMs perceived building up capabilities for xEV technologies as challenging. Nonetheless, informants saw the development of technologies that were relevant for xEVs as an enabler of new business models. Electric drivetrains were perceived as a means to differentiate from competitors. OEMs recognized that in order to establish technological leadership, they needed to bring their innovations to the mass market. However, the timing of new technologies represented a major uncertainty for OEMs. Furthermore, informants stated that their company's size and structure would not support the industrialization of innovations, partly leading to changes in organizational structures (e.g., development of new technologies in separate organizational units). Furthermore, high lead times of vehicles in combination with environmental uncertainty were a concern for informants. Informants stated that OEMs reacted by shortening product cycles and increased flexibility of development processes to account for possible changes later in the vehicle development process. Informants also emphasized that increasing flexibility needs to be supported by the OEMs' corporate culture. In addition, one informant from OEM Delta underlined that management commitment was a crucial factor for their company's activities in the area of xEVs. Furthermore, the informant from OEM Delta outlined the importance of establishing economies of scale with components required for xEVs.

**Role of technological feasibility for changing business models:**
Informants stated that OEMs demonstrated the technological feasibility of xEV technologies early on. Technological components (e.g., batteries) required for xEVs were perceived as limiting factors (e.g., high costs and high weight). OEMs, therefore, investigated multiple options for xEVs relying on batteries or hydrogen fuel cells as the main power source as well as following hybrid approaches (i.e., HEVs, FCEVs, BEVs). Informants from OEM Delta underlined the fact that incremental developments that partly relied on established technology (e.g., HEVs) were an unattractive option. Furthermore, OEMs stated that ensuring the long-term reliability of xEVs was seen as difficult since they lacked experience with new technologies.

**Role of financial feasibility for changing business models:**
Informants indicated that vehicle costs of xEVs (partly due to high costs for components, such as batteries) were a concern. Besides, necessary investments in the technology hindered OEMs from establishing respective business models. Due to its small market share and low expected growth, as well as the current high costs for xEVs, informants in OEMs stated concerns about earning back investments. Informants from OEMs expressed concerns about committing to xEVs since the dominant technology was not perceived as clear. Recurring revenues from xEVs (e.g., revenues from xEV maintenance) were also expected to be lower as compared to conventional vehicles.

**Influence of ecosystem actors on business model change:**
Informants from OEMs stated that they were partly influenced by competitors and underlined the need for partners to make the development of xEVs financially more attractive. In that regard, informants in OEMs stated that suppliers were partly not able to deliver components for xEVs at the desired conditions (e.g., time, costs). Furthermore, the informants highlighted the need to be able to react to changes in their environment at a fast pace.

**Table 46:** Notable quotes provided by informants from central ecosystem actors regarding influences on their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| PS6, PS7<br>n.a. | OEM Beta on ways to cope with organizational inertia | *"It is of course difficult to change something in a large corporation like [COMPANY], simply because the structure is very large. [...] By necessity the change is forced and so it will just happen. That's already it. [...] Here, a parallel team was created in addition to long-established development departments. The willingness to change everything radically will always have some resistance."* (adjusted for better readability) |
| PS6, PS7<br>n.a. | OEM Beta on market and profit expectations of xEVs | *"So we will probably never be able to sell [an electric vehicle] in millions of units, and the technology that we have in such an [electric vehicle] is a very expensive technology, so in terms of profit it will be very difficult to use something like that so widely."* (adjusted for better readability) |
| MS23<br>00h 19min 20s -<br>00h 19min 57s | OEM Beta on risks associated with late expected returns on investment with new technologies | *"So I think the risks are more in the economic development than with us, with the technology. First of all, a major risk for us is that the investment we are currently making in electric mobility will not generate a return on investment in time. The problem is that we have invested a huge amount of money, but we don't know when this "turn around" will happen, that more vehicles will be sold electrically than, for example, with combustion engines."* |
| MS24<br>00h 35min 56s -<br>00h 36min 17s | OEM Beta on knowledge transfer and changes of business models | *"If a competitor or a partner shows us how to optimize components of our business model, we will do so. Otherwise, a company could not survive if it is not willing to adapt its business model."* |
| MS24<br>00h 36min 35s -<br>00h 37min 10s | OEM Gamma on uncertainty regarding value propositions | *"I would say the customer value proposition is clear at a later stage - which shortens our development times. The customer added value can only be quantified very late, which strongly influences our development goals. The market can no longer be precisely forecast in the long term."* (adjusted for better readability) |
| MS24<br>00h 41min 21s -<br>00h 42min 19s | OEM Gamma on mechanisms for coping with uncertainty | *"But the whole development process is adjusting, so to speak, to changes that are still unknown. That's the big impact. And that is technologically, but also economically in the cooperation with the partners. And procedurally the steps we can take creatively. And then, if something unforeseen occurs that is greater than what we could have foreseen, then we try to be able to deal with it properly with quick decision-making mechanisms within the company, so that here, too, we don't wait until some rule-adverse processes have run through, which may extend over weeks and months, but to be able to take shortcuts, defined shortcuts, perhaps also to go to the decision-relevant level. And to be able to bring about decisions quickly enough."* (adjusted for better readability) |

Table 46 continues on next page

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| Quote origin | Case and context | Quote |
|---|---|---|
| MS24 00h 40min 11s - 00h 41min 20s | OEM Gamma on the flexible development processes | *"In development, we try to provide for development processes that are as flexible as possible. There are always points in the development process where you can make major changes. In other words, we assume in advance that changes will be made, and we prepare for them in the process. [...] Especially when we work together with a Tier 1, the flexibility is already contractually fixed, so it is agreed to still define the changes to implement, which is quite difficult if you do not know them yet, but we try as good as we can to consider changes in packages - content you can then fill later when the changes actually come."* (adjusted for better readability) |
| MS24 00h 43min 33s - 00h 43min 53s | OEM Gamma on the competition between multiple technologies | *"Another risk is that a new technology may be in competition with another new technology and we can't tell at the time which one will be the successful one. And we still have to choose one, that can be a risk that we have to row back."* |
| MS25 52:20 00h 51min 58s - 00h 52min 24s | OEM Delta about aspects to differentiate with regards to xEVs | *"Of course, differentiation can now be made in terms of range, efficiency, yes, very much so, weight, charging times, etc., I think there's enough to differentiate. And the differentiating features have probably changed. And they are perhaps a bit less emotional than they used to be, you could also say that they are a bit more sober."* |

### 8.3.3 Results for upstream ecosystem actors

In this section, the data on the influences on business models reported by informants in upstream companies are presented. Consequently, the data reported by suppliers as well as providers of engineering technology are presented.

#### a) Data on influences towards suppliers' business models

**Strategic considerations for technology related changes in business models:**
Informants from investigated Tier 1 suppliers (SUP Alpha, SUP Beta) highlighted the need to investigate new technologies for xEVs. Specific reasons cited by investigated suppliers differed. Both SUP Alpha and SUP Beta acknowledged the need to focus on selected technological areas to build up new competencies but were – in part – limited with regard to how far they could scale up technologies by their existing production infrastructure. Informants from the Tier 1 supplier SUP Beta highlighted that capabilities for new technologies needed to be developed in selected technological areas according to customer requirements. Furthermore, non-core elements of its overall value creation were stated as being purposively outsourced. Informants from SUP Beta also stated the need to cover a broad range of technologies to be an attractive partner for the suppliers' customers in case they pursued a fast-follower approach. Interestingly, both customer

commitment and broad technological capabilities were mentioned as factors that could reduce the suppliers' risks. A further reason stated by SUP Beta was the need to develop broad technological competencies to be able to react to regulatory changes. In contrast, the informants from SUP Alpha mentioned the intent of establishing technological leadership but were limited by the large company size and rigid internal processes in reacting to new technologies. As a result, SUP Alpha established separate organizational units to investigate new technologies. Components for new technologies were initially acquired from ecosystem actors (other suppliers or competitors). However, informants from SUP Alpha further stated their intention to build up capabilities for new technologies inside the company to reduce its dependence on other actors. Suppliers positioned further upstream (SUP Gamma, SUP Delta), in contrast, either focused on a niche (SUP Gamma) or proactively managed their technologies to enter markets at a favorable time. Suppliers relying on a focused area of technologies (SUP Epsilon, SUP Zeta), in turn, stated that they avoided manufacturing high volumes of their products on their own. This way, they were more flexible in their technological solutions and less dependent on customers.

**Role of technological feasibility for changing business models:**
Informants from Tier 1 suppliers perceived substantial risks in xEV technologies (e.g., unclear timing of technologies, unclear dominant technologies, or a lower potential to create value). Technological risks originated partly in the large spectrum of use cases - and consequently different markets - the individual technologies for xEV could be applied in. Markets and use cases were, in turn, affected by standards as well as the availability of complementarities (e.g., charging infrastructure). In order to minimize risks, informants stated that they modularized their products to be able to offer them for xEVs as well as conventional vehicles. Overall, informants from suppliers perceived customers in the automotive industry as risk-averse.

**Role of financial feasibility for changing business models:**
Informants from Tier 1 suppliers reported high financial risks associated with xEV technologies and the respective business models. Specific risks mentioned were investment risks associated with necessary investment in new production infrastructure – in particular uncertainty regarding earning back investments and the OEMs' low price expectations and associated low margins generated with new technologies. SUP Beta stated that modularizing technologies could help to reduce product costs by establishing economies of scale while providing modules for multiple customers. In addition, the technological development of xEV components (e.g., batteries) was expected to bring xEV costs down. Informants from the Tier 2 supplier SUP Gamma highlighted the fact that changes in the technological components were usually justified by cost savings. Informants from SUP Epsilon stated that they would follow a holistic approach (from development to production) to keep product costs down. Furthermore, informants from SUP Epsilon recognized that, from a purely financial standpoint, xEVs were not yet competitive but could provide higher utility values than conventional vehicles in specific areas.

**Influence of ecosystem actors on business model change:**
Customers of investigated suppliers (ultimately the OEMs and end customers of vehicles) were perceived to have a strong influence on technologies applied to create value and respective elements of business models. Customers, in turn, were driven by governmental influences (e.g., regulations on emissions). With the notable exception of SUP Delta, suppliers that were located further

upstream were stated as having only a limited influence on investigated suppliers. Cooperations with new ventures, such as start-ups, to access new technologies were stated as being unattractive due to the overall technological uncertainty and the expected high level of volatility with regard to respective business relations. Informants from SUP Gamma (Tier 2) emphasized the need to align efforts tin introducing new products with customer requirements. SUP Zeta stated that they wanted to avoid exclusive relations to single actors to avoid influences from external actors.

As mentioned before, suppliers showed distinct characteristics depending on, for example, their position in the ecosystem and technological focus. Table 47 underlines the obtained findings by providing a selection of direct quotes from the interviews.

**Table 47:** Notable quotes provided by informants in suppliers regarding influences on their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS1<br>00h 01min 54s - 00h 01min 09s | SUP Alpha about the risks of technological shifts | *"It is a fact that today our company - like the entire automotive industry - does not know where and at what speed the entire technological development will be directed."* (adjusted for better readability) |
| MS1<br>00h 03min 09s - 00h 03min 39s | SUP Alpha on flexibility and influences in the supplier network | *"Everything is connected in a bigger network and they, in turn, watch us and look at what we are doing and so the whole chain pretty much goes on. In other words: All in all, one has to say that nowadays it is more important than ever to be highly flexible. Agile, flexible - these are of course the mottos of the hour."* (adjusted for better readability) |
| MS1<br>00h 39min 26s - 00h 40min 17s | SUP Alpha about the influence of technological and financial risks on their business models | *"The risks? Well, the risks are, first of all, missing things. That, I'd say, is the main risk. But I see good approaches to this, that people are well aware that this is the sword of Damocles par excellence. [...] The second risk is the compensation of the traditional revenues from the old business models. They need to be transferred to a new business model and that the infrastructure and costs are adapted to the new sources of income, which is a great risk."* (adjusted for better readability) |
| MS3<br>00h 13min 12s - 00h 13min 40s | SUP Beta about competences and added value | *"You just have to find out what your core competence has to be, to be an attractive partner for the customers. And where that comes from. In all the considerations that we have already touched upon, it is also possible to buy components. The things that are not relevant for a differentiation potential can be bought, that is - if there is enough added value in the company. That is the consideration."* (adjusted for better readability) |
| MS4<br>00h 12min 25s - 00h 12min 35s | SUP Beta about the automotive industry | *"The automotive industry is very sluggish also towards end customers. It is always difficult to predict what the end customer will really accept and adopt."* |

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| Quote origin | Case and context | Quote |
|---|---|---|
| MS4<br>00h 47min 47s -<br>00h 48min 25s | SUP Beta about environmental trends and related uncertainties | *"The interesting thing for us is that now that there are going to be changes in the business segment - everything is about the environment. Sustainability of the future and mobility concepts. These two have an impact, but we don't know how. We can't estimate it. And because we can't anticipate it, we are positioned very broadly in our considerations, in our projects, in our concepts in order to be able to determine all possible parameters and to react as quickly as possible when the time comes."* (adjusted for better readability) |
| MS8<br>01h 01min 05s -<br>01h 02min 25s | SUP Beta on actors drivers for xEVs | *"I would say that the technology that we are seeing now, the technology change in the automotive industry where we are talking about now, from e-mobility, has relatively little impact on the business model, at least for the part of the manufacturing of the product and the marketing. The business model is actually more influenced by other factors, as we have called it. From the trend towards "shared mobility", disadvantages in urban environments, the ownership of cars, simply a fundamental change in the, how shall I put it, the mindset of the masses."* |
| MS9<br>00h 22min 45s -<br>00h 23min 10s | SUP Delta about new actors in the field of xEV technologies | *"Well, in the direction of electrification there are of course new institutes, also universities. Then there are certainly other players emerging suddenly, well, other service providers, other consultants who specialize in the topic. Yes, and a completely different supplier structure."* (adjusted for better readability) |
| MS11<br>00h 40min 41s -<br>00h 41min 02s | SUP Zeta about dealing with technological uncertainty | *"You always try to keep all horses in the race as long as possible. You can predicate some aspects yourself quite well and you ask yourself the question "How can you set yourself up broadly, how can you also set the course as long as possible?" And this is how we are positioned now."* (adjusted for better readability) |

### b) Data on influences towards business models of providers of engineering and technology

**Strategic considerations for technology related changes in business models:**
ETP Alpha tried to anticipate customer demands, explore technologies, and build capabilities in advance. Volatile markets were stated as requiring ETP Alpha to perform more agile product management as well as to provide an overall broader portfolio of technologies. To do so, ETP Alpha invested substantial resources in its R&D activities. Informants from ETP Alpha stated that the company also tried to push its technological solutions to the market. Due to the growing demand for xEV technologies, informants recognized that ETP Alpha faced low competition in these technological areas. Technologies for xEVs explored by ETP Alpha were stated to complement its existing portfolio. Effectively exploring and utilizing these technologies, in turn, required ETP Alpha to increase communication within the company. Informants from ETP Alpha highlighted the commitment of management towards new technologies. Informants from ETP Beta, in contrast,

saw their company as a technological follower. Informants from ETP Beta stated that market requirements and the business environment determined its technologies.

**Role of technological feasibility for changing business models:**
Both informants from ETP Alpha and ETP Beta saw the coexistence of established as well as several new technologies (e.g., batteries, fuel cells, electric motors). Informants stated that the application of individual technologies depended on a specific use case. Informants from ETP Alpha recognized the existence of multiple technologies as a risk, requiring the company to broaden its technological portfolio. However, informants from ETP Alpha also predicted that technological uncertainty held business opportunities for the company.

**Role of financial feasibility for changing business models:**
Technologies for conventional vehicles (e.g., for ICE engines) accounted for a major share of ETP Alpha's revenues. The company subsequently used current revenues to finance its technological transition. Informants stated that the company considered market sizes and the expected returns of a specific technology in their decisions. Financial risks were, for the most part, faced by EPT Alpha's customers. In turn, customers were perceived as being influenced by necessary high investments in the industrialization of new technologies and regulatory uncertainties (e.g., emission regulations). In addition, high costs for vehicle end customers were seen as a disadvantage for xEVs, with use cases being estimated as being only partly financially feasible. Informants from ETP Alpha stated that customers demanded modularized products and flexibility in pricing. Furthermore, informants from ETP Beta mentioned the risk of investing in technologies that ultimately do not become relevant.

**Influence of ecosystem actors on business model change:**
Informants from ETP Alpha stated that customers along the automotive value chain applied their company's know-how in specific technology-based modules. Informants further stated that the regulations and complexity of xEV technologies had a positive effect on its business. Changing customer requirements and the customers' commitments towards technologies were perceived as positively impacting ETP Alpha. However, changes in the customers' strategies and changes in terms of commitment to a technological direction required ETP Alpha to keep a broad portfolio of technologies. These findings are supported by statements from informants in ETP Beta, who perceived that OEMs xEV initiatives lacked funding and commitment to new technologies.

The presented findings are underlined by selected statements from informants (see Table 48).

**Table 48:** Notable quotes from informants in companies providing engineering and technology regarding influences on their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS13<br>00h 08min 14s -<br>00h 08min 46s | ETP Alpha about offering flexible solutions to customers | *"As I said, the customers do not want to commit themselves, so we are actually forced to offer more flexible solutions. Well, it's not that it was our idea, but we see that customers don't want to commit themselves. They don't want to invest a large amount of money they don't know if this really has a long-term future and therefore we are forced to offer innovative, new business models to take the investment risk off their shoulders."* |
| MS13<br>00h 08min 48s -<br>00h 09min 24s | ETP Alpha about uncertainty and flexible solutions | *"At the moment they are simply facing an immense investment risk, but it is also, and we can see this in part in the services, that the OEMs don't know whether they should develop a battery electric vehicle, whether they should develop more hybrids, what is the concept that they are developing most sensibly? We also see that with the companies, that they are constantly changing their strategy. They start to develop a battery electric vehicle, then they cancel development and continue developing a hybrid, because they have the feeling that the market requirements are constantly changing, they don't quite know what will prevail in the medium term."* |
| MS13<br>00h 12min 35s -<br>00h 13min 27s | ETP Alpha about uncertainty and flexible solutions | *"Our risk is certainly that we cannot predict the situation in a few years. There are so many uncertainties because they [technologies] are not only technically determined, but also - as one also notices in the discussion - are partly determined politically, legislatively, are determined on the basis of public opinion, are determined on the basis of investments in the area of infrastructure. This means that we can only look at vehicle development, we cannot even assess it, but there are so many parameters in the environment that will influence it that it is difficult to predict today what will be the result."* (adjusted for better readability) |
| MS14<br>00h 42min 24s -<br>00h 42min 43s | ETP Alpha about the co-existence of multiple propulsion technologies | *We still live off the internal combustion engine. Because without the income from the internal combustion engine, we could never be able to establish the others at that rate, never. But the internal combustion engine is the cash cow for developing new things."* (adjusted for better readability) |
| MS16<br>00h 24min 23s<br>00h 24min 42s | ETP Alpha on the need to develop technologies proactively | *"We can do that and that is why we get the orders. This means we really recognize the requirements at an early stage and bring the solution to the requirements and do not wait for the customer to ask you exactly for an implemented solution. Much too late! So that means with our technology service provider business model, you have to be very, very early or you're gone."* |

Table 48 continues on next page

Table 48 continued from previous page

| Quote origin | Case and context | Quote |
|---|---|---|
| MS16<br>00h 25min 40s - 00h 26min 01s | ETP Alpha about the co-existence of multiple propulsion technologies | *"We have the electrified combustion engine, it will be completely electrified in the future, we have the battery vehicle, and we have the fuel cell. These are essentially the 3 propulsion systems that you can foresee for the next 20 years. So, they're in competition. And the competition is more open than most people think, because each system has its advantages and disadvantages."* (adjusted for better readability) |
| MS19<br>00h 09min 55s - 00h 10min 08s | ETP Beta about uncertainty and flexible solutions | *"We are determined by the customers. We cannot make a strategy that lets us develop our own product, we are always driven by the strategy and the needs of the customer. We adapt to that. That is simply the relationship."* (adjusted for better readability) |

### c) Data on influences on ecosystem business models perceived by research institutions

**Strategic considerations for technology related changes in business models:**
Informants from research institutions expected a gradual shift towards xEVs. Informants stated that besides gaining experience with the technology, xEVs were often operated for marketing purposes to increase the image of companies.

**Role of technological feasibility for changing business models:**
While the current technologies for conventional (ICE) vehicles were perceived as matured, the informants also stated that they were at their performance limit. The informants further recognized the existence of multiple alternative technologies, whereby a clear dominant technology is yet to emerge. The feasibility of a specific technology was predicted to depend on individual use cases.

**Role of financial feasibility for changing business models:**
Informants from research institutions saw necessary investments in technologies and, subsequently, products as a major hindrance for xEVs. xEVs were currently estimated to be financially not feasible. Automotive actors were perceived as beginning to investigate technologies for xEVs. Informants, nonetheless, also stated that actors from the automotive ecosystem tried to maximize their profits with established (ICE) technologies while shifting technologies. Companies pioneering the technology were stated as reducing the risks for technology followers.

**Influence of ecosystem actors on business model change:**
Informants saw that new OEMs entering the ecosystem for xEVs were a driving force for established automotive OEMs. Furthermore, xEVs were seen as an attractive option for corporate customers. However, selling high volumes of xEVs would require the appropriate performance of xEV technologies (e.g., vehicle ranges) as well as the availability of complementary offers (i.e., infrastructure).

As before, the findings are underlined by a selected statement (see Table 49).

**Table 49:** A notable quote from an informant in a research institution regarding influences on business models in the xEV ecosystem. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS21<br>00h 02min 49s<br>00h 03min 20s | RI Beta on OEMs financial considerations when balancing established and new technologies | *"The switch from combustion engine to e-motor is like the switch from steam power to the combustion engine. There are simply completely different key technologies available all at once. And what no one could afford, of course, is to simply develop these things preemptively, yes. Of course, I'm trying to - where I invested for years in combustion engines and thus also vehicle concepts, which are all optimized - I have to use this investment to the fullest."* (adjusted for better readability) |

## 8.3.4 Results for downstream ecosystem actors

In this section, the data are presented on the influences on business models as reported by informants in downstream companies. Consequently, the data reported by informants from automotive retailers, corporate operators of vehicle fleets, companies in the energy sectors, and infrastructure companies are described in detail.

### a) Data on business model influences from automotive retailers

**Strategic considerations for technology related changes in business models:**
RET Beta stated that the overall low availability of vehicles was a limitation for the uptake of xEVs.

**Role of technological feasibility for changing business models:**
Technological aspects of xEVs (range, battery lifetime) and complementary offers for xEVs (e.g., charging infrastructure) were seen as factors that hindered the establishment of business models based on xEVs. Informants in RET Beta predicted a gradual shift from conventional vehicles to xEVs. Informants further recognized the existence of multiple technological alternatives to conventional vehicles that could satisfy user requirements (e.g., HEVs combining high ranges with environmental sustainability). However, informants from RET Beta stated that current developments in the automotive sectors were partly independent of xEVs and their respective technologies (e.g., mobility on demand, car-sharing).

**Role of financial feasibility for changing business models:**
RET Alpha stated that the high likelihood that xEV price drops (e.g., due to technological developments) could present a financial obstacle for its customers, preventing them from committing

to xEVs.[1] Informants from RET Alpha also stated that the company lacked experience with reselling xEVs, which further increased the overall uncertainty associated with xEVs. Moreover, informants from RET Beta recognized that (1) offering xEVs at a price attractive to customers was challenging, while (2) an increase in its xEV business would potentially cause the company's after-sales revenues to drop. This would require automotive retailers to find other income sources with xEVs.

**Influence of ecosystem actors on business model change:**
Informants from automotive retailers stated that they would depend on actors for electric charging infrastructure in their xEV business models. Furthermore, informants mentioned cooperations with start-ups to access specific technologies needed for xEVs.

Table 50 provides a notable quote provided by an informant from an automotive retail company.

**Table 50:** Notable quote provided by an informant from an automotive retail company on influences on their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS28<br>00h 14min 17s - 00h 14min 45s | RET Beta about price as barrier of EV sales | *"But in the end, it is the customer who decides whether the electromobility strategy is successful or not. And there are many factors that play a role here, and it is ... a key point is simply still price. There is no way around it. As long as electromobility is considerably more expensive than the same internal combustion engine, then he would say: Well, why? If nobody is forcing me to do it?"* |

## b) Data on business model influences from corporate operators of vehicle fleets

**Strategic considerations for technology related changes in business models:**
Informants stated that stakeholder requirements regarding the sustainability and commitment of management (e.g., in the form of substantial investments) in fleet operators were the dominant reasons for using xEVs in vehicle fleets. Including a large number of xEVs was stated as being feasible to establish economies of scale when operating the technology. Furthermore, using xEVs was also seen as a means to address the demands of corporate customers. Consequently, xEVs were utilized by corporate operators of vehicle fleets to establish a competitive advantage.

**Role of technological feasibility for changing business models:**
Overall, the low availability of xEVs on the market and their low technological performance (e.g., range) were viewed as limiting factors for informants from both investigated FOs. Furthermore, the low availability of infrastructure complements for xEVs was seen as a major limitation. However, the recent performance increases have made xEVs more attractive for both of the investigated

[1] Dropping prices would devalue investments in vehicles for corporate customers.

fleet operators' use cases. Interestingly, FO Beta mentioned that their conventional vehicles fell short in performance[1]. FO Beta further stated that its familiarity with a car brand was considered as a precondition for buying xEVs. This seemed to exclude new OEMs (partly from Asia) from entering the xEV ecosystem.

**Role of financial feasibility for changing business models:**
The fast-paced development of xEVs was described as presenting a financial risk to vehicle owners. This was due to the possibility that technological progress would reduce the value of the owned vehicles. Subsequently, FO Alpha tried to lease its xEVs instead of purchasing them. However, as xEV technology matured, FO Alpha increased its leasing periods. Similarly, informants from FO Beta stated that xEVs were not cost-competitive at the time of data collection due to the high initial investments required. Since the recurring costs were estimated as being lower than those of conventional vehicles, informants stated that the TCOs of xEVs became increasingly attractive. Interestingly, FO Beta stated that investing in its own private infrastructure was estimated as being more cost-effective in the long run than cooperating with established providers of electric charging infrastructure. However, FO Beta avoided making investments in the energy grid. One informant from FO Beta recognized that financial incentives and subsidies made xEVs more attractive. Furthermore, the informant from FO Beta also expected that regulations would increasingly favor xEVs (e.g., in urban areas).

**Influence of ecosystem actors on business model change:**
FO Beta stated to be in contact with OEMs for testing xEVs, to provide data on the operation of xEVs, as well as to build up its capabilities with xEVs.

Relevant statements on the topic provided by informants are summarized in table 51.

**Table 51:** Notable quote provided by an informant from a corporate operator of vehicle fleets on influences on their business models in the xEV ecosystem. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS27<br>00h 56min 02s - 00h 56min 30s | FO Beta about coping with technological uncertainty | *"The problem is that nobody knows at the moment how exactly the technological leaps will look like. And I have to make decisions on a certain kind of uncertainty."* |

### c) Data on business model influences from companies in the energy sector

**Strategic considerations for technology related changes in business models:**
The investigated electric energy companies (EC Alpha, EC Beta, EC Gamma) tended to focus on their core competencies. Informants mentioned technological and financial uncertainty regarding new technologies and potential co-opetition with OEMs as factors that influenced this behavior.

[1] In particular, it was mentioned that a reason for this could be the adaptions to ICE-drivetrains, which were made to meet the emission regulations.

However, EC Delta mentioned their aim to be a first-mover in the area of new technologies, but in an isolated technological area (i.e., selected solutions in the area of electric charging). Furthermore, EC Gamma mentioned the need to shift its culture and technological capabilities due to increased volatility in its business environment. In contrast, informants from the investigated petrol companies (EC Delta, EC Epsilon) stated that they perceived pressure from shareholders to shift towards more ecologically sustainable solutions. However, the technologies that supported the provision of alternative energies were described as representing only a small part of their expenditures. Informants from EC Epsilon reported that, although the company investigated new technologies in-house, it separated large-scale ventures that applied technologies and supported xEVs from its core business and shifted these activities into distinct entities, such as joint ventures.

**Role of technological feasibility for changing business models:**
Informants recognized that improvements in xEV technologies (e.g., increased vehicle ranges and charging times) made the technology more attractive. They especially highlighted the need for reliable and user-friendly technology with respect to xEV charging. Technological standards for xEV charging (e.g., communication between vehicles and infrastructure, billing) would support the introduction of affiliated business models. However, the current standards were described as insufficient to meet the electric energy suppliers' requirements. Particularly EC Gamma stated that committing to new technologies depended on several aspects of the respective ecosystem (e.g., availability of resources or energy). Interestingly, the need for ecosystem actors to commit to a technology and the respectively high market share of technology products was also raised by informants in energy companies with a petrol background. They saw the uptake of xEVs into the ecosystem as a prerequisite for intensifying their activities to support the new technology.

**Role of financial feasibility for changing business models:**
Informants from electrical energy suppliers stated that they considered the profit expectations of activities other than providing xEV infrastructure to be inflated. Concrete risks mentioned were the uncertain development of the xEV market as well as the respective technologies and concerns regarding slow returns on investments in the xEV charging area. Informants from EC Beta specifically mentioned that they saw a risk of operating an outdated technology before they could recoup their initial investments. Informants in companies from the petrol sector took a more pragmatic approach. These informants mentioned that they would not undertake substantial investments until a certain technology had been proven financially attractive.

**Influence of ecosystem actors on business model change:**
The regulations, technological development of xEVs, and customer demand were perceived as being driving forces of xEVs. However, OEMs that provided an overall low number of xEVs on the market as well as the overall high delivery times for xEVs influenced the energy companies' business models for electric charging. Simultaneously, informants from energy companies saw the need to introduce business models in order to react to OEMs that entered the energy sector and offered solutions for electric charging. New business models were in part introduced by forging collaborations between ecosystem actors.

A relevant statement on the topic provided by an informant is presented in Table 52.

**Table 52:** Notable quote provided by an informant from an energy company regarding influences on its business models in the xEV ecosystem. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS33<br>00h 31min 09s - 00h 31min 40s | EC Delta on financial resources for technological shifts | *"Business models towards better, emission-free and climate-healthier technology - the oil and gas industry with its enormous free cash flow will be able to make a major contribution to investing in this transformation process and to being at the forefront again. Nobody else has the hundreds of billions of dollars to provide that, we do."* |

## d) Data on business model influences from infrastructure companies

**Strategic considerations for technology related changes in business models:**
INF Alpha was involved in providing infrastructure in line with government requirements by taking on an infrastructure coordinator's role. According to informants, the company developed infrastructure solutions to improve the attractiveness of the underlying technology. Currently, INF Alpha is pursuing solutions for electric charging. However, the company has observed developments in using hydrogen as fuel and, at the time of the interview, was prepared to offer solutions based on the technology if necessary. INF Beta, in contrast, noted that actors were substantially influenced by shareholders (i.e., companies from the energy sector) to offer solutions for electric charging. INF Gamma followed a flexible approach in addressing the market needs of BEVs. Informants underlined the need to have a company culture that embraces uncertainties. Similarly, INF Delta constantly refined its business model, relying on a small number of core technologies and external partners.

**Role of technological feasibility for changing business models:**
INF Beta relied on its network of partners to provide innovation that could be transformed into products and subsequently business models to test them on the market at a fast pace. Similarly, INF Delta tried to innovate rapidly. According to informants from INF Delta, this was because the timing of technologies was seen as a relevant factor in providing value for its customers. However, INF Delta's customers still faced a large share of risks associated with the failure or success of new technologies.

**Role of financial feasibility for changing business models:**
Although INF Alpha was mainly motivated by political intentions, informants stated that partnering actors faced potential risks if technologies were pushed too early. The partners faced financial risks (e.g., investing in an overall unprofitable business or in a potentially outdated technology). In a similar vein, informants from INF Beta stated the need to assess the financial and technological feasibility of meeting its customers' demands. Furthermore, INF Gamma highlighted the need for enough xEVs to be available to ensure the overall viability of the technology. INF Delta stated

that the availability of internal resources and the associated costs were criteria that it used for its sourcing decisions.

**Influence of ecosystem actors on business model change:**
Informants from INF Alpha highlighted that the company relied on partners to establish an appropriate electric charging infrastructure coverage. Furthermore, INF Delta underlined the role of customer demand, indicating its major influence on their business model.

A selection of relevant statements on the topic provided by informants is presented in table 53.

**Table 53:** Notable quotes provided by informants from infrastructure companies on influences on their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS35<br>00h 55min 14s -<br>00h 56min 03s | INF Alpha about influences for providing xEV infrastructure | *"Yes, the risk is of course whether it really takes off in time - in the sense that the vehicles will come. You have to achieve market penetration. Because if we now build up the charging infrastructure and continue to consolidate it, if no customers come, then at some point the five players mentioned before[1] will say: It won't work, because the charging infrastructure will be outdated by the time the customers come. So they have to come now, that is of course the risk."* (adjusted for better readability) |
| MS36<br>00h 13min 36s -<br>00h 13min 39s | INF Beta about requirements towards charging infrastructure | *"There must be customer demand, it must be financially viable and technically realistic."* |
| MS36<br>00h 09min 02s -<br>00h 09min 17s | INF Beta about disruptive innovations as drivers of its BMs | *"Yes, that is one of the drivers, [...] these disruptive innovations break through from below - flourish in our network. And we make products out of them, which either prevail or do not prevail."* (adjusted for better readability) |
| MS37<br>00h 42min 54s -<br>00h 43min 09s | INF Gamma about co-evolution of vehicles and charging infrastructure | *It's not as if tomorrow we suddenly won't have any more combustion engines. [...] It's a gradual transition. In these days when the car is changing, the infrastructure simply changes with it. It's just hard in the beginning.* |
| MS37<br>00h 45min 16s -<br>00h 45min 41s | INF Gamma about handling uncertainty | *"What will happen in the future is simply not predictable. But I think it's important to know that everything changes. [...] That's why you have to set up your team in a way that you can change things or react to things very flexibly. I think it is almost as important as forseeing what is going to happen."* |

[1] Author's remark: Energy companies and charge point operators.

### 8.3.5 Summary

The investigated automotive actors were confronted with situations whereby the established automotive ecosystem in which they operated showed large technological overlaps with the xEV ecosystem. However, in specific areas, participating in the xEV ecosystem with their business models required them to apply vastly different technological solutions as compared to the solutions they would apply in an established automotive ecosystem. This, in turn, had a major impact on the actors' business models - and particularly on the value creation and value proposition aspects of their business models. Two major factors that influenced the attractiveness of undertaking business model change activities were the technological and financial feasibility of technologies needed in the xEV ecosystem. Automotive actors who tried to participate in the xEV ecosystem were confronted with the need to change their existing business models in order to demonstrate value in the technological areas required to participate in the xEV ecosystem. Consequently, the actors differed in how they specifically engaged in initiatives to introduce changes to their business models or even how they established completely new business models. Their respective approaches tended to depend on their individual positions in the ecosystem as well as their ecosystem roles. For instance, as actors from the energy sector predominantly acted as complementors, these actors tended to face a lower risk of investing in technologies as compared to automotive actors who were shifting from their established ecosystem into an ecosystem centered around xEVs. An overview of the identified factors is presented in Table 54. Furthermore, the interactions and influences observed among ecosystem actors, which are outlined with regards to research question three (compare Section 8.2), were stated as being relevant factors that influenced the individual ecosystem actor's business models. These interactions and influences included upstream interactions orchestrated by OEMs as central ecosystem actors and downstream engagements that helped these actors overcome co-dependencies in value creation and offering complementary values in the xEV ecosystem.

**Table 54:** Overview of empirical data gathered from investigated actors regarding influences on their business model(s) in the xEV ecosystem. The table provides the abbreviated versions of the main categories. See Figure 8.3 for a detailed breakdown of the respective category system.

| Actors | | Strategic considerations | | | | | Technological feasibility | | | | Financial feasibility | | | Ecosystem actors | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | G1 | G2 | G3 | G4 | G5 | H1 | H2 | H3 | H4 | I1 | I2 | I3 | J1 | J2 | J3 | J4 |
| OEM | | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ |
| SUP | Tier 1 | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ |
| SUP | Tier 2 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ |
| SUP | Focus | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ |
| ETP | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| RI | | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ |
| RET | | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✓ | ✗ | ✗ |
| FO | | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ |
| EC | Electric | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ |
| EC | Petrol | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ |
| INF | | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✗ |

**Legend**

- **G1** General strategic considerations and positioning
- **G2** Market-placement of technologies
- **G3** Management commitment and company culture
- **G4** Organizational influences
- **G5** Strategic development and sourcing of technologies
- **H1** Influence of technological risks for changing business models
- **H2** Influence of technological performance and reliability
- **H3** Influence of technology timing
- **H4** Influence of technological flexibility
- **I1** Investment risks of new technologies
- **I2** Regulatory influences on technology-costs
- **I3** Shift in revenue-generation with new technologies
- **J1** Regulatory influences on business model feasibility
- **J2** Direct influences of ecosystem actors on changing business models
- **J3** Indirect influences of ecosystem actors on changes of business models
- **J4** Focal companies' role and position in the ecosystem

## 8.4 The actors' business models in the ecosystem

In this chapter, the results are categorized according to the established business model dimensions of *"value proposition," "value delivery," "value capture,"* and *"value creation"* (Clauss, 2017; Remane et al., 2017). To ensure the clarity and simplicity of the presented results, the dimensions of value proposition and value delivery were combined. Moreover, the business model changes of research institutions were not explicitly investigated and are not addressed in detail—however, the informants from research institutions provided outside perspectives on business models in the xEV ecosystem. A detailed case-based description of the investigated aspects is provided in Appendix A.3.

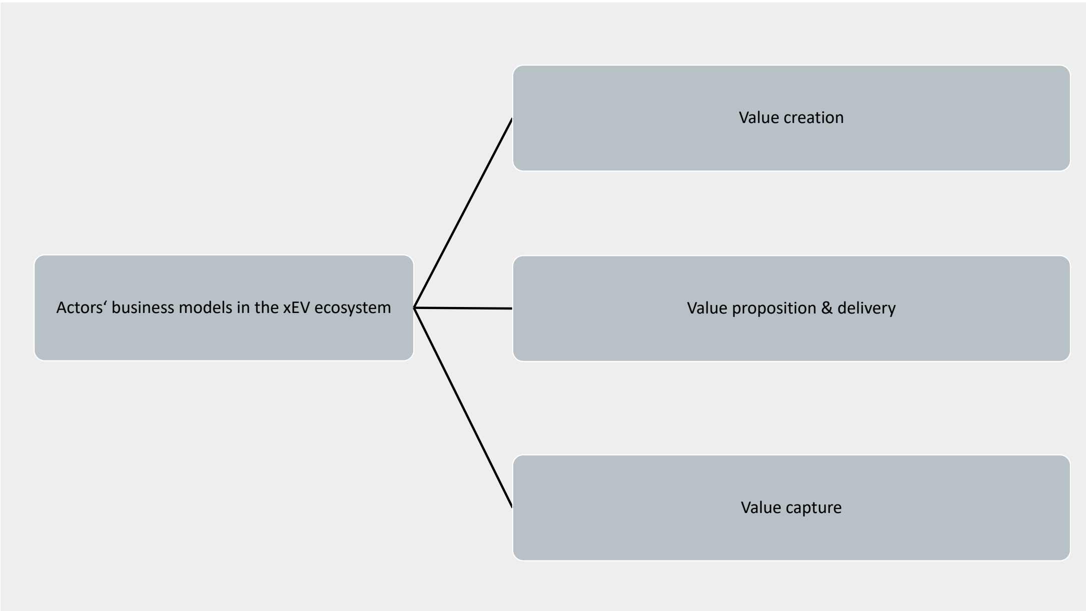


**Figure 54:** Overview of the literature-based dimensions (Clauss, 2017; Remane et al., 2017) used to structure the results for research question four - sub-question two

### 8.4.1 Results for central ecosystem actors

**Value creation:**
The informants from OEMs stated that they tried to preserve their current vehicle competencies as well as extend their competencies to new areas that were required to offer value propositions based on xEVs. Furthermore, the informants from OEMs highlighted that this included building up capabilities in technological areas that were relevant for xEVs and complementary areas, such as xEV charging. To manage this shift, the OEMs relied on collaborations with upstream actors such as suppliers, engineering and technology providers, as well as research institutions. At the time of the interviews, suppliers were perceived as having a higher level of technological expertise in certain areas that were relevant to xEVs. However, informants from OEMs mentioned that

their companies tried to increase the internal capabilities for products that were provided by their suppliers. This, in turn, was described as slowing down development efforts. In addition, informants from OEMs recognized a general tendency to perform M&A activities to increase new capabilities rapidly. Overall, the principal approach regarding how OEMs collaborated with partners seemed to remain unchanged. For example, OEMs still tried to remain largely independent of suppliers, requiring at least two suppliers for an individual component. Nonetheless, the informants also mentioned that they tried to shorten their development cycles and to integrate more flexibility into development processes. This was deemed as necessary by informants due to the high amount of environmental volatility, especially in the area of xEVs. As a result, OEMs tended to require more flexibility from suppliers. Interestingly, OEM Delta highlighted initiatives that enabled them to act as fleet operators and to act as a supplier for other ecosystem actors. OEM Delta also emphasized the fact that actors needed to operate xEVs to gain experience with the technology.

**Value proposition and delivery:**
Informants from OEMs expected that vehicles would be largely electrified. However, this description included vehicles with a low degree of electrification up to fully electric BEVs. Predicting customer requirements was seen as a challenge by informants from OEMs. One informant from OEM Delta stated that the primary value proposition with regard to xEVs differentiated the company's value proposition in terms of its design and vehicle performance. In order to overcome obstacles that stood in the way of providing an overall ecosystem value proposition for xEVs, the OEMs (1) tried to provide appropriate vehicle properties (e.g., range) (2) started to investigate solutions for charging infrastructure as well as providing the respective charging energy and (3) engaged in activities to provide customers with mobility solutions (e.g., car sharing). Interestingly, while OEMs facilitated points (2) and (3), these activities were carried out in separate legal/organizational entities that, however, were still strongly affiliated with the OEMs. Further, OEM Gamma said that it had high standards regarding its suppliers in order to demonstrate a higher value to its customer (e.g., ethical and moral standards of the suppliers). Overall, informants from OEMs indicated that their companies were preparing to provide offers (both components and complements) that would enable them to be able to sell high volumes of xEVs in the near future.

**Value capture:**
OEMs stated that xEVs were mainly supplied to corporate customers. In that regard, vehicles were described as being mainly leased rather than sold. Furthermore, the informants mentioned the high costs of xEVs. Subsequently, they tried to reduce the xEV costs by, for example, offering xEV components to other ecosystem actors. Informants from OEMs stated that their companies would generate high revenues from upper-class conventional vehicles (which usually emitted high amounts of emissions) and used xEVs in their portfolio to meet regulatory emission goals to avoid fees.

The findings are underlined by selected quotes provided by informants from automotive OEMs (see Table 55).

**Table 55:** Notable quotes provided by informants from automotive OEMs regarding their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| **Quote origin** | **Case and context** | **Quote** |
|---|---|---|
| PS6<br>PS7<br>(time stamp n.a.) | OEM Alpha on electric charging infrastructure | *"The petrol station network has developed over years. It has been recognized that nobody really takes the issue of charging infrastructure into their own hands. In principle, it was expected that the energy suppliers would take care of this issue, but this is not yet apparent. [...] That's why we are forced to go in this direction, because this is the only way to sell the cars in the future."* |
| MS23 04:38<br>00h 04min 38s - 00h 05min 25s | OEM Beta on pursuing multiple technological alternatives | *"We are very broadly positioned. But the question of whether we will only make electric vehicles in the future does not arise for us. We will continue to develop and pursue all technologies, including conventional vehicles and electric vehicles. We are also developing the fuel cell. [...] In the case of conventional vehicles, we will continue to pursue both diesel and gasoline. The important thing is that all vehicles, including conventional ones, will always have a small proportion of electrification. From mild hybrids to plug-in hybrids, but there will be no completely conventional vehicles without electric support."* (adjusted for better readability) |
| MS23<br>00h 05min 51s - 00h 06min 39s | OEM Beta on infrastructure and vehicle energy storages | *"Where we will have a problem is the infrastructure. That's where it's always lacking. And there are now two possibilities for the future. Either we make the energy source which we use to run an electric vehicle so practical that it can really be recharged in a few minutes, we will probably have to change or adapt the battery technology ourselves. [...]. Or we change the charging infrastructure in a way that makes vehicles practically usable. [...] No matter if it is electric energy or hydrogen or whatever."* (adjusted for better readability) |
| MS23<br>00h 31min 22s - 00h 31min 32s | OEM Beta on capabilities and collaborations | *"Yes, first we check whether we can do it internally, whether we have the know-how, whether we can build up centers of excellence, and if all this does not work, then we rely on external partners."* |
| MS25 29:38<br>00h 28min 52s - 00h 29min 28s | OEM Delta about the role of cost reductions | *"Yes, the products are getting better, cheaper. I think that's the main benefit at the moment. Simply being freed from this initial ballast, where all companies have now invested an insane amount in recent years and are trying to transfer that and try to generate value there, of course. The art is, how can I make the products affordable without this ballast and that is the direct benefit for the customers. You will also see that the batteries will become cheaper, the components cheaper, the cars cheaper in general."* |

### 8.4.2 Results for upstream ecosystem actors

In this section, the data on business models as reported by informants in upstream companies are provided. Consequently, the data reported by informants from suppliers as well as engineering and technology providers are presented.

#### a) Data on business models from automotive suppliers

**Value creation:**
Informants from Tier 1 suppliers mentioned that their companies used financial resources to perform M&A activities to extend their competencies into the area of xEVs. Furthermore, informants stated that suppliers needed to act more flexibly. In turn, Tier 1 suppliers relayed flexibility requirements to their suppliers further upstream. According to informants, Tier 1 suppliers acquired new technology components on the market while increasing their capabilities in selected areas (e.g., electric motors) in order to be able to produce them on their own. One reason mentioned by informants from SUP Beta was that new technologies for xEVs reduced the company's potential to create value. Adapting employee capabilities (e.g., through training) was mentioned as a necessary and challenging undertaking. Technological capabilities were cited as key skills for integrating technologies into vehicle systems and ensuring the overall system properties. Furthermore, integrating new technologies was stated as requiring changes in the development processes. Overall, accessing the other actors' resources and capabilities by forming collaboration was stated as a necessity for xEV technologies. However, informants from SUP Beta highlighted the need to demonstrate core competencies in the selected technological area while relying on suppliers for non-essential goods or services. Informants from SUP Beta mentioned that suppliers for xEV technologies tended to have a narrow technological focus.

Informants from the investigated Tier 2 suppliers stated that they performed improvements in production processes for xEV technologies. However, the approaches taken by the investigated Tier 2 suppliers differed. Informants from SUP Delta highlighted the need for their company to demonstrate distinct values with technologies. Consequently, SUP Delta cooperated with research institutions as well as engineering and technology providers. Furthermore, informants from SUP Delta mentioned that their company relied on different suppliers for xEV technologies than for its conventional business, leading to an overall increase in the number of partners.

Focused suppliers of technologies stated that they performed the steps required to bring technology to the market largely in-house. However, both SUP Epsilon and SUP Zeta avoided investing in production infrastructure. Alternatively, both companies took on the role of a technological enabler for their customers and helped them industrialize their products. SUP Zeta relied on a network of actors to market its technologies/products.

**Value proposition and delivery:**
Informants from Tier 1 suppliers stated that the archetypical business model of developing and selling products to customers (primarily OEMs) did not change in the case of xEVs. However,

informants also recognized that the underlying technologies of its value proposition were gradually changing. Furthermore, informants from suppliers stated that sharing risks when developing and industrializing technologies and subsequent products for xEVs provided additional value to their customers. Creating appropriate values for customers was ensured through communication and information exchange. Similarly, informants from the investigated Tier 2 suppliers stated that their principal business model had remained largely unchanged by the OEMs' shift towards xEVs. Informants also emphasized contact and information exchange with customers. Interestingly, both Tier 2 suppliers emphasized the need to deliver their products to customers worldwide. Informants in focused suppliers of technology emphasized the customer-oriented development of technologies as well as customer support when industrializing their products as part of their offers.

**Value capture:**
In Tier 1 suppliers (SUP Alpha, SUP Beta), profits were achieved by direct product sales. Development capabilities were used to justify the sale prices and improve cost efficiency in terms of the development efforts. However, investments in technologies for xEVs were considered as unprofitable. Furthermore, revenues from after-sales business (e.g., product maintenance) were predicted as lower with xEV technologies. Focused suppliers (SUP Epsilon, SUP Zeta) generated revenues by licensing their technologies, carrying out development projects with customers, and obtaining research grants.

Again, the findings are underlined using direct quotes from informants, as summarized in table 56.

**Table 56:** Notable quotes provided by informants from suppliers regarding changes in their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS1<br>00h 08min 01s<br>00h 08min 26s | SUP Alpha on the small change of their business model | *"Well, I have to say that I have been in the business for almost 30 years now, so I would say that the business model - in the narrow sense - has hardly changed at all to date. Of course the technology has changed. But the business model, and by that I mean our role in a larger conglomerate hasn't really changed."* |
| MS2<br>00h 08min 10s -<br>00h 08min 42s | SUP Alpha about changing technologies in the industry | *"The bigger disruption will come in the next few years, when we suddenly say, we don't need [specific type of transmissions] any more, because we are talking very intensively about hybrid, about the combination of electric and diesel, because we are talking very intensively about electrification. There really is a disruption in the technology. We are in the process of getting ourselves in the right position for this. We don't want to be the Kodak of tomorrow."* (adjusted for better readability) |

Table 56 continues on next page

Table 56 continued from previous page

| Quote origin | Case and context | Quote |
|---|---|---|
| MS7<br>00h 03min 19s - 00h 04min 25s | SUP Beta about what constitutes their added value in the ecosystem | *"After all, we are an automotive supplier. That means if I consider the OEM as a customer, I would say now, that the issues of zero emissions, i.e. reducing fleet emissions, especially in the case of electric mobility are essential to him. But that is more or less irrelevant as long as you only look at the drivetrain components. I think the topic becomes more exciting when you look at the entire value chain. In other words, also in terms of batteries, rare earths, which are the critical elements for electric mobility. I believe that if you look at it from the point of view of what we are dealing with today, you will see that for us, understanding the overall system is the added value for the customer."* (adjusted for better readability) |
| MS7<br>00h 19min 07s - 00h 19min 32s | SUP Beta on the influence of electric mobility on their business model | *"So for me this has not really resulted in a new business model yet. I say that was actually a technological shift. You just switch from ICE, or combustion engine, to electric mobility. The business model, where I say I still sell a vehicle with an electric motor inside, is still the same for me. It's just the same in green, literally."* |

### b) Data on business models from engineering and technology companies

**Value creation:**
Informants from ETP Alpha stated that xEVs required largely different technological capabilities as compared to conventional vehicles. In addition, integrating technologies into the vehicle required knowledge about the overall vehicle system. Informants from ETP Alpha stated that they used substantial resources to explore new technologies and build the corresponding capabilities. This also included training current employees as well as hiring employees skilled in new technologies. Furthermore, ETP Alpha acquired companies to expand its competencies into new areas. The exact approach taken, regarding how technologies were explored, depended on the readiness of the individual technologies. While ETP Alpha initially participated in funded research projects with other actors (e.g., research institutions, start-ups) to increase capabilities, it later used its own capabilities to deliver technological solutions to meet the customer requirements. While the focus of R&D activities initially was placed on establishing the desired technological properties (e.g., efficiency, durability), the focus also later shifted towards integrating technologies into the customers' vehicle systems. Informants from ETP Alpha further stated that they coordinated a large network of suppliers that contributed technological components in projects for customers. However, ETP Alpha did not rely on production infrastructure.

Like ETP Alpha, informants from ETP Beta emphasized cooperations with research institutions to perform R&D in selected areas. Unlike ETP Alpha, however, ETP Beta increased capabilities largely in joint projects with customers and was perceived by informants as being largely independent of suppliers in its activities.

**Value proposition and delivery:**
While informants perceived that ETP Alpha's value proposition remained unchanged on a principal level, the underlying capabilities and technologies underwent massive transformations. According to informants from ETP Alpha, the company used prototypes to demonstrate and communicate its capabilities to customers. As a result, ETP Alpha's technologies for xEV largely differed from its other technological solutions. This change in technologies and capabilities was due to the fact that ETP Alpha's value proposition was based on the company's own capabilities to support customers in (1) identifying and (2) developing new technologies as well as (3) industrializing corresponding products and (to some degree) (4) increasing the customers' competences with regard to new technologies. Furthermore, ETP Alpha added value for customers by relaying information and requirements between actors in the ecosystem. Especially for xEVs, shortening development cycles (time to market) and more agile approaches (especially with regard to new ecosystem actors) required ETP Alpha to adapt its processes.

In contrast, ETP Beta provided engineering solutions on a service basis and focused on integrating solutions provided by its customers' suppliers into vehicle systems. However, informants from ETP Beta also recognized the customers' demand to act more flexibly in development projects.

**Value capture:**
Informants from ETP Alpha and ETP Beta both strongly stated that revenues were generated either through (1) engineering projects or (2) engineering services. Informants from ETP Alpha stated that customers were increasingly demanding a higher degree of flexibility in their payment solutions. Furthermore, informants from ETP Beta added that the profitability of technological areas was a criterion that should be used to revise the company's technological approaches.

As before, the findings are underlined by a selection of illustrative quotes provided by informants (see Table 57).

**Table 57:** Notable quotes provided by informants from engineering and technology providers regarding changes in their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS14<br>00h 41min 38s -<br>00h 42min 16s | ETP Alpha about new actors in the field of xEV technologies | *"The business model is this: We do engineering. That is our business model. And this business model is what we do. We do world-leading engineering, world-leading technology. And you can make this business model for combustion engines, you can make this business model for transmissions, for software and for everything else. That is the business model. In this respect, the business model changes very little. The product that we develop within the business model has become different, that has become massively different. But the business model is actually the same."* |

Table 57 continues on next page

Table 57 continued from previous page

| Quote origin | Case and context | Quote |
|---|---|---|
| MS15<br>00h 05min 11s - 00h 05min 49s | ETP Alpha about changes in its value proposition | *"So it is - you probably always have to see it a little bit in contrast to companies that really sell products that can just use one and the same product for different customers and different applications. With us, it's really just a special solution that we offer. [...] Generally speaking, the value is actually always similar. So, in the end, he buys technology that meets his requirements."* |
| MS15<br>00h 21min 11s - 00h 22min 05s | ETP Alpha about the value it offers to its customers | *"Yes, well, in principle it probably happens that what the customer wants is to a certain extent something new for us. But that is actually part of our business model. So in the end we don't do something that has been around for a long time, that you do every day, but that's also the special thing about coming to us with really new ideas that have not yet been implemented in this way, but that we are very confident that we can deal with it because we simply know that we have a certain development process, we know how to proceed in order to develop a new technology and we can also plan accordingly."* |
| MS17<br>00h 49min 09s - 00h 49min 25s | ETP Alpha about the high importance to build employee competences | *"The skills of the employees are very important. And the challenge is probably really the knowledge, the know-how, to actually build, maintain or get the know-how in such a broad technical spectrum."* |

### 8.4.3 Results for downstream ecosystem actors

In this section the data on business models as reported by informants in downstream companies are provided. Consequently, the data reported by informants from automotive retailers, corporate operators of vehicle fleets, companies in the energy sectors and infrastructure companies are presented.

#### a) Data on business models from retailers

**Value creation:**
Informants in the investigated automotive retailers started to build up capabilities for xEVs. This included training their employees (e.g., maintenance of xEVs). Furthermore, informants from the investigated retailers mentioned that they collaborated with subsidies of the affliated OEMs that provided charging solutions for customers as well as with additional partners for electric charging and electrical energy.

**Value proposition and delivery:**
Informants from RET Beta perceived no change in its principal value proposition of providing vehicles as mobility solutions to customers. However, both RET Alpha and RET Beta offered

private charging infrastructure for xEVs to customers. Furthermore, RET Beta combined xEVs with leasing options for conventional vehicles to give customers access to a wider range of use cases (e.g., offering a limited amount of long-distance travel).

**Value capture:**
The investigated retailers stated that the high initial costs and loss of vehicle value over time due to the expected, rapidly-paced technological development made the xEVs currently unattractive for customers. Furthermore, selling private charging infrastructure to xEV customers was seen as a negligible business by informants from automotive retailers. Informants from RET Alpha stated that xEVs were primarily leased, while RET Beta provided options to customers that helped them finance xEVs. Informants from RET Beta mentioned that providing alternative forms of mobility was currently not a profitable business for automotive retailers. Nonetheless, these informants also predicted major shifts in the after-sales business due to an increased share of xEVs. The concrete form of these shifts was stated as not yet being clear.

Table 58 presents notable direct quotes on the matter provided by informants from automotive retailers.

**Table 58:** Notable quotes provided by informants from automotive retail companies regarding changes in their business models in the xEV ecosystem. Quotes were translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS28<br>00h 13min 47s -<br>00h 14min 17s | RET Beta about customers limited availability of xEVs | *"Well, the customer actually always plays the central role, because he has to buy it, he has to buy the thing. And I say, the truth is that the launch is still very slow. This is of course due to a small amount of supply that exists, one has to say. There are not very many vehicles on the market now that are suitable for volume production."* |
| MS28<br>00h 16min 37s -<br>00h 17min 27s | RET Beta about the transition in the vehicle market | *"Theoretically, if we would only sell electric vehicles from now on, it would still take many years where the others are still on the market. So this is a transition, where I say that it is not so disruptive, but it is rather a gradual development."* (adjusted for better readability) |
| MS28<br>00h 18min 14s -<br>00h 18min 42s | RET Beta about alternative approaches to capture value | *"So you have to put that into perspective somewhere, but in spite of everything you are now forced to think about what I can do now, what business models, or what added value I can perhaps generate somewhere, if at some point in the near future certain revenues simply break away. They won't disappear completely overnight, but they will gradually decrease a bit here and there."* |
| MS28<br>00h 50min 43s -<br>00h 50min 59s | RET Beta about OEMs' efforts in the xEV market | *"We are now at the beginning of a really massive model offensive by all manufacturers, which will hit the industry over the next few years."* (adjusted for better readability) |

### b) Data on business models from corporate operators of vehicle fleets

**Value creation:**
Both investigated corporate operators of vehicle fleets integrated a substantial number of xEVs[1] into their corporate vehicle fleets. Informants from FO Beta stated that the company investigated xEVs early on to build competencies with the technology, allowing the company to make informed decisions later on. To be able to operate a high number of xEVs, both investigated companies established their own non-public electric charging infrastructure. One factor that was mentioned by informants from both FO Alpha and FO Beta was that the high predictability of routes and distances over which their vehicles were used supported the installation of their own charging infrastructure. However, while FO Alpha considered making investments in the electrical grid, FO Beta avoided investing in this area and instead adapted their xEV operations to fit the existing grid. Informants from FO Beta further mentioned that they saw high potential in the use of "intelligent" charging solutions (e.g., load management, using xEVs as buffers for the electrical grid). Furthermore, FO Alpha relied on additional access to public infrastructure to complement their charging infrastructure, while, in contrast, FO Beta focused on primarily using its own charging infrastructure. FO Alpha relied on several different companies that provided technological solutions for electric charging (e.g., for charge points or digital solutions for billing charging operations). Informants from FO Beta said that they relied on external actors to perform activities outside their company's focus (e.g., maintenance of xEVs).

**Value proposition and delivery:**
Both corporate operators of vehicle fleets provided value for internal stakeholders. FO Alpha provided mobility solutions for employees, while FO Beta provided vehicles to perform logistics operations. In both cases, charging infrastructure was not made available to the public for both security reasons and to ensure the accessibility of infrastructure for corporate uses. FO Alpha ensured the availability of infrastructure for its employees by offering digital solutions (e.g., to book charging infrastructure). FO Beta emphasized the reliability of its xEVs to ensure the usability of xEVs in company operations.

**Value capture:**
Informants reported that the disadvantage of high initial costs for xEV could, in the long run, be balanced out by the low cost of operating the vehicles. In particular, FO Alpha decided to install its own non-public infrastructure to reduce operating costs, as relying on public infrastructure providers was deemed financially unattractive.

Table 59 presents a notable quote on the matter provided by an informant from an operator of corporate vehicle fleets.

[1] Author's remark: Companies primarily installed BEVs, and to a small extent FCEVs.

**Table 59:** Noteable quote provided by an informant from a corporate operator of vehicle fleets regarding its business models in the xEV ecosystem. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS26<br>00h 23min 37s - 00h 23min 56s | FO Alpha about charging infrastructure | *"We first make a system we can manage ourselves, which we can influence ourselves, and only then switch to a system when we know that it works. If you don't have your own charging infrastructure, [...] you are dependent on the public charging networks."* |

## c) Data on business models from companies in the energy sector

**Value creation:**
All investigated providers of electrical energy (EC Alpha, EC Beta, EC Gamma) operated public infrastructure for the electric charging of xEVs. Furthermore, the investigated companies also mentioned having initiated collaborations with other energy companies to mutually provide access to their electric charging infrastructure. Informants stated that providing a charging solution required the involvement of additional partners. Establishing private (home) charging solutions to customers often required the formation of collaboration with real estate developers, while establishing public charging infrastructure typically required collaboration with municipalities. EC Alpha also stated that they relied on start-ups to establish innovative charging solutions. Informants from the investigated providers of electrical energy mentioned a tendency to focus on core competencies while relying on suppliers for additional competencies and resources. Informants from energy companies recognized that their companies co-developed (primarily digital) solutions for electric charging together with suppliers and/or research institutions. Informants from EC Beta emphasized that they operated BEVs and FCEVs in their fleet so that employees could gain experience with the technology and also started to investigate solutions for hydrogen infrastructure.

Informants from companies that offered petrol-based energy followed a different approach. EC Epsilon emphasized hydrogen as a potential energy carrier. Subsequently, EC Epsilon focused more on hydrogen infrastructure than infrastructure for electrical charging. As a result, EC Epsilon cooperated with ecosystem actors to build knowledge and was in contact with additional suppliers that could provide hydrogen as a fuel for FCEVs.

**Value proposition and delivery:**
Investigated providers of electrical energy offered solutions for electric charging. However, they provided substantially different values to B2C and B2B customers (e.g., operators of vehicle fleets). B2B customers were offered solutions that enabled them to have their own non-public charging infrastructure, which subsequently enabled them to operate their xEV fleets. B2C customers were offered at-home charging solutions. Informants from energy suppliers also mentioned their intention to install xEV charging infrastructure near newly constructed buildings. In addition, electrical energy companies operated public infrastructure for electric charging. Energy companies emphasized the relevance of offering digital solutions that enabled electric charging, provided added

value, and bound customers to companies. Furthermore, informants from EC Beta emphasized the fact that their company was offering "green" energy to provide customers with additional value, while EC Gamma underlined the importance of providing private customers with simple and robust charging solutions. Companies from the petrol sector started to provide hydrogen fueling infrastructure at selected locations.

**Value capture:**
Although energy companies were currently not fully able to recoup their investments in infrastructure, providing electrical energy for xEV charging was seen as an attractive business. For example, informants from EC Alpha stated that B2B customers acquired their electric energy for charging directly from the energy supplier. However, informants from EC Beta predicted that providing low-cost energy for xEV charging was not feasible in the long run - mainly due to the necessary investments in charging infrastructure. However, informants from EC Beta also stated that coming up with "intelligent" solutions (e.g., by flattening load curves or vehicle to grid applications) could reduce the necessary investments in the energy grid. Furthermore, digital solutions, and especially those used to manage charging operations (authentication, monitoring of charging infrastructure) and the billing of xEV charging energy, were described as highly relevant for capturing value.

Results are supported by the quote provided in Table 60.

**Table 60:** Noteable quote provided by an informant from an energy company regarding their business models in the xEV ecosystem. Quote was translated from German to English by the author.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS34<br>00h 39min 33s -<br>00h 39min 55s | EC Epsilon on financial resources for technological shifts | *"I am still an enabler of mobility. Namely by offering the energy. That's just it, we don't want to turn our core competence into a disruptive one - we have decided for us, we don't have to be."* |

## d) Data on business models from infrastructure companies

**Value creation:**
INF Alpha did not offer technological solutions for electric charging itself. However, the company coordinated partnering actors that provided charging infrastructure to establish a broad coverage of electric charging opportunities, according to predefined standards. INF Alpha supported actors either by directly investing in electric infrastructure or setting criteria to incentivize partners to invest in infrastructure.

All of the other investigated infrastructure companies relied heavily on actors in their ecosystems to demonstrate a technological value proposition for electric charging. However, the exact ways in which the partners were integrated into their business models for creating value differed. INF Beta relied on its network of ecosystem partners for innovations and performed funded research. INF Gamma coordinated its suppliers to install charging solutions for customers. INF

Delta cooperated with external partners to access complementary technological capabilities and capacities to manufacture the company's products.

**Value proposition and delivery:**
INF Alpha acted as an enabler for other companies, offering electric charging infrastructure. Subsequently, it contributed to the overall ecosystem value proposition for xEVs. INF Beta provided value propositions in two areas: First, it operated the public electric charging infrastructure. Second, it enabled and operated the charging infrastructure for corporate customers. INF Beta emphasized the use of digital solutions in its value proposition. INF Gamma focused on offering at-home charging solutions for private customers as well as on providing solutions for B2B customers. Informants from INF Gamma considered customer consulting as part of their company's value proposition and partly relied on sales channels from their affiliated OEM. INF Gamma focused purely on B2B actors as customers and offered solutions that could be used to store energy for electric charging.

**Value capture:**
INF Alpha enabled operators of charging infrastructure to generate revenues from electric charging by renting out properties. INF Alpha's investments in the electrical grid were recouped through higher rents. INF Beta generated revenues from charging fees. Informants from INF Beta and Gamma stated to be optimizing its infrastructure's electrical load to increase cost-efficiency. INF Delta generated revenues through product sales and license fees.

Table 61 provides exemplary quotes on the subject provided by two informants.

**Table 61:** Noteable quotes provided by two informants from infrastructure companies regarding their business models in the xEV ecosystem.

| Quote origin | Case and context | Quote |
|---|---|---|
| MS36<br>00h 06min 37s - 00h 07min 11s | INF Beta about using technologies in business models | *"So I think we're one of the drivers right now. We have an electric mobility business model, we are specialists. [...] So we are moving with the times and trying to introduce new technologies and turn them into a business model."* |
| MS37<br>00h 04min 37s - 00h 04min 46s | INF Gamma about energy grid limitations for xEV charging | *"Without intelligent energy management systems, however, you will soon realize that it will not always be possible to achieve the required and desired charging performance in the local grid."* |

### 8.4.4 Summary

Actors pursued varying degrees of business model change when engaging in the xEV ecosystem, ranging from making minor adaptions in the business models to creating business models that were new to the industry. Several factors influenced the degree of business model change, including those outlined in the previous section as well as the actor's ecosystem position and the role they tried to fill in the xEV ecosystem. As central ecosystem actors, automotive OEMs needed to introduce business models to engage in the xEV ecosystem and ultimately demonstrate an attractive ecosystem value proposition. As outlined with regard to research questions two and three (compare Sections 8.1 and 8.2), these business model initiatives were influenced by bottlenecks (both upstream in terms of providing attractive xEVs as well as downstream in terms of creating customer value by offering complementary values), which often kept an attractive ecosystem value proposition from being fulfilled. Consequently, they engaged in multiple business model initiatives that addressed these bottlenecks. In the upstream area, OEMs used their substantial influence in the automotive ecosystem to ensure the commitment of suppliers (both established suppliers and new suppliers relevant for xEV technologies) to introduce value propositions based on xEVs. These suppliers adjusted the value creation aspects of their business models, as they required a different set of capabilities to create value propositions that contributed to xEVs in ways that met the OEMs' requirements. Suppliers, in turn, relied on dedicated providers of engineering and technology solutions to manage this shift. Therefore, engineering and technology providers contributed both directly and indirectly to the xEV ecosystem by offering technological solutions and acting as intermediaries between actors from different sectors that had largely disparate technological capabilities. The upstream actors seemed to co-evolve their business models to achieve automotive OEMs values based on xEVs. In addition to orchestrating upstream business models, OEMs engaged in initiatives in the downstream region of the ecosystem to establish separate business models in attempts to overcome complement bottlenecks. One influencing factor in this respect was that established actors from the energy sector were said to be reluctant to commit themselves to demonstrate complementary offerings for xEVs on a large scale. Thereby, companies that offered xEVs and companies that offered complementary value propositions for xEVs (predominantly solutions for electric charging) could enter a situation of co-dependency while creating value in the xEV ecosystem and while entering the same competitive arena with regard to electric charging. Consequently, the ability of xEV customers to introduce business models that were able to overcome complement bottlenecks (e.g., by installing their own charging infrastructure) was a major factor in the adoption of xEVs.

## 8.5 Focus group results

The focus group was conducted at the end of the data collection period. As described in Section 7, the preliminary results obtained from the case studies were presented to facilitate discussion and receive feedback that was then used to improve the empirical findings. All presented quotes were translated from German to English by the author.

### 8.5.1 Key results of the focus group

**Role of political and regulatory influences:**
Participants in the focus group agreed with the insights that had been obtained in the case studies, namely, that actors entering the xEV ecosystem were largely influenced by regulatory and legislative factors:

> The *"[...] regulator - the legislator - is pushing very, very strongly in this direction and, of course, is forcing very, very many manufacturers in this direction due to the current state of technology. Because there are hardly any alternatives available due to the time constraints."* (Focus Group; 00h 07min 20s - 00h 07min 41s)

Interestingly, while political and regulatory factors were seen as highly influential, participants stated that they had substantial concerns with regard to technologies for xEVs:

> *"So from my point of view this is a purely political issue. Electric drive systems will leap into the market, especially battery-powered electric drives. We know all the problems with batteries."* (Focus Group; 00h 11min 27s - 00h 11min 37s)

Participants mentioned the role of general trends, which influenced the underlying technological conditions. In particular, environmental considerations were cited as playing a dominant role regarding xEVs:

> *"Because electrifying is what we are doing to make cars greener and more environmentally friendly [...] and not to put multi media centers on the road."* (Focus Group; 00h 25min 25s - 00h 26min 00s)

This aspect may be related to political agendas and regulatory frameworks that influence the emergence and development of the xEV ecosystem. In addition, the complexity and interrelated nature of the multiple yet separate trends that influenced the topic of xEVs were emphasized. One particular aspect was the uncertainty that the companies were currently facing:

> *"There is a large uncertainty associated with the presented topics. Although we are no longer in a period of high growth at the moment, we are still in a relatively good economic phase. The automobile retail in Austria is currently experiencing a 2-digit*

> *minus, which is enormous. Where does that come from? It comes from uncertainty, that is part of the uncertainty. There are political conditions etc. that also play their part."*[1] (Focus Group; 00h 38min 37s - 00h 39min 04s)

Consequently, the data indicate that the described uncertainty was rooted in political and regulatory interventions pushing xEVs.

**Role of governance of the xEV ecosystem to demonstrate value:**
Participants also recognized the complexity of coordinating multiple actors in order to establish a joint ecosystem value proposition centered around xEVs. One particular aspect mentioned was the role of ecosystem governance, as exemplified in the following statement:

> *"It will not work without steering. [...] It is a complex field in reality. That's why we can see that it takes so long for this technology to establish itself on the market or not."* (Focus Group; 00h 13min 03s - 00h 13min 24s)

One particular aspect that required ecosystem governance was the role of complementary offers, which could be used to deliver xEV customers and operators an attractive ecosystem value proposition. These complementary offers, in turn, needed to be integrated into the customers' use cases:

> *"Infrastructure will be a driver. [...] We've heard it: 92 % of vehicles are stationary, so if I see them now as normal, i.e., not in future car sharing, my vehicle will often be stationary, and this is also the time for charging and that is overnight, [...] and if I don't have a charging infrastructure at home, then electric mobility doesn't really [...]"* make sense. (Focus Group; 00h 08min 24s - 00h 08min 57s; adjusted for better readability)

Furthermore, in agreement with the insights from the conducted case studies, automotive OEMs were cited as being a determining factor for the xEV ecosystem. Concurrently, suppliers were said to be building new capabilities while orienting themselves towards OEMs requirements proactively.

> *"These topics are driven by the OEMs. The supplier only has to recognize how this OEM will position itself in the future, how the topic will develop in its own company, and can then react to it in good time, of course. He will certainly also have to invest in research and development in advance, but that is already the case. But the supplier industry will not drive the issue."* (Focus Group; 00h 14min 35s - 00h 15min 03s)

**Establishing a fit between customer demand and ecosystem value proposition:**
However, introducing complementary offers that could be integrated into the customers' use cases was perceived as a challenging endeavor. Moreover, merely enabling value was deemed insufficient. Participants highlighted the need to communicate the value provided through the xEV ecosystem to customers:

[1] The focus group was conducted in September of 2019 - a few months before the COVID-19 pandemic changed the overall economic situation.

> *"We give a lot of thought. For example, how can we create the kind of integration that you mentioned between e.g., electricity supply, I will say electricity supply, i.e., the issue of how to solve the problem, how to get energy, how to get everything from one source? We have a cooperation with [a local electrical energy provider], etc., but we see that it is relatively complicated to make this clear to the customer."* (Focus Group; 00h 39min 11s - 00h 39min 33s; adjusted for better readability)

In addition, the economic benefits of xEVs were considered as a factor that influenced the attractiveness of the overall xEVs ecosystem. However, the possible economic benefits were considered to depend on the infrastructure and ecological considerations:

> *"From an economic point of view, perhaps there is also an economic incentive somewhere, when you say that there is potential, when you say: Ok, we now have that from an environmental point of view, from an infrastructural point of view there is no denying an economic aspect."* (Focus Group; 00h 09min 24s - 00h 09min 40s)

Customers were emphasized as relevant factors in the ecosystem. On the one hand, the xEV ecosystem needed to offer a value proposition that satisfied the customers' demands. On the other hand, customers were also cited as influencing the evolution of the ecosystem, as highlighted in the following quote:

> *"The factor "customer" is certainly also interesting, because in the end it is the customer who buys it, but is also influenced in certain directions - or not."* (Focus Group; 00h 09min 19s - 00h 09min 25s; adjusted for better readability)

One major aspect mentioned was the suitability of technological solutions with regard to the customers' requirements. Participants emphasized that the customers' concrete use cases determined the feasibility of a specific xEV technology:

> *"But the topic of drive systems, of electric drive systems: I see this very much in urban areas, because there the ranges are manageable and you don't need huge batteries. For me personally, i.e. I live here in Styria, and also a lot in Upper Austria, and also in Vienna, the vehicles that are offered today are practically unusable. [...] So we are still very much at the beginning of this technology, yes."* (Focus Group; 00h 12min 05s - 00h 12min 49s; adjusted for better readability)

Consequently, the value proposition offered in the xEV ecosystem depended on the underlying technologies. However, improvements in technologies were considered as likely.

**Economic feasibility of xEV technologies for ecosystem actors:**
Participants questioned how attractive it was for automotive OEMs to pursue activities in several ecosystems that faced mutual competition in specific areas:

> *"It is a kind of cannibalism that the OEMs themselves are carrying out. [...] The consumer can only drive one vehicle at a time. He can put five in the garage if he*

*can afford it, but it will never be necessary to drive more than one car. And this is exactly where I see the next problem, where I say: Electric mobility - yes. As has been rightly said, we will have different drive systems, different storage systems and whether these are batteries, hydrogen or other systems for the various applications. What are we doing today? Today I have a car which I drive into town, with which I go on holiday, and with which I drive 1000 km to the customer. Then I need 3 cars? Now that is a provocative question. But this is exactly the topic that comes up, as a business model for all of us."* (Focus Group; 00h 36min 32s - 00h 38min 35s; adjusted for better readability)

Another major factor that was cited as influencing the technological development in the industry was the compatibility of technological solutions. As actors in the automotive ecosystem faced uncertainty regarding the dominant technologies for xEVs, they pursued a modular approach. This enabled actors to reduce risks and allowed them to transition gradually between their technologies:

*"Electric mobility will not have a huge impact in many areas. The products we develop, even the next level of these products is backwards compatible. This means I can also install them in a conventional vehicle with a cumbustion engine. OEMs are also toying with the idea that certain products that they are developing today could be used by suppliers as product upgrades for other models or vehicles."* (Focus Group; 00h 16min 58s - 00h 17min 20s)

**Alignment of business models in the xEV ecosystem:**
As seen in the investigated cases, the change in the business models of automotive suppliers when participating in the xEV ecosystem was also described as a process of gradual evolution:

*"Electrification alone will not change our business model. It opens up opportunities for components again, but the business model does not change. But all in all, a little bit with the - I call it system issue - we are forced to do it anyway, and electrification is only a part of it, and we need to understand the overall systems better. To offer compatible solutions at system level and at least to build up more system know-how."*[1] (Focus Group; 00h 19 min 12s - 00h 19min 44s)

Overall, the topic of business model change was perceived as multifaceted. However, participants recognized that dominant ecosystem actors were starting to adapt the values they offered:

*"With regard to the business model, we only notice the change in products at OEMs and Tier 1s."* (Focus Group; 00h 23min 15s - 00h 23min 21s)

Moreover, while participants mentioned that the values offered in the industry were described as constantly evolving, other aspects, such as development times, were stated to be shortening a rapid rate:

[1] The statement refers to the business models of automotive suppliers.

> *"Business models have always changed. I always shake my head when I hear: We are in a revolution and we all have to rethink etc. We have always had to, right? [...] Yes, the changeover - that is not a change, that is a motivation for further development and not putting on blinders and saying: Well, now we have to completely reorient ourselves. Well, I don't think that's it. We have to be present on the market and keep our eyes open, and find the right solutions, which will be needed in the future. But that is nothing new. The only thing that has changed is that, in the past, vehicle development took 6 years. Now it has to be done almost within 24 months."* (Focus Group; about established automotive suppliers; 00h 15min 15s - 00h 16min 18s; adjusted for better readability)

Interestingly, it was mentioned that the external pressures placed on established automotive actors might lead to rushed and inconsiderate decisions being made along the line:

> *"So, I also believe that the external pressure on OEMs is far too great at the moment, that this topic is currently pushed far too hard and that some wrong decisions are being made. And that will go well for a while, but at some point this issue will come up on the table with these wrong decisions, and at some point there will be an adjustment. As I said, I am convinced that electric mobility is justified in certain areas, especially in urban areas. If large OEMs now focus completely on this niche, as [a German OEM] is currently planning to do, I think they will have a huge problem."* (Focus Group; 00h 40min 14s - 00h 40min 50s)

### 8.5.2 Summary

Insights from the focus group were used to refine the initial iteration of the coding system used to analyze the data collected in the main study. The results of the focus group data analysis supported the previous insights. It was emphasized that political and regulatory factors were relevant drivers for companies that engaged in the xEV ecosystem. Furthermore, focus group participants presented another angle with regard to the role of ecosystem governance to demonstrate value to xEV customers/operators. Specifically, participants highlighted the role of central ecosystem actors with regard to ecosystem governance in that they could facilitate the introduction of complementary offers in the downstream region of the xEV ecosystem. With regard to the upstream region, the determining role of OEMs as central ecosystem actors was emphasized in the focus group, a result that agreed with insights obtained from the case studies conducted. Another aspect mentioned was that the integration of several systems should be enabled to offer customers added value with regard to their individual use cases. Furthermore, the focus group highlighted the relevance of communicating the added value to customers. The participants also mentioned strategic concerns regarding the feasibility of OEMs pursuing to serve multiple ecosystems (i.e., ecosystem centered around conventional vehicles and xEV ecosystem). In that regard, ensuring the modularity of the technological components was stated as a feasible approach that could be taken to manage the technological transitions from one ecosystem to another. Regarding the alignment of business models, the informants mentioned that particularly suppliers located upstream of OEMs were confronted with an ongoing gradual shift in their business models. However, one interesting aspect was that the informants mentioned that the underlying processes showed substantial amounts of change (e.g., development times), while the value they offered to their customers was undergoing a constant but low rate of evolution with regard to xEV technologies. Thereby, the focus group results support the insights from the conducted case studies, which indicate that the upstream actors accelerated their development processes due to the high level of uncertainty regarding xEV technologies.

# Part IV

# Discussion and Summary

# 9 Discussion of obtained results

As described in Chapter 1, using the xEV ecosystem as an example, the focus of the empirical research was to (1) identify influences on actors to enter an ecosystem, (2) better understand how individual actors interact in the context of an ecosystem centered around a technological innovation to create value, and (3) understand how actors align business models in this ecosystem.[1] To address these aspects, the chapter is structured as follows: First, in Section 9.1, the findings regarding what encourages individual actors to enter an ecosystem centered around a novel technology are discussed, and research question two is answered. Second, to answer research question three, in Section 9.2 actors' interactions to create value based on the novel technologies are discussed. Third, research question four is answered in Section 9.3 discussing in more detail what influences actors to change their business models and what types of business model change they undertake. This section serves to improve the understanding of how actors align their business models to fulfill a joint ecosystem value proposition centered around novel technologies.

## 9.1 Factors influencing ecosystem actors' participation in ecosystems centered around novel technologies

In this section, the data presented in Chapter 8.1 are discussed to provide an answer to the following research question:

**Research Question 2:**
What influences do ecosystem actors perceive that encourage them to participate in an ecosystem centered around novel technologies?

Below, the results obtained are aggregated from individual cases studied to answer the presented research question. This serves as a basis for a detailed discussion of the results, as well as a means to derive recommendations for both academia and practice. The answer to research question two provides a solid basis to address the subsequent research questions presented in this thesis.

[1]Some of these results have already been published (see Rachinger et al. (2020)). However, the following section provides a substantially more comprehensive and in-depth analysis of the obtained results.

### 9.1.1 Aggregation and interpretation of factors influencing actors' ecosystem participation

The structure of this section mirrors the different ecosystem areas. Thereby, factors influencing central actors, upstream actors, and downstream actors are described and put into perspective with regard to the relevant literature.

#### a) Factors influencing central ecosystem actors

As outlined in Chapter 8.1 and supported by the literature (see, for example, Mazur et al. (2013, p. 1061) and Priessner et al. (2018, p. 710)), the main drivers to enter the xEV ecosystem cited by informants in automotive OEMs were political and regulatory influences - in particular regulations targeted to reduce OEMs' $CO_2$ emissions (see, for example, Arena et al. (2014, p. 4)). The following statements by informants in an investigated automotive OEM and a supplier illustrate this insight:

> *"Yes, that's, well, my perception is, that it is purely political and economic pressure - without that, we wouldn't run into it so quickly because there are also many, many risks in it."* (OEM Beta, Interview MS22; 00h 11min 45s - 00h 12min 03s; translated and adjusted for readability by the author)

> *"Well, e-mobility is quite clearly driven by legislation. So, it is not that the customer is now necessarily going to come and say "I absolutely need an electric vehicle". But the political environment has changed so much that electric cars are suddenly a must."* (SUP Delta, Interview MS9; 00h 14min 51s - 00h 15min 10s; translated by the author)

However, the described influences were seen more as acceleration forces rather than as triggers of the OEMs' xEV initiatives. Actors in central positions in the ecosystem were reported to wield strong influence over individual ecosystem actors, and particularly on actors further upstream. As illustrated in Figure 55, OEMs - as central ecosystem actors - were able to facilitate their upstream suppliers' entry into the xEV ecosystem. OEMs' initiatives were partly viewed critically by informants. One particular factor that was present in the data was the considerations regarding the feasibility of introducing xEVs into the existing market. These considerations subsequently affected the attraction of entering the xEV ecosystem. The following statement illustrates this aspect:

> *"It is a kind of cannibalism that the OEMs themselves are carrying out. [...] The consumer can only drive one vehicle at a time. He can put five in the garage if he can afford it, but it will never be necessary to drive more than one car. And this is exactly where I see the next problem, where I say: Electric mobility - yes. As has been rightly said, we will have different drive systems, different storage systems and*

> *whether these are batteries, hydrogen or other systems for the various applications. What are we doing today? Today I have a car which I drive into town, with which I go on holiday, and with which I drive 1000 km to the customer. Then I need 3 cars? Now that is a provocative question."* (Focus Group; 00h 36min 32s - 00h 38min 25s; translated by the author and adjusted for better readability)

Another point raised by the informants was that they perceived the introduction of xEVs as rushed. As exemplified by the following quote, informants stated concerns regarding the applicability of xEVs to a larger audience. In turn, the established OEMs' activities, carried out to enter the xEV ecosystem at the cost of leaving their established ecosystem, were believed to carry severe risks:

> *"So, I also believe that the external pressure on OEMs is far too great at the moment, that this topic is currently pushed far too hard and that some wrong decisions are being made. And that will go well for a while, but at some point this issue will come up on the table with these wrong decisions, and at some point there will be an adjustment. As I said, I am convinced that electric mobility is justified in certain areas, especially in urban areas. If large OEMs now focus completely on this niche, as [a German OEM] is currently planning to do, I think they will have a huge problem."* (Focus Group; 00h 40 min 14s - 00h 40min 50s; translated by the author and adjusted for better readability)

Informants in OEMs also stated that they perceived the described regulative influences to be fragmented. Moreover, legislative influences, and particularly the ambiguous nature of regulations and policies, could also represent a barrier that hinders companies from entering an ecosystem (Almpanopoulou et al., 2019). The data indicate that OEMs need to factor in regulatory uncertainties when pursuing xEV technologies. Informants specifically stated that OEMs were confronted with ambiguities regarding policies and regulations, which lowered the attractivity of committing resources towards xEVs. Furthermore, despite the existing demand and predictions of rapid growth, the market for xEVs was seen as negligible as compared to the OEMs' traditional core business (compare with the predictions of Wu et al. (2019), Mosquet et al. (2020), and Hertzke et al. (2019)) - limiting the xEV ecosystem's attractiveness. The following statement illustrates regulatory and financial considerations that influence the actors' participation in the xEV ecosystem:

> *"The automotive industry actually supports electromobility through the profits from conventional vehicles and operates electromobility based on $CO_2$ specifications that are defined by regulators. Against this background, I can see e-mobility and also the disruption and I believe that this is simply being pushed into the market step by step by regulatory means, and this is also creating the whole ecosystem."* (SUP Zeta; Interview MS11; 00h 4min 23s - 00h 4min 53s; translated by the author)

Overall, the data indicate that automotive OEMs, as central ecosystem actors, relied on upstream actors to enable their xEV operations while also sharing potential risks associated with entering the xEV ecosystem. Consequently, automotive OEMs were found to be a determining factor for the xEV ecosystem and its respective technologies. An overview of the outlined factors for central ecosystem actors is presented in Figure 55.

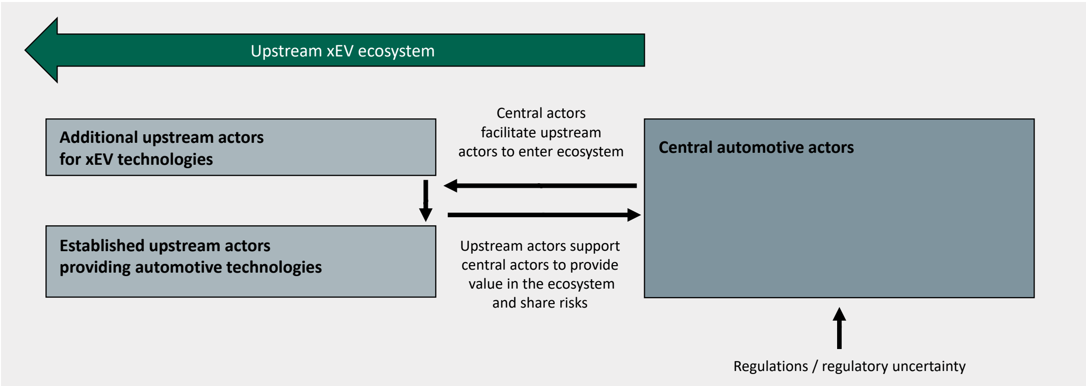


**Figure 55:** Principal factors influencing the participation in the ecosystem from the perspective of central ecosystem actors (personal illustration)

### b) Factors influencing upstream actors

Informants situated in the supplier companies stated that a major driver for them to investigate technologies for xEVs was to maintain their ability to satisfy OEMs' requirements. The following statement illustrates the influence of OEMs in the ecosystem and the reactions of the involved suppliers:

> *"These topics are driven by the OEMs. The supplier only has to recognize how this OEM will position itself in the future, how the topic will develop in its own company, and can then react to it in good time, of course. He will certainly also have to invest in research and development in advance, but that is already the case. But the supplier industry will not drive the issue."* (Focus Group; 00h 14min 35s - 00h 15min 03s; translated by the author)

OEMs, in turn, used their influence and relayed requirements that were rooted in regulations towards actors located upstream in the xEV ecosystem. These requirements were reported to be changing - particularly with respect to (end-) customers[1]. Moreover, requirements were influenced by the feasibility of realizing infrastructure to complement xEV technologies, which, in turn, impacted the attractiveness of adding value to the xEV ecosystem:

> *"But if the government now politically promotes electric mobility, but [...] does not establish the entire infrastructure, over which we have no influence, in a timely manner, then that is indeed a major problem."* (OEM Beta; Interview MS23; 00h 24min 19s - 00h 24min 36s; translated by the author and adjusted for better readability)

[1] The mentioned (end-) customers were OEMs, but also vehicle customers and vehicle operators.

As a consequence, upstream actors began to investigate technologies relevant for xEVs. This, in turn, was done to be able to help OEMs manage their technological shifts towards xEVs.

Other influences mentioned by informants in upstream companies were (1) new *"born electric OEMs"* entering the ecosystem as central actors that increased the competitive pressure on established *"legacy OEMs"* as well as (2) new suppliers that concentrated on a small technological area relevant to xEVs (see Figure 58). However, it has to be noted that while these new central actors increased the competitive pressure on established automotive OEMs, they simultaneously represented additional customers for upstream actors in the ecosystem. Thus, they made adding value in the xEV ecosystem more attractive for upstream actors. The following statement by an informant from an automotive supplier serves to illustrate the described development:

> *"Electrification has simply added new customers. There are now new customer groups who say they don't even care about the ICE ballast, and a tradition as an OEM. They are now coming because of the lower entry barriers and say, "We want to develop an e-vehicle. And we want to bring it onto the market." That's mainly in Asia and very strongly driven in China. So there are just new players in the market."* (SUP Beta; Interview MS8; 00h 11min 43s - 00h 12min 11s; translated by the author)

Interestingly, while established suppliers were largely oriented toward fulfilling the OEMs' requirements, the aforementioned, smaller, more focused suppliers reportedly entered the ecosystem to enact influence over established OEMs and their suppliers' technological solutions (see also Figure 56). A relevant factor that was stated by informants from research institutions was that technologies for conventional vehicles (particularly technologies for internal combustion engines) were at the limit of their performance. This view was also shared by informants from corporate operators of vehicle fleets. In addition, informants from research institutions recognized the variety of technological alternatives that could - in principle - be used for xEVs (see also Chapter 6). As a consequence, xEVs had the potential to become more attractive for a specific use case.

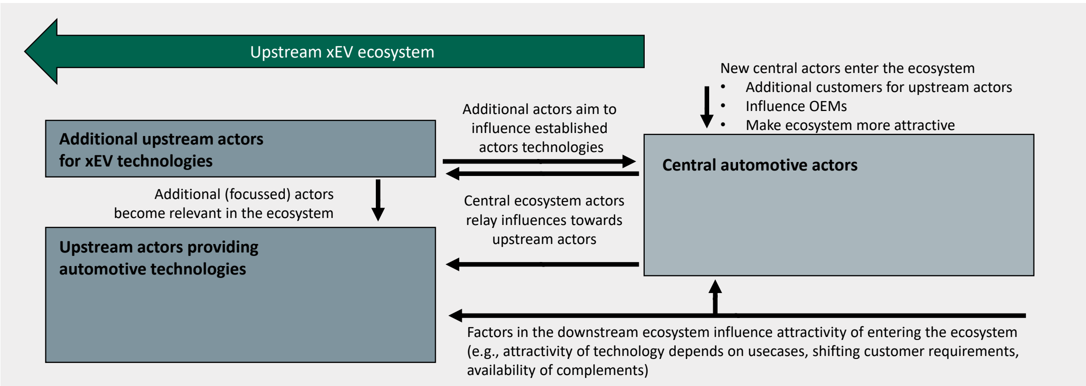


**Figure 56:** Principal factors influencing the participation in the ecosystem from the perspective of upstream actors (personal illustration)

The large variety of possible use cases then paved the way for a potential coexistence of multiple technological approaches for xEVs. While this increased technological diversity and technological uncertainty, it also made the ecosystem more attractive for additional actors. Critical factors for upstream actors to participate in the xEV ecosystem are summarized in Figure 56.

### c) Factors influencing downstream actors

Looking at the data from informants in companies located in the downstream ecosystem, several determining factors influencing actors to enter the xEV ecosystem became evident (see Figure 57). In the upstream part of the ecosystem OEMs were the major determining factor. In contrast, informants located in various positions in the downstream ecosystem reported being affected by either political or legislative influences, which positively impacted their entry into the xEV ecosystem. As exemplified by the following statement, influences indicated by informants included incentives and political influences directed at corporate operators of vehicle fleets:

> *"The influence of end customers will also decline. [...] And in return, the requirements of large logistics companies, for example, will rise sharply. And they will be triggered again, via the back door of the policy of sustainability, sustainability reports, total $CO_2$ balance, etc. in the company. So there's something big, a big influencing factor coming at us, I think, in the future."* (EC Alpha; Interview MS30; 00h 43min 43s - 00h 44min 10s; translated and adjusted for better readability by the author)

Specific influences mentioned were governmental subsidies for xEVs, customer requirements for environmentally friendly mobility, as well as potential of driving bans for conventional vehicles. Informants reported political influences aimed at companies providing and/or coordinating charging infrastructure for xEVs:

> *"The energy suppliers are very much in the hands of the state. So, in comparison to other commercial enterprises, we are already very strong in business areas that do not directly have such strong, direct pressure on earnings, but where there is also the public interest. In the development of public charging infrastructure, there is already interest on the part of the owners to drive the matter forward and, I believe, here, in particular, there is an interest in really also driving innovations forward. So that is one, probably one of the main reasons why we dedicated ourselves to the topic very early on because the owners simply demanded it."* (EC Alpha; Interview MS29; 00h 33min 02s - 00h 34min 10s; translated and adjusted for better readability by the author)

In that regard, informants mentioned general sustainability requirements towards energy companies and dedicated infrastructure companies. However, informants in companies aiming to provide infrastructure for xEVs also indicated that regulations were sometimes incoherent and partly hindered the downstream actors' xEV activities (i.e., regulations preventing the installation of xEV charging infrastructure):

> *"A major example for an obstacle is - that is solveable by technology - how do I install wallboxes in the garages of apartment buildings without massive investments or having to ask all residents. That is a regulatory issue that has a massive impact on electric mobility."* (INF Gamma; Interview MS37; 00h 08min 27s - 00h 09min 16s; translated by the author)

Informants in the investigated corporate operators of xEV fleets stated that their companies, influenced by political influences and anticipated changes in regulatory conditions, tried to gain experience with xEVs at an early stage. This was underlined by an informant from an automotive retail company, who provided the following statement:

> *"For private customers it is simply not an attractive option. Also corporate clients only adopted it since the introduction of tax benefits."* (RET Alpha; Interview PS8; n.a.; translated and adopted for better readability by the author)

Interestingly, the aforementioned struggle in the upstream part to demonstrate attractive technological solutions for xEVs - in terms of costs and technological performance as well as available numbers - was directly reflected in bottlenecks reported by corporate fleet operators (i.e., low availability of xEVs as well as long delivery times). Therefore, corporate operators attempting to electrify their vehicle fleets were being held back by the low availability of - and long delivery times for - xEVs. Similarly, factors in the downstream ecosystem were reported as keeping upstream actors from scaling up their xEV operations. One prominent factor that was mentioned was the lack of necessary infrastructure to operate xEVs properly. As indicated by the data, this results in two co-dependent bottlenecks regarding (1) infrastructure complements for xEVs and (2) the overall availability of attractive xEVs.

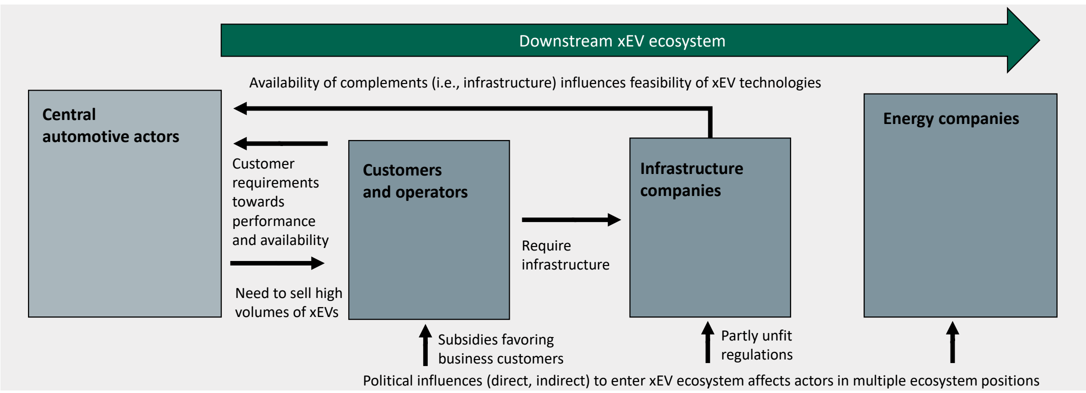


**Figure 57:** Principal factors influencing the participation in the ecosystem from the perspective of downstream actors (personal illustration)

The bottleneck regarding the low availability of attractive xEVs prevented actors from entering the ecosystem and committing to install an appropriate level of complementing infrastructure. In turn, the lack of infrastructure complements represented a bottleneck for customers, who, as a result, hesitated to adopt xEVs. This then prevented OEMs and upstream actors from providing larger volumes of xEVs and made installing infrastructure complements unattractive. An overview of the outlined factors for downstream ecosystem actors is presented in Figure 57. Overall, the described bottlenecks hinder actors in the downstream area of the ecosystem and discourage them from entering and subsequently taking on a larger role in the xEV ecosystem.

### 9.1.2 Discussion and implications

Relevant findings regarding factors that influenced actors to enter the xEV ecosystem are summarized in Figure 58. The illustration provides an overview of the discussed findings and the insights presented in Figures 55, 56, and 57. As shown, regulatory factors represented a major driver that influenced actors in the central and downstream ecosystem. Figure 58 illustrates that the central ecosystem actors were particularly influenced by policies and regulatory influences. Additional central actors entering the xEV ecosystem also impacted the ecosystem. These actors were potential competitors for established automotive actors entering the xEV ecosystem. However, new central actors entering the ecosystem also made the values offered for xEVs more attractive for upstream actors. Consequently, predominantly established central actors (having their roots in the established automotive ecosystem) facilitated the upstream actors' entry into the ecosystem and relayed the changed requirements to the upstream actors. Upstream actors entering the xEV ecosystem were, on the one hand, established actors from the automotive ecosystem. On the other hand, additional upstream actors providing technologies and/or components relevant for xEVs entered the ecosystem's upstream region. In the downstream regions, (corporate) customers required an attractive value proposition to be able to enter the xEV ecosystem. However, this demand was not yet fully satisfied due to the low availability of xEVs from central actors, xEVs low technological performance (e.g., in terms of vehicle range), and the lack of infrastructure complements. In the following, empirical insights regarding research question two are discussed referring to the literature. Consequently, the implications for academia and practical recommendations are presented.

#### a) Discussion

Overall, the research findings indicate that the uptake of xEVs was largely driven by legislation directed at automotive OEMs as central ecosystem actors. The results support the insights of Teece (2007, p. 1323), who pointed out that participants in an ecosystem were subject to complex interactions and co-evolution, but also that their activities were influenced by external constraints imposed by, e.g., regulators or standardization bodies. Interestingly, the reported influences were seen as accelerating factors rather than as initial triggers for the change in technologies. The collaboration among actors in the ecosystem seems to have its roots in an environment that - influenced by regulations and policies - favores technological innovation (Smorodinskaya et al., 2017, p. 5248). In particular, central actors that had their roots in an established ecosystem were well-suited to take on the role of ecosystem leaders (Moore, 1993, 1996). These actors

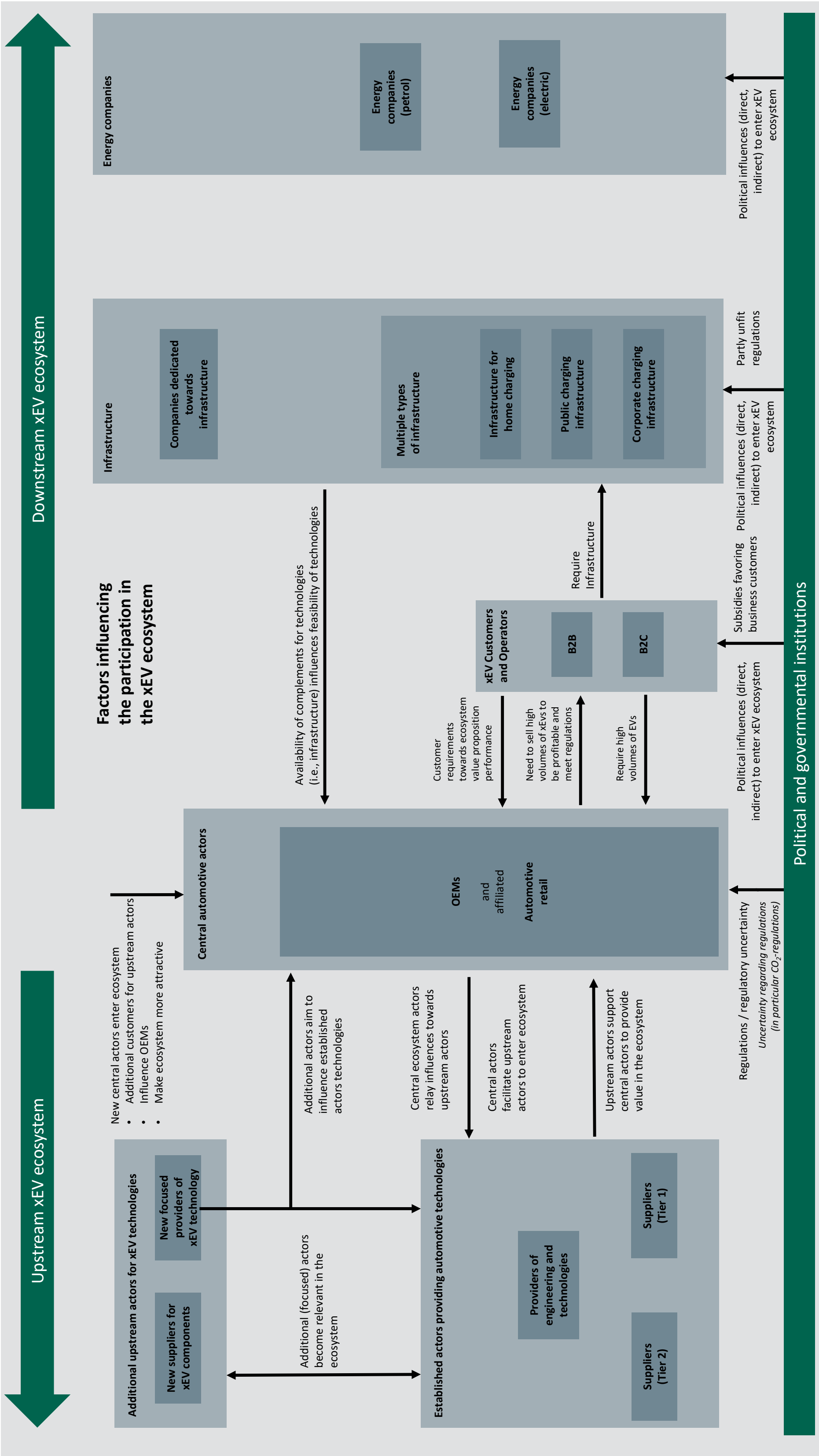


**Figure 58:** Overview on the identified factors encouraging actors to enter the xEV ecosystem (personal illustration)

were in a favorable position to introduce a holistic vision for the new ecosystem (Shalender, 2018, pp. 78-79).

However, according to the data, activities in their original ecosystems prevented their initiatives to enter a new ecosystem. One reason for this might be that the original and the new ecosystem could involve a similar group of actors. This indicates that several modes of action could be pursued by these established central actors. According to Adner and Kapoor (2016a, p. 641), one possible course of action could be the use of *"spillbacks,"* where initiatives to overcome technological challenges in the emergence of a new ecosystem prolonged the life of already established technologies. In the case at hand, these *"spillbacks"* could, for instance, be vehicles that relied on a low degree of electrification. Another option could be *"last gasp"* efforts where companies refused to shift to a new technology and tried to capture value based on the established technology (Adner and Kapoor, 2016a, p. 641). Informants indicated that this approach incurred substantial risks of losing business. Ultimately, companies could also pursue *"last resort"* efforts whereby multiple types of actors that are unable to manage a new technology try to extend the life of an established technology (Adner and Kapoor, 2016a, p. 641).

Consequently, the factors that encourage actors to enter the ecosystem differed depending on whether actors were positioned upstream or downstream of the central actors. Companies taking on the role of an ecosystem leader (Moore, 1993, 1996) in the new ecosystem were able to leverage their influence and facilitate their upstream suppliers to enter the new ecosystem. In line with Russel and Smorodinskaya (2018, p. 125), the data also indicate that the introduction of innovations in the upstream section of the ecosystem was driven by the demand of central ecosystem actors. Specific incentives of individual actors to commit to an ecosystem, centered around a technological innovation, were influenced by the actor's individual capabilities. Nonetheless, central actors did not yield the full control over additional ecosystem actors necessary for the new ecosystem. The results thereby indicate that central actors who took on the role of ecosystem leaders were able to arrange actors in the upstream region of the new ecosystem to a large degree *"top-down."* However, central ecosystem leaders struggled to establish an appropriate number of downstream complements. One explanation for this lack of actors offering complementing solutions could be that central actors did not wield the necessary influence in the downstream ecosystem to foster the entry of actors at a sufficient scale. Consequently, they encouraged collaboration with and among downstream actors to motivate them to provide complementing offers and, in turn, facilitated the emergence of the downstream regions of the ecosystem (Smorodinskaya et al., 2017, p. 5248). The obtained results support other findings in the literature, namely, that innovation-centered ecosystems could either be introduced *"top-down"* or emerge *"bottom-up"* (Tsujimoto et al., 2018, p. 55).

Coordinating both actors offering downstream complements and upstream suppliers of components was reported to be challenging. Consequently, actors trying to commit to the xEV ecosystem faced multiple bottlenecks in the ecosystem (compare Figure 58). The bottlenecks included shortcomings with regard to the availability and performance of components provided by upstream actors, as well as an insufficient availability of complements provided by downstream companies. Moreover, similar to insights reported by Dattee et al. (2018, p. 467), the results indicated that the identified bottlenecks represented by the value provided by central and upstream actors and the complements available in the downstream ecosystem were co-dependent. This means that ecosystem actors needed to overcome a *"hen and egg"* type of problem which, in turn, lowered the attractivity for additional actors to enter the ecosystem. In contrast, the entry of additional actors from outside the traditional automotive segment might serve to increase the xEV ecosystems' overall attractiveness. The results indicate that these were newly founded suppliers with a narrow technological focus, established actors from different segments, or newly established automotive OEMs. Relevant factors with regard to these actors were an increase in the demands of central actors and an improved availability of the technological solutions required in the new ecosystem. Moreover, additional central actors taking on the role of ecosystem leaders would potentially increase the competitive pressure towards already established central actors - particularly actors that pursued activities in both the new and the old ecosystems. Furthermore, the entry of central actors into the new ecosystem might also serve to increase the overall competition between the actors' established ecosystem and the new ecosystem (Moore, 1996, p. 162).

## b) Implications for academia

These findings have several theoretical implications. A brief overview of these implications is presented below:

- First, using the framework established in Chapter 5 (see Figure 42), the presented evidence connects the initial approaches proposed to describe ecosystems (Moore, 1996) with later, more structural and innovation-based approaches (Adner and Kapoor, 2010; Adner, 2017; Talmar et al., 2018). The obtained results highlight the relevance of governmental policies and regulatory influences proposed by Moore (1996) to understand the formation and change of ecosystems. This implication is particularly relevant, as these aspects were often neglected by later - more structural - approaches of describing ecosystems (Adner and Kapoor, 2010; Adner, 2017; Jacobides et al., 2018). The findings, therefore, agree with those of Almpanopoulou et al. (2019, p. 6361), who commented that a lack of policy-driven incentives could hinder the emergence of ecosystems centered around a technological innovation.

- Second, the results support the fact that actors already active in an ecosystem could encourage the entry of additional actors into an ecosystem. Influences took place on several levels. The data indicate that the involved relations included direct business relations as well as the influences of stakeholders and regulators. These findings agree with those of Tsujimoto et al. (2018, p. 55), who described ecosystems as multilayered social networks. In the investigated case, interdependencies among actors were often based on technological requirements that needed to be met (Ardilio and Lab, 2009), enabling them to participate and add value to an ecosystem. Further factors were the attractiveness of an ecosystem's offer for targeted markets and governmental policies. The results thereby improve the understanding of relevant factors for the introduction and development of ecosystems that are centered around a technological innovation (Russel and Smorodinskaya, 2018; Almpanopoulou et al., 2019).

- Third, central ecosystem actors taking on the roles of ecosystem leaders (Moore, 1993, 1996) could be critical for ecosystems, as they are likely able to leverage their influence and apply it to upstream actors, facilitating their entry into the ecosystem. Thereby, central ecosystem leaders might be able to introduce the upstream region of the new ecosystem to a large degree *"top-down."* However, these actors struggled to establish an appropriate number of downstream complements, which required them to increase the attractiveness of the overall ecosystem to encourage the entry of downstream actors. The insights improve the understanding regarding whether innovation-centered ecosystems emerge *"bottom-up"* or can be introduced *"top-down"* (Smorodinskaya et al., 2017; Tsujimoto et al., 2018).

- Fourth, the data indicate the existence of co-dependent bottlenecks between the value provided by central and upstream actors and the complements available in the downstream ecosystem. This co-dependency in creating value (Dattee et al., 2018, p. 467) indicated by the data also limits the incentives for additional actors to join the ecosystem. Insights thereby improve the understanding of how bottlenecks in an ecosystem might influence the entry of additional actors.

- Finally, the data indicate that established central actors in a mature ecosystem could be particularly well-suited to take on the role of ecosystem leaders (Moore, 1993, 1996) in a new ecosystem centered around a technological innovation as described by Adner and Kapoor (2010) and Adner (2017). Interestingly, contributing to a new ecosystem that potentially represented competition to an actor's original ecosystem was partly seen as unattractive. One particular factor was that the collaboration of actors in the new ecosystem did not rule out their competition within and beyond this ecosystem (Russel and Smorodinskaya, 2018). However, adding to the insigths of Moore (1996), additional actors entering the ecosystem to take on the role of a central ecosystem leader might make a novel ecosystem more attractive for additional actors - particularly in the upstream regions of the ecosystem. These insights improve the understanding of how an ecosystem's composition of actors influences its overall attractiveness for additional actors.

### c) Practical implications

The findings hold multiple implications for both practitioners as well as legislators:

- First, legislators need to be aware of the implications of regulations targeted at ecosystem actors. As indicated by the data, central ecosystem actors typically relied on multiple actors both upstream and downstream when adjusting to changes in regulations. Furthermore, involved ecosystem actors - particularly actors downstream - were often directly subject to various political influences and regulations. Here, one critical insight is that individual regulations need to be coordinated to increase their impacts and keep regulations from working against one another. This is relevant, as a lack of policy incentives could hinder ecosystem emergence (Almpanopoulou et al., 2019, p. 6361). In that regard, the data also indicated that, while policies targeted at OEMs were a major driver for xEVs, regulations partly hindered the installation of infrastructure. Thereby regulations were a driving factor for central and upstream actors but partly also hindered the efforts of downstream companies to provide complements.

- Second, practitioners in companies trying to enter an ecosystem need to consider the relations of individual actors and technological dependencies in their activities. For instance, actors trying to introduce new technological solutions need to consider actors integrating these solutions in products (often upstream suppliers and central ecosystem actors) and actors applying solutions (in many cases, customers/operators located downstream). In particular, practitioners need to be aware of the involved actors' incentives to participate in activities for a new technology (e.g., the involved profit potential), as described in an ecosystem's *"value blueprint"* (Adner, 2012).

- Third, practitioners in companies who are trying to contribute to a new ecosystem need to be aware of the respective actors' capabilities to handle involved technologies. This is the case as a lack of capabilities or resources might indicate bottlenecks in the ecosystem that could prevent the realization of an attractive ecosystem value proposition. This aspect is especially relevant, as Almpanopoulou et al. (2019, p. 6361) recognized that the dispersed capabilities of actors could hinder ecosystem emergence.

The obtained insights highlight the need to understand the individual actors' interactions and how these can help to create value in the ecosystem, as addressed in research question three (see Section 9.2).

## 9.2 Actors' ecosystem interactions to create value

In this section, empirical data that are presented in Chapter 8.2 are used to answer research question three:

> **Research Question 3:**
> How do ecosystem actors interact to create value in an ecosystem centered around novel technologies?

Below, the results obtained from individual cases regarding research question three are aggregated. This serves to form a basis for a detailed discussion of the results, as well as to derive recommendations for both academia and practice.

### 9.2.1 Aggregation and interpretation of results on interactions for ecosystem value creation

As before, the structure of this section mirrors the different ecosystem areas. Thereby, interactions with regards to central actors, upstream actors, and downstream actors are laid out and put into perspective with regards to relevant literature.

#### a) Interactions initiated by central ecosystem actors

As discussed with regard to research question two (see Section 9.1), established automotive OEMs could substantially influence ecosystem actors, particularly the suppliers and engineering companies located upstream. The results indicate that OEMs governed activities of established upstream actors as well as additional actors entering the upstream ecosystem for xEVs. Thus they acted similar to what (Moore, 1993, 1996) described as ecosystem leaders. The OEMs initiatives which they used to influence the value creation of upstream suppliers are exemplified in the following statement:

> *"We have to prepare both sides for our future issues. And that is not only a huge task for us, but also for our partners. And clearly, through many cooperation deals, we can also tell them in which direction they want to go or have to go. We can only achieve something together if we both make major changes."* (OEM Beta, Interview MS22; 00h 33min 49s - 00h 34min 25s; translated and adjusted for readability by the author)

In doing so, the OEMs increased both the technological feasibility as well as the profitability of their respective xEVs. Consequently, by leveraging their influence in the ecosystem and governing the upstream actors' behavior, the OEMs displayed signs of a (classical) dominator[1] strategy (as described by Iansiti and Levien (2004b, p. 75)) in this region of the ecosystem. Specifically, as described below, the data indicate that OEMs aimed to leverage existing actors in the upstream area of the ecosystem to manage competence shifts while trying to integrate core technologies from additional suppliers.

**Leveraging existing upstream actors to manage the competence shift towards xEVs:**
The established ecosystem centered around conventional vehicles and the xEV ecosystem show considerable overlaps. This partly allowed upstream actors to utilize their technological solutions in both ecosystems. One informant in the focus group stated that:

> *"Electric mobility will not have a huge impact in many areas. The products we develop, even the next level of these products is backwards compatible. This means I can also install them in a conventional vehicle with a cumbustion engine. OEMs are also toying with the idea that certain products that they are developing today could be used by suppliers as product upgrades for other models or vehicles."* (Focus Group; 00h 16 min 58s - 00h 17min20s)

Thereby, upstream suppliers were able to perform a type of ecosystem carryover (compare Adner (2012, p. 194)). Nonetheless, informants reported difficulties associated with different technological approaches required for xEVs as compared to those required for conventional vehicles. Consequently, OEMs needed to expand the overall scope of their capabilities towards xEVs while maintaining their capabilities in the area of conventional vehicles. As mentioned when discussing research question two (see Section 9.1), OEMs facilitated the entry of upstream actors into the xEV ecosystem. Interestingly, informants stated that OEMs subsequently relayed their needs in terms of capabilities for xEVs to actors located further upstream in the ecosystem. As shown by Mazur et al. (2013, p. 1060), the obtained results show that OEMs focused on their own capabilities and relied on external actors for *"disruptive or less familiar technologies"* (i.e., technologies for xEVs):

> *"Since the technologies are very, very new and the companies are not positioned in such a way that they also have this comprehensive knowledge, especially with the current OEMs or the classic OEMs who have made conventional drives so far, they simply need adequate support."* (ETP Alpha, Interview MS13; 00h 04min 24s - 00h 05min 03s; translated by the author)

The literature (compare Kale et al. (2000); Draschbacher et al. (2020)) shows that, while they initially relied on the external actors' resources and capabilities, informants in OEMs stated that their intent was to gain experience with new technologies and build up capabilities required for xEVs in-house.

**Integrating core technologies from additional upstream actors:**
Informants stated that the overall number of partners and the intensity with which the OEMs

[1] In the following, if not state otherwise, the term dominator refers to the strategy/role of the classical dominator, and not the value dominator (hub landlord) also described by Iansiti and Levien.

interacted with their partners increased. Additional suppliers that had previously not interacted with automotive companies were a relevant factor for xEV core technologies (e.g., electrical machines, batteries). However, informants in OEMs stated the possibility of becoming dependent on suppliers for new technologies as a critical consideration:

> *"Now a young company, or a new, innovative company brings a technology, looks really great, but can you adjust to it now without becoming dependent on it?"* (OEM Delta, Interview MS25; 00h 07min 40s - 00h 07min 55s; translated and adjusted for readability by the author)

The increasing relevance of additional actors in the xEV ecosystem is supported by the literature that proposes that core components will be outsourced to specialized suppliers (Abdelkafi et al., 2013, pp. 1340003-23-1340003-24). This aspect is particularly important as the data indicate that core technologies represent a bottleneck in terms of their technological performance and available numbers. Furthermore, core technologies were also stated as representing a major cost driver for xEVs. The following quote from an informant in a supplier illustrates the outlined relations:

> *"We then have a certain test and validation plan behind this technology carrier and for that we simply need some energy storage units, for that we need an energy converter, for that we simply need the elements that are important for that and often we cannot fall back on mass production products because they are new technologies that you can't get off the shelf. So here is the situation: Where do I get hardware from in time, a very important point in the whole network."* (SUP Beta; Interview MS5; 00h 29min 30s - 00h 30min 04s; translated by the author)

**Forging collaborations and introducing new actors downstream:**
As described in Section 9.1, OEMs which tried to introduce xEVs faced bottlenecks in the downstream area of the xEV ecosystem. One critical bottleneck in this regard, that prevented xEVs from becoming attractive for a broader customer segment, was the lack of required charging infrastructure (compare with, for example, Adner (2012), Adner and Kapoor (2010, p. 307), Adner and Kapoor (2016a, p. 310) and Adner and Kapoor (2016b, p. 65)).

As stated by informants, OEMs began to address the lack of charging infrastructure by forging collaborations with other OEMs as well as with downstream actors. While they collaborated with actors to introduce solutions for xEV charging, the OEMs also created separate actors (for example, by forming joint ventures) to independently offer solutions for xEV charging to complement their vehicles. OEMs' initiatives to influence the creation of value in the downstream region of the xEV ecosystem are exemplified in the following statement:

> *"Yes, the biggest risk is certainly the whole issue of infrastructure. Because of the whole infrastructure, on which we are also dependent, of course we can influence that, and we influence it as much as possible. So we also have joint ventures now with [name of Joint Venture], for example, or we are also looking for opportunities that, for example, with our [electric vehicle of the OEM] we also provide a card with*

> *which our customers have to pay the same price at all charging stations."* (OEM Beta, Interview MS22; 00h 20min 00s - 00h 20min 36s; translated and adjusted for readability by the author)

Thereby, OEMs influenced the ecosystem's value creation architecture. The OEMs' behavior in the downstream region of the ecosystem resembled that of a keystone actor, as described by Iansiti and Levien (2004a, p. 75), that tried to make the ecosystem more attractive to additional actors. The data further indicate that OEMs tried to leverage their existing resources and capabilities. This insight adds to the understanding of resource deployment in ecosystems (cf. Hannah et al. (2016, p. 45)). Moreover, the findings support the insights provided by Bohnsack et al. (2014, p. 298), who highlighted the fact that OEMs tended to rely on existing assets and facilities. An overview of the outlined interactions from the perspective of central ecosystem actors is presented in Figure 59.

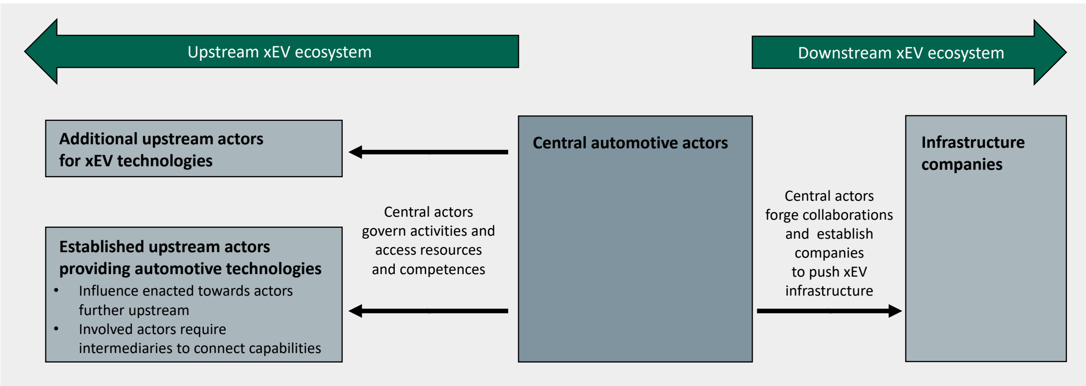


**Figure 59:** Principal data on ecosystem interactions initiated by central ecosystem actors (personal illustration)

## b) Interactions initiated by actors in the upstream ecosystem

**The upstream actors' adjustments towards the central actors' requirements:**
As established above, as central actors, automotive OEMs tried to leverage their influence and govern upstream actors. The following statement provided by an informant in a supplier illustrates the relationship between the involved actors:

> *"They say: Yes, if you want to continue to be a supplier to me, then you have to embrace these technologies and open up these technologies. That has a great impact. On the supplier side as well, of course. Yes, of course. [...] On the one hand they come with their own technologies. On the other hand, they are the ones who make these technologies possible in the first place."* (SUP Beta; Interview PS2; 00h 18min 56s - 00h 19min 32s; translated by the author)

Congruently, informants in suppliers cited the level of commitment demonstrated by OEMs towards a specific technology as a precondition for investing resources on a large scale. However, as informants in research institutions mentioned, companies that did not manage to adapt their capabilities could lose their relevance to the automotive industry. Consequently, the investigated automotive companies (OEMs, suppliers, providers of engineering and technology) pursued M&A activity to acquire competencies rapidly:

> *"So if you have a look at it, many old ones are just falling away, i.e. the companies that were around for years in the traditional topics are disappearing. These are also often companies that simply don't have the money or possibility to carry out this transformation. Many small companies, which are specialized, fall away. That means you can see that at the moment there is a turnaround in the industry. Everybody is trying to acquire something in order to be able to serve these topics quickly, and we are not exempt from that. There are companies that used to, let's say, grow naturally from the inside out, they no longer have the time. They suddenly buy companies."* (ETP Alpha; Interview MS19; 00h 32min 12s - 00h 32min 57s; translated and adjusted for better readability by the author)

The data indicate that reactions to the changing OEM requirements differed with regard to the upstream actors' capabilities and ecosystem positions. Incumbent[1] suppliers expanded their competencies and pursued joint development efforts with OEMs (compare Chesbrough and Schwartz (2007, p. 55)). The involved actors were motivated to form these development partnerships to reduce risks, as highlighted by one informant in SUP Beta:

> *"Why does the customer come to us with such topics? Because he simply has someone with whom he can share the risk. This means he comes to us with a lot of business, or because of the incentive, because he says ok - I come to you and share the risk."* (SUP Beta; Interview MS6; 44min; translated by the author)

**Role of additional upstream actors in the ecosystem:**
As described in Section 9.1, informants from the investigated pool of actors in multiple ecosystem positions recognized that new actors providing technology components became relevant in the xEV ecosystem. This resulted in an overall increase in the number of suppliers as compared to the numbers in the conventional automotive ecosystem:

> *"I mean, through technology, of course, other partners have come into play. That is clear because they are completely different suppliers than those in our core business, but that is probably not something special either. If, as I said, I now start to develop battery vehicles or fuel cell vehicles and before that it was just internal combustion engines, then it is clear that I have new suppliers. In this respect, that has certainly changed."* (ETP Alpha; Interview MS15; 00h 40min 02s - 00h 40min 31s; translated and adjusted for better readability by the author)

[1] As described in Chapter 7 in this thesis, the case data on established automotive suppliers was obtained from Tier 1 and Tier 2 actors.

Interestingly, informants in the examined focused suppliers of technological solutions stated that they held distinct positions in the ecosystem:

> *So we are between T1 and T2 level, but we are also detached from it, because we do not only supply to OEMs, but also provide infrastructure.* (SUP Zeta; Interview MS11; 00h 38min 16s - 00h 38min 29s; translated and adjusted for better readability by the author)

Based on their positions in the ecosystem, suppliers providing solutions in a focused technological area estimated their influence as substantial. The following quote exemplifies this insight:

> *"That we have been able to push the entire industry in this direction, that the acceptance is there and that we have been able to present the advantages transparently. That is point 1. Point 2: This is also confirmed by the fact that there are now some competitors who have very, very similar concepts to ours."* (SUP Gamma; Interview MS10; 00h 39min 01s - 00h 39min 31s; translated and adjusted for better readability by the author)

However, since these focused suppliers depended on the flexibility of their technological capabilities, they did not offer technology based components on a large scale themselves. Instead, they sought partnerships in which they could support other ecosystem actors and help them to industrialize their solutions. This finding is similar to that of Segers (2016, p. 135), who emphasized the role of collaborations and partnerships - particularly for smaller companies. Another factor that affected their perceived influence was the good fit of their value propositions with the requirements of other ecosystem actors, which, in turn, were driven by external factors, such as regulations (see Section 9.1).

**Entry barriers and preconditions to contribute towards ecosystem value:**
Informants perceived the barrier to enter the xEV ecosystem as lower than the barrier to enter the traditional automotive ecosystem. Subsequently, informants reported that *"born electric OEMs"* that entered the ecosystem required support for developing vehicles from established automotive suppliers and ETPs:

> *"Now that we see that many new players are pushing into the automotive industry, who actually have no experience with vehicles, but rather come from the service side, but are still thinking about building their own cars. We can help them to find the optimum in terms of costs and technology. At the end of the day, we make sure that the right technologies or dimensions are developed for their planned area of application i.e. support the vehicle specification."* (SUP Beta; Interview MS7; 00h 06min 15s - 00h 06min 52s; translated and adjusted for better readabilty by the author)

However, informants in providers of engineering and technology reported that the number of relevant suppliers for xEV core components was still limited. In that regard, informants in suppliers mentioned that a major precondition for new actors entering and contributing to the ecosystem was their ability to provide high volumes of xEV components (see Section 9.1). Furthermore, informants in research institutions mentioned that as soon as OEMs commited to producing large volumes of xEVs, upstream suppliers of components would realize scale effects (Gulati et al., 2000, p. 203). This insight is exemplified by the following statement:

> *"We can never directly demonstrate these cost targets, that's the risk of the customer pulling this up and then actually coming down with the costs. This is quite difficult for a new technology, because in the end you have to make sure that the customer builds up the supply chain. It's the same as in the automotive industry, in the classic one, where there are 20 manufacturers for each connecting rod and for each valve, who are under extreme cost pressure and can produce very cheaply. That's where you have to get to with a new technology, where there are perhaps new components, where there are not yet so many suppliers. And I believe that this is, in my view, a very big risk. You can't solve that overnight."* (ETP Alpha; Interview MS15; 00h 15min 14s - 00h 16min 09s; translated and adjusted for better readabilty by the author)

Therefore, increasing the number of (upstream) ecosystem actors could lower costs of xEV core components (e.g., in case of cost-intensive components, such as batteries) and, as a result, make the ecosystem value proposition based on xEVs more attractive.

**Shifts in value creation between ecosystem actors:**
The insights provided by informants in OEMs, who indicated that their companies relied on upstream actors for xEV technology, also mirror statements by informants from engineering and technology providers who perceived a tendency whereby established actors (i.e., predominantly OEMs and Tier 1 suppliers) outsourced elements of their development activities to reduce costs and set a high pace in their development efforts. The described development was particularly underlined by one informant in an automotive OEM:

> *"Another very important pillar is engineering service providers who help us deal flexibly with order changes, especially in the area of safety. That we can fall back on flexible resources outside the company, particularly when it comes to changes in the law, exhaust or emissions legislation, we have to ensure our product's safety."* (OEM Gamma; Interview MS24; 00h 14min 32s - 00h 15min 06s; translated and adjusted for better readabilty by the author)

This goes hand in hand with statements made by informants from both suppliers and companies providing engineering and technology. Moreover, these actors showed tendencies to modularize their offerings, as described by Baldwin and Clark (1997). For instance, informants in suppliers highlighted the fact that they modularized their products for multiple use cases (for uses in both conventional vehicles and xEVs). This approach increased the flexibility of upstream actors and lowered risks associated with exploring technologies, but also opened up possibilities to realize scale effects. Modularity in that regard could play a critical role in ecosystem governance, as it enables multiple actors to produce interdependent components (Jacobides et al., 2018, p. 2260). Moreover, modularity might help to overcome mutual dependencies in creating ecosystem value, as it can support the coordination of actors (Jacobides et al., 2018, p. 2260). The finding is supported by the results of Mason and Mouzas (2012, p. 1361), who highlighted the role of flexibility in the context of both upstream and downstream relationships. An interesting insight provided by informants from engineering and technology providers was that, due to their broad array of capabilities, they were able to act as intermediaries and connect actors from the automotive sector with actors from other industries that were trying to contribute to the xEV ecosystem. These results, therefore, support those provided by Dedehayir et al. (2018, p. 24), who emphasized the importance of building ecosystem relations. Moreover, the findings line up with the notion that relationships need not necessarily be built by ecosystem leaders. Instead, the task could be accomplished by actors that take on the role of ecosystem experts or champions (Dedehayir et al., 2018, p. 24). These support roles could thereby build connections, offer technological expertise, and enable market access (Dedehayir et al., 2018, p. 26). One informant stated:

> *"We provide the network as well, in fact. We offer to introduce customers to the industry, to introduce them to suppliers. We also offer studies on the state of the art of a technology - intellectual property, for example. So everything related to the topic where the customer wants more security or needs a decision basis for strategic decisions."* (ETP Alpha; Interview MS17; 00h 34min 37s - 00h 35min 10s; translated and adjusted for readability by the author)

The findings support results provided by Vuori (2005, p. 908) who proposed that *"knowledge-intensive service organizations"* participated in various innovation networks and business networks. However, while Vuori (2005, p. 908) found that these organizations were susceptible for co-opetition in their business environments, the empirically investigated actors took a more complex approach. Specifically, informants from providers of engineering and technology mentioned that they (1) facilitated communication between different actors, (2) established a fit between the suppliers' capabilities and customers' requirements, and (3) influenced their customers by, for example, making a pre-selection of suppliers for xEV components. Therefore, the results support those of Katzy et al. (2013, p. 306), who found evidence that companies acting as intermediaries developed capabilities to identify and match relevant actors for collaborations, manage innovation processes, and highlight the value of innovations between involved actors. However, informants stated that the specific influences of engineering and technology providers could depend on the size and type of involved actors.

Moreover, like the results of Monios and Bergqvist (2020, p. 8), the obtained results also indicate that incumbent suppliers were confronted with the option to take on additional roles further downstream (i.e., directly offering or enabling other actors to provide mobility solutions) and thus to engage in competition with their current customers. Overall, the informants noted that the technological shift towards xEVs resulted in a substantially different supply structure for xEVs as compared to the supply structure for conventional vehicles. An overview of the outlined interactions from the perspective of upstream ecosystem actors is presented in Figure 60.

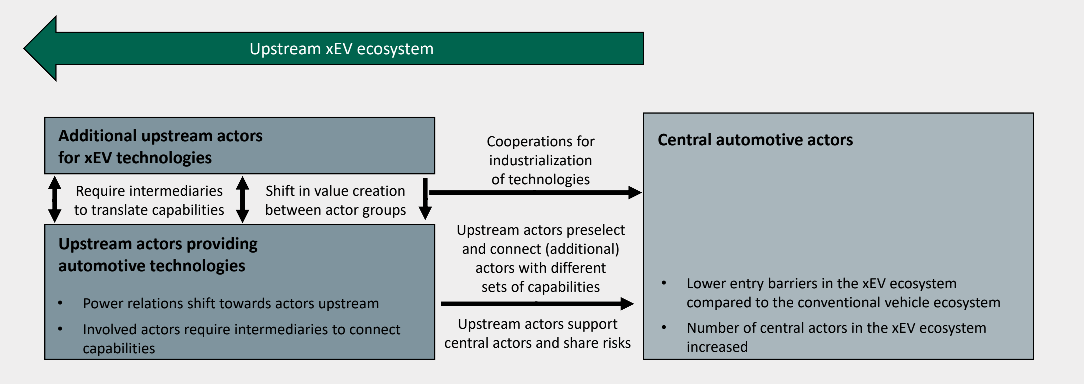


**Figure 60:** Principal data on ecosystem interactions initiated by upstream ecosystem actors (personal illustration)

## c) Interactions initiated by actors in the downstream ecosystem

**Multiple types of actors introducing complementing offers:**
As described in detail above, automotive OEMs engaged in activities in the downstream ecosystem to push infrastructure for xEVs - predominantly by forging partnerships and establishing separate companies (see Figure 59). Interestingly, as illustrated in Figure 61, companies located in the downstream ecosystem pursued similar activities. For instance, companies originating in the energy sector introduced solutions for electric charging themselves. Furthermore, they also formed dedicated companies to offer charging solutions. This resulted in companies from the energy sector and automotive sector finding themselves needing to cooperate (e.g., for electrical energy) while also competing to offer solutions for electric charging, and ultimately indicating a co-opetition relation (Vuori, 2005). Moreover, automotive retailers started to cooperate with additional actors from both the automotive and the energy sector to support this goal (e.g., actors affiliated with OEMs offering charging solutions, automotive rental companies, energy providers).

**Changes in the ecosystem architecture and actors' strategies:**
The introduction of additional actors and collaborations caused changes in the value creation architecture of the ecosystem for xEVs (Adner, 2012). This observation supports results provided by Dedehayir et al. (2018, p. 22), who proposed that actors usually entered an ecosystem and forged partnerships when an ecosystem started to become more attractive but before a *"critical mass"* had been reached. The results of Hannah and Eisenhardt (2018, p. 3189) also support the obtained findings, in that the potential to co-operate with actors from multiple industries required actors to carefully select an appropriate ecosystem strategy. In particular, the results indicate the existence of multiple ecosystems centered around different technological solutions. These were predominantly the ecosystem centered around conventional vehicles and the xEV ecosystem. These results further complement those of Bohnsack et al. (2020, p. 739), who highlighted the aspect of entry timing and the importance of first movers to diverge and subsequently drive the transition towards xEVs. In addition to the aforementioned initiatives, infrastructure company INF Alpha reacted to political influence by taking on the role of a coordinator of other infrastructure

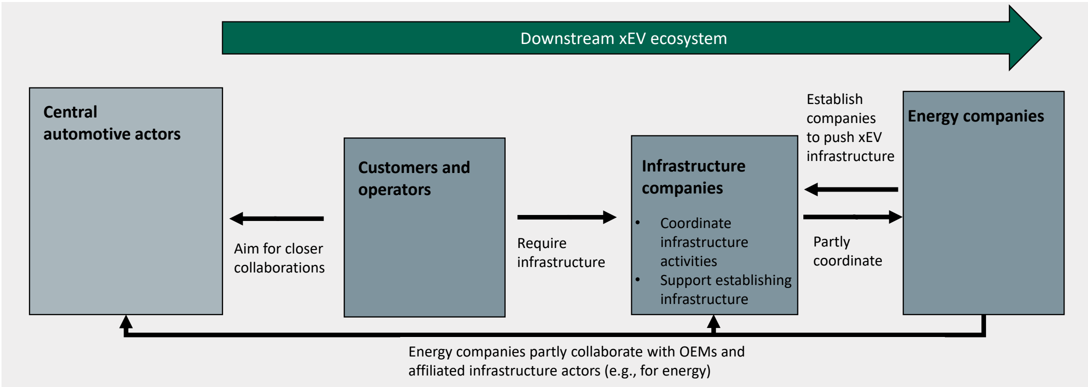


**Figure 61:** Principal data on ecosystem interactions initiated by downstream ecosystem actors (personal illustration)

companies. In doing so, this company tried to establish a basic coverage of electrical charging solutions. Again, an overview of the outlined interactions from the downstream ecosystem actors' perspectives is presented in Figure 61.

## 9.2.2 Discussion and implications

Relevant factors with regard to research question three discussed in this section are summarized in Figure 62. The illustration presents an aggregation of the insights presented in Figures 59, 60, and 61. As shown in Figure 62, the xEV ecosystem overlaps considerably with the established automotive ecosystem. The creation of value in the upstream region of the ecosystem was largely governed by central actors that tried to access resources and competencies for xEVs. Consequently, due to the different requirements for demonstrating an attractive value proposition, additional actors entering from other industries became more relevant. In the upstream ecosystem, these new actors included suppliers of new technologies and components. This ultimately led to a shift in value creation between new actors and ecosystem actors that were based in the automotive ecosystem. However, due to the differences between the newly entering ecosystem actors' capabilities and the capabilities of actors that already had experience in the automotive ecosystem, intermediaries were necessary to facilitate the exchange of value between these groups of actors. Both informants from established Tier 1 suppliers and informants from engineering and technology providers stated that their companies were able to perform this function. Due to the higher technological flexibility of engineering and technology providers, however, they were in a better position to take on this role. In the downstream regions of the ecosystem, several structural changes were introduced to overcome shortcomings with regard to companies offering complementary charging solutions. Thereby, both actors based in the automotive ecosystem and actors based in the energy sectors began to set initiatives for electric charging. In addition, both types of actors established new ventures to offer infrastructure complements. Below, the empirical results regarding research question three are discussed with reference to the literature. Consequently, implications of and recommendations for research and industry are presented.

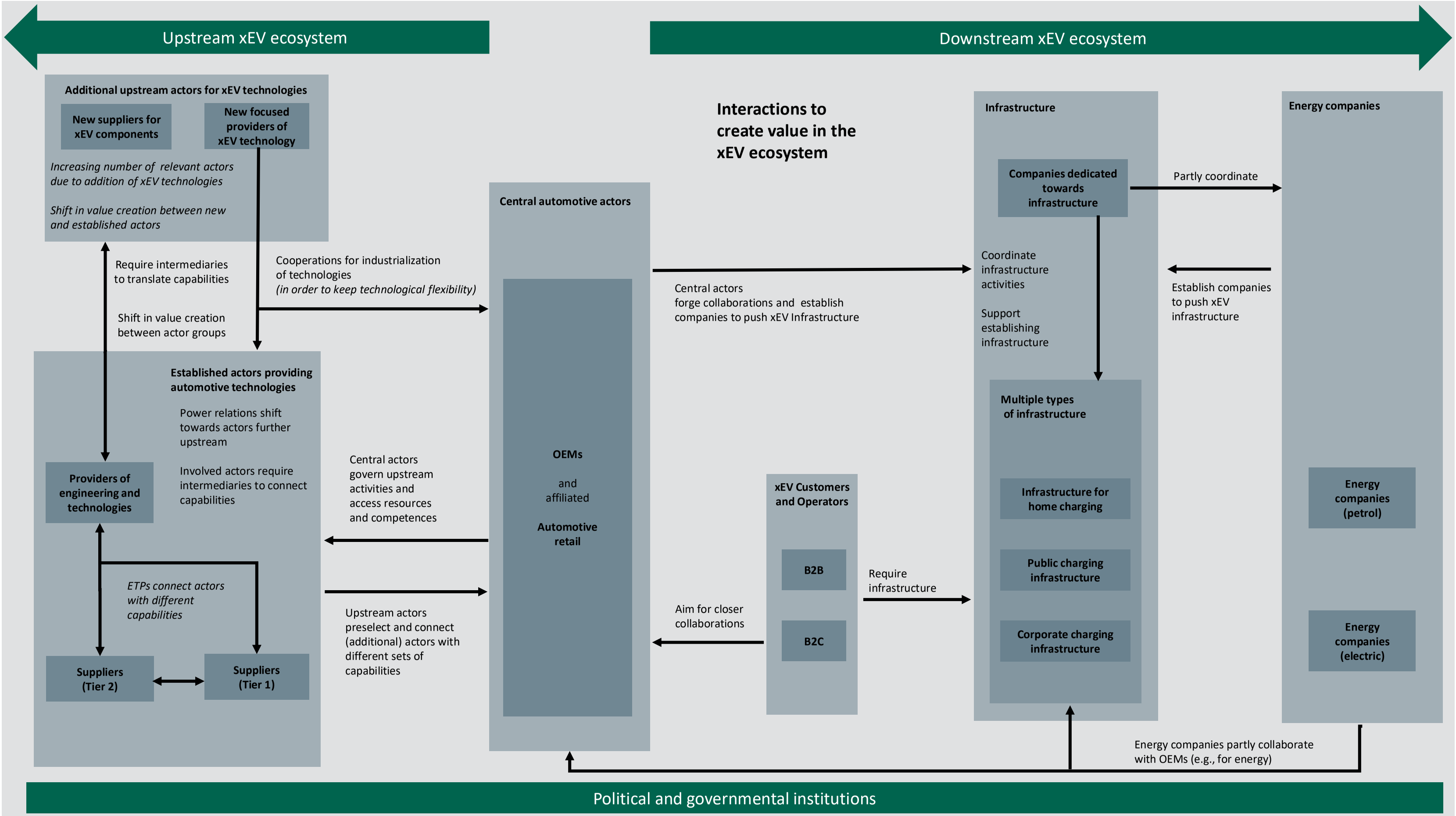


**Figure 62:** Identified interactions and dependencies for creating value in the xEV ecosystem (personal illustration)

## a) Discussion

Actors involved in the novel ecosystem were to a large degree based in other, more established, ecosystems. Actors that were found in central and upstream parts of the ecosystem initially displayed a tendency to rely on additional actors to create ecosystem value based on novel technologies (Kale et al., 2000; Mazur et al., 2013). Despite their initial reliance on additional actors, companies located in these central and upstream areas tended to try to build up in-house capabilities in technological areas they deemed as relevant. As summarized in Figure 62, the necessary adjustments in collaborations, actor structure, as well as the introduction of new ecosystem actors thereby resulted in differences between the actors' original ecosystems and the ecosystem centered around a novel technology. As illustrated, in the upstream regions of the ecosystem, additional actors entered that provided resources and capabilities as well as complementary offers. Overall, the structural changes between the established and new ecosystems were due to the fact that (1) additional actors that provided components and/or technologies entered the upstream ecosystem, (2) additional actors entered the downstream ecosystem to provide complementary offers, and (3) companies from multiple sectors introduced separate actors to offer complementary solutions in the xEV ecosystem. Similar to descriptions provided by Rong and Shi (2015, p. 137), the ecosystem composition, as well as actors' respective activities to create value based on novel technologies, changed. Consequently, the new ecosystem seems to rely on a different *"value blueprint"* (Adner, 2012) than the blueprints of the former ecosystems of the majority of actors. Nonetheless, while the *"value blueprint"* for the newly established ecosystem began to form, it continued to show substantial overlaps with the established automotive ecosystem. The data, therefore, provide a vivid example of what Adner (2012, p. 194) called *"ecosystem carryover,"* where elements developed in the construction of an ecosystem are leveraged to construct another ecosystem. However, until the *"value blueprint"* of the new ecosystem was settled, the ecosystems' value proposition could not fully address customer demand. This was exemplified by the low availability of required core components due to the lack of a fully established partner network (see Moore (1996, p. 260) and Rong and Shi (2015, p. 137)) as well as the lack of actors providing complementing solutions. Informants in engineering and technology providers, as well as Tier 1 suppliers, stated that their companies took on value creation support roles similar to those described by Dedehayir et al. (2018). These actors acted to connect the capabilities and offerings of newly entered upstream actors with the requirements of established automotive actors that were active in the xEV ecosystem. Moreover, they supported ecosystem actors by facilitating the formation of networks. Overall, however, the offered ecosystem value can be described as similar to that of *"precursor products,"* which could be - at least in part - acceptable to customers (Moore, 1996, p. 124). Moreover, results indicated that actors interacted differently, depending on whether the focus of their activities was located upstream or downstream in the ecosystem. This might be explained by the different types of values they contributed to the ecosystem (i.e., products, core technologies, complementary offers). Accordingly, the data show that the central actors' strategies differed with regard to the specific ecosystem regions they addressed. In the upstream regions of an ecosystem, central actors engaging in a dominator strategy (Iansiti and Levien, 2004a,b) were able to leverage their - often substantial - influence over suppliers and other upstream actors to determine technological solutions for xEVs. In contrast, in the downstream region of an ecosystem, central ecosystem companies acted as keystone actors (Iansiti and Levien, 2004a,b) to improve ecosystem health (Dattee et al., 2018) and make the ecosystem more attractive to additional actors by providing - or enabling - complementary offers. One prominent finding was that established automotive actors needed to balance their engagements between the new ecosystem and their established ecosystem. Co-opetition relations are one possible outcome due to these aspects (Velu, 2016). Supporting the findings of Hannah and Eisenhardt (2018), the data also show how ecosystem actors balanced cooperation and competition within the investigated ecosystem as well as between their original ecosystems. Ultimately, however, new ecosystems might deliver more attractive value propositions to customers, making the previous ecosystems less attractive. As described by Moore (1996, p. 232), this could then result in actors leaving established ecosystems.

### b) Implications for academia

The discussed results have multiple implications for the formation of ecosystems centered around novel technologies:

- First, actors involved in the ecosystem centered around a novel technology were based largely in other, more established ecosystems, providing a vivid example of what Adner (2012, p. 194) called *"ecosystem carryover."* The results indicate that structural changes occurred as new technologies became more relevant to ecosystem actors. This improves the understanding of how a *"value blueprint"* undergoes structural changes when a novel ecosystem emerges from an established ecosystem.

- Second, the findings contribute to those on the roles in the generation of ecosystems provided by Dedehayir et al. (2018). Specifically, while the newly formed ecosystem relies in part on actors from other ecosystems, some actors benefit from capabilities that they can carry over (Adner, 2012, p. 194) from another ecosystem. Therefore, actors that take on value creation support roles could be crucial for connecting the - often vastly different - capabilities from new actors with the requirements of actors that could in part rely on already existing capabilities.

- Third, until the value blueprint of the new ecosystem had fully formed, the ecosystem could not completely satisfy customer requirements with its value proposition. Consequently, the ecosystem needed to address customers with a value proposition similar to that of a *"precursor product"* (Moore, 1996, p. 124). This finding contributes to literature in that it highlights relations between the ecosystem structures (Adner and Kapoor, 2010; Adner, 2012, 2017) and the offered (ecosystem) value propositions (Talmar et al., 2018).

- Fourth, the data indicate that, as a new ecosystem emerge from an established ecosystem, central actors from an established ecosystem might adopt multiple simultaneous strategies/roles (e.g., keystone, dominator) to operate in a new ecosystem (Iansiti and Levien, 2004a, p. 75). Actors might need to balance competition and cooperation within and between different ecosystems (Hannah and Eisenhardt, 2018). These results improve the understanding of the actors' strategic choices and adopted roles when new ecosystems evolve from established ecosystems.

- Fifth, the findings represent an example of a situation in which the emergence of new ecosystems could result in the inability of established ecosystems to meet the needs of involved actors in the established ecosystem. This, ultimately, could lead to the withdrawal of actors from the established ecosystem (Moore, 1996, p. 232).

## c) Practical implications

Practitioners in companies engaging in an ecosystem centered around a novel technology can benefit from the obtained results as follows:

- First, practitioners in established upstream ecosystem companies need to be aware that they might need to proactively adjust their competencies to participate in a new ecosystem that relies on different technological requirements than its traditional ecosystem (Teece, 2007). This is particularly the case if the new ecosystem shows the potential to replace the previous ecosystem (Moore, 1996, p. 260). Furthermore, practitioners might also consider investing resources to influence the generation and future shape of new ecosystems (Dattee et al., 2018, p. 490). If investing resources and adjusting capabilities is not a feasible option, then companies might need to withdraw from their current ecosystem and/or apply their existing competencies differently (e.g., in different technological areas or to different customers) (Moore, 1996, p. 232).

- Second, as pointed out in Section 9.1, participating in an ecosystem centered around a novel technology involves interactions among multiple actors. Thereby, demonstrating value in an ecosystem centered around on a novel technology is likely to involve newly established actors, as well as actors from different industries. As indicated by the data, these additional actors tended to yield competencies for a critical component (e.g., batteries) or had competencies and resources in technological areas that the established ecosystem actors initially lacked. Informants pointed out that value creation involving established actors as well as actors new to the ecosystem required the transference of competencies from the actors' individual backgrounds into the focal ecosystem. Fulfilling this role may require the actors to broaden their capabilities, as described by Sirmon et al. (2009, p. 287). Consequently, the capabilities of ecosystem actors might be dispersed (Almpanopoulou et al., 2019, p. 6361). To address this issue, practitioners need to consider the requirements and capabilities of these individual companies at an early stage. This is particularly the case, as actors usually enter an ecosystem and forge partnerships when an ecosystem starts to become attractive, but before a *"critical mass"* has been reached (Dedehayir et al., 2018, p. 22). In turn, this requires practitioners to address the actors' requirements and coordinate ecosystem actors located at multiple positions in the ecosystem. Potential preconditions for this coordination effort could be that (1) ecosystem actors take on the role of intermediaries (Katzy et al., 2013, p. 306), (2) ecosystem actors take on value support roles that provide technological expertise, build connections, and enable market access (Dedehayir et al., 2018, p. 26), or (3) the presence of ecosystem leaders (Moore, 1993, 1996) that ensure the coordination of actors located both upstream and downstream.

## 9.3 Alignment of the actors' business models to fulfill an ecosystem value proposition

In this section, the results presented in Chapter 8 are used to answer research question four as well as the respective sub-questions:

> **Research Question 4:**
> How can actors participating in an ecosystem centered around novel technologies align their individual business models to contribute to a joint ecosystem value proposition?
>
> **Sub-Question 1:**
> How does participating in an ecosystem centered around novel technologies influence the individual actors' business models?
>
> **Sub-Question 2:**
> How do individual ecosystem actors change their business models when participating in an ecosystem centered around a novel technology?

First, in Sections 9.3.1 and 9.3.2, sub-questions one and two are addressed. Based on the results of investigating both sub-questions, an answer to research question four is provided in Section 9.3.3. Consequently, in Section 9.3.4 the reflections on insights regarding research question four and the implications for researchers and industry are presented.

### 9.3.1 Aggregation and interpretation of results on influences on the actors' business models

First, the results are discussed to identify the influences that affect the ecosystem actors' business models when they participate in the xEV ecosystem. This serves to answer the following research question:

> **Research Question 4 Sub-Question 1:**
> How does participating in an ecosystem centered around novel technologies influence the individual actors' business models?

As mentioned in the discussion of research question two in Chapter 9.1, regulatory factors were identified as strongly influencing OEMs to enter the xEV ecosystem. In turn, actors participating in the ecosystem tended to need to explore new technologies and to adjust their business models. This result supports that of Saebi et al. (2017, pp. 570, 576), who highlighted the fact that companies required strong incentives to change their business models. However, informants from

OEMs also stated that, while obtaining capabilities for xEVs required large amounts of resources and was challenging, it could also have strategic advantages, such as enabling them to differentiate themselves from competitors. By combining insights from individual cases, the multiple influences on business models in the xEV ecosystem could be identified.

The following section is structured as follows: First, the role of uncertainty with regard to technologies and customer requirements is discussed. Second, influences on business models based on the ecosystem architecture are investigated in greater detail. Third, considerations regarding the impact of the actors' roles and positions in an ecosystem are presented.

## a) Influence of uncertainty in the ecosystem

**Customers' requirements:**
According to the data, one factor influencing the perceived uncertainty was the long development cycle required for new vehicles and the variable acceptance of xEVs by customers/operators. One informant in an automotive supplier particularly highlighted this aspect:

> *"The automotive industry is very sluggish - also towards end customers. It is always difficult to predict what the end customer will really accept and adopt."* (SUP Beta; Interview MS4; 00h 12min 25s - 00h 12min 35s; translated by the author)

Another informant from a provider of engineering and technology solutions reported that the xEV activities of OEMs were volatile:

> *"At the moment they are simply facing an immense investment risk, but it is also, and we can see this partly in the services, that the OEMs don't know whether they should develop a battery electric vehicle, whether they should develop more hybrids, what is the concept that they are developing most sensibly? We also see that with the companies, that they are constantly changing their strategy. They start to develop a battery electric vehicle, then they cancel development and continue developing a hybrid, because they have the feeling that the market requirements are constantly changing, they don't quite know what will prevail in the medium term."* (ETP Alpha; Interview MS13 ; 00h 08min 48s - 00h 09min 24s; translated by the author)

In addition, a third informant from an automotive retailer summarized his perceptions of the influence of customers towards xEVs as follows:

> *"But in the end, it is the customer who decides whether the electromobility strategy is successful or not. And there are many factors that play a role here, and it is ... a key point is simply still price. There is no way around it. As long as electromobility is considerably more expensive than the same internal combustion engine, then I would say: Well, why? If nobody is forcing me to do it."* (RET Beta; Interview MS28; 00h 14min 17s - 00h 14min 45s; translated by the author)

Therefore, addressing the customers' needs was seen as a challenging undertaking. This was particularly the case, as the value proposition of the xEV ecosystem was not attractive to a majority of customers from the standpoint of performance and price. In turn, providing an attractive value proposition was hindered by the long xEV development times and the uncertainties regarding customers' expectations. The following quote exemplifies the challenges faced by OEMs with regard to xEVs:

> *"I would say the customer value proposition is clear at a later stage - which shortens our development times. The customer added value can only be quantified very late, which strongly influences our development goals. The market can no longer be precisely forecast in the long term."* (OEM Gamma; Interview MS24; 00h 36min 35s - 00h 37min 10s; translated and adjusted for better readability by the author)

The findings highlight the fact that market factors had a strong impact, as they were considered to have the potential to facilitate the exchange of information and distribution of risks among actors (Berghman et al., 2006, p. 970).

**Technological uncertainties:**
Informants in upstream suppliers and companies that provide engineering and technology solutions perceived substantial levels of uncertainty regarding the timing of xEV technologies and the dominant technology. Consequently, informants from upstream actors stated that they perceived increased demands for flexibility from OEMs due to the use of multiple technologies. In particular, informants from engineering and technology providers perceived their customers' requirements (OEMs, suppliers) as becoming more volatile while the development cycles shortened and cost pressure increased. This insight is exemplified by the following statement:

> *"We have the electrified combustion engine, it will be completely electrified in the future, we have the battery vehicle, and we have the fuel cell. These are essentially the 3 propulsion systems that you can foresee for the next 20 years. So, they're in competition. And the competition is more open than most people think, because each system has its advantages and disadvantages."* (ETP Alpha; Interview MS16; 00h 25min 40s - 00h 26min 01s; translated and adjusted for readability by the author)

As discussed with regard to research question two, these uncertainties were partly due to factors related to regulations and governmental policies (see Section 9.1). Actors located in the upstream ecosystem addressed this situation by exploring multiple technologies simultaneously. This insight was also underlined by several statements provided by informants situated in different types of suppliers. For instance, one informant in a Tier 1 supplier stated:

> *"The interesting thing for us is that now there are going to be changes in the business segment - everything is about the environment. Sustainability of the future and mobility concepts. These two have an impact, but we don't know how. We can't estimate it. And because we can't anticipate it, we are positioned very broadly in our considerations, in our projects, in our concepts in order to be able to determine all*

> *possible parameters and to react as quickly as possible when the time comes."* (SUP Beta; Interview MS4; 00h 47min 47s - 00h 48min 25s; translated and adjusted for readability by the author)

Similar statements were also provided by informants from focused technology suppliers:

> *"You always try to keep all horses in the race as long as possible. You can predicate some aspects yourself quite well and you ask yourself the question "How can you set yourself up broadly, how can you also set the course as long as possible?" And this is how we are positioned now."* (SUP Zeta; Interview MS11; 00h 40min 41s - 00h 41min 02s; translated and adjusted for readability by the author)

This indicates that, due to the described difficulties, actors in the xEV innovation ecosystem were reluctant to commit to a specific technology for xEVs (see Section 9.1). This reflected the statements from suppliers, who were rethinking their capabilities for adding value to the xEV ecosystem:

> *You just have to find out what your core competence has to be, to be an attractive partner for the customers. And where that comes from. The things that are not relevant for a differentiation potential can be bought, that is - if there is enough added value in the company.* (SUP Beta; Interview MS3; 00h 13min 12s - 00h 13min 40s; translated and adjusted for better readability by the author)

However, as suggested by the data, actors in the upstream region of the ecosystem explored new technologies, which could be used to adapt the value creation aspect of their business model for strategic reasons. Thereby, suppliers aimed to position themselves as attractive partners for OEMs. As pointed out when discussing research question three (see Section 9.2), these undertakings may have been due to the expected change of actors in both the ecosystem for conventional vehicles and the xEV ecosystem. Informants in SUP Zeta also underlined this:

> *"So you have electric mobility as a big disruptive change with the whole supply chain for the vehicle itself. That is quite remarkable, so many of the established T1s are actually left out because they are not needed. You simply don't need a manufacturer of connecting rods or whatever for electric vehicles."* (SUP Zeta; Interview MS11; 00h 44min 52s - 00h 45min 12s; translated by the author)

With regard to the insights gained when asking research question three (see Section 9.2), informants stated that the investigated actors (both upstream and downstream) relied on collaborations with additional suppliers to extend the capabilities they could apply in their business models. The results thereby support previous statements by Rong et al. (2018, p. 243), who emphasized the fact that the *"[...] ecosystem in which the business model evolves influences the capability to be flexible."* This is particularly the case, as individual actors often did not have sufficient internal expertise on their own, and business model innovation tended to span the companies' boundaries (Spieth and Meissner, 2018, p. 1850042-16). Thereby, the findings complement those provided by

Spieth and Meissner (2018) and Rong et al. (2018, p. 243). In addition to accessing resources and capabilities, knowledge transfer was mentioned as a relevant factor when adjusting business models in order to work with additional partners (Spieth and Meissner, 2018, p. 1850042-16). One informant from Supplier Beta said:

> *"You can work with partners where the gradient goes in the right direction. Where the partner knows at least as much or maybe even more in the area where you work together. [...] One works together with such a service provider where he has a lot to offer that the knowledge gradient points in the right direction."* (SUP Beta; Interview MS3; 00h 14min 24s - 00h 14min 48s; translated and adjusted for readability by the author)

Consequently, due to the outlined uncertainties in the ecosystem, upstream actors needed to change their business models to access the resources and capabilities necessary for xEVs. Therefore, the results agree with those of Rong et al. (2018, p. 235) who emphasized the fact that ecosystems could support the development of business models. At the same time, uncertainties regarding market demand (the type of customers, number of customers) discouraged companies from investing in capacity/supply (Rong et al., 2018, p. 235).

**Influence of managerial commitment:**
Despite the outlined uncertainties, informants from automotive OEMs, engineering and technology providers, corporate operators of vehicle fleets, as well as dedicated actors providing infrastructure cited that their company management exhibited a high level of commitment towards xEVs. For instance, one informant from a company operating a corporate vehicle fleet mentioned:

> *"[...] nobody knows at the moment how exactly the technological leaps will look like and I have to make decisions on a certain kind of uncertainty."* (FO Beta; Interview MS27; 00h 56min 02s - 00h 56min 30s; translated by the author)

These actors subsequently explored options to integrate xEVs into their business models at an early stage. This finding supports others reported in the literature that suggest that top management commitment plays a crucial role for the success of business model innovation (see Foss and Saebi (2018, p. 17) and Doz and Kosonen (2010, p. 376)).

### b) Changes in the ecosystems architecture to cope with new technologies

Informants in companies providing engineering and technology reported that the described uncertainties with regard to technologies and customers kept OEMs from fully committing to xEVs. In turn, this also limited the upstream actors' ability to provide specific technologies to satisfy the OEMs' requirements. The following statement provided by an informant in an upstream engineering and technology provider exemplifies this insight:

> *"As I said, the customers do not want to commit themselves, so we are actually forced to offer more flexible solutions. Well, it's not that it was our idea, but we see that customers don't want to commit themselves, they don't want to invest a large amount of money. They don't know if this really has a long-term future and therefore we are forced to offer innovative, new business models to take the investment risk off their shoulders."*[1] (ETP Alpha; Interview MS 13; 00h 8min 14s - 00h 08min 46s; translated by the author)

Therefore, particularly actors in the upstream ecosystem were drawn into the xEV ecosystem (see the discussion of research question two in Section 9.1) and used by central actors to demonstrate value (see the discussion of research question three in Section 9.2). However, OEMs did not fully commit to a specific technology for xEVs and relied on upstream actors to share the risks involved with the introduction of new technological solutions. This occurred because the OEMs faced uncertainties with regard to regulations and customer preferences. Informants reported that several changes in the ecosystem architecture could help to overcome this issue. These changes, in turn, could affect the involved actors' business models.

**Changes in the ecosystems processes and structures:**
As reported by informants from upstream actors, OEMs began to introduce cultural changes, shorten their development cycles, and pursue flexible engineering approaches. Such activities were already reported by Moore (1993, p. 85), who highlighted that leading actors in business ecosystems *"[...] sometimes have no choice but to undertake profound structural and cultural changes."* A major aspect in that regard was to be better at addressing changing requirements of customers.[2] However, as noted by informants, the established actors from the automotive ecosystem struggled to perform these changes.

> *"In development, we try to provide for development processes that are as flexible as possible. There are always points in the development process where you can make major changes. In other words, we assume in advance that changes will be made, and we prepare for them in the process. [...] Especially when we work together with a Tier 1, the flexibility is already contractually fixed, so it is agreed to still define the changes to implement, which is quite difficult if you do not know them yet, but we try as good as we can to consider changes in packages - content you can then fill later when the changes actually come."* (OEM Gamma; Interview MS24; 00h 40min 11s - 00h 41min 20s; translated and adjusted for better readability by the author)

The obtained findings underline those of Spieth and Meissner (2018, p. 1850042-19), who emphasized the fact that *"[...] the automotive industry in particular struggles to adapt too [sic] much shorter product life cycles and planning horizons when entering new business field."* One informant described the role of ecosystem processes for business models of upstream suppliers as follows:

[1] The informant referred to OEMs and Tier 1 suppliers as customers in the given statement.

[2] Main customers for upstream suppliers were OEMs. OEMs, in turn, were influenced by the changing requirements of vehicle (end-)customers and operators.

> *"Business models have always changed. I always shake my head when I hear: We are in a revolution and we all have to rethink etc. We have always had to, right? [...] Well, I don't think that's it. We have to be present on the market and keep our eyes open, and find the right solutions, which will be needed in the future. But that is nothing new. The only thing that has changed is that, in the past, vehicle development took 6 years. Now it has to be done almost within 24 months."* (Focus Group; about established automotive suppliers; 00h 15min 15s - 00h 16min 18s; adjusted for better readability)

Furthermore, as outlined by Spieth and Meissner (2018, p. 1850042-19), differences in the processes and transaction speeds and ways of dealing with new partners from outside the automotive industry could require the introduction of shared structures as well as a common understanding of targets, measures, and standards. In addition, actors that started to contribute to the xEV ecosystem - and, in particular, the newly formed businesses - needed to demonstrate their legitimacy and encourage stakeholders to contribute to the focal actor's business model while remaining aware of environmental constraints (Amit and Zott, 2015, pp. 342-343). Further, the results also agree with those of Hagedoorn (1993, p. 378) who found that shortening innovation-times, technological complementarity, as well as factors related to the market were dominant motives to enter cooperations.

**Changes in technological modularity and flexibility:**
Informants in the investigated Tier 1 suppliers recognized the need to be more flexible but were - at least in part - constrained in their ability to carry out value creation activities for xEV technologies by the existing manufacturing infrastructure.

> *"Everything is connected in a bigger network and they, in turn, watch us and look at what we are doing and so the whole chain pretty much goes on. In other words: All in all, one has to say that nowadays it is more important than ever to be highly flexible. Agile, flexible - these are of course the mottos of the hour."* (SUP Alpha: Interview MS1; 00h 03min 09s - 00h 03min 39s; translated and adjusted for better readability by the author)

Interestingly, focused suppliers offering solutions in narrow areas of technologies were stated to be more flexible regarding their technological solutions and their respective business models than established suppliers. Consequently, as outlined in Section 9.2, upstream actors tended to modularize their offerings (Baldwin and Clark, 1997). In doing so, they were able to flexibly serve multiple customers and offer them similar value propositions. This extends the insights made by Baden-Fuller and Haefliger (2013, p. 425), who proposed that modularity " *[...] could help explain technological development and the joint implications of changing customer demands and technological evolution for the business model."* Modularity could support the coordination of interactions between ecosystem actors (Jacobides et al., 2018, p. 2260), as well as the exchanges of values between the actors' business models. Moreover, the modularization of products and firm activities could serve to shift the focus of innovations and operations away from a focal actor and towards the ecosystem (Fjeldstad and Snow, 2018, p. 37). However, flexibility could also be limited by the *"[...] formal structures, agreements, processes and channels of communication [...]"*

required to handle complexity (Rong et al., 2018, p. 242). Interestingly, Rong et al. (2018, p. 242) proposed that this reduced flexibility and the subsequently longer reaction times could destabilize the incumbent companies' business models (Rong et al., 2018, p. 242).

### c) Influences of the actors' role and ecosystem position on interactions:

Overall, the informants stated that actors depended on one another to create an ecosystem's value proposition. Actors exerted a considerable amount of influence on other actors further upstream in the supply chain. The individual actors' influences on technologies – and the respective business models – were described as fragmented and partly depended on the type of company and its respective position in the ecosystem. The informants recognized that the influence of OEMs as ecosystem leaders was less pronounced with regard to the novel technologies required in the xEV ecosystem. One possible explanation for this result could be that, as described when discussing research question two in Section 9.2, OEMs tended to rely on the upstream actors' contributions to create value. Thereby, changing business models by outsourcing value creation activities to upstream actors could potentially reduce the outsourcing companies' influence and result in a more democratic ecosystem (Rong et al., 2018, p. 238). In the same way, informants mentioned that companies providing engineering solutions and technologies found themselves in a comfortable position: Since their focus was inherently on technological capabilities rather than manufacturing high volumes of products, they were flexible with regard to the specific added value they offered to customers. This finding is exemplified by the following statement from an informant, who was situated in a company providing engineering and technology solutions:

> *"We can do that and that is why we get the orders. This means we really recognize the requirements at an early stage and bring the solution to the requirements and do not wait for the customer to ask you exactly for an implemented solution. Much too late! So that means with our technology service provider business model, you have to be very, very early or you're gone."* (ETP Alpha; Interview MS16; 00h 24min 23s - 00h 24min 42s; translated by the author)

Companies providing engineering and technologies to customers faced a lower risk of investing in new technologies as compared to their customers, that needed to industrialize technologies to offer high product volumes. Thereby, the results underlined the fact that the actors' business model changes could affect multiple actors in the ecosystem. This finding supports that of Foss and Saebi (2018, p. 17), who argued that the value of a business model / business model change would depend on its environmental context - in particular with regard to companies providing complementary offers. Interestingly, however, actors in energy companies (petrol and electric energy) took a more cautious approach. While informants mentioned strategic considerations (e.g., being a first mover) as well as shareholder pressure as driving factors, they were hesitant when faced with the potential competition from OEMs for electric charging.

### 9.3.2 Aggregation and interpretation of the results regarding changes in the actors' business models

Based on the identified influences discussed in Section 9.3.1, the changes in individual actors' business model elements are further explored in this section. This investigation helps to answer the following research question:

**Research Question 4 Sub-Question 2:**
How do individual ecosystem actors change their business models when participating in an ecosystem centered around a novel technology?

As described in detail in Chapter 3, the concepts described by Saebi (2015) and Foss and Saebi (2017) were adopted in this thesis work to categorize the degree of business model change with regard to the environment. Consequently, Table 62 builds on a typology proposed by Foss and Saebi (2017, p. 217) and Saebi (2015) (see Section 3.2). The business models are categorized in this table based on both their scope (modular, architectural) and novelty (new to the company, new to the industry) (Saebi, 2015; Foss and Saebi, 2017). The table presents an overview of the degree of change in the actors' business models when participating in the xEV ecosystem.

**Table 62:** The table presents a characterization of the degree of business model changes for the investigated actor types. Change intensity is characterized with regard to the scope of business model change and the novelty of a business model to a company or industry. (The typology used is based on characterizations of business model changes proposed by Saebi (2015) and Foss and Saebi (2017))

| Business model change type | Change intensity | Planned outcome | Investigated company types | Companies' activity focus |
|---|---|---|---|---|
| **Business model evolution** | • Modular<br>• New to company | • Natural<br>• Minor adjustments | • Providers of engineering and technology<br>• Established automotive suppliers (Tier 1 and 2)<br>• Energy companies (petrol) | • Upstream<br>• Upstream<br>• Downstream |
| **Business model adaption** | • Architectural<br>• New to the company | • Align with environment | • Automotive OEMs (core business)<br>• Automotive retail | • Central and upstream<br>• Central and downstream |
| **Focused business model innovation** | • Modular<br>• New to industry | • Disrupt market conditions | • Energy companies (electric)<br>• Corporate operators of xEV fleets | • Central and downstream<br>• Downstream<br>• Downstream |

Table 62 continues on next page

Table 62 continued from previous page

| Business model change type | Change intensity | Planned outcome | Investigated company types | Companies' activity focus |
|---|---|---|---|---|
| **Complex business model innovation** | • Architectural<br>• New to industry | • Disrupt market conditions | • Focused suppliers of xEV technologies<br>• Dedicated infrastructure companies | • Central and downstream<br>• Downstream |

Specifically, Table 62 illustrates the fact that both suppliers and companies providing engineering and technology predominantly performed modular changes that relied on elements that were new to the company. Examples of this are upstream companies that built up new/additional technological capabilities to provide an adjusted type of value proposition to customers. Although the actors provided values for xEVs that are different than those provided for conventional vehicles, the informants perceived few changes in their business models. Consequently, these business model changes could be categorized as business model evolution. Exceptions were suppliers of focused technological solutions that tended to apply business models which were new to the industry and had the intent to disrupt market conditions. Interestingly, the changes in business models that were performed by petrol energy companies could be categorized as evolutionary. Companies that provided electric energy, in contrast, showed different types of business model changes, as they tended to engage actively in offering infrastructure complements for xEVs. Few actors offered infrastructure complements at a large scale. Therefore, due to the novelty of their undertakings, these actors arguably performed focused business model innovation. Looking at central ecosystem actors, a differentiation with regards to the foci of these actors' activities is feasible. Central ecosystem actors (i.e., automotive OEMs and their affiliated retailers) stayed rather close to their existing business models in that they leveraged upstream actors to provide attractive value (i.e., vehicles) to customers. Thereby, the respective changes in their business models could be categorized as business model adaptions. In addition, central actors also established dedicated companies to introduce business models to provide complements. Like the examined focused suppliers of technologies, these newly founded companies introduced business models that could be categorized as complex business model innovations. Operators of corporate vehicle fleets introduced new value propositions to their customers based on the xEVs' specific properties (e.g., lower emissions). This required these fleet operators to adjust the value creation and value capture dimensions of their business models. Therefore, these actors arguably also pursued a type of focused business model innovation.

The categorization in Table 62 serves to highlight the fact that individual types of business model innovation are closely related to the environment in which innovation is performed (Saebi, 2015, p. 153). This finding mirrors that of Abdelkafi et al. (2013, p. 1340003-1), who emphasized that applying certain patterns of business models depended on an actor's role in a system (e.g., manufacturer, supplier, service provider) and of Mason and Mouzas (2012, p. 1361), who remarked that substantial influences existed with regard to the actors' positions and activities in network relations. Thereby, business models can be seen as results that emerge from specific types of relational configurations, which subsequently shape how problems are solved (Mason and Mouzas, 2012, p. 1361). In the following sections, detailed descriptions are presented of the investigated actor types with regard to their business model changes.

### a) Companies pursuing business model evolution

**Suppliers and providers of engineering and technolgy:**
Informants from established suppliers as well as engineering and technology providers emphasized that they followed a similar business model approach for xEVs as for conventional vehicles. The data also indicate that these actors only performed minor adjustments in their activities while building up new areas of competence. However, taking a closer look revealed that established upstream actors adapted their processes (e.g., to increase flexibility in development efforts) and capabilities (e.g., exploration of new technologies) with regard to xEVs. This indicated that an evolutionary business model change (compare Table 62) took place. One informant from an automotive supplier stated:

> *So for me this has not really resulted in a new business model yet. I say that was actually a technological shift. You just switch from ICE, or combustion engine, to electromobility. The business model, where I say I still sell a vehicle with an electric motor inside, is still the same for me. It's just the same in green, literally.* (SUP Beta, MS7; 00h 19min 07s - 00h 19min 32s; translated by the author)

This impression also is reflected in statements provided by informants from engineering and technology providers:

> *"The business model is this: We do engineering. That is our business model. And this business model is what we do. We do world-leading engineering, world-leading technology. And you can make this business model for combustion engines, you can make this business model for transmissions, for software and for everything else. That is the business model. In this respect, the business model changes very little. The product that we develop within the business model has become different, that has become massively different. But the business model is actually the same."* (ETP Alpha; Interview MS14; 00h 41min 38s - 00h 42min 16s; translated and adjusted for better readability by the author)

This finding supports those of Nailer and Buttriss (2020, p. 680), who argued that *"[...] business model evolution demonstrates the dynamics of how networks evolve as actors are motivated by anticipated value."* Specifically, the informants in suppliers stated that they proactively adjusted to expected (i.e., not yet realized) changes in regulations that affected the OEMs' requirements. In particular, established suppliers leveraged their - as compared to OEMs - higher technological flexibility and offered to share the risks of (joint) development efforts together with other ecosystem actors (e.g., OEMs - see Sections 9.2 and 9.3.1). The results support those of Forkmann et al. (2017, p. 151), who highlighted that, due to constant changes in business environments, manufacturers need to revise the compositions of their offers on a recurring basis. The findings also support the literature, which proposes that centrally governed networks often merely re-configure their existing products and services, resulting in stagnant value creation and value delivery and overall low levels of business model innovation (Dellyana et al., 2016, p. 209).

**Petrol energy companies:**
Interestingly, as indicated by informants, companies that focused on petrol energy introduced value proposition for xEVs in their current organization, and relied on capabilities close to their existing business (i.e., the introduction of hydrogen infrastructure). Informants stated that they were preparing for the gradual implementation of technological solutions that acted as complements for xEVs. This was done by expanding the scope of their collaborations and establishing dedicated actors to explore solutions for xEV infrastructure. Simultaneously, companies engaged in petrol energy were also involved in introducing new dedicated actors that could provide infrastructure solutions for xEVs (see Section 9.2). Therefore, while petrol energy companies were reluctant to introduce business models to provide complements for the xEVs themselves, they supported the introduction of separate companies that pursued complex business model innovation to offer complements.

Overall, established automotive suppliers, engineering and technology providers as well as petrol energy companies changed elements of their business models in a modular manner to include elements that were new to their companies. This indicates that these actors pursued a rather evolutionary approach toward changing their business models (see Table 62).

## b) Companies pursuing business model adaption

**Automotive OEMs and automotive retail:**
The data indicate that OEMs try to achieve higher levels of technological performance with their xEVs to make them more attractive for customers (e.g., improved vehicle ranges, cost reductions). This indicates that *"compensating"* and *"enhancing"* tactics are being used, as outlined by Bohnsack and Pinkse (2017, p. 89). This observation is supported by statements made by informants from automotive retailers:

> *"We are now at the beginning of a really massive model offensive by all manufacturers, which will hit the industry over the next few years."* (RET Beta; Interview MS28; 00h 50min 43s - 00h 50min 59s; translated and adjusted for better readability by the author)

Due to the high lead times of technologies, regulatory ambiguities and the uncertain acceptance of xEVs on the market (see the influences on business models discussed in Section 9.3.1), informants from OEMs stated that they were trying to introduce more flexibility into their development processes and reduce development times. Intriguingly, informants from OEMs mentioned their intentions to expand their competencies towards xEVs while maintaining their companies' current capabilities. This result is similar to that of Abdelkafi et al. (2013, pp. 1340003-23 ff.), who emphasized that when value creation and competencies are transfered from automotive OEMs to suppliers, these OEMs may have to redefine their core competencies.

The data indicate that OEMs began to adapt their established business models to fit the use of multiple types of vehicles (both conventional as well as xEVs). The archetypical business model (Massa and Tucci, 2014, p. 433) operated by automotive OEMs and automotive retailers that relied on manufacturing and selling vehicles remained largely unchanged. However, upon closer inspection, the OEMs' business models for xEVs relied on a different set of partners for xEVs, performed different activities to create a value proposition based on xEVs, and addressed other customer segments.

This finding mirrors that of Bohnsack et al. (2014, p. 299), who found that, while the value propositions for xEVs were not substantially different, individual components of the automotive OEMs' business models such as the value network as well as the revenue/cost model had distinct characteristics. Overall, both the OEMs' and the retailers' business models showed changes in their overall architecture. The data indicate that these adjustments were made to align the business models with changes in the environment that started to favor different technologies. Thus, the changes seen in the OEMs' and retailers' business models for xEVs represent an example of a business model adaption (see Table 62). However, despite following similar approaches for conventional vehicles and xEVs, the respective business models for xEVs were not yet *on par* with their established business models. In particular, as noted by one informant in an automotive retail company, OEMs were not yet able to provide xEVs on a large scale:

> *"Well, the customer actually always plays the central role, because he has to buy it, he has to buy the thing. And I say, the truth is that the launch is still very slow. This is of course due to a small amount of supply that exists, one has to say. There are not very many vehicles on the market now that are suitable for volume production."* (RET Beta; Interview MS28; 00h 13min 47s - 00h 14min 17s; translated by the author)

Therefore, while the introduction of xEVs potentially required OEMs and their affiliated retailers to introduce changes in their business models, they were held back by bottlenecks in production and consumption (see the discussion of research questions two and three in Sections 9.1 and 9.2).

### c) Companies pursuing focused business model innovation

**Electric energy companies acting as complementors:**
Informants from the energy sector emphasized the need to introduce business models to offer value propositions for electric charging of xEVs in multiple areas: (1) public charging, (2) private at-home charging, and (3) charging solutions for corporate customers (see the discussions on interactions in the ecosystem in Section 9.2 and the influences on ecosystem business models in 9.3.1). Energy companies acted partly due to political influences (see the discussion of factors to enter the xEV ecosystem in Section 9.1). Informants from electric energy companies indicated

a tendency to focus on their own capabilities and only selectively pursued co-development relations with suppliers to introduce value propositions centered around electric charging to their customers (Chesbrough and Schwartz, 2007). One informant from an energy company stated:

> *"I am still an enabler of mobility. Namely by offering the energy. That's just it, we don't want to turn our core competence into a disruptive one - we have decided for us, we don't have to be."* (EC Epsilon; Interview MS34; 00h 39min 33s - 00h 39min 55s; translated by the author)

Informants further revealed that energy companies intensified collaborations among one another to provide complements for xEVs (Adner, 2012). Consequently, as shown in Table 62, energy companies showed signs of focused business model innovation in their undertakings to establish infrastructure complements. However, energy companies partly relied on additional actors to provide technologies that had previously not been required (e.g., digital solutions to handle charging operations). In their undertakings energy companies differentiated between offerings addressing B2B and B2C customers and solutions for public charging infrastructure. The obtained insights were supported by perceptions from informants in automotive suppliers that characterized electrical energy companies and their initiatives towards xEV infrastructure as follows:

> *"We also know that the energy suppliers are not a particularly innovative industry. They have always been system maintainers and have changed [...] only since the European liberalization of electricity and new things are beginning to happen, and they say they are thinking about new business models. But otherwise they are not particular drivers of innovation, also not regarding the business model. That the OEMs don't do this is obvious somehow, and they usually don't have the competence. They have a completely different business model, that would be something in addition, especially something that is very cost intensive, nobody really wants to put on that shoe."* (SUP Beta; Interview MS8; 00h 40min 31s - 00h 41min 22s; translated by the author)

Based on the presented data, it can be concluded that energy companies introduced additional modular business models that complemented their original focus. While business models for electric charging complements were not completely new to the industry, similar business models were scarce. This supports the argument that energy companies pursued a focused type of business model innovation (modular, new to the industry).

**Operators of corporate vehicle fleets:**
Operators of corporate vehicle fleets tried to shift their capabilities proactively to be able to introduce and scale up their business models centered around xEVs (see Section 9.3.1). However, while relying on external actors to extend their capabilities and manage xEV technologies, they avoided long term dependencies:

> *"[...] we first make a system we can manage ourselves, which we can influence ourselves, and only then switch to a system when we know that it works. If you don't*

> *have your own charging infrastructure, [...] you are dependent on the public charging networks."* (FO Alpha; Interview MS26; 00h 23min 37s - 00h 23min 56s; translated by the author)

Therefore, unlike private customers and operators of xEVs, corporate operators of vehicle fleets were able to overcome complement bottlenecks that kept them from introducing higher degrees of business model change. Moreover, the introduction of xEVs allowed them to provide different types of value to customers. Again, as corporate operators of vehicle fleets performed modular changes to their business models and introduced changes that were - at least to a large degree - new to the industry, they represent a case of focused business model innovation (compare Table 62).

### d) Companies pursuing complex business model innovation

**Dedicated actors offering infrastructure complements:**
As highlighted in the discussion of interactions in the ecosystem (see Section 9.2), both actors from the automotive and energy sectors established separate companies to offer complementary solutions for electric charging. These actors and their business models showed indicators of a complex business model innovation, as summarized in Table 62. This is exemplified by the following statement, which illustrates that these actors tended to pursue substantially different approaches than other ecosystem actors that were offering complements:

> *"So I think we're one of the drivers right now. We have an electric mobility business model, we are specialists. [...] So we are moving with the times and trying to introduce new technologies and turn them into a business model."* (INF Beta; Interview MS36; 00h 06min 37s - 00h 07min 11s; translated by the author)

However, the data indicate that there were differences in the actors' specific business model approaches. Like the findings of Bohnsack et al. (2014), results show that infrastructure actors that were affiliated with the automotive sector strongly relied on the existing sales infrastructure and channels of automotive OEMs. Companies based in the energy sector took a more indirect approach and tended to act as enablers for other companies (e.g., by supporting business customers with their expertise or by offering "white label" products) while - in part - also engaging in collaborations with upstream automotive suppliers. However, infrastructure companies based in the energy sectors were reported as being cautious, as they considered automotive actors to behave rigidly:

> *"We work with OEMs. I don't think that you really can push them into a technology or innovation, because they have their very, very rigid road map, and they stick to it. And it's incredibly difficult to take them along and influence them. So this is the monolith in the middle. They define the direction and you can only work around them, sometimes with them, but just very long term."* (INF Beta; Interview MS36; 00h 26min 42s - 00h 27min 08s; translated and adjusted for better readability by the author)

The findings, therefore, support those of Mason and Mouzas (2012, p. 1363), who proposed that intensifying interactions with upstream suppliers could help support companies to identify and influence technological solutions. As a result, this could enable companies to introduce innovations, open business opportunities, and influence markets (Mason and Mouzas, 2012, p. 1363). Furthermore, like the results cited by Spieth and Meissner (2018, p. 1850042-6), the obtained results indicate that actors differed with regard to the process velocities of their xEV activities. Informants from infrastructure companies affiliated with both the energy sector as well as the automotive sector stated the intent to offer *"complete"* xEV solutions[1] - either directly or through their affiliated infrastructure companies. Adding a *"so far unrelated customer value,"* such as providing access to vehicles in case of energy companies or charging and energy options in the case of automotive companies could be interpreted as a *"coupling tactic"* as suggested (Bohnsack and Pinkse, 2017, p. 89).

**Suppliers of focused technological solutions:**
As described in Section 9.2, the expected uptake of xEVs has led to the emergence of suppliers that provide technological solutions in focused technological areas. The investigated actors that took this approach were characterized by the fact that they did not directly offer large volumes of their technologies themselves. Instead, they relied on incumbent suppliers and OEMs to manufacture and integrate their technologies into vehicles. Interestingly, these actors took this approach to connect the xEV technologies explored by upstream actors with downstream companies that provide complementing offers (i.e., addressing suppliers, OEMs, and infrastructure actors).

Both the investigated dedicated actors for infrastructure, and the focused suppliers of new technologies displayed signs of a complex business model innovation (see Table 62) - particularly as technological actions may serve to influence environmental conditions and organizational change (Tushman and Anderson, 1986, p. 463). This finding reflects those in the literature, such as those of Massa and Tucci (2014, p. 427), who highlighted the - often disruptive - potential of newly formed ventures employing novel business models by stating that they *"[...] often operate in market niches, serve customers that incumbents do not serve, and at price points they would consider unattractive and rely on novel resources that are not necessarily under the control of incumbents."*

### 9.3.3 Aggregation and interpretation of results on the alignment of the ecosystem actors' business models

The insights gained by asking sub-questions two and three, which are outlined in Sections 9.3.1 and 9.3.2, are now used as a basis to answer research question four:

**Research Question 4:**
How can actors participating in an ecosystem centered around novel technologies align their individual business models to contribute to a joint ecosystem value proposition?

[1] Typically, the electric vehicle itself in combination with charging and home energy solutions.

Similar to the approach presented by Talmar et al. (2018), the findings on both the ecosystem level as well as on the level of individual companies and their respective business models are presented to answer the question.

The section is structured as follows: First, the role of ecosystem leaders in aligning upstream business models is discussed. Second, the aspect of aligning business models to provide downstream complements is explored. Third, factors that influence the introduction of an attractive ecosystem *"value blueprint"* are presented. Fourth, a framework for aligning business models towards an attractive ecosystem *"value blueprint"* is provided. Finally, conclusions regarding research question four are drawn, and implications for academia and practice are described.

## a) Role of ecosystem leaders in aligning upstream business models

As described in Section 9.1, automotive OEMs entered the ecosystem because they need to be able to sell high volumes of xEVs. A major factor for OEMs in that regard was adhering to regulations. In turn, the ecosystems' value proposition centered around xEVs needed to fit the vehicle customers' and operators' requirements (Ardilio and Lab, 2009).

However, the OEMs' capabilities to provide xEVs at a large scale in their business model were not fully established yet. This is partly due to bottlenecks present in the upstream ecosystem. In addition, bottlenecks with regard to infrastructure complements can prevent customers from fully realizing the performance of xEVs (see Section 9.3.2). Consequently, OEMs pursued initiatives directed at actors located both upstream and downstream to align business models and to introduce an attractive ecosystem value proposition (cf. Adner (2017) and Talmar et al. (2018)).

**The central actors' initiatives as ecosystem leaders:**
As described in the literature, automotive OEMs, as central ecosystem actors, have been in a favorable position to take on a leading role in the xEV ecosystem (Moore, 1993, 1996) and contribute to the alignment of actors. One informant from an infrastructure company described the position of OEMs in the ecosystem as follows:

> *"The OEM is insanely strong in its field. So it is calling the shots, clearly. It also tries to push the ISO standard and the standardization so that it can scale. But you can work wonderfully around it, be ahead of it with speed. So yes, in the long run they have a very, very strong power and there's no getting around them. But you can counter it like a speedboat on the left and on the right, and then you can innovate a fair bit yourself."* (INF Beta; Interview MS36; 00h 25min 50s - 00h 26min 24s; translated and adjusted for better readability by the author)

However, established OEMs faced substantial uncertainty regarding the involved technologies and customer preferences, which impacted the business models they pursued. Consequently, they were reluctant to fully commit to xEVs despite their substantial influence in the ecosystem (see the discussion on influences on business models in Section 9.3.1). One informant from a research institution summarized the implications of OEMs' behavior as follows:

> *The moment the OEMs have started to say that they are really going in the direction of mass production - to invest their energies - at that moment it was clear to everybody. [...] They need hundreds, thousands of sockets, preferably one for every car driver. Because they know they have to sell their vehicles now. Because they have to charge the vehicles as soon as this high-volume idea was really there.* (RI Beta; Interview MS21; 00h 17min 56s - 00h 18min 33s; translated and adjusted for better readability by the author)

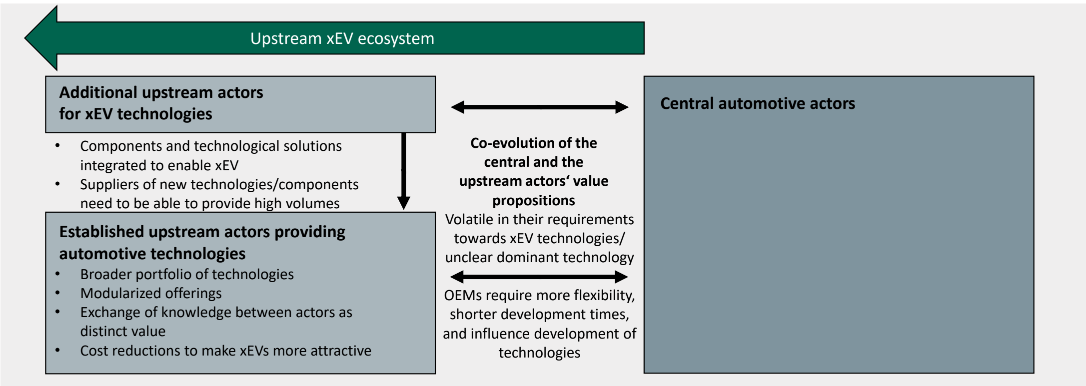


**Figure 63:** Co-evolution of value propositions of upstream actors, enabling automotive OEMs to demonstrate values based on xEVs (personal illustration).

As illustrated in Figure 63, OEMs subsequently began to co-evolve their value proposition along with established and additional ecosystem actors for xEVs. As outlined when discussing relevant influences on business models in the ecosystem in Section 9.3.1, due to uncertainty regarding the technologies and partly unclear market acceptance of the ecosystem's value proposition, upstream actors kept a broad portfolio of technologies and modularized their value propositions (Baden-Fuller and Haefliger, 2013; Jacobides et al., 2018). In that regard, information about technologies was reported by informants from among the upstream actors as a part of their value propositions.

Furthermore, as shown in Figure 63, a major aspect was the suppliers' abilities to provide technologies and respectively technology-based components required for xEVs in high volumes. This seemed to require cost reductions of the xEVs. Moreover, as described in Section 9.3.1 when summarizing relevant influences on the actors' business models, upstream companies modularized their offerings.

### b) Aligning business models to provide downstream complements

**Co-opetition for infrastructure complements:**
The data indicate that OEMs in the downstream region of the ecosystem tend to (1) engage in collaborations to provide complementary value propositions for xEVs as well as (2) establish dedicated actors providing complementary value propositions (see Section 9.2):

> *"The petrol station network has developed over years. It has been recognized that nobody really takes the issue of charging infrastructure into their own hands. In principle, it was expected that the energy suppliers would take care of this issue, but this is not yet apparent. (...) That's why we are forced to go in this direction, because this is the only way to sell the cars in the future."* (OEM Alpha; PS6 and PS7; (n.a.); translated and ajusted for better readability by the author)

In addition, as described in Section 9.3.2, the data suggest that OEMs began to investigate options for providing complements for xEV charging. This resulted in a high perceived potential for co-opetition between companies based in the automotive sector and the energy sector (Vuori, 2005). The situation is reflected in a quote provided by an informant from an electric energy company:

> *"There are vehicle suppliers who are perhaps now completely reorganizing the value chain and supplying the energy for it, and that naturally influences us when such key players on the vehicle side perhaps offer not only the vehicle, but also the charging infrastructure and the necessary green electricity. And there are also initiatives and subsidiaries of these companies, and the strategy now seems to be going in that direction, so that does have an impact on us."* (EC Alpha; Interview MS29; 00h 48min 58s - 00h 49min 27s; translated by the author)

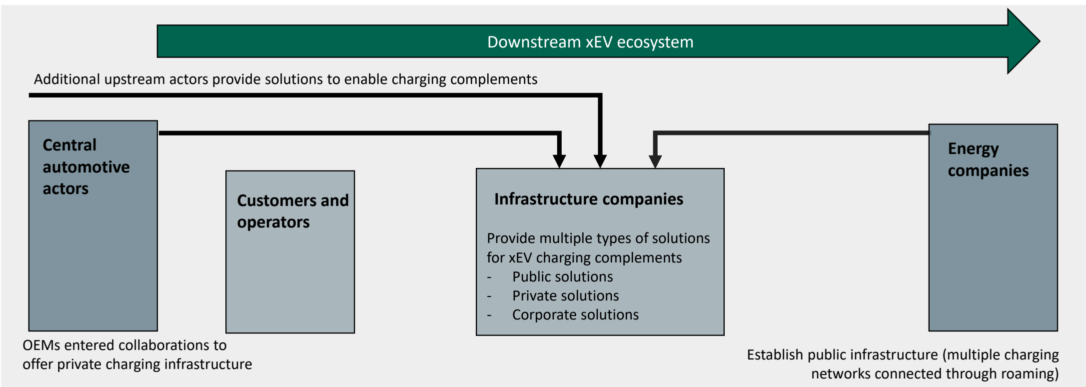


**Figure 64:** Alignment of business models' value propositions to fit a joint ecosystem value proposition in the downstream region of the xEV ecosystem (personal illustration)

Figure 64 illustrates that both automotive OEMs and electric energy companies started collaborations in their individual sectors to introduce business models offering complements. Furthermore, they also introduced separate actors to provide charging complements (see also Section 9.2). Interestingly, as shown in Figure 64, the value propositions offered by companies affiliated with automotive OEMs and respectively energy companies showed distinct similarities. These actors tended to offer business models for (1) public charging, (2) at-home charging solutions for private customers, as well as (3) charging solutions for corporate customers. The obtained findings, therefore, support those of Velu (2016, p. 124), as both companies with a high (i.e., OEMs) and a low degree of dominance (i.e., companies from the energy sector) introduced business models that led them to engage in co-opetition.

**The actors' capabilities to introduce infrastructure complements:**
Subsequently, infrastructure solutions were provided by multiple types of actors from different backgrounds. As mentioned by the informants, these actors provided infrastructure in different areas: (1) public infrastructure, (2) at-home charging infrastructure, and (3) corporate infrastructure (see Section 9.3.2). Informants in the investigated corporate operators of xEV fleets perceived the availability of infrastructure for xEV charging as a bottleneck for creating value in the ecosystem. Interestingly, statements provided by informants from fleet operators point towards the misalignment of individual actors as a possible reason for these bottlenecks:

> *"An illustrious group of companies is building up, all of which have a certain strategy but none of them knows exactly how it will work. There is a great deal of uncertainty in it."* (FO Beta; Interview MS27; 00h 55min 38s - 00h 55min 49s; translated by the author)

As outlined in Section 9.3.2, to avoid being kept from ramping up their xEV operations by the low availability of complementary offers in the ecosystem, the investigated operators of corporate vehicle fleets chose to build up their own charging infrastructure. As illustrated in Figure 65, corporate operators of vehicle fleets thereby acted simultaneously as customers/operators of xEVs while also engaging with infrastructure companies to establish complementary offers for their vehicle fleets themselves. However, informants from corporate operators of vehicle fleets highlighted the fact that they relied on companies that provide solutions for xEV infrastructure to provide their electric charging solutions.

The findings suggest that it is not always feasible to clearly distinguish between the business models of customers/operators of xEVs and companies providing complementary offers, subsequently broadening the concept of ecosystems as described by Adner and Kapoor (2010). This also serves to illustrate how companies in an ecosystem can interact to mitigate bottlenecks and align their business models to fulfill an overall ecosystem value proposition (Zott et al., 2011; Adner and Kapoor, 2010; Talmar et al., 2018). In addition, corporate fleet operators were said to be held back in their xEV activities by the lack of vehicles on the market. This, in turn, underlines the misalignment of the upstream actors' business models.

The factors presented above allow for a better understanding of the alignment of business models of actors in upstream, central, and downstream positions in the xEV ecosystem. Based on the

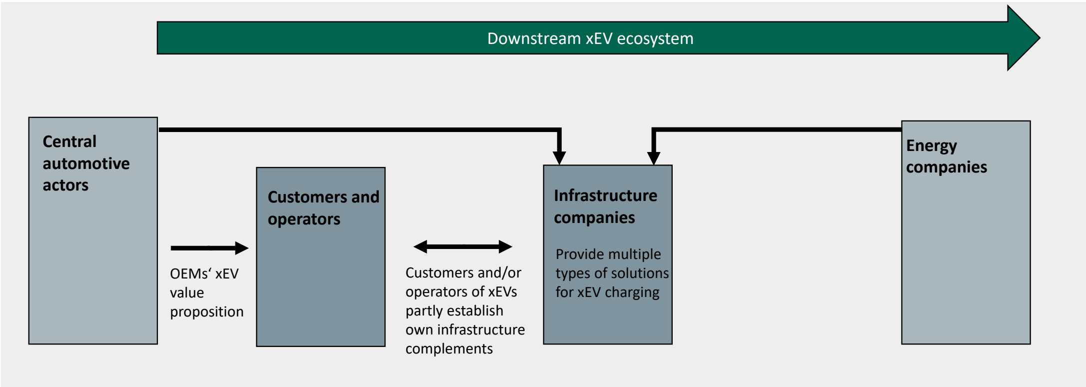


**Figure 65:** Relevant aspects with regard to value propositions for infrastructure which are complementary in the downstream region of the xEV ecosystem (personal illustration)

presented factors, in the following sections, results are presented regarding relevant aspects of introducing an attractive *"value blueprint"* that considers the alignment of ecosystem actors' business models.

### c) Introducing an attractive ecosystem value blueprint

The actors' strategies need to address the creation and coordination of ecosystems centered around technological innovations, the appropriation of value, as well as the involved business models to exploit ecosystem externalities (Autio and Thomas, 2014, p. 223). Like the results cited by Autio and Thomas (2014, p. 208), the obtained results indicate that the ecosystem for xEVs is characterized by a variety of technologies and the respective organizational competencies, whereby multiple ecosystem actors can co-produce different types of value for multiple user groups. Characteristic elements of value were (1) components for xEVs offered and enabled by actors upstream in the ecosystem, as well as (2) complements to demonstrate value with xEVs offered predominantly by actors in a position downstream in the ecosystem. The results support insights from the literature regarding the creation of value in ecosystems (Adner and Kapoor, 2010; Adner, 2012; Jacobides et al., 2018). These results further indicate that OEMs need to introduce a viable ecosystem value proposition based on xEVs that considers these characteristic elements of an ecosystem. The business model thereby presents a suitable lens to understand how companies can orchestrate their activities within the network they operate in (Massa and Tucci, 2014, p. 423). However, while OEMs could enact substantial influence in the upstream area of the ecosystem in their role as ecosystem leaders (cf. Moore (1993, 1996)), they could not unilaterally control the ecosystem hierarchically (Jacobides et al., 2018, p. 2266). As discussed in Section 9.1, OEMs particularly lacked control in the downstream regions of the ecosystem. This lack of control presented a major difficulty, as companies changing their business models to align themselves towards an ecosystem value proposition (Adner, 2017) were subject to interdependencies and operated under a restricted degree of freedom (Berglund and Sandström, 2013, p. 279). Moreover, as outlined by Ketonen-Oksi and Valkokari (2019, p. 101), actors participating in the ecosystem might need to *"[...] kill their current business model(s) to survive within the evolving ecosystem."* Consequently, OEMs that acted as ecosystem leaders needed to enable business models centered around xEVs in a *"value blueprint"* that would be attractive for the involved ecosystem actors (Adner, 2012). As illustrated in the following quote, automotive OEMs were considering multiple options to achieve this goal:

> *"Where we will have a problem is the infrastructure. That's where it's always lacking. And there are now two possibilities for the future. Either we make the energy source which we use to run an electric vehicle so practical that it can really be recharged in a few minutes, we will probably have to change or adapt the battery technology ourselves. [...]. Or we change the charging infrastructure in a way that makes vehicles practically usable. [...] No matter if it is electric energy or hydrogen or whatever."* (OEM Beta; Interview MS23; 00h 05min 51s - 00h 06min 39s; translated and adjusted for better readability by the author)

Crucially, findings indicate the existence of a *"hen and egg"* type of problem (Dattee et al., 2018, p. 467) for companies trying to establish a viable ecosystem value proposition (Talmar et al., 2018) around xEVs. This issue stemmed from a mutual dependency on component values (Dattee et al., 2018, p. 467) created by actors in the upstream ecosystem and on complement values created by actors in the downstream ecosystem (see also the discussion of influences to enter an ecosystem in Section 9.1). Dattee et al. (2018, p. 467) proposed that a *"keystone"* actor, as described by Iansiti and Levien (2004a, p. 75), could overcome this co-dependency by introducing an attractive "*"value blueprint"* (Adner, 2012) for the ecosystem. This blueprint needed to allow for the introduction of feasible business models by all involved actors (Adner, 2017, p. 51). However, as indicated by the obtained results, introducing feasible business models requires the demonstration of the technological performance and financial feasibility of xEVs which, in turn, would require companies to overcome multiple bottlenecks in the ecosystem (see Sections 9.1 and 9.2). Accordingly, as discussed in Section 9.2, the OEMs tried to use their influence in the ecosystem to leverage upstream actors as a value dominator to demonstrate attractive technological solutions while adopting the role of a keystone actor in the downstream area of the ecosystem to push the availability of complementary offers (Iansiti and Levien, 2004a, p. 75). This result complements that of Dattee et al. (2018, p. 467), as actors might need to perform multiple ecosystem strategies simultaneously to introduce an attractive value blueprint. In the upstream region of the ecosystem, this led both established as well as new actors to adjust their value creation activities to provide value propositions centered around xEV technologies (see Figure 68). Specifically, upstream actors began to modularize their products and engaged in co-development relations to reduce risks leading them to co-evolve their value propositions with OEMs (see Section 9.3.1). This co-evolution of the value propositions of suppliers (both incumbent and new), companies providing engineering and technology, and OEMs served to enable attractive vehicle performances (both in terms of costs and technological performance) for end customers and vehicle operators. Therefore, the alignment of the upstream actors' business models ultimately allowed OEMs to introduce attractive xEV-based value propositions themselves (see Sections 9.3.1 and 9.3.2). The obtained results complement those of Shalender (2018, p. 67), who emphasized the role of business model flexibility, industry spanning partnerships, and shared resources as preconditions for the success of xEVs.

Overall, the findings indicate that three issues need to be addressed together – both in terms of time and locality – to fulfill an attractive ecosystem value proposition based on xEVs. The relations among the outlined factors are summarized in Figure 66.

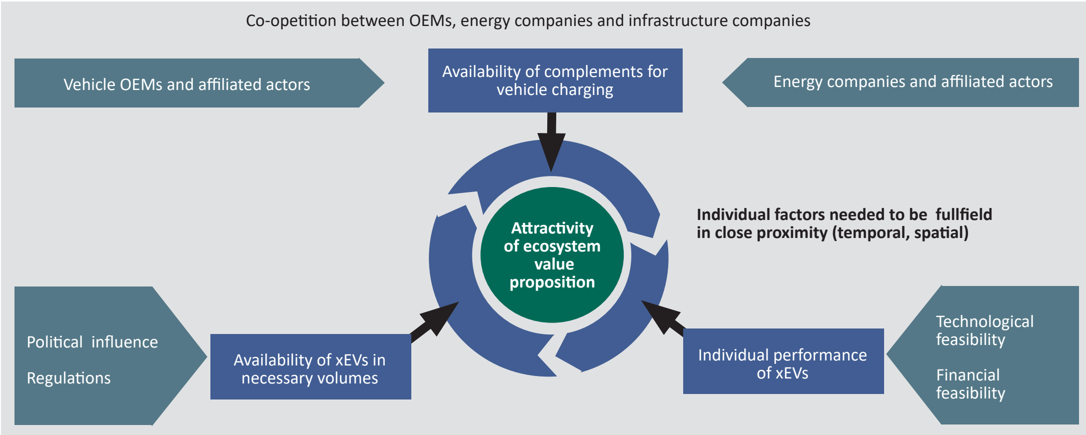


**Figure 66:** Identified factors in the central and downstream areas of the investigated ecosystem (personal illustration based on considerations by Rachinger et al. (2020))

- **Individual performance of xEVs:** Companies offering xEVs should be able to demonstrate attractive properties with their individual value propositions. This includes providing an attractive performance in terms of technological aspects (e.g., vehicle range), financial feasibility (i.e., in terms of vehicle costs or total cost of ownership), as well as ancillary benefits (e.g., ecological sustainability).

- **Availability of xEVs in necessary volumes:** Companies need to make xEVs available to customers in sufficient numbers. This would support OEMs in meeting their regulatory targets (i.e., regulations on $CO_2$ emissions) and thus help them respond to political influences. On the one hand, OEMs that promise to deliver high volumes of xEVs could support the exploration of technologies and realize scale effects both directly at the OEM and upstream actors. On the other hand, this would also make the ecosystem more attractive for downstream actors by providing complementary value propositions for xEVs (i.e., infrastructure) (Dedehayir et al., 2018).

- **Availability of complements for vehicle charging:** Fulfilling an attractive ecosystem value proposition based on xEVs requires increasing the complementary value propositions for electric charging in multiple areas: (1) public charging infrastructure, (2) private at-home charging solutions, and (3) charging solutions for corporate customers. As previously described, both actors from the automotive and energy sectors have begun to contribute to charging solutions, leading to likely co-opetition between vehicle providers and energy providers.

One important point is that data suggest that addressing the factors outlined in Figure 66 on an individual basis represents a manageable task that individual groups of actors could carry out. However, actors in the xEV ecosystem were struggling to align their business models to overcome co-dependencies regarding the creation of an overall ecosystem value proposition and addressing the outlined issues simultaneously (Adner, 2012, 2017; Dattee et al., 2018). This is exemplified by the statement provided by an informant from a company that was trying to coordinate infrastructure efforts:

> *"Yes, the risk is of course whether it really takes off in time - in the sense that the vehicles will come. You have to achieve market penetration. Because if we now build up the charging infrastructure and continue to consolidate it, if no customers come, then at some point the five players mentioned above*[1] *will say: It won't work, because the charging infrastructure will be outdated by the time the customers come. So they have to come now, that is of course the risk."* (INF Alpha; Interview MS35; 00h 55min 14s - 00h 56min 03s; translated and adjusted for better readability by the author)

The results are similar to those of Adner (2006, p. 106), who highlighted three factors that could potentially lead to the failure of innovation ecosystems: (1) technical difficulties of individual innovations (e.g., in the given case, the xEVs themselves), (2) difficulties with regard to the coordination of innovation in the ecosystem (e.g., the alignment of individual actors' business models), as well as (3) the probability that a *"[...] market does not emerge within the time frame required to support the investment."* Thus, the insights summarized in Figure 66 highlight the aforementioned *"hen and egg"* type of problem, whereby shortcomings of one of the factors can prevent the establishment of an attractive *"value blueprint"* and consequently threaten the attractiveness of the ecosystem's overall value proposition (Adner, 2012; Dattee et al., 2018). Avoiding potential shortcomings, in turn, required aligning the interests, capabilities, and business models of multiple actors in the ecosystem - both upstream and downstream - to fulfill a common value proposition for xEVs (Adner and Kapoor, 2010; Adner, 2012; Talmar et al., 2018; Jacobides et al., 2018). Actors needed to adopt a common vision of the xEV ecosystem and to consider resources and capabilities of actors in their environment (Shalender, 2018, p. 78). This, according to Shalender (2018, p. 78), required introducing business models that were *"[...] weaved around compatibility of related ecosystem players so that benefits arising from related firms can also be utilized to its own advantage."* In turn, this could allow actors to add value to an overall ecosystem value proposition with their business models (Wirtz et al., 2016; Talmar et al., 2018). As outlined by Fjeldstad and Snow (2018, p. 37), this is particularly because ecosystems could present a promising source of business model innovation by offering companies *"[...] new arenas, structures, and processes for business model experimentation."*

### d) A framework for aligning ecosystem business models to establish an attractive value blueprint

Results indicate that the investigated ecosystem actors engaged in multiple initiatives to overcome what Dattee et al. (2018, p. 467) described as co-dependencies in creating value. The findings

[1] Author's remark: Energy companies and charge point operators.

extend those provided by Adner (2017, p. 51) who stated that a successful ecosystem relied on the alignment of multiple companies, whereby the partners' business models are equally important as that of a focal company. This idea is also found in the literature on business models (Zott and Amit, 2010, p. 217). Thereby, the anticipated value might act as a binding force in the involved actors' relationships (Nailer and Buttriss, 2020, p. 680). Consequently, achieving the anticipated value is believed to involve actors that interact through connected business models, as described by Nailer and Buttriss (2020, p. 680). As noted by Foss and Saebi (2018, p. 17), two important factors for the success of business models are (1) a sufficient number of users and providers that are (2) *"[...] connected in an intricate system of complementary activities in the creation, delivery and capture of value."* Furthermore, creating value for all involved business model participants can enhance the commitment of stakeholders to the focal companies' business models (Amit and Zott, 2015, p. 337). Similarly, Diaz Lopez et al. (2019, p. 29) proposed that technological barriers tended to be dominant on the supply side, while market barriers often were a crucial factor on the demand side. Moreover, Shalender (2018, p. 78) highlighted the fact that for *"[...] achieving sustainable growth in the EV segment, it is crucial that the organization has a vision for a holistic EV ecosystem, and partnership must be forged with both complimenting and competing proposition."*

Using the obtained data on the xEV ecosystem, insights on the roles of components and complements (Adner and Kapoor, 2010; Adner, 2012; Adner and Kapoor, 2016a; Jacobides et al., 2018) can be connected with the literature on the alignment between business models and their environments (Giesen et al., 2010; Saebi, 2015; Saebi et al., 2017). The results presented in this thesis support the literature review findings in that they indicate that the factors influencing the ecosystem value proposition can be grouped into (1) factors stemming from the upstream region and (2) factors stemming from the downstream region of the ecosystem:

- The available performance (in terms of technological performance and attractive price points) for a given use case achieved with an ecosystem value proposition centered around xEVs is largely determined by the alignment of the upstream ecosystem actors' business models. In particular, the alignment of business models in the upstream ecosystem serves to overcome technological bottlenecks in value creation, while subsequent scale effects could serve to reduce production costs.

- The alignment of the actors' business models in the downstream ecosystem could enable complementary solutions for an ecosystem value proposition. This, in turn, could serve to convert the available performance into the actual performance of the ecosystem value proposition for customers and operators in the xEV ecosystem.

Combining the dimensions of (1) the *"degree of alignment of the upstream actors' business models"* to achieve an attractive technological performance of an ecosystem value proposition (as determined by upstream actors) and (2) the *"degree of alignment of the downstream actors' business models"* to ensure the appropriate availability of complements to demonstrate an attractive ecosystem value proposition (as determined by downstream providers of complementary offers) allows for the characterization of the current state of an ecosystem value proposition. By taking the alignment of business models in the xEV ecosystem as an example, the obtained data allow to derive the following insights:

- **Low alignment upstream - low alignment downstream:** As described in Section 9.3.1, informants from among the upstream actors reported that different technologies were available for use in xEVs. Informants named the commitment of dominant ecosystem actors (i.e., OEMs) as a determining factor for exploring new technologies and introduced business models for participating in the xEV ecosystem. Furthermore, informants in companies located upstream mentioned the availability and feasibility of complementary offers as a factor they considered when committing to a technology. For example, hydrogen as an energy carrier was mentioned as attractive, but technical difficulties regarding the respective infrastructure were seen as a challenge. This, in turn, prevented incumbent upstream actors from investing resources in the technology on a large scale.

- **High alignment upstream - low alignment downstream:** Business models centered around technologies deemed feasible for large-scale applications were explored more intensively by upstream actors. As described in Section 9.3.3, a major risk associated with investing in new technologies for xEVs was the availability of upstream suppliers of specialized components and downstream providers of complements. Informants estimated using electrical energy to operate xEVs as more feasible than other available options (e.g., hydrogen). This is likely due to the generic nature of electricity as a complement (Jacobides et al., 2018). In addition, using electric power sources allowed hybrid solutions to be used with little additional effort and for modularized components to be re-used, subsequently realizing scale effects. Thus, the data suggest that vehicles relying on electric energy are candidates that can fulfill an attractive ecosystem value proposition but are still hindered by a lack of infrastructure complements.

- **Low alignment upstream - high alignment downstream:** Informants from downstream companies reported that investing in complementary added values for xEVs required (1) the technological integration of infrastructure with vehicles and (2) the availability of large volumes of vehicles. Only when a sufficient number of vehicles were available to make use of available complementary offers could the respective business models become financially feasible. This, in turn, would allow the actors to contribute consistently to the overall ecosystem value proposition.

- **High alignment upstream - high alignment downstream:** The obtained data indicate that establishing attractive value propositions in the xEV ecosystem required central actors that could demonstrate the high performance of their offers (in terms of technological performance and price) but also access to complementary offers to achieve this performance. Interestingly, the obtained data indicate that a fragmented section of customers (i.e., corporate operators of xEVs) carried out initiatives to introduce business models that demonstrated an attractive xEV ecosystem value proposition. Specifically, corporate operators of vehicle fleets were able to overcome bottlenecks represented by a lack of complementary offers by introducing their own infrastructure. The reason for these undertakings mentioned by informants from the investigated corporate operators of vehicle fleets was that they expected xEVs to surpass conventional vehicles in selected use cases (e.g., urban logistics). Besides, they saw xEVs as a way to satisfy customer requirements (e.g., sustainable operations).

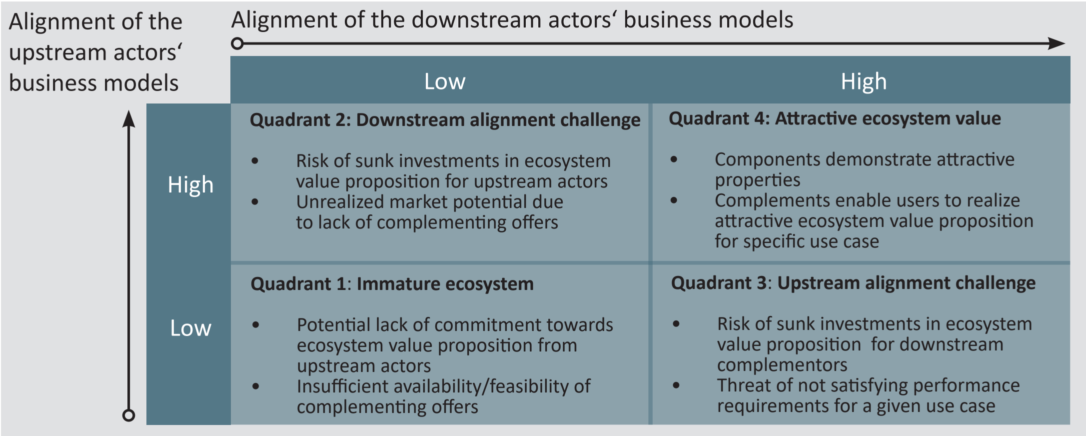


**Figure 67:** Proposed framework for evaluating the state of an ecosystem based on the alignment of actors' business models (personal illustration)

As illustrated in Figure 67, the combination of the aforementioned factors allows the derivation of archetypical states of an ecosystem and the assessment of their ability to provide an attractive value proposition. Specifically, depending on the alignment of business models of upstream and downstream actors, these states are:

- **Quadrant 1 - Immature ecosystem:** When business models in both the upstream and downstream regions of an ecosystem that is centered around a technological innovation lack the alignment (Adner, 2017) to contribute to a joint ecosystem value proposition, the overall state of an ecosystem presents itself as unappealing. Thereby, the ecosystem lacks complementary offers both in terms of production and consumption (Jacobides et al., 2018). The potential lack of the actors' commitment might be rooted in the lack of ecosystem leaders (Moore, 1993, 1996) or initiatives to align business models. Other possible reasons could include a lack in terms of maturity of the technology (Foster, 1986) the ecosystem is centered around or in terms of companies' inability to introduce appropriate business models to transform technological properties into economic value (Chesbrough, 2007b; Massa and Tucci, 2014).

- **Quadrant 2 - Downstream alignment challenge:** In quadrant two, upstream actors managed to align their business models to fulfill an ecosystem value proposition centered around a novel technology (Adner, 2017; Talmar et al., 2018). As indicated by the obtained data (see Section 9.3.2), these actors might only need to perform small amounts of business model change to establish alignment with their environment (Saebi, 2015). A factor supporting companies that manage this task is arguably a severe misalignment between their previous business models and their environment (Giesen et al., 2010, p. 19). This misalignment might be due to *"tectonic industry changes"* that, in turn, might eventually have their roots in technological discontinuities or policy changes (Massa and Tucci, 2014, p. 435). Therefore, policymakers might facilitate the emergence of a technology and its respective ecosystem (Adner and Kapoor, 2016a, p. 643). Consequently, this alignment of upstream actors helps to overcome bottlenecks in production (Adner and Kapoor, 2010; Jacobides et al., 2018). One approach to support alignment could be modularization of components, as described by Baldwin and Clark (1997). This might allow for the production of interdependent components by several ecosystem actors (Jacobides et al., 2018, p. 2266) and would probably support upstream actors in demonstrating an attractive value to customers. Simultaneously, however, customers would be held back by the lack of complementary offers, as downstream actors would not have aligned their business models to fulfill a joint ecosystem value proposition. One cause of this is the form of the ecosystem's *"value blueprint"*, as described by (Adner, 2012), that might fail to consider the business models of downstream actors appropriately (Adner, 2017). Consequently, as illustrated in Figure 67, upstream actors that align their business models to fulfill an ecosystem value proposition face the risks of sunk investments. These stem from unrealized market potential due to a lack of complementary offers that would make the ecosystem's value proposition attractive to customers.

- **Quadrant 3 - Upstream alignment challenge:** Quadrant three represents a case that is the opposite of that depicted in quadrant two. Here, business models of downstream providers of complementary offers would be in good alignment with the ecosystem value proposition (Adner, 2017; Talmar et al., 2018). The results indicate that actors performed higher degrees of business model change - or even introduced novel business models to achieve the alignment of downstream actors and to provide a sufficient level of complementary offers (see Section 9.3.2). As Saebi (2015) noted, these business models tend to try to change their environments. However, an overall attractive value proposition is prevented by a lack of alignment of the upstream actors' business models, preventing the creation of attractive products to ultimately use complements with. Therefore, companies facing this situation might risk sunk investments while attempting to fulfill an ecosystem's value proposition and might not meet the customers' requirements. The specific approaches pursued by actors seem to depend on the types of companies (Kapoor and Furr, 2015, p. 432). Established companies that entered an ecosystem to diversify, according to Kapoor and Furr (2015), were *"[...] more willing to trade off high technical performance for the availability of complementary assets."* In contrast, new companies, such as start-ups, tended to trade the availability of complements for an overall higher technological performance of the value proposition (Kapoor and Furr, 2015, p. 432).

- **Quadrant 4 - Attractive ecosystem:** Quadrant four shows that an attractive *"value blueprint"* (Adner, 2012) which enables actors to fulfill an attractive ecosystem value proposition (Adner, 2017; Talmar et al., 2018) requires the alignment of business models from actors both upstream and downstream. Thereby, both ecosystem bottlenecks in production and consumption are resolved (Jacobides et al., 2018). The alignment of business models of actors participating in an ecosystem centered around a technological innovation seems to require the governance of an ecosystem leader, as described by Moore (1993, 1996). The presented insights indicate that this ecosystem leader might need to take on multiple ecosystem roles. Relevant roles in that regard could be that of a dominator to align business models in the upstream ecosystem and a keystone to make the downstream ecosystem more attractive to additional ecosystem participants and improve the overall ecosystem health (Iansiti and Levien, 2004a; Dattee et al., 2018). To demonstrate an attractive value proposition, offers from both upstream and downstream actors need to co-evolve simultaneously. However, the utility of an ecosystem's value proposition will probably depend on the fit between the properties of the underlying technologies' and the customer-specific use cases and requirements, as described by Ardilio and Lab (2009).

The presented results suggest that consumers do not typically value a singular technology's performance, but rather the function it provides when embedded in a system (Adner, 2006). Consequently, technologies need to be implemented in appropriate business models to add value to an ecosystems value proposition (Chesbrough and Rosenbloom, 2002; Christensen, 2006; Chesbrough, 2010; Baden-Fuller and Haefliger, 2013). The results indicate that multiple actors' business models were involved in establishing an attractive ecosystem value proposition (Talmar et al., 2018) for xEVs. Involved actors might increase the chance of establishing an attractive ecosystem value proposition by strengthening the alignment of the individual actors' business models (Saebi, 2015; Adner, 2017). Thereby, the framework in Figure 67 shows that the alignment of the actors' business models – and their underlying technologies – in specific regions of the ecosystem is not sufficient to establish an attractive ecosystem value proposition. Instead, the alignment of the actors' business models, both upstream and downstream, needs to take place in a coordinated manner (both in terms of time and of locality) to avoid alignment challenges. This will require the coordination of additions of individual value to the ecosystem value proposition made by individual actors and with respect to ecosystem requirements. Therefore, the insights provided regarding the alignment of business models that, in turn, translate technological performance into economic outputs (Chesbrough and Rosenbloom, 2002, p. 536) add to the understanding of technological performance in ecosystems. These results stress the importance of involving the business models of multiple actors in the ecosystem to handle technological changes (e.g., by accessing resources from ecosystem actors) when entering ecosystems (Spieth and Meissner, 2018; Nailer and Buttriss, 2020).

### 9.3.4 Discussion and implications

Relevant findings regarding the alignment of ecosystem business models are summarized in Figure 68. The illustration presents an aggregation of the insights presented in Figures 63, 64, and 65. Overall, Figure 68 illustrates that the value propositions of actors positioned central or upstream in the xEV ecosystem co-evolved. However, due to uncertainties with regard to the involved technologies and customer requirements, central actors demanded shorter development times and higher amounts of technological flexibility. Upstream actors, in turn, broadened their technological portfolios and modularized their offers. New actors supplying components and/or technologies needed to provide the high volumes of their offers while lowering costs. In the downstream region of the ecosystem, both automotive OEMs, as central ecosystem leaders, and companies from the energy sector facilitated the introduction of business models that offered complements for xEV charging for private and corporate customers as well as public charging solutions. This led to the establishment of dedicated infrastructure actors (as discussed in Section 9.2), which offered infrastructure complements as the central value proposition of their business models. These actors' business models tended to rely on the upstream actors' solutions that enabled their value propositions. Informants in the automotive retail companies stated that private customers were often not able or had too few incentives to utilize the xEV ecosystem's value proposition. Corporate operators of vehicle fleets, in contrast, were both influenced by regulators and stakeholders to commit towards xEVs and had the ability to overcome potential complement bottlenecks by introducing their own infrastructure. This allowed them to offer value propositions centered around xEVs with their

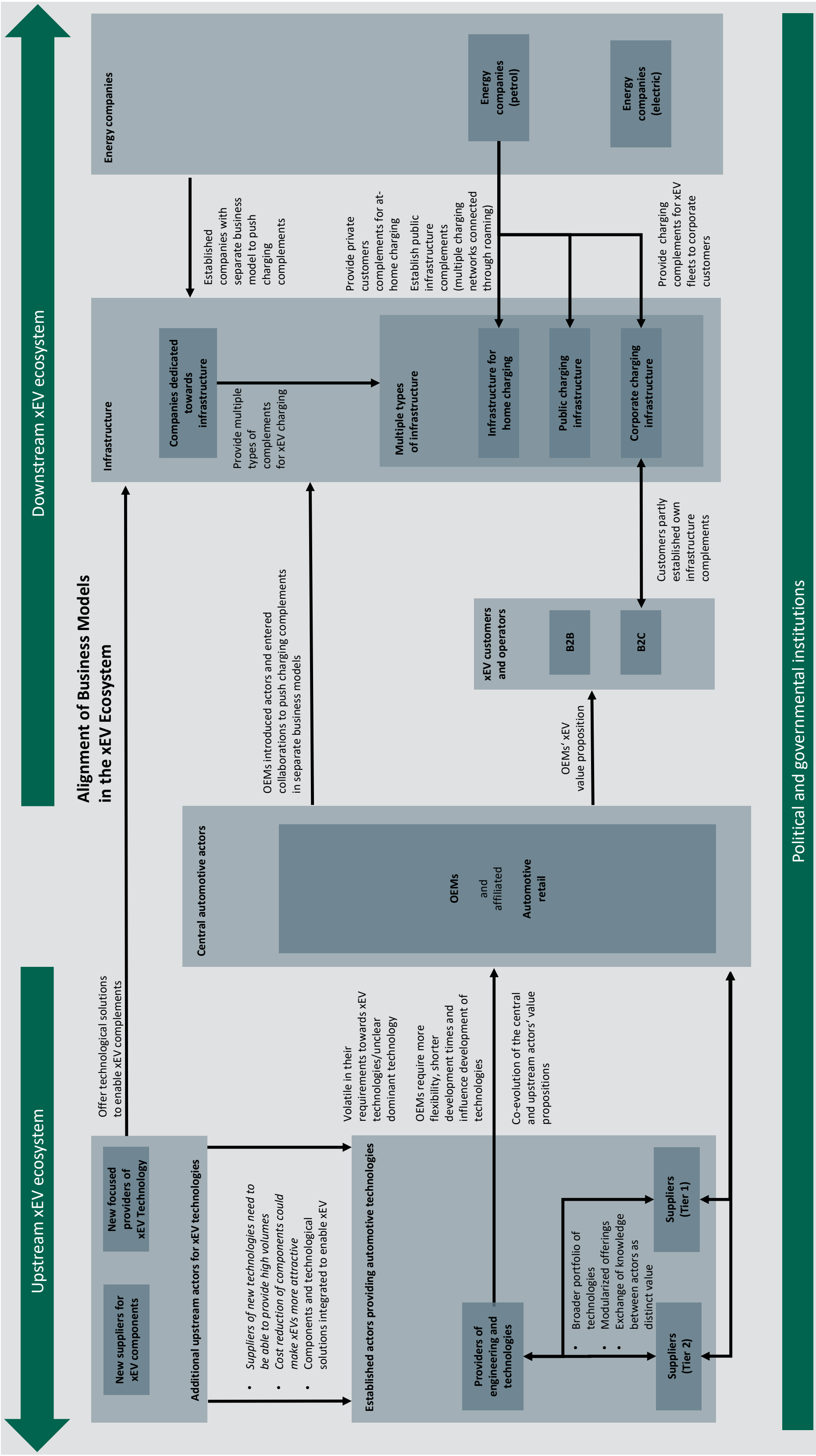


**Figure 68:** Overview of results of the alignment of ecosystem actors business models (personal illustration)

business models. Nonetheless, corporate operators of vehicle fleets tended to require support from companies that provided infrastructure. Next, the empirical insights regarding research question four and its respective sub-questions are discussed with reference to the literature. Consequently, the implications for research and industry and practical recommendations are presented.

### a) Discussion

As outlined in early descriptions of business models (Amit and Zott, 2001, 2015), business models need to take the unique environmental influences into consideration. In turn, the choices underlying a business model implicitly select the ecosystem within which they operate (Demil et al., 2018). This particularly applies to ecosystems that are centered around a specific technological innovation (Adner and Kapoor, 2010; Adner, 2017). In that regard, the individual actors' business models can be seen as critical elements that could allow the transformation of technological properties into economic value (Chesbrough and Rosenbloom, 2002, p. 536). However, when entering an ecosystem (Demil et al., 2018), changes in business models often take place under conditions of restricted freedom and need to consider interdependencies with other ecosystem actors (Berglund and Sandström, 2013, p. 279). Consequently, the individual actors' business models in an ecosystem need to be aligned in such a way as to (1) serve the needs of the involved actors (Adner, 2012), (2) enable bottlenecks due to the misalignment of business models both upstream and downstream (Adner and Kapoor, 2010) to be overcome, and (3) ultimately allow the demonstration of an attractive ecosystem value proposition, as described by Adner (2017) and Talmar et al. (2018). However, results show that aligning business models to overcome bottlenecks in creating ecosystem value might be a particularly challenging undertaking, as this alignment needs to be established in close proximity (local, temporal). Moreover, actors that tried to contribute value to an ecosystem centered around a technological innovation were confronted with many uncertainties that influenced their business model change activities. These uncertainties were largely rooted in customers' requirements as well as the type and timing of technologies when participating in an ecosystem. In turn, ecosystem leaders facilitated changes in the ecosystem's architecture. These changes were made to shorten development processes and modularize offers. Modularized offers, as described by Baldwin and Clark (1997), were pursued by companies to adjust their business models in response to technological developments and customer demand (Baden-Fuller and Haefliger, 2013, p. 425). Moreover, modularity could support the coordination and exchange of values between ecosystem actors (Jacobides et al., 2018, p. 2260). The obtained results on the actors' business models indicate that their position in the ecosystem also influenced both their abilities to change their business models and the respective drivers. Central ecosystem actors pursued different strategies in the upstream and downstream ecosystem (as described in Section 9.2). This is also reflected in the respective business models they pursued. Their business models were designed to introduce xEVs as a vehicle on the market and largely adapted in terms of how they created value as compared to their other business models. However, central actors needed to introduce additional business models aimed to provide complementary offers for xEVs on a large scale. They forged collaborations and facilitated the introduction of separate actors that provided complementary offers as a main value proposition. This served to make the ecosystem value proposition centered around xEVs more attractive. The obtained results indicate that actors upstream performed lower degrees of business model change than actors downstream. The exact ability and incentive to change business models may depend on the actor's specific type and role as well as its position in the ecosystem. Upstream actors performed more evolutionary or adaptive approaches in changing their business models. Actors located downstream in the ecosystem tended to perform more focused or complex types of business model innovation (Saebi, 2015; Foss and Saebi, 2017). The results on the actors' interactions extended those of Lindgren et al. (2010, p. 130), who found that competing as an individual actor becomes increasingly difficult. They stated that companies need to (1) develop their core competencies individually and (2) rely on external actors both upstream and downstream for *"network-based innovation"*[1]. This was especially the case when the knowledge and competencies required to be competitive are not available inside the company (Lindgren et al., 2010, p. 130). Only specific types of actors, namely, corporate customers and operators of xEVs, had both the support of management and the available resources at their disposal, enabling them to overcome the specific complement bottlenecks that affected them. Moreover, the obtained results allow the conclusion that those ecosystem strategies that concentrated on single misaligned business models in the ecosystem will probably fail. Instead, ecosystem leaders (Moore, 1993, 1996) need to coordinate actors and align their individual business models in order to overcome relevant bottlenecks simultaneously, ensure the overall health of the ecosystem (Dattee et al., 2018), and demonstrate an attractive ecosystem blueprint (Adner, 2012) where multiple actors can add value to a joint ecosystem value proposition (Talmar et al., 2018). Therefore, successful ecosystem strategies need to consider all the necessary actors' business models as critical (Adner, 2017, p. 51). Ultimately, establishing a good alignment among the actors' business models might help to create an attractive value blueprint (Adner, 2012) and encourage additional actors to participate in the ecosystem (Dattee et al., 2018).

### b) Implications for academia

The discussed results hold multiple implications for the alignment of business models in ecosystems centered around technological innovations:

- First, the presented empirical results connect the two previously largely distinct constructs of business models (Amit and Zott, 2001; Zott and Amit, 2010) and ecosystems (Moore, 1996; Iansiti and Levien, 2004b; Adner, 2017). Thereby, the results extend the understanding of business model change to establish alignment with the actors' environment (Giesen et al., 2010; Saebi, 2015; Foss and Saebi, 2017). The obtained findings contribute to this nascent field in the literature by providing evidence that the environmental alignment of individual business models as proposed in the business model literature (Giesen et al., 2010; Saebi, 2015; Foss and Saebi, 2017) is insufficient. Instead, individual actors need to consider business models in their ecosystem (Adner, 2017) and need to ensure the overall alignment of the individual actors' business models to fulfill a joint ecosystem value proposition, as described by Talmar et al. (2018).

[1] Lindgren et al. (2010, p. 130) specifically highlighted contributions of competition, customers, suppliers, consultants, and knowledge institutions.

- Second, the presented results indicate that the influence of individual actors on other ecosystem actors' business models is closely related to their position in the ecosystem, as well as the actor's ability to create value (Adner and Kapoor, 2010, p. 307). Central actors taking on the role of an ecosystem leader (Moore, 1996) could be particularly well-suited to pursuing this undertaking. Specifically, central ecosystem leaders could potentially influence upstream suppliers by taking on the role of a value dominator (Iansiti and Levien, 2004a, p. 75) to ensure the alignment of the actors' business models (Adner, 2017). The data indicate that, in this case, central ecosystem actors gradually co-evolved the business models that participated in a specific ecosystem (Moore, 1993, 1996; Dellyana et al., 2018; Fehrer et al., 2018) to be able to contribute to the new ecosystem's value proposition (Adner, 2017; Talmar et al., 2018). Consequently, as indicated by the data, upstream actors adopted or evolved their business models (Saebi, 2015; Foss and Saebi, 2017). With regard to downstream companies offering complementary values, ecosystem leaders could pursue a keystone approach (Iansiti and Levien, 2004a, p. 75) to improve the ecosystem's health. The data suggest that establishing the alignment of downstream actors to fulfill the ecosystem's value proposition requires high degrees of business model innovation or even actors that introduce new business models to the industry (Saebi, 2015; Foss and Saebi, 2017). These results extend the insights provided by Giesen et al. (2010), Saebi (2015) and Foss and Saebi (2017) in two ways: First, data on the actors' business models indicate that both the individual actors' influence, as well as their position in the ecosystem, affected their incentive and ability to influence the business models of other ecosystem actors. Second, the amount of business model change necessary to establish alignment to fulfill an ecosystem value proposition seems to depend on the actor's position in the ecosystem. This highlights the relationship between the structure and governance of an ecosystem with the changes in the involved actors' business models.

- Third, in addition to the need to align ecosystem business models, the presented results show that the business models of actors involved in ecosystems that are centered around a technological innovation need to be able to translate properties of underlying technologies into economic value (Chesbrough and Rosenbloom, 2002, p. 536) in order to participate in an ecosystem and subsequently add value to the ecosystems' value proposition. This particularly applies to ecosystems centered around technological innovations, as without appropriate business models, the involved technologies provide little objective value (Chesbrough, 2010, p. 354).

- Fourth, the outlined findings highlight a direct link between the governance of business models and ecosystems. Specifically, the modularity of offerings in an ecosystem (Jacobides et al., 2018, p. 2660) could support ecosystem coordination while also allowing the actors' business models to be adjusted to meet customer demands and technological developments more flexibly (Baden-Fuller and Haefliger, 2013, p. 425).

- Fifth, different types of bottlenecks (Adner and Kapoor, 2010) may exist simultaneously in an ecosystem (e.g., upstream component bottlenecks, downstream complement bottlenecks), thus preventing an attractive ecosystem value proposition (Talmar et al., 2018) from being realized. As noted by Adner (2006, p. 106), some of these bottlenecks may be partly due to technological difficulties. Others, however, might stem from difficulties in coordinating systems and the late emergence of respective markets (Adner, 2006, p. 106). In particular, the latter two factors are arguably related to the misalignment of the ecosystem actors' business models. Data presented in this thesis support the notion that the misalignment of business models could represent a type of bottleneck in an ecosystem.

- Sixth, based on the collected data and considerations of Adner and Kapoor (cf. Adner and Kapoor (2010); Adner (2012); Adner and Kapoor (2016a); Adner (2017)), a framework to structure the alignment of business models and their underlying ecosystem initiatives is proposed. The framework provides a holistic view of how single actors might align their individual business models with their business environments (Giesen et al., 2010; Saebi, 2015) in an attractive *"value blueprint"* (Adner, 2012) to contribute towards a joint ecosystem value proposition, as described by Talmar et al. (2018).

- Finally, the presented findings support the notion that management commitment is a prerequisite for changing business models (Doz and Kosonen, 2010; Saebi et al., 2017) and aligning them to fulfill a joint ecosystem value proposition (cf. Adner (2017) and Talmar et al. (2018)). The obtained data indicate that this particularly applies to business models contributing to an ecosystem centered around a technological innovation that is in its early stages (Draschbacher et al., 2020), as actors potentially faced substantial amounts of uncertainty.

### c) Practical implications

Again, practitioners in companies engaging in an ecosystem centered around a novel technology can benefit from the obtained results:

- First, practitioners need to be aware of the characteristics of the ecosystem in which they choose to participate with their business models (Demil et al., 2018). This bears particular relevance, as ecosystems might involve actors and their business models from several industries.

- Second, when multiple actors start to engage in activities to contribute to a joint ecosystem value proposition (Adner, 2017; Talmar et al., 2018), practitioners might need to consider that the individual actors' business model change activities (Saebi, 2015; Foss and Saebi, 2017) need to be governed to ensure that individual contributions add value to the ecosystem value proposition. Thereby, practitioners need to be aware of the possible misalignment of the individual actors' business models, as these misaligned business models could represent bottlenecks to creating value in their ecosystems. The framework presented in Figure 67 might serve as a starting point to consider the state of an ecosystem and could offer guidance for practitioners who want to address misaligned business models in a coordinated manner. This could prevent spending time and/or resources on resolving isolated bottlenecks and create ecosystem value while failing to ensure an attractive *"value blueprint."* Leading ecosystem actors (Moore, 1993, 1996) that take on the role of a keystone and/or value dominator (Iansiti and Levien, 2004a) could be particularly well suited for this undertaking.

- Third, the obtained data indicate that changes in business models to align them towards a joint ecosystem value proposition seem to depend on the specific position and type of an ecosystem actor. Business models of ecosystem actors appeared to act in concert to contribute to a joint ecosystem value proposition (cf. Talmar et al. (2018)). As shown, upstream actors tended to take more evolutionary or adaptive approaches toward changing their business model. In contrast, actors downstream pursued focused or complex business model innovation (see Table 62) (Saebi, 2015; Saebi et al., 2017). In addition, as central ecosystem actors wielded substantial influence and had resources, they were in positions to adopt or introduce business models in order to fulfill specific functions in an ecosystem. Therefore, practitioners have a starting point when considering which type of business model change activity could be suited to their specific circumstances.

# 10 Concluding summary and outlook

## 10.1 Summary of main results

The literature review results and empirical study reveal that the boundary-spanning nature of business models (Amit and Zott, 2001; Berglund and Sandström, 2013; Saebi, 2015; Spieth and Meissner, 2018; Saebi et al., 2017) is connected to the literature on ecosystems (Moore, 1996; Iansiti and Levien, 2004b; Adner and Kapoor, 2010; Adner, 2012; Adner and Kapoor, 2016a,b) . This chapter provides a summary of the obtained insights.

### a) Main results for research question one

First, to answer the first research question, the literature combining business model innovation and business ecosystems was investigated by means of a systematic review. The main relevant aspects regarding research question one are summarized in Table 63.

**Table 63:** Overview of key findings for research question one

| | |
|---|---|
| **Research Objective** | Identification of relevant themes in literature regarding changes of business models in ecosystems |
| **Research Question 1** | What are relevant issues in the literature addressing changes in business models in combination with ecosystems? |
| **Key findings** | • A descriptive review of relevant publications allowed for the characterization of the state of the research field. In addition, prominent research approaches, as well as research settings, were highlighted.<br>• The aggregation of insights from investigated papers served to highlight relevant concepts and themes in the literature and provided an overview of the current state of research.<br>• Findings were used to extend the established ecosystem frameworks to include mutual relations between the focal actors' business model changes and ecosystem aspects. |
| **Contributions** | Using insights from the review and preliminary conceptual considerations, a framework was established to consider relevant factors for changing business models in the context of ecosystems. The framework provides a solid basis for (1) practitioners who would like to consider external influences when innovating their business model, as well as (2) researchers trying to shed light on the relations between business models and ecosystems. |

Based on the results of the review, main themes in the literature were identified and combined with existing approaches taken to describe ecosystems. Subsequently, a conceptual framework was proposed comprising the relations of both business model innovation and the ecosystem constructs.

### b) Main results for research question two

Second, as shown in Table 64, using primary data from multiple case studies, factors were explored that influenced actors to participate in an ecosystem centered around a technological innovation. This was done by taking the prominent example of the xEV ecosystem.

**Table 64:** Overview of key findings for research question two

| | |
|---|---|
| **Research Objective** | Improve the understanding of relevant factors perceived by actors, which encourage them to participate in an ecosystem centered around a technological innovation. |
| **Research Question 2** | What influences do ecosystem actors perceive that encourage them to participate in an ecosystem centered around novel technologies? |
| **Implications for academia** | • Referring to the framework established in research question one, findings highlight the roles of government policies and regulatory influences on the formation of and change in ecosystems.<br>• The results indicate that actors that are already active in a novel ecosystem played a major role in facilitating the entry of additional actors. Influences could be enacted on multiple levels, such as direct business relations as well as through changes in (technological) requirements.<br>• The findings highlight the role of central ecosystem actors as ecosystem leaders. These actors could substantially influence others, facilitating the upstream entry of actors in an ecosystem centered around a technological innovation. In the downstream ecosystem, however, results indicate that ecosystem leaders lacked influence and were required to foster collaborations and facilitate the entry of additional actors to ensure an appropriate number of complementary offers.<br>• The existence of co-dependencies in creating specific values that represent bottlenecks in an ecosystem might prevent additional actors from entering the ecosystem.<br>• Central actors from an established ecosystem could be particularly well-suited to take on the role of ecosystem leaders. However, these actors were prevented from carrying out initiatives in the new ecosystem by their involvement in their original ecosystems. |
| **Implications for practice** | • Coordination of regulations could help to avoid contradictory influences and increase their overall impact.<br>• Actors aiming to enter an ecosystem centered around technological innovations could benefit from being aware of the *"value blueprint"* as well as the involved actors' requirements and capabilities regarding the handling of the respective innovations. |
| **Contributions** | Regulations were strongly influential in that they facilitated the entry of central and downstream actors into the ecosystem. This led to a situation where upstream actors were "pulled" into the ecosystem. Subsequently, central actors relayed their requirements to actors upstream. In addition, central actors started initiatives in the downstream ecosystem to achieve an attractive level of complementary offers in the new ecosystem. |

Governmental policies and regulatory influences impacted central ecosystem actors, actors providing complementary offers, and customers/operators of novel value propositions. These influences, in turn, accelerated their entry into the novel ecosystem. The findings underline the fact that central ecosystem actors that provided an elemental part of the ecosystem's value proposition were able to take on the role of an ecosystem leader. The results also indicate that regulations directed at actors in the central and downstream regions of the ecosystem facilitated the entry of additional actors into these regions. Upstream actors oriented themselves toward the central actors' initiatives and requirements and tended to be "pulled" into the ecosystem. However, central actors needed to overcome multiple co-dependencies in value creation, indicating that bottlenecks both in the upstream and downstream regions of the ecosystems could limit the overall ecosystem's attractiveness.

### c) Main results for research question three

As summarized in Table 65, in research question three, the ecosystem actors' interactions to create value in an ecosystem centered around a technological innovation were investigated.

**Table 65:** Overview of key findings for research question three

| | |
|---|---|
| **Research Objective** | Understand how actors can interact in an ecosystem centered around a novel technology to create value. |
| **Research Question 3** | How do ecosystem actors interact to create value in an ecosystem centered around novel technologies? |
| **Implications for academia** | • The findings add to the understanding of changes in value blueprints when novel ecosystems emerge from established ecosystems. The results thereby indicate that newly founded ventures and additional actors from other industries might play substantial roles in contributing both component- as well as complement values to a novel ecosystem.<br>• Value creation support roles could be critical in that they enable partners from other ecosystems that have vastly different sets of capabilities to create value in a focal ecosystem.<br>• The findings illustrate the need to address customer requirements while establishing a *"value blueprint"* for new ecosystems. This adds to the understanding of how an ecosystem's value proposition and structure are related.<br>• Central actors in a novel ecosystem with their roots in an established ecosystem might simultaneously adopt multiple ecosystem strategies. The data indicate that these actors tend to act as *"value dominators"* towards upstream ecosystem actors while showing indications of *"keystone"* actors in their downstream initiatives (Iansiti and Levien, 2004b, p. 75)<br>• The emergence of an ecosystem centered around a novel technology from an established ecosystem might render the established ecosystem unattractive. This could result in the withdrawal of actors from the previous ecosystem. |

Table 65 continues on next page

Table 65 continued from previous page

| | |
|---|---|
| **Implications for practice** | • Practitioners might need to adapt their companies' competencies proactively to be prepared for the downturn in their current ecosystem. Furthermore, they might also influence the generation and development of novel ecosystems.<br>• Actors entering from other industries might require intermediaries in order to translate their offers to fit the ecosystems' requirements. |
| **Contributions** | Novel ecosystems centered around a technological innovation might emerge from established ecosystems. In these cases, while overlaps in actor structure are likely, new actors often become relevant. The data indicate that major actors tended to operate in both their old and the new ecosystems simultaneously. Established actors tried to introduce an attractive *"value blueprint"* by introducing dedicated actors that were active in the new ecosystem. Moreover, central actors acting as ecosystem leaders in an ecosystem could introduce changes in the existing - as well as foster the introduction of new - cooperative and competitive relations among actors. |

To a large degree, actors in the new ecosystem were also active in their previous, more established, ecosystem. In part, due to ecosystem carryover, the new ecosystem showed substantial overlaps with this previous ecosystem. However, providing value that is centered around a technological innovation required structural changes with regard to the actors' established ecosystems as well as changes in the existing actors' relations (e.g., modularity of offerings, pace of development efforts). Consequently, although both actors upstream and downstream contributed to a joint ecosystem value proposition, the focus and the interactions in these areas of the ecosystem largely differed.

Looking at the upstream part of the ecosystem, central ecosystem leaders showed indications of a value dominator when pursuing the introduction of new value propositions. In turn, influenced by the central ecosystem leaders' requirements (which were, in turn, influenced by governmental regulations), upstream actors focused on exploring and delivering new technological solutions to satisfy the central actors' requirements. A notable factor for actors in the upstream region of the ecosystem was their ability to leverage their capabilities while remaining technologically flexible. This put them in an advantageous position that allowed them to act as an intermediary between actors new to the ecosystem and established actors. Overall, the data indicate that a co-evolution of the upstream and central actors' value propositions took place, enabling them to overcome technological and/or component-related bottlenecks. This, in turn, allowed central actors to provide attractive value propositions with regard to the new ecosystem in their business models. The downstream regions of the ecosystem had different characteristics. Combining the insights from multiple cases in the downstream ecosystem indicated that central ecosystem leaders acted as keystone actors in the new ecosystem's downstream segment. They pursued this course of action to increase the availability of complementary offers and overcome bottlenecks in value creation. Thereby, the data indicate that two specific groups providing complementary offers were forming around actors from historically largely distinct sectors that showed different behaviors depending on their origins.

## d) Main results for research question four

Regarding research question four, challenges to align actors' business models both upstream and downstream, preventing them from fulfilling a joint ecosystem value proposition, were investigated in greater detail. Table 63 summarizes the obtained results.

**Table 66:** Overview of key findings for research question four

| | |
|---|---|
| **Research Objective** | Explore how actors align factors on the company level (individual actors' business models) and the ecosystem level (added values of multiple actors) to contribute to a joint ecosystem value proposition centered around xEVs. |
| **Research Question 4** | How can actors participating in an ecosystem centered around novel technologies align their individual business models to contribute to a joint ecosystem value proposition? |
| **Implications for academia** | • The results connect the previously largely distinct literature streams of business models and ecosystems by highlighting the fact that aligning individual business models to fit their environments seems to be insufficient. Instead, business models might need to be aligned to contribute to an ecosystem's value proposition.<br>• The actors' position and influence in an ecosystem influenced the ability to - as well as the respective incentives for - influencing other ecosystem actors' business models. This insight connects the aspect of ecosystem governance and structure with changes in the actors' business models.<br>• The degree of business model change necessary to align the model to fit an ecosystem value proposition seems to depend on the actor's position in an ecosystem. Upstream actors might only need to evolve or adapt their current business models, while downstream actors might need to pursue focused or complex business model innovation. Thereby aspects typically associated with individual actors are connected with factors stemming from the actors' ecosystems.<br>• In ecosystems centered around technological innovation, the individual actors' business models need to translate properties of the underlying technologies into economic value. This finding adds to the understanding of the role of business models both in the context of technologies as well as their environments.<br>• The results improve the understanding of bottlenecks, as misaligned business models in ecosystems might themselves represent a type of ecosystem bottleneck.<br>• A framework was proposed to consider the alignment of the individual actors' business models. The framework could support the introduction of attractive ecosystem blueprints.<br>• Changing a business model to add value to early-stage ecosystems seems to require high amounts of commitment from management. This connects the role of the individual actor's leadership, in terms of their ability to handle strategic discontinuities, with the literature on the alignment of actors in ecosystems. |
| **Implications for practice** | • Practitioners changing their business models need to be aware of the ecosystem they implicitly choose as well as the relevant actors in these ecosystems.<br>• Practitioners might need to factor in the role of ecosystem governance in aligning business models to fit an ecosystems' value proposition.<br>• This thesis provides guidance for practitioners by linking a suitable degree of business model change with the actors' ecosystem positions. |
| **Contributions** | An attractive ecosystem value proposition requires the simultaneous alignment of the upstream and downstream actors' business models. This allows the transformation of values offered by central and upstream actors into actual performance for customers through sufficient complementary offers. |

The results provide insights on an ecosystem level as well as on an actor level. On the ecosystem level, the previously largely distinct groups of actors found themselves in a mutual co-dependency with regard to their value propositions while simultaneously engaging in co-opetition with regard to their ability to provide complementary offers in the downstream area of the ecosystem. On the level of individual actors, the results show how the investigated actors changed their business models to align them with an ecosystem's value proposition. Depending on their ecosystem role and position, actors tended to perform changes in their business models that ranged from business model evolution or adaption (predominantly central and upstream actors) to focused or complex business model innovation (downstream companies, newly introduced actors connecting the upstream and downstream ecosystems).

## 10.2 Limitations and further research

The obtained findings reveal the changes that occur in actors' business models when they enter innovation ecosystems. Although early publications on business models emphasized their boundary-spanning character (Amit and Zott, 2001), later publications focused on the business models of individual organizations (Berglund and Sandström, 2013). Researchers only recently began to explore the role of business models as entities that are embedded in their surrounding ecosystems (e.g., Spieth and Meissner (2018); Demil et al. (2018)). The work presented in this thesis addressed this gap by (1) exploring factors that encouraged companies to enter an ecosystem centered around a technological innovation and (2) contributing to the understanding of how companies adjust their business models in an innovation ecosystem to realize an attractive ecosystem value proposition. However, as with any research, this thesis work had several limitations and, therefore, might represent a starting point for other fruitful research directions.

### 10.2.1 Limitations

Although studies on business models and ecosystems have been the focus of researchers for more than a decade (compare with, for example, Amit and Zott (2001) and Adner (2006)), studies combining both topics are still scarce. Consequently, as shown in Chapter 5, the study described in this thesis represents one of the first studies to investigate business model innovation in combination with ecosystems, relying on rich data from multiple in-depth case studies and considering the perspectives of different relevant actors.

**Principle research approach:**
One limitation of this research is that it exclusively relied on qualitative data. Nevertheless, as argued in Chapter 1, publications combining business models and ecosystems represent a nascent stream in the literature (Adner, 2017; Järvi and Kortelainen, 2017; Demil et al., 2018; Rong et al., 2018; Tsujimoto et al., 2018). Thus, adopting an interpretivist stance (Saunders et al., 2016, p. 140) and performing qualitative inquiries was deemed as a suitable approach to generate novel insights on this topic (Edmondson and McManus, 2007, p. 1177). The published recommendations

for case study research were followed (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Yin, 2009; Gioia et al., 2012; Gehman et al., 2017), and an extensive database consisting of 27 cases that rely on data from 46 interviews as well as one focus group was established. However, the research approach chosen limits the generalizability of the study's findings. To address the potential shortcomings of the conducted study, a strong emphasis was put on addressing the quality criteria recommended for qualitative research (Lincoln and Guba, 1985; Bortz and Döring, 2007a; Schou et al., 2012). Consequently, (1) detailed arguments for the choice of methodological approach and the selection of data sources were provided, (2) the performed research was meticulously documented, (3) rich data were gathered from multiple sources, allowing for the replication of findings between similar cases, (4) triangulation (in terms of chosen methods, informants and involved researchers) was applied whenever possible, (5) peer-debriefings were held regularly, (6) detailed descriptions for each investigated aspect were provided, and (7) the data were linked to the interpretation using appropriate quotes. Detailed information about how individual quality criteria were considered during this research is presented in Section 7.4.

**Data sample:**
The data presented in this thesis were collected from companies in Austria and Germany. The sample was limited to 27 cases with a total of 46 interviews as well as data from a focus group. The data collection took place from 2015 to 2017 (pre-study) and, respectively, from 2018 to 2019 (main study). Due to likely differences in market behavior, industry structure (Hertzke et al., 2019, p. 87) and regulatory regimes (Arena et al., 2014) between individual geographic regions, findings might not be fully applicable in other regions. Moreover, due to the limited data collection periods, the insights provided in this thesis might not fully apply to other time periods. Furthermore, as data were collected over a limited time frame, it does not allow for process perspectives that could explain the evolution of the investigated subject (Langley, 1999; Langley et al., 2013).

**Complexity of the conducted empirical study:**
Due to the complexity of the topic, finding suitable informants was a challenging undertaking. Informants needed to be able to provide insights into the company's business model with regard to the chosen empirical context. Furthermore, interview partners needed to have a deep knowledge of their company's relations with other ecosystem actors. Consequently, the author of this thesis needed to develop a comprehensive understanding of the investigated ecosystem by considering the individual actors' perspectives. This, in turn, required the collection of an extensive amount of data, multiple iterations in terms of analyzing, coding, and re-coding the empirical material, as well as cycling back and forth between the material and literature. Due to resource constraints, the author of this thesis analyzed the qualitative interview data alone, resulting in potential researcher bias. However, by adhering to the quality criteria described in Section 7.4, the obtained insights were regularly discussed with peers and the supervisor of this thesis.

**Transferability of results:**
A qualitative research approach has inherent limitations regarding the transferability of the obtained results to other areas or different settings. In this study, a major limitation affecting the transferability of results (external validity) is the focus on a single empirical setting. However, as described in Section 7.4, the study limitations in terms of external validity were minimized by applying appropriate measures recommended in the literature (Lincoln and Guba, 1985; Bortz

and Döring, 2007b; Schou et al., 2012). Referring to the literature emphasizing the external orientation of business models (Amit and Zott, 2001; Saebi, 2015; Demil et al., 2018) as well as the alignment of actors in ecosystems (Adner, 2017; Talmar et al., 2018), the findings could be transferred to settings where ecosystems have formed around a technological innovation (Dattee et al., 2018; Dedehayir et al., 2018) and faced similar shortcomings with regard to the structure of actors providing components and complementary offerings to add value with their business models towards the ecosystem's value proposition (Adner, 2017; Talmar et al., 2018; Jacobides et al., 2018; Kapoor, 2018). This might be particularly applicable where regulators, standardization bodies, laws, social behaviors, and business ethics impose a similar regime of constraints on ecosystem actors (Teece, 2007, p. 1323). In these cases, actors are confronted with similar *"rules of the game"* (Teece, 2007, p. 1323) providing a fruitful ground to transfer the obtained insights to the respective settings.

### 10.2.2 Further research

This study addressed the lack of holistic investigations of ecosystems, which was prominently pointed out by Järvi and Kortelainen (2017). The research findings thereby highlight the necessity to carry out further research on business models in the context of their ecosystems.

First and foremost, the novelty of this topic necessitates more qualitative empirical groundwork. To explore the investigated issue further, similar research could be performed that takes into consideration the insights of additional ecosystem actors (e.g., private customers of xEVs or new OEMs and suppliers entering the ecosystem). However, investigating business models of actors in the context of their ecosystems inherently requires the collection of substantial amounts of data. From the authors' perspective, the amount of collected and analyzed data represents the limit of what is feasible for a single researcher within a limited time frame. Further research could address this issue by conducting a large-scale qualitative inquiry on the topic, involving multiple researchers to gather and analyze data. Moreover, this study could be repeated in different empirical settings to gain broader insights into the relations between business models and ecosystems.

In addition, as the collected primary data only allowed for gaining a snapshot of the state of the ecosystem and the involved actors' business models, process studies on the investigated relations between business models and ecosystems might yield novel insights. However, as mentioned previously, the resources necessary to merely obtain the snapshot presented in this thesis were substantial. Therefore, investigations such as those performed by Draschbacher et al. (2020), which relied on consistently available secondary data and covered longer time periods, might be examples of a feasible approach that can be taken to investigate the processes and dynamics of an ecosystem and its actors' business models (Langley, 1999; Langley et al., 2013). While qualitative research is well-suited for nascent fields of research, Edmondson and McManus (2007, p. 1168) pointed out that, at some point, a mix of qualitative and quantitative or even fully quantitative investigations of the topic could provide novel insights.

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# A Appendix

## A.1 Details about the data collected from investigated cases

**Table 67:** Overview of interview data collected over the course of the pre-study work.

| Id. | Category | Case | Description | Respondent | Length | Mode |
|---|---|---|---|---|---|---|
| PS1 | SUP | SUP Alpha | Tier 1 supplier (Subdivision A) | Vice-president level | 36min | in person[1] |
| PS2 | SUP | SUP Beta | Tier 1 supplier (Subdivision A) | Head level (Engineering) | 37min | in person[1] |
| PS3 | SUP | SUP Gamma | Tier 2 supplier (Subdivision) | Managing director | 1h 18min | in person[1] |
| PS4 | ETP | ETP Alpha | Engineering (Subdivision 2) | Manager level (Sales) | 48min | in person[1] |
| PS5 | ETP | ETP Alpha | Engineering (Subdivision) | Head level | 41min | in person [1] |
| PS6 | OEM | OEM Alpha | Automotive OEM (Subdivision) | Head level (Engineering) | n.a. | in person[23] |
| PS7 | OEM | OEM Alpha | Automotive OEM (Subdivision) | Head level (Engineering) | n.a. | in person[23] |
| PS8 | RET | RET Alpha | Automotive retail | Manager | n.a. | in person [2] |

**Table 68:** Overview of collected interview data from investigated cases throughout the main study. Data were gathered from December of 2018 till September of 2019. All interviews were recorded and transcribed in full.

| Int. | Category | Case | Description | Respondent | Length | Mode |
|---|---|---|---|---|---|---|
| MS1 | SUP | SUP Alpha | Tier 1 supplier (Subdivision) | Head level | 1h 05min | in person |
| MS2 | SUP | SUP Alpha | Tier 1 supplier (Subdivision) | Head level | 45min | in person |
| MS3 | SUP | SUP Beta | Tier 1 supplier (Subdivision 1) | Head level (Engineering) | 39min | in person[4] |
| MS4 | SUP | SUP Beta | Tier 1 supplier (Subdivision 2) | Head level (Engineering) | 1h 14 min | in person |
| MS5 | SUP | SUP Beta | Tier 1 supplier (Subdivision 2) | Head level (Engineering) | 56min | in person |
| MS6 | SUP | SUP Beta | Tier 1 supplier (Subdivision 2) | Head level | 1h 21min | in person[5] |
| MS7 | SUP | SUP Beta | Tier 1 supplier (Subdivision 2) | Manager level (Mobility) | 1h 21min | in person[5] |
| MS8 | SUP | SUP Beta | Tier 1 supplier (Subdivision 2) | Head level (Strategy) | 1h 26min | in person |

Table 68 continues on next page

[1] The interview was conducted as part of the author's master's thesis.
[2] The interview was conducted by one of the author's master's students.
[3] The interviews PS6 and PS7 were conducted as a double interview.
[4] The interview was conducted by the author, together with a master's student.
[5] The interviews MS6 and MS7 were conducted as a double interview

Table 68 continued from previous page

| Int. | Category | Case | Description | Respondent | Length | Mode |
|---|---|---|---|---|---|---|
| MS9 | SUP | SUP Delta | Tier 2 supplier | Head level (Innovation) | 42min | via phone |
| MS10 | SUP | SUP Epsilon | Focused technology supplier | Manager level (Engineering) | 1h 4min | via phone[4] |
| MS11 | SUP | SUP Zeta | Focused technology supplier | Managing director | 1h 26min | in person |
| MS12 | SUP | SUP Zeta | Focused technology supplier | Business development | 1h 22min | in person |
| MS13 | ETP | ETP Alpha | Engineering and technology (Subdivision 2) | Manager level (Engineering) | 1h 10min | in person[4] |
| MS14 | ETP | ETP Alpha | Engineering and technology (General) | Head level (R&D) | 45min | in person |
| MS15 | ETP | ETP Alpha | Engineering and technology (Subdivision 1) | Manager level (Engineering) | 1h 04min | in person |
| MS16 | ETP | ETP Alpha | Engineering and technology (General) | Head level | 55min | in person[4] |
| MS17 | ETP | ETP Alpha | Engineering and technology (Subdivision 1) | Manager level (Engineering) | 1h 08min | in person |
| MS18 | ETP | ETP Beta | Engineering and technology Services | Head level (Engineering) | 44min | in person |
| MS19 | ETP | ETP Beta | Engineering and technology Services | Manager level | 1h 05min | in person |
| MS20 | RI | RI Alpha | Automotive Research institute | Professor | 1h 00min | in person |
| MS21 | RI | RI Beta | Automotive Research institute | Head level | 47min | in person |
| MS22 | OEM | OEM Beta | Automotive OEM (Subdivision A) | Manager level (Engineering) | 43min | via phone |
| MS23 | OEM | OEM Beta | Automotive OEM (Subdivision B) | Manager level (Engineering) | 38min | via phone[4] |
| MS24 | OEM | OEM Gamma | Automotive OEM (Subdivision) | Manager level (Engineering) | 1h 15min | via phone[4] |
| MS25 | OEM | OEM Delta | Automotive OEM (Subdivision) | Managing director (Engineering) | 1h 09min | in person |
| MS26 | FO | FO Alpha | Electrified vehicle fleet and infrastructure | Manager level (Fleet operations) | 1h 28min | in person |
| MS27 | FO | FO Alpha | Electrified vehicle fleet and infrastructure | Head level (Fleet operations) | 1h 15min | in person |
| MS28 | RET | RET Beta | Automotive retail (Subsidiary) | Managing director | 1h 16min | in person[4] |
| MS29 | EC | EC Alpha | Electric energy and charging infrastructure | Staff position (Electric Mobility) | 59min | in person |
| MS30 | EC | EC Beta | Electric energy and charging infrastructure | Head level (Mobility and Infrastructure) | 1h 03min | in person |
| MS31 | EC | EC Beta | Electric energy and charging infrastructure | Manager level (Mobility and Infrastructure) | 1h 26min | in person |
| MS32 | EC | EC Gamma | Electrified vehicle-fleet and infrastructure | Head level (Business Development) | 1h 12min | in person |
| MS33 | EC | EC Delta | Company focus on petrol energy | Senior director | 47min | via phone |
| MS34 | EC | EC Epsilon | Company focus on petrol energy | Head level (New energy) | 50min | via phone |
| MS35 | INF | INF Alpha | Public infrastructure | Head level (Infrastructure) | 1h 34min | in person |
| MS36 | INF | INF Beta | Charging infrastructure | Head level (Operations) | 37min | via phone |

Table 68 continues on next page

Table 68 continued from previous page

| Int. | Category | Case | Description | Respondent | Length | Mode |
|---|---|---|---|---|---|---|
| MS37 | INF | INF Gamma | Charging solutions | Head level (Operations) | 53min | in person |
| MS38 | INF | INF Delta | Battery Charging Solutions | Managing director | 2h22min[1] | in person |

[1]A previous interview with the respondent was conducted in April of 2018. The sample includes data from both interviews.

## A.2 Used interview material

**FRAGEBOGEN FÜR UNTERNEHMEN**
**INHALTLICHER FOKUS: TECHNOLOGIEN FÜR ELEKTROMOBILITÄT**

**KONKRETER FOKUS:** ________________________________________

**Einleitende Fragen**

Einleitend Business Model Canvas vorstellen; Hauptaspekte erklären; keine falschen Antworten

**Welche Funktion nehmen Sie in Ihrer Organisation wahr?**

- Seit wann sind Sie in der Unternehmung tätig?
- Welche Aufgaben sind mit Ihrer Funktion verbunden?
- Was sind die relevantesten Technologien in Bezug auf Elektromobilität mit denen Ihr Unternehmen Mehrwert für Ihre Kunden schafft? *(für konkreten Fokus)*

**Externe Einflüsse auf Technologien**
Wie geht Ihr Unternehmen mit technologischen Innovationen um?

- Stammen besagte technologische Veränderungen eher aus dem Umfeld der Unternehmung oder aus Ihrer Unternehmung selbst?
- Welche konkreten Maßnahmen treffen Sie, um auf Änderungen von technologischen Rahmenbedingungen (regulatorische Eingriffe, geändertes Kundenverhalten, …) angemessen reagieren zu können?
- Wo sehen Sie die Risiken bei der Einführung und Anwendung neuer Technologien im Unternehmen?

**Fragen zu Geschäftsmodellinnovation**
Wie sieht das Geschäftsmodell Ihrer Unternehmung aus?

- Wie schafft Ihr Unternehmen Nutzen für seine Kunden?
- Wie generieren Sie aus diesem Nutzen Einnahmen?
  *(Checklist: Value Proposition, Value Creation, Value Capture)*

Wie beurteilen Sie die Notwendigkeit zur Anpassung bzw. Überarbeitung des gerade beschriebenen Geschäftsmodells für Ihre Unternehmung?

- Welche konkreten Änderungen im Geschäftsmodell *(bzw. im wichtigsten GM, wenn mehrere vorhanden)* Ihrer Unternehmung gab es in der Vergangenheit?
- Welche Auslöser (Ereignisse bzw. neue Möglichkeiten) haben in der Vergangenheit zu Veränderungen von Geschäftsmodellen Ihres Unternehmens geführt?

**Technologien und Geschäftsmodelle**
Wie haben technologische Veränderungen in der Vergangenheit die Geschäftsmodelle Ihres Unternehmens beeinflusst?

- Welche Kompetenzen bzw. Fähigkeiten werden in einem Unternehmen benötigt um Anlässe (z.B. neue Technologien, externe Faktoren) für Geschäftsmodellveränderungen zu erkennen?
- Gab es Beispiele bei denen die Entwicklung oder die Adaption von Technologien das Geschäftsmodell Ihres Unternehmens beeinflusst haben?
- Wie sehen Sie den Einfluss von technologischen Innovationen auf den Nutzen, den Ihre Unternehmung für Kunden generiert (Value Proposition, Produkte)?
- Wie haben in der Vergangenheit Änderungen in den Geschäftsmodellen Ihres Unternehmens die Anforderungen an bzw. den Einsatz von Technologien in Ihrer Unternehmung beeinflusst?
- Wie sieht speziell der Einfluss von Digitalen Technologien auf den Kundennutzen aus?

1

**Externe Einflüsse und Interaktion mit dem Unternehmensumfeld**

- Wie beurteilen Sie die Wirkung von äußeren Einflüssen (z.B. Stakeholder, politische Einflüsse) auf die Geschäftsmodelle Ihrer Unternehmung?
- Welche Rolle spielen Wettbewerber bzgl. Technologien und Geschäftsmodelländerung für Ihre Unternehmung?

*Probe: Was waren im betrachteten Zeitraum die (drei) relevantesten Einflüsse?*

Wie würden Sie die Beziehung zu Partnern im Unternehmensumfeld (Wertschöpfungsnetzwerk) beschreiben?

- Was sind aus Ihrer Sicht bezüglich der betrachteten Technologie die wichtigsten Gruppen von Akteuren im Unternehmensumfeld (Wertschöpfungsnetzwerk) Ihres Unternehmens?
- Was sind aus Ihrer Sicht bezüglich der betrachteten Technologie die wichtigsten konkreten Partner bzw. Unternehmen, mit denen Sie zusammenarbeiten?
- Über welche Bereiche/Aktivitäten in der Wertschöpfungskette erstreckt sich die Zusammenarbeit mit den jeweiligen Partnern bzw. Unternehmen?
- Worin sehen Sie die Hauptgründe für die Zusammenarbeit mit den jeweiligen Partnern bzw. Unternehmen?

Welche Rolle nimmt Ihre Unternehmung in seinem Unternehmensumfeld (Wertschöpfungsnetzwerk) ein?

- Wie würden Sie den Einfluss ihres Unternehmens auf Partner im Unternehmensumfeld (Wertschöpfungsnetzwerk) beschreiben?
- Wie würden Sie die Abhängigkeit Ihres Unternehmens von Partnern im Unternehmensumfeld (Wertschöpfungsnetzwerk) beschreiben?

- Welche für Ihren Unternehmenserfolg relevanten Leistungen (Produkte, Dienstleistungen) beziehen Sie aus Ihrem Wertschöpfungsnetzwerk?
- Welche Leistungen stellen Sie Kunden in Ihrem Wertschöpfungsnetzwerk bereit?

- Wie würden Sie den Einfluss Ihres Unternehmensumfeldes (Wertschöpfungsnetzwerkes auf Ihr Geschäftsmodell beschreiben?
- Wie würden Sie den Einfluss ihres Unternehmens auf Geschäftsmodelle von Geschäftspartnern im Unternehmensumfeld beschreiben?

- Wie bewerten Sie den Einfluss des Umfelds (z.B. Netzwerk, Lieferanten, Partner, Kunden, Stakeholder, …) Ihrer Unternehmung auf die von Ihrem Unternehmen eingesetzten Technologien?
- Wie beeinflusst Ihre Unternehmung die Entwicklung von Technologien in Ihrem Umfeld (z.B.: Netzwerk, Lieferanten, Partner, Kunden, Stakeholder, …)?

Änderungen in der Zusammenarbeit

- Welche größeren Veränderungen gab es in Ihrem Unternehmensumfeld (Wertschöpfungsnetzwerk) in den letzten Jahren (Änderungen von Partnern, Änderungen in der Zusammenarbeit mit Partnern, Änderungen in den angebotenen Leistungen von Partnern)?
  - Was waren aus Ihrer Sicht die Gründe für Änderungen in der Zusammenarbeit?
  - Wie beurteilen Sie die Wirkung von äußeren Einflüssen (z.B. Stakeholder, politische Einflüsse) auf die Zusammenarbeit mit Unternehmen aus dem Wertschöpfungsnetzwerk Ihres Unternehmens?
- Was waren hinsichtlich der betrachteten Technologie die maßgeblichen Einflüsse auf Ihre Zusammenarbeit mit Partnern im Unternehmensumfeld (Wertschöpfungsnetzwerk)?
- Wie würden Sie die Veränderungen in Ihrem Wertschöpfungsnetzwerk durch den Trend zur Digitalisierung beschreiben?

2

**Abschlussfragen**
Welche Rolle spielt das Thema Unternehmenskultur für die besprochenen Aspekte?

Welche weiteren Herausforderungen sehen Sie bezüglich des Themas Technologien und Geschäftsmodelle für Ihre Unternehmung?



A 6

# A.3 Descriptions of investigated cases

## A.3.1 Case descriptions of perceived influences on ecosystem participation

### a) Case descriptions of automotive OEMs

**Table 69:** Overview of influences on OEMs to contribute to the xEV ecosystem

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| OEM Alpha | Due to the lower ranges of BEVs compared to ICE-powered vehicles, OEM Alpha needed to explore options for electric charging. The OEM introduced alternative mobility options and expected that these would increasingly gain relevance in the future. | Informants from OEM Alpha saw heterogenous political influences. While in parts of Asia, electric mobility was pushed by politics, other countries would likely take longer to shift towards electric mobility. According to informants in OEM Alpha, governmental incentives favored business customers, leading to the situation that a large degree of current xEVs was leased to corporate customers. | According to informants in OEM Alpha, its xEVs were currently used mainly in a business context (as company vehicles). OEM Alpha saw the need to make xEVs attractive to a larger customer segment. One approach was fitting existing vehicle concepts with an electric/electrified drivetrain and to increase driving ranges (e.g., through improvements in battery technology). |
| OEM Beta | Informants in OEMs saw the need to improve the infrastructure for electric charging. Further, informants from OEM Beta saw the need to provide options for charging xEVs using "green" energy to ensure the technology's environmental sustainability. | Informants from OEM Beta perceived political as well as economic pressure towards electric vehicles. Especially regulations and fees on $CO_2$-emissions were stated to threaten the OEMs profitability. Informants in OEM Beta predicted that the company would not be able to meet regulations with its current ICE technology. According to informants, a technological development towards xEVs would have occurred naturally. However, political influence and regulations accelerated this technological shift. Informants in OEM Beta saw a disparity in political actors influencing OEMs while not establishing the necessary charging infrastructure for xEVs. In addition, informants from OEM Beta saw uncertainty with regard to governments' taxes on the energy required for charging xEVs.[1] | OEM Beta clustered its innovation options by use case. Innovations that satisfied customer demands or generated a competitive advantage were initiated. |
| OEM Gamma | - | Informants from OEM Gamma saw an influence on governmental influences and regulations on how it develops its products. | For OEM Gamma its customers' requirements (comfort, driving dynamics) were a major factor to shift its product portfolio towards xEVs. |
| OEM Delta | Informants in OEM Delta saw the need to improve the charging infrastructure for electric vehicles. Using hydrogen as fuel was seen as unattractive due to its largely inefficient production- and storage options. | OEM Delta was confronted with influences from overall tightening regulations on emission, which impacted its initiatives towards xEVs. Further, regulatory influences were also seen as a key driver for the overall xEV-market. However, informants in OEM Delta perceived regulatory and legal issues as a more relevant hindrance for the widespread installation of electric charging infrastructure (e.g., in public areas) than technical difficulties. | OEM Delta saw a high acceptance of xEVs on the market. However, OEM Delta was careful when introducing xEVs to new markets and evaluated financial feasibility and technological risks before taking action. From the perspective of OEM Delta, xEVs were able to cover a large degree of typical use cases. |

[1] Author's remark: It was mentioned that governments potentially lose tax revenues if a shift from oil to electric energy occurs. This could eventually lead to increased taxes on electric energy and overall higher energy prices.

## b) Case descriptions of automotive suppliers

**Table 70:** Overview of data regarding influences on automotive suppliers to contribute to the xEV ecosystem

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| SUP Alpha<br>*Tier 1* | - | Environmental politics and regulations were seen as influences on the supplier's (end-) customers. This, in turn, affected SUP Alpha's behavior as a supplier. | (End-)customers of vehicles were seen as determining factors for SUP Alphas orientation. Changes in market demand led SUP Alpha to question its current technologies. |
| SUP Beta<br>*Tier 1 Sub-1* | - | Emission targets (specifically regarding $CO_2$ emissions) were seen as drivers for electric mobility. Short-term changes in regulations were seen as problematic for customers (OEMs). | SUP Beta aimed to support customers (OEMs) in their products to enable them to reach emission targets. Customers were stated to aim for reaching emission goals with the lowest possible financial effort while keeping up their unique characteristics. SUP Beta highlighted the need to anticipate markets and customers' future demands due to unavoidable lead time for products. |
| SUP Beta<br>*Tier 1 Sub-2* | Global megatrends (e.g., global warming, aging populations, vehicle sharing, second use) were stated to influence SUP Beta's technological orientation. The impact of xEV technologies on SUP Beta was seen as low. Using hydrogen as fuel was seen as a more attractive technology than using batteries as energy storage. However, the low availability of hydrogen infrastructure currently prevented operating hydrogen-powered vehicles on a large scale. Also, infrastructure for electric charging was seen as critical. Interestingly, the changes in mobility-concepts and energy-concepts (e.g., vehicle to grid) xEVs were estimated to have a substantial impact on SUP Beta. Shifting away from conventional (ICE-powered) vehicles was perceived as a topic with substantial implications for society. | Regulations (e.g., emission regulations and the respective fees for OEMs, possible driving bans for ICEs in certain areas) were perceived as drivers for xEVs. The aim of certain regulations, as well as the fragmented (e.g., different regulations in different regions), volatile and partly unpredictable nature of regulations, was seen as critical. Informants in SUP Beta also perceived strategic reasons for governments in Asia pushing towards xEVs, since their industries were perceived as not being able to compete with European automotive OEMs regarding ICE technologies. In addition, the overall (environmental) sustainability of batteries as energy storage as well as using electric energy to power vehicles was taken into question. | Current customer expectations towards xEVs were perceived as not realistic. SUP Beta saw the need to adapt towards new or shifted customer requirements and additional use cases of xEVs (e.g., shared mobility concepts). The low availability of infrastructure (predominantly electric charging) limited the adoption of xEV technologies. Informants in SUP Beta described the automotive industry as revenue-driven and sluggish (also towards the final customer). End-customer acceptance of new concepts was estimated as uncertain. |
| SUP Gamma<br>*Tier 2* | - | - | SUP Gamma aimed to coordinate with customers and applied technologies according to their requirements. |
| SUP Delta<br>*Tier 2* | SUP Delta perceived lowering costs for batteries as a driver towards alternative technologies for drivetrains. | Informants in SUP Delta saw the regulatory environment - especially emission regulations ($CO_2$) - as a driving force towards alternative drivetrain technologies. | Informants in SUP Delta recognized a drastic change in the market for xEV-technologies. Due to changes in vehicle drivetrains, new technologies and products had to be developed. |
| SUP Epsilon<br>*Focus* | Underlying technological conditions (e.g., availability of infrastructure for charging) implicitly influenced the requirements towards SUP Epsilons technologies. In turn, SUP Epsilon aimed to enact influence by offering complementary solutions to adjust the underlying conditions for its technologies. | - | SUP Epsilon oriented its technological base and the use of technologies in specific products on customer requirements (e.g., energy density, available space). |

Table 70 continues on next page

Table 70 continued from previous page

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| SUP Zeta *Focus* | Charging infrastructure was seen as a major limitation for xEVs. One particular reason that was mentioned was high times for charging. Technologies that could reduce charging times were (at the time of data collection) seen not economically feasible. | SUP Zeta perceived that the shift towards xEVs was mainly driven by governmental regulations towards OEMs (especially on $CO_2$-emissions, but also possible driving bans or administrative barriers), which relayed new and changed requirements towards their suppliers. | SUP Zeta focused on the European and Asian markets. The company developed its technologies with respect to the requirements of its customers to establish itself as a technology leader. |

## c) Case descriptions of providers of engineering and technologies

**Table 71:** Overview of data regarding perceived influences on providers of engineering and technology to contribute to the xEV ecosystem

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| ETP Alpha General | Informants in ETP Alpha saw the need to offer more technological solutions that enable ecological sustainability. | Governmental influences and regulatory changes (e.g., Paris climate agreement) affected ETP Alpha's customers. As a result, regulatory influences drove the development and application of xEV technologies. | To provide their customers with solutions that required engineering and technology presented ETP Alpha's core business. Changes in regulations tended to increase business opportunities for the company. |
| ETP Alpha *Sub-1* | New technologies required different kinds of infrastructure. | Regulations on emissions (especially $CO_2$) as well as several types of incentives were stated as major drivers of technologies in the industry. | ETP Alpha's customers (OEMs and automotive suppliers) demanded new types of technologies due to regulations. New technologies for xEVs had a good fit with ETP Alpha's current product portfolio. |
| ETP Alpha *Sub-2* | ETP Alpha aimed for more sustainable technologies. However, the sustainability of xEV technologies was perceived as uncertain. Informants from ETP Alpha recognized the increased relevance of technologies from other sectors (e.g., electrical engineering). | Regulatory uncertainties increased the risk associated with developing new technologies. Informants in ETP Alpha stated regionally different governmental interventions in support of xEV technologies. These interventions were seen as partly strategic in nature (e.g., to establish technological leadership in xEV technologies). | Customers increasingly demanded more sustainable solutions. ETP Alpha aimed to provide scalable technology-based solutions to customers. The dominant technology for xEVs was not yet clear. In turn, customers demanded more modular concepts to increase their technological flexibility. In addition, new customers (e.g., OEMs with different requirements and faster, more agile processes) entered the field for new technologies. |
| ETP Beta | The low availability of infrastructure was not only a limitation but also a determining factor for the adoption of simultaneously available technologies (e.g., infrastructure for electric charging was perceived as easier to handle than for hydrogen). The sustainability of the energy used in xEVs was seen as questionable. | Overall political and governmental pressure as well as emission regulations (e.g., $CO_2$) were major factors for the expected uptake of xEVs. | Customer demand was perceived to shift towards increased ecological sustainability and the integration of digital technologies. Informants in ETP Beta saw a trend away from car ownership towards usage-based models. |

## d) Case descriptions of research institutions

**Table 72:** Overview of data regarding perceived influences on research institutions to contribute to the xEV ecosystem

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture |
|---|---|---|---|
| RI Alpha | Informants in RI Alpha saw xEVs as an option to contribute towards ecological sustainability (e.g., through decreased local air pollution). Charging times, ranges, and availability of infrastructure for xEVs were limitations. However, informants in RI Alpha estimated that limitations could be overcome through technological improvements. | Informants in RI Alpha perceived pressure from regulators towards xEVs. Informants in RI Alpha suspected political pressure towards xEV technologies in Asian regions to be motivated by strategic considerations (e.g., to establish leadership in new technological areas). | Informants in RI Alpha estimated that vehicles based on new/different technologies had substantial market potential. However, OEMs required sufficient charging infrastructure in order to be able to market their vehicles to customers. Informants from RI Alpha estimated that current vehicle use cases could, to a large degree, be covered by xEVs. However, hydrogen-fuelled vehicles were predicted to be more suitable for heavy-duty commercial applications. |
| RI Beta | The public perception of ICE technologies has suffered in the past, making xEVs more attractive for OEMs. Battery electric vehicles were stated to be a rather simple alternative drivetrain technology. In addition, electric infrastructure was relatively manageable, compared to, e.g., hydrogen infrastructure. | Informants in RI Beta were under the impression that European OEMs were forced by regulations to commit towards xEVs. OEMs offering high volumes of xEVs were predicted to make the technology more attractive for additional actors. | Informants in RI Beta currently saw a low market demand as well as an overall slow market uptake of xEVs. Vehicles would need to be available in high numbers to bring vehicle costs down and make them attractive for customers. However, informants in RI Beta perceived the correct timing to bring xEVs to the market as highly uncertain. |

## e) Case descriptions of automotive retailers

**Table 73:** Overview of data regarding perceived influences on automotive retailers to contribute to the xEV ecosystem

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| RET Alpha | Informants in RET Alpha saw three hindrances for xEV-adoption: (1) charging infrastructure, (2) charging technology, and (3) batteries. | Informants in RET Alpha were under the impression that political factors to push xEVs to contribute to the environment were relevant. Informants in RET Alpha perceived large regional differences between governmental actions towards xEVs. However, informants in RET Alpha recognized that OEMs shifted towards xEVs to meet regulatory requirements, such as limitations on $CO_2$ emissions or the threat of driving bans in urban areas. | With low ranges, lack of charging infrastructure, and uncertainty regarding batteries, xEVs provided few incentives (one incentive could be, for example, social status) to the majority of customers. However, regulatory actions (e.g., municipalities banning ICE-powered vehicles) could increase the overall value xEVs provided for customers. RET Alpha saw that only a small amount of its BEV business came from private customers. A large portion of BEVs was supplied to corporate customers. Private customers' interest in hybrid xEVs was higher than in pure battery electric vehicles. |
| RET Beta | Informants in RET Beta stated the energy grid as a limitation for EV-charging times. This issue could be solved by (1) improving the energy grid (which was seen as unattractive due to high investments) or (2) pushing for energy storage for xEV charging. | According to informants in RET Beta, the shift towards electric mobility was involuntary. A major reason for the automotive sector for shifting towards xEVs was OEMs that faced emission regulations. Informants in RET Beta recognized a limitation in installing private charging infrastructure in estate housing situations or public parking areas. | Informants in RET Beta saw providing an attractive value based on xEVs as a crucial element for the success or failure of xEVs. Informants in RET Beta perceived few incentives for customers to switch to xEVs. A major limitation for customers stated by informants were comparatively high vehicle prices and vehicles' lower utility value (as compared to conventional vehicles - e.g., due to limited availability of charging infrastructure). In addition, informants in RET Beta perceived emotional resentments towards xEVs. |

## f) Case descriptions of corporate operators of vehicle fleets

**Table 74:** Overview of data regarding perceived influences on corporate operators of vehicle fleets to contribute to the xEV ecosystem

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| FO Alpha | FO Alpha's decision towards new technology was influenced by (1) limited predictability of public charging infrastructure (e.g., regarding the predictability of available charging options) (2) at the time of the decision inhomogenous charging standards and billing practices of public infrastructure as well as (3) despite high initial investments for energy-infrastructure lower costs for charging vehicles (energy costs for charging) and finally (4) high predictability of the company's driven routes and distances. The fleet operator also investigated operating vehicles relying on hydrogen as fuel but did not follow through due to an overall missing fueling infrastructure. | A major shareholder of the fleet operator set the goal of electrifying 20% of the fleet operator's fleet due to political considerations. Before that, the fleet operator relied on only a small number of xEVs. | Major considerations when acquiring xEVs were vehicle costs as well as the range and the fleet operator's dominant use case (mid-range intercity travel with long stops). Integration of the vehicles in the fleet operator's vehicle fleet required digital solutions for booking charging stations. |
| FO Beta | Charging infrastructure was seen as a large obstacle for the integration of xEVs in the fleet operator's vehicle fleet. FO Beta saw the need for intelligent charging solutions and buffer batteries to lower infrastructure costs. Since the current electric supply line arrangements were not fit to handle the required power-loads, intelligent charging solutions could reduce the need to build additional electric supply lines to charging points. Technological limitations of ICEs to meet regulations required FO Beta to shift from ICE-based vehicles towards electrified vehicles. Further, informants in FO Beta saw the need to shift to alternative technologies to contribute towards the company's ecological sustainability. | FO Beta perceived political pressure to shift towards electrified vehicles. In addition, xEVs were financially incentivized by governments, increasing their attractiveness. Further, FO Beta also considered the possibility of driving bans in urban areas. However, in terms of TCOs xEVs were not yet able to compete with ICE vehicles. | Development of xEVs properties (e.g., range, costs - partly through subsidies) made them increasingly attractive options for FO Beta's use cases (logistics operations). In addition, FO Beta's customers (e.g., large retail platforms) started to see sustainable logistics as a competitive advantage and demanded more sustainable approaches in FO Beta's operations. FO Beta expected future drops in xEV's prices (e.g., through cheaper batteríes), which would make them more attractive. Already commonly known vehicle brands were stated to be easier to integrate into the vehicle fleet. |

## g) Case descriptions of companies in the energy sector

**Table 75:** Overview of data regarding perceived influences on energy companies to contribute to the xEV ecosystem

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| EC Alpha<br><br>electrical energy | The lack of available locations hindered EC Alpha's efforts to install infrastructure for electric charging. | Informants in EC Alpha expected an increase of xEVs by 2022 due to stricter emission regulations. However, uncertainty regarding the timing and concrete form of governments' incentives and regulations (e.g., regulation on charging infrastructure in buildings) represented a barrier towards xEVs from EC Alpha's perspective. EC Alpha largely depended on private owners and municipalities to provide locations to install charging infrastructure. | Informants in EC Alpha saw significant technological uncertainties with no clear dominant technology emerging. Informants in EC Alpha expected the coexistence of different propulsion technologies where the specific use case determined the application of a technology. |

Table 75 continues on next page

Table 75 continued from previous page

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| EC Beta<br><br>electrical energy | Requirements regarding corporate sustainability pushed EC Delta towards electric mobility. Current (as of 2019) xEVs inability to use intelligent charging solutions represented an obstacle for EC Delta. Informants in the EC Beta expected a significant increase in xEV market share and saw the need to extend charging infrastructure for xEVs and use intelligent charging solutions as well as digital applications for booking charging infrastructure. EC Beta's technological solutions could be scaled and used for B2B as well as B2C customers. | Informants in EC Beta saw a strong political influence in support of xEVs. The overall adoption of xEV could be facilitated by regulations reducing obstacles for installing charging infrastructure in buildings. Regulations towards billing of energy used for charging xEVs were seen as an obstacle. Changes in regulations could also devalue already undertaken investments in charging infrastructure. | Customer demand for charging infrastructure was seen as a major driver to expand EC Beta's charging infrastructure. Business customers were perceived as a major factor in this regard due to their need for charging infrastructure in order to meet their own sustainability requirements. EC Beta expected the coexistence of multiple technologies (e.g., BEVs, FCEVs) with their actual application depending on specific use cases. |
| EC Gamma<br><br>electrical energy | The EC recognized the integration of digital solutions into charging hardware as crucial. This could enable the transparent operation of charge points as well as intelligent charging solutions. | Electric mobility heavily depended on political factors (e.g., funding). As a result, the competition between groups of actors for xEVx was seen as an outcome of the political environment. | EC Gamma saw the currently fragmented offerings for vehicle charging as a downside for customers. Informants in EC Gamma perceived two separate crucial areas: (1) technology needed to be mature while (2) also providing overall value to customers. |
| EC Delta<br><br>petrol energy | Informants in EC Delta perceived an overall increasing pressure from shareholders and stakeholders to operate more sustainably. | EC Delta was in contact with regulators. However, shifts in regulations (e.g., emission regulations due to the Paris climate agreement) could substantially impact the EC Delta's operations in the mobility sector. | New technologies (e.g., hydrogen fuel infrastructure) were stated to be explored. However, substantial investments in new technologies were not attractive due to technological uncertainty and reluctance to commit to other ecosystem actors' new technology. |
| EC Epsilon<br><br>petrol energy | Informants in EC Epsilon saw the current charging infrastructure not suited to deal with large amounts of electric vehicles. According to informants in EC Epsilon, the sustainability of the energy used for charging EVs needed to be considered when evaluating xEVs overall ecological sustainability. | Informants from EC Epsilon cited lacking government commitment as a risk. A shift towards xEVs was seen as likely due to emission regulations directed at OEMs. EC Epsilon predicted that an increase of xEVs would lead to significantly reduced government revenues on energy taxes under the current regulations. As a result, EC Epsilon saw the risk of governments increasing the tax on xEV-charging energy, subsequently making the technology less attractive. | EC Epsilon investigated options to satisfy (corporate) customer's demands for sustainable energy to stay competitive with their complementing offerings. The company investigated multiple technological options suited for different use cases. Due to xEVs' high prices, they were estimated to be only attractive to a small market segment of private customers. |

## h) Case descriptions of infrastructure companies

**Table 76:** Overview of data regarding perceived influences on infrastructure companies to contribute to the xEV ecosystem

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| INF Alpha | INF Alpha evaluated providing infrastructure for various technologies (e.g., using hydrogen as fuel) and took action in case a technology became a relevant option. | The local government, as a major shareholder of INF Alpha, determined the companies overall orientation towards xEVs. | INF Alpha saw usability of charging solutions as a critical issue. For INF Alpha, this required charge point operators (CPO) that (1) enabled roaming[1] between other CPOs and (2) provided price transparency. |

Table 76 continues on next page

[1] Roaming in this context was understood as enabling users affiliated with one CPO to charge and pay for energy at multiple other CPOs.

Table 76 continued from previous page

| Category & Case | Underlying conditions for technologies | Political and/or regulatory influences | Technological market fit |
|---|---|---|---|
| INF Beta | Informants in INF Beta saw technological developments in its network as the basis for its activities. | Informants in INF Beta saw a large influence through governments (taxes, incentives) as well as through national and international funding and research projects towards a technological shift in the automotive sector. | INF Beta provided products based on disruptive innovations. INF Beta's products needed to be economically and technologically feasible while creating and meeting customer demand. The (as of the time of data collection) fast pace of the shift in selected areas opened business opportunities for INF Beta since established companies were not fully able to cope with the speed of technological shift. INF Alpha saw the need to bring innovations to the market and let customers determine the success of INF Beta's products. |
| INF Gamma | According to INF Gamma, due to limitations of the energy grid, charging xEVs would require intelligent energy management systems. Otherwise, substantial investments in the energy grid would be necessary. | Informants in INF Gamma saw regulatory and legal limitations for installing and billing charging infrastructure for private customers (home charging). Informants in INF Gamma were under the impression that regulations needed to be adapted according to new circumstances and actively pointed this issue out to political regulators. Simultaneously, governments pushed the topic of electric mobility (e.g., by providing funding, subsidies, and financial incentives). | Informants in INF Gamma required customers' commitment for its efforts. Societal trends (e.g., "Fridays for Future") favored the adoption of more sustainable technologies. |
| INF Delta | - | INF Delta perceived the possibility of regulatory intervention as a driver for xEVs. However, INF Delta investigated solutions for xEV charging independent of regulations. | INF Delta was largely oriented towards customer requirements in developing and applying technologies. |

## A.3.2 Case descriptions of actors' ecosystem interactions

### a) Case descriptions automotive OEMs

**Table 77:** Overview of gathered empirical data regarding OEMs' interactions with their ecosystem to create value

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| OEM Alpha | - | - | Informants in OEM Alpha saw a lack of initiative from energy companies towards infrastructure for electric charging. In order to be able to sell xEVs, OEM Alpha subsequently needed to address the issue of the infrastructure itself. However, OEM Alpha recognized the need for multiple actors' joint initiatives to establish a sufficient coverage of charging infrastructure for EVs. | For electric mobility, additional technologies were necessary. Although existing partners partly provided competencies for xEV-technologies, this led to an overall increase in the total number of business partners. |
| OEM Beta | OEM Beta introduced xEVs in the past but did not manage to be profitable. Informants in OEM Beta saw the need to cooperate with other actors to increase the profitability of xEVs. OEM currently needed to cooperate with partners for their technological know-how. However, the OEM aimed to establish this know-how inside the company. | OEM Beta was able to influence the technological directions of partners, particularly smaller partners. Further, OEM Beta was open to cooperating with new suppliers. However, before cooperating, the OEM needed to get familiar with new partners. The OEM typically required two suppliers to reduce its risks. If the OEM's partners did not develop in the same technological direction, the termination of a specific partnership was likely. | Managing technological shifts required cooperations where both the OEM and its partnering companies needed to adapt to new technologies. Informants in OEM Beta saw a shift in competence between the OEM and its suppliers, as these suppliers had partly better know-how in new technologies. Subsequently, the OEM intensified the cooperations with companies that previously acted as suppliers of components. Informants in OEM Beta saw its partners' scope expanding as new actors for xEV-technologies became relevant (e.g., electric motors, battery, high voltage electronics). According to OEM Beta, these changes affected the OEM's whole supply chain. | In addition to collaborating with an increased amount of ecosystem actors, OEM Beta cooperated with energy suppliers to provide "green" energy for charging its vehicles. Also, the OEM participated in joint ventures to improve the coverage of charging infrastructure. |
| OEM Gamma | OEM Gamma saw shortened development cycles and required a higher degree of flexibility from its suppliers. Further, informants in OEM Gamma recognized increased volatility in the technological properties the OEM required from its suppliers. | OEM Gamma relayed stakeholder influences (e.g., governmental regulations) to its supply network (e.g., technological requirements, quality, costs). Subsequently, OEM Gamma saw a substantial influence of stakeholders on its suppliers. Sourcing regulations (e.g., towards local sourcing) required the OEM to work with additional partners. OEM Gamma required flexible resources outside the company to be able to cope with changing requirements. In addition, OEM Gamma aimed to keep the dependence on its suppliers as low as possible. In newer cooperations, the OEM enacted stronger influence. Moreover, the OEM needed to get familiar with a supplier. However, in long-term cooperations, an initial supplier-buyer relation could shift towards an intensified collaboration. | Innovations, especially in new technological areas for xEVs, were triggered both by the OEM as well as by its suppliers. The OEM's technological direction directly influenced its supply network. For example, suppliers anticipated its technological requirements and proactively performed development efforts. According to OEM Gamma, the individual parts of its value chain were increasingly interdependent when developing new technologies. Relevant actors for the OEM needed to be coordinated to ensure the functionality of the overall system. | Due to the OEM's flexibility needs, the company intensified its collaborations with providers of engineering services and technologies. OEM Gamma still relied on Tier 1 and Tier 2 suppliers. The principle relations remain unchanged. However, the collaborations took on a more dynamic form. |

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| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| OEM Delta | OEM Delta offered its technological components (e.g., powertrains) to other actors (OEMs) and tried to realize economies of scale. | OEM Delta was reluctant to commit to new technology if it was offered only by a single supplier since the supplier would gain too much influence on the OEM. | Informants in the OEM saw the need for energy companies to establish more charging infrastructure. | OEM Delta cooperated with start-ups for innovations and established suppliers in the automotive area to benefit from their technological competencies. By offering its technology to other actors, OEM Delta took on the additional role of a supplier. |

## b) Case descriptions of automotive suppliers

**Table 78:** Overview of gathered empirical data regarding automotive suppliers' interactions with their ecosystem to create value

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| SUP Alpha<br><br>*Tier 1* | SUP Alpha actively monitored its environment, especially important customers (i.e., OEMs), and their requirements for factors that could influence the company to shift its competencies and technologies. This was done to position SUP Alpha as an attractive partner for OEMs with regard to new technologies. Dominant customers (OEMs) required SUP Alpha to be more flexible. | SUP Alpha saw itself dependent on its network environment. Most influential for SUP Alpha were OEMs' decisions. In turn, SUP Alpha could wield substantial influence on its own suppliers. | SUP Alpha performed several substantial acquisitions to access competencies in new technological areas. M&A-activities were performed to build capabilities in a fast manner. The overall number of SUP Alpha's partners, especially for new technologies, had increased. | SUP Alpha extended the number of its partners to provide customers with values based on xEV technologies. |
| SUP Beta<br><br>*Tier 1*<br>*Sub-1* | SUP Beta enforced its core capabilities to be in an attractive position for customers. Thereby, the company tried to maneuver itself into the position of a strategic partner for customers. SUP Beta further tried to produce core elements of its technologies in-house rather than buying them on the market. This was done to demonstrate added value to business partners. However, the most dominant criterion for customers was the price of individual products. Non-core products were outsourced. Cooperations with partners were selected based on their financial feasibility. | Customers (e.g., OEMs) were stated to have a substantial influence on SUP Beta. The development of technological competencies can be a prerequisite to be considered as a supplier. However, SUP Beta was partly able to influence its customer's requirements. Further, SUP Beta was also selective about and influenced its own suppliers (e.g., in terms of technologies or production numbers). SUP Beta also expected inputs and improvements from its partners. Informants in SUP Beta stated to avoid dependencies from suppliers and only selectively intensified their respective collaborations. | SUP Beta performed a substantial acquisition. Development activities were partly outsourced in case (1) it did not affect the company's core competencies or (2) partners had better know-how in selected areas. | SUP Beta developed its own technologies, bought technologies (either directly on the market via acquisitions of other actors), and relied on dedicated providers for engineering and technologies. Supplier Beta was in contact with its customers (OEMs) to align roadmaps (products, measures; especially for xEV-technologies) to be able to provide suitable replacements for its currently offered products. |

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| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| SUP Beta<br>*Tier 1 Sub-2* | Long development times and uncertain end-customer acceptance of vehicles were seen as hindrances for xEVs. Using existing competencies to take on new roles in the ecosystem (e.g., providing vehicles directly to operators of vehicle fleets) might bring SUP Beta in competition with OEMs. One option mentioned was to offer brand-independent "white label" products. SUP Beta observed influential actors' technological needs - if more actors headed in the same direction, the overall risk would be reduced, and investigating technologies was seen as more attractive. Sharing of risks - especially with new technologies - was perceived as a major reason for OEMs to cooperate with SUP Beta. SUP Beta saw electric energy as a limitation for xEVs (charging infrastructure, potential increases in energy prices). SUP Beta was more flexible with regards to technologies and production capacities than OEMs, thus increasing its attractiveness in cooperations. SUP Beta avoided exclusive partnerships since it would limit its business opportunities. | SUP Beta's customers (typically OEMs) communicated their requirements and determined the used technological solutions. In turn, the influence of SUP Beta on OEMs was seen as low. SUP Beta perceived that established OEMs were influenced by "new entry OEMs" that, in turn, accelerated overall initiatives towards xEVs. Informants in SUP Beta perceived limitations in the availability of xEV-products/components from suppliers in high volumes. | The automotive industry was stated to be reluctant to innovate. Lower entry barriers into the xEV ecosystem compared to traditional ICE-industry attracted "new entry OEMs." These "new entry"-OEMs typically lacked competencies with respect to traditional automotive areas and relied on established automotive suppliers for engineering and manufacturing in these areas. Also, a large number of start-ups provided solutions for new xEV technologies (e.g., batteries, electric charging). Overall, the number of actors for xEVs had increased. However, informants in SUP Beta expected that the number of actors would consolidate. SUP Beta performed M&A-Activities to access new capabilities and expand to new markets. Informants in SUP Beta saw a tendency that OEMs began to insource value creation activities for xEVs. Further, they perceived that actors from multiple sectors were beginning to investigate solutions for xEVs. Moreover, the lower complexity of xEV-drivetrains as compared to ICE vehicles was expected to result in lower value creation for OEMs, while providers of technologies for xEVs (e.g., batteries) would gain relevance. | In early development phases (pre-development, research projects), SUP Beta increased cooperations with partners that had competencies in focused technological areas to demonstrate the overall feasibility of a product or technology. This enabled learning potentials for both partners. In later phases (industrialization), SUP Beta required partners that were able to deliver large volumes of technologies/components. SUP Beta also cooperated with dedicated research institutions to access their vehicle know-how. In addition, SUP Beta performed co-development activities with customers (OEMs). Subsequently, SUP Beta found itself to some degree in a co-opetition relation with its customers (OEMs). Informants from SUP Beta further perceived a high value in cooperations for new technologies. |
| SUP Gamma<br>*Tier 2* | SUP Gamma monitored its environment for changes in markets and customers to address their requirements. The supplier aimed for continual improvements of its products and processes, mainly to achieve cost reductions. However, even large changes in its processes had only a small effect on customers. | Informants in SUP Gamma saw its activities determined by industry processes. However, SUP Gamma avoided the influence of customers on the selection of its suppliers to keep a strategic advantage. | Informants in SUP Gamma stated that OEMs had outsourced their value creation activities to a large degree over the last decades. | SUP Gamma delivered its products partly to intermediaries that performed pre-assembly for Tier 1 suppliers. The supplier performed co-development activities with its customers (mainly Tier 1 suppliers). |
| SUP Delta<br>*Tier 2* | SUP Delta oriented its R&D activities towards market requirements. In the area of xEVs, customers were perceived as open to new solutions. | Informants in SUP Delta perceived influences from customers, as well as the network of partners. | Informants in SUP Delta saw new, specialized actors emerging for xEV technologies. This also implied a radically different supply structure. | SUP Beta cooperated with its customers (i.e., OEMs). Further, SUP Beta relied on providers of engineering and technology as well as research institutes for xEV core technologies. |
| SUP Epsilon<br>*Focus* | SUP Epsilon screened its environment for factors influencing its technologies. Partners (customers, suppliers) and cooperations were selected based on strategic considerations, technological capabilities, and previous experiences. Technological activities were mostly influenced by customers' and competitors' behavior and only to a small degree influenced by SUP Epsilon's suppliers. | SUP Epsilon was able to influence the technological development in the industry. The supplier avoided investments in high production capacities to maintain its technological flexibility. Products were influenced by governmental regulations as well as customer requirements. | Informants in SUP Epsilon perceived substantial changes with regards to new actors entering the ecosystem as well as cooperations being forged to promote xEV technologies. Informants in SUP Beta further expected convergence of the mobility sector and the energy sector (e.g., for electric charging without putting too much strain on the electric grid). | SUP Epsilon applied and improved its capabilities by partly co-developing products and technologies with customers. SUP Epsilon supported customers with the industrialization of its technologies. Elements used in products were bought from multiple suppliers and integrated into larger systems. |

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| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| SUP Zeta<br><br>*Focus* | SUP Zeta needed partners to industrialize the high-volume production of its products and technologies. Licensing to partners that handled production was also seen as a strategic factor for SUP Zeta since it could accelerate the market entry of its products. One goal of these activities was to establish SUP Zeta's technology as standard - subsequently, SUP Zeta was reluctant to commit exclusively towards a specific partner (OEM). Potential customers precisely defined requirements SUP Zeta needed to fulfill. Projects with key customers were performed to market SUP Zetas technologies. | Direct contact with customers and relevant actors was valued to understand the overall technological developments in the industry. SUP Zeta saw operators of vehicle fleets as influential actors in the ecosystem that could influence OEMs' vehicle specifications in line with their use cases. Fleet operators were perceived to be influenced by governmental regulations. The company aimed to support actors in coping with governmental influences and, in turn, provided added value to end customers. SUP Zeta managed to get the awareness of larger actors. Further, SUP Zeta was partly able to influence industry standards. | SUP Zeta purposively positioned itself upstream in the value chain and aimed to collaborate with OEMs and suppliers of OEMs while providing complementary offers for charging infrastructure. Informants in SUP Zeta recognized the emergence of new groups of actors for xEVs. Similarly, informants in SUP Zeta predicted that current suppliers that added value in the more established automotive ecosystem would in part become obsolete. Established energy companies (petrol energy) were seen as relevant actors due to their current strategic access to fuelling infrastructure and substantial capital resources. | SUP Zeta partly outsourced manufacturing developed technologies together with dedicated research institutions and collaborated with operators of vehicle fleets to showcase and test its technology. The supplier aimed to rely on standardized components in its products. SUP Zeta needed relations with automotive suppliers, OEMs as well as infrastructure companies to establish its technology. According to informants, SUP Zeta partly performed co-development activities with customers. |

## c) Case descriptions of companies for engineering and technologies

**Table 79:** Overview of gathered empirical data regarding providers of engineering and technologies' interactions with their ecosystem to create value

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| ETP Alpha<br><br>General | ETP Alpha performed R&D activities and built prototypes for technology modules in line with customer specifications. The company's customers profited from ETP Alpha's competencies but also faced risks associated with a specific technology (e.g., investments in industrialization, uncertain market success). | Trust in the company's competencies was seen as a relevant factor in order to be considered as a potential partner as well as for long-term cooperations. Competencies were demonstrated through development projects. The company was able to influence the technological solutions of its customers through the co-development of technologies. ETP Alpha emphasized the need to coordinate activities with other actors (e.g., OEMs, suppliers) in joint development projects. This coordination was particularly needed in case of overlapping competencies in a project. | ETP Alpha acted as an enabler for its customers by providing engineering solutions and performing co-development activities with suppliers. As a result, ETP Alpha was able to connect new as well as established actors with different industry backgrounds. This was especially necessary since these actors had different approaches and capabilities compared to traditional actors in the automotive industry. Solutions provided by ETP Alpha were integrated at different points in the value chain (e.g., in modules that are subsequently supplied to OEMs or directly by the OEM). ETP Alpha saw a large number of new actors becoming relevant in the area of xEV technologies. ETP Alpha performed M&A-activities to quickly extend capacities as well as its technological capabilities. | ETP Alpha cooperated as well as co-developed technologies with suppliers and customers. ETP Alpha relied on suppliers for selected core elements it uses in its technologies. Competition with suppliers was seen as low as they were becoming increasingly partners for technologies. ETP Alpha saw the potential for coopetition in cases where external actors had overlapping competencies. |

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| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| ETP Alpha Sub-1 | Informants in ETP Alpha saw the risks in developing and offering a technology compared to the risk of customers when industrializing and commercializing technologies as low. Due to its comparatively low risk with regards to technologies, ETP Alpha was more flexible in its technologies allowing it to position itself in a favorable position for customers. | ETP Alpha provided information about the market-feasibility of technologies to customers. The company also communicated the requirements of markets and customers to suppliers. | ETP Alpha perceived that the industry needed to commit towards a certain technology to ensure its overall success. Due to the high complexity of new technologies, suppliers and customers could not cover all areas of competence. Currently, the number of suppliers for core components for new technologies was seen as limited. The company also connected its customers with suppliers to improve the overall ecosystem value creation. However, due to the novelty of xEV technologies, suppliers of core technologies struggled to demonstrate economies of scale. ETP Alpha performed M&A-activities (e.g., acquisition of suppliers) to broaden its competence portfolio. | Informants in ETP Alpha confirmed an increasing demand for xEV technologies resulting in a rising number of customers. ETP Alpha relied on a large network of suppliers (e.g., for core components of a specific technology) it could access to deploy technology prototypes. However, ETP Alpha relied on largely different suppliers for xEV technologies than for other technologies. ETP Alpha saw itself in competition with other companies that provided similar offerings. |
| ETP Alpha Sub-2 | Customer requirements were perceived as becoming more volatile. This increased the demand for more modular and adaptable solutions. Customers (suppliers, OEMs) lacked capabilities and resources in new technologies. Thus ETP Alpha found itself in a favorable position to address customer requirements. | The influence of ETP Alpha on suppliers depended on the size of partnering actors and ranged from communicating its experiences (large component suppliers) up to a substantial influence with smaller firms and research institutions. In addition, ETP Alpha supported its customers in adapting their own capabilities (e.g., training of employees) to be able to handle xEV technologies. Communication with partners provided information about attractivity and feasibility as well as the timing of technologies for ETP Alpha. | ETP Alpha cooperated with - or bought - companies to extend its competencies in selected areas. Further, ETP Alpha performed a pre-selection of suppliers for its customers. ETP Alpha communicated technological requirements to focused suppliers of technology that lacked experience in the automotive industry. Due to the different nature of xEV technologies compared to previously applied technologies, ETP Alpha required additional suppliers. | ETP Alpha cooperated with research institutions (e.g., in funded research projects) to develop technologies. Cooperations with partners that did not follow current technological trends were scaled down. ETP Alpha co-developed technologies together with customers. For example, ETP Alpha participated in research cooperations with OEMs and Tier 1 suppliers to develop components required for xEVs. The downside of shared knowledge among partners was compensated with a higher overall breadth of ETP Alpha's technologies. |
| ETP Beta | Industry cycles for established actors (e.g., OEMs) were perceived to be shortening while they also were under increasing cost pressure. This lead established actors to outsource development to keep pace in their development efforts and save costs, subsequently benefiting ETP Beta. | Customer and their specific requirements were a determining factor for ETP Beta's technology developments. Thus, the selection of customers influenced ETPs Beta's capabilities with regard to technologies. ETP Beta's influence depended on the individual partnership. While it could act as an enabler for Tier 1 suppliers, the company was rather exchangeable for OEMs. The company profited from knowledge exchanges and market intelligence obtained in projects with customers. Informants in ETP Beta saw the need to adhere to the industry's processes that were largely defined by OEMs. | Informants in ETP Beta perceived that the ongoing developments in the industry with regard to xEVs would result in a shift in the value creation architecture in the ecosystem. Established actors were expected to lose their capabilities to add value in selected areas. This was to be due to the high likelihood that core components would be acquired from new actors entering the ecosystem to add value for xEVs. Established actors were stated to focus on their current competencies - if feasible - or began to shift their competencies towards technologies for xEVs. The shift in competencies was in part performed through M&A-activities in order to build up capabilities in a rapid manner. Companies that were not able to manage to shift their competencies would leave the ecosystem. | ETP Beta offered resources and capabilities to customers that outsource engineering activities. ETP Beta tried to establish long-term relations with customers (e.g., through supporting the industrialization of technologies/products). ETP Beta cooperated with RI in research projects to develop technologies and prototypes. |

## d) Case descriptions of research institutions

**Table 80:** Overview of gathered empirical data regarding interactions of research institutions with their ecosystem to create value

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| RI Alpha | Current automotive actors performed R&D on new technologies to be an attractive partner for automotive companies (e.g., OEMs). While RI Alpha predicted that automotive actors' capabilities would partly become less relevant for current applications, these capabilities could be used in different areas. | RI Alpha saw the demands and requirements posed by automotive OEMs as a major influence in the automotive supply chain. RI Alpha perceived municipalities as a relevant actor for xEVs - on the one side as an actor involved in providing infrastructure, on the other side as regulator (e.g., driving-bans for non xEVs). | New core components (e.g., batteries) resulted in significant changes in value creation structure. Informants in RI Alpha saw that companies managing to shift their business towards new technologies for xEVs tended to be acquired by other actors. Further, informants in RI Alpha saw capabilities in new technologies (e.g., batteries, electronics) in European companies as low compared to other geographic regions, such as Asia. However, actors from outside the automotive sector were able to take on the role of supplier for these technologies. | Automotive companies began to forge collaborations to access new technologies, partly resulting in local production capacities. Further, informants in RI Alpha saw that major actors engaged in collaborations to address electric charging infrastructure. |
| RI Beta | According to informants in RI Beta, the shift from ICE-vehicles to xEVs threatened OEMs' core-competencies since vastly different technologies became relevant. | OEMs that were committed to providing xEVs in high volumes were estimated to have a substantial impact on related actors. OEMs, in turn, were perceived to be under the strong influence of their vehicle customers. | Asian OEMs were perceived to have capabilities in technologies relevant for xEVs (e.g., batteries, electronics). RI Beta acted as an enabler for other ecosystem actors. Informants in RI Beta saw the possibility of OEMs competing with ECs (e.g., as operators of vehicle fleets) as low. A major reason for this was seen in the OEMs' dominant influence on vehicle technologies (e.g., electric charging). | RI Alpha interacted with OEMs and suppliers for R&D-topics. |

## e) Case descriptions of automotive retailers

**Table 81:** Overview of gathered empirical data on interactions of automotive retailers with their ecosystem to create value

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| RET Alpha | Informants in RET Alpha saw the need to react to competitors entering the xEV-market. | - | Informants in RET Alpha recognized that energy providers started to introduce solutions that offered customers combinations of vehicles and charging energy (e.g., EV, private charging infrastructure, charging-energy). | RET Alpha's affiliated OEM collaborated with car rental companies to offer customers additional benefits for countering the current (at the time of data collection) disadvantages of xEVs. |
| RET Beta | - | RET Beta largely depended on OEMs and their distributors. RET Beta could communicate its experiences with new technologies to its affiliated OEM but recognized that it had only a minor influence. | RET Beta relied on energy companies to be able to provide solutions for xEV-charging to its customers. | RET Beta aimed to collaborate with established actors from the energy sector. RET Beta cooperated with companies offering energy storage technologies. Further, RET Beta increasingly worked together with energy companies for xEV-charging. |

## f) Case descriptions of corporate operators of vehicle fleets

**Table 82:** Overview of empirical data regarding influences on investigated corporate operators of vehicle fleets' interactions with their ecosystem to create value

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| FO Alpha | High costs and potential dependence from larger providers for charging-infrastructure solutions were seen as critical by informants in FO Alpha. FO Alpha also took external partners' ability to provide xEV maintenance and services into account when acquiring xEVs for their vehicle fleet. | Due to its large fleet, homogenous (non-public) charging solutions, and substantial data on vehicle operations, FO Alpha was able to communicate with OEMs to directly support technological improvements. Information exchange and learnings from other companies that also electrified their vehicle fleets supported FO Alpha in adopting xEVs. | - | FO Alpha cooperated with providers of booking software for their non-public infrastructure as well as operators of public infrastructure to increase the number of charging points for their EV-fleet. |
| FO Beta | FO Beta signaled to federal authorities and funding agencies that xEVs needed to be incentivized to be viable for the company. Subsequently, governmental actions, funding, and companies' initiatives towards xEVs were linked. | Informants saw FO Beta's role in upscaling proven innovations provided by ecosystem companies to serve its customers' requirements. This required capabilities for screening the company's environment. FO Beta actively investigated new suppliers of vehicles (OEMs). Also, FO Beta relied on a small number of OEMs as suppliers for their vehicles and used its position as a large fleet operator to influence their behavior and communicate change requirements. In turn, FO Beta relied on OEMs to supply them with xEVs. Energy companies played only a minor role for FO Beta. However, the company exerted influence on the real estate sector to be able to install charging infrastructure. | Electric charging was perceived as challenging since sophisticated solutions for charging solutions required a substantial market share of xEVs. This high market share was perceived as limited through OEMs providing only a small number of xEVs. As a result, FO Beta had to rely on OEMs due to the currently limited number of available xEVs on the market. The company observed regulatory changes in the energy sector in order to find viable technical options for charging xEVs at home on a large scale. | Informants in FO Beta saw a high value in long-term cooperations with their suppliers[1] for innovations. Further, informants perceived a positive effect of competition between its suppliers resulting in lower prices in conventional areas. Due to the limited number of suppliers for xEVs, informants perceived FO Beta's position in this technological area as difficult. Informants in the further saw the potential for partnerships with energy companies (e.g., using the substantial xEV-fleet as energy buffer during off-times). |

[1] FO Beta also referred to automotive OEMs as suppliers.

## g) Case descriptions of companies from the energy sector

**Table 83:** Overview of gathered empirical data regarding energy companies' interactions with their ecosystem to create value

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| EC Alpha<br>electric energy | Informants recognized that as more actors began to commit resources towards electric mobility the respective technologies and markets started to mature. | EC Alpha participated in an institutionalized collaboration with other energy companies to improve charging conditions for xEVs. This enabled the collaborating companies to increase their influence and implement projects. Informants in EC Alpha saw automotive OEMs as a driving force of electric mobility. | From the perspective of the EC Alpha, the low availability and long delivery times of xEVs on the market represented a major hindrance. Informants in EC Alpha saw a relation between xEVs price reductions and increased usage of its charging infrastructure. Informants in EC Alpha expected further price drops that would make xEVs attractive for a larger customer segment. EC Alpha investigated the option of acting as operator of a vehicle fleet but discarded the option due to strategic reasons. | Informants in EC Alpha saw the potential for competition between energy companies acting as energy providers and automotive OEMs providing infrastructure and energy for xEVs. EC Alpha relied on suppliers in selected technological areas. For example, EC Alpha cooperated with various start-ups that provided technological solutions for charging infrastructure (e.g., load-management). In addition, EC Alpha co-developed tailored charging solutions together with partnering companies (suppliers). |
| EC Beta<br>electric energy | Its position as an established provider of energy hindered EC Beta from introducing innovations. EC Beta oriented its strategies on OEMs. Informants in EC Beta were aware that the timing of technologies (e.g., digital solutions) was crucial in order to avoid competition with OEMs developing similar products. | EC Beta had little to no influence on larger actors outside of its core business (e.g., OEMs). In areas more related to the company's core business (e.g., charging infrastructure), EC Beta was able to develop technologies on its own, subsequently limiting its dependence on suppliers. | EC Beta found that previously unconnected sectors (e.g., automotive and energy) were becoming increasingly relevant for electric mobility. Further, informants in EC Beta recognized that previously distinct products were increasingly integrated into the portfolio of solutions provided by a single actor (e.g., "vehicle to grid," "smart home"). Necessary solutions were, to a large degree, digital. EC Beta used its technological solutions (1) for its own xEV-fleet as well as (2) to enable xEV operations for (corporate) customers. Informants in EC Beta saw a consolidation regarding companies providing charging infrastructure. Informants in EC Beta recognized the emergence of new actors providing complementary technologies for xEVs. | Informants in EC Beta recognized a shift away from competing with other energy companies towards an increased collaboration for charging infrastructure (e.g., roaming). Also, informants in EC Beta saw potential competition with OEMs. Specifically, as OEMs (respectively individual subsidies of OEMs) began to enter the energy sector (xEV car-sharing, charging infrastructure). EC Beta collaborated with other energy companies to influence regulations and standards as well as with dedicated research institutions to access technologies. In addition, EC Beta collaborated with suppliers for technologies in the area of xEVs (e.g., digital technologies, charging infrastructure). Further, EC Beta acted as an infrastructure enabler for its customers itself (e.g., by providing infrastructure and billing solutions). |
| EC Gamma<br>electric energy | EC Gamma actively monitored its environment for technologies and innovations. According to informants in EC Gamma, the market for xEVs was growing at a fast pace but was also perceived to be volatile. Addressing this new market required more flexible approaches than companies in the energy sector typically applied. Informants in the company stated an intent to focus on its core competencies. | EC Gamma had no influence over OEMs. In turn, OEMs determined the overall technological trajectory of xEV technologies as well as the respective charging infrastructure. EC Gamma had local influence due to its high regional market share. The company was partly dependent on suppliers for digital solutions required for electric charging. | From the perspective of EC Gamma, the low total number of xEVs supplied by OEMs represented a bottleneck that slowed down market development. In turn, OEMs were expected to offer solutions in EC Gamma's core markets. EC Gamma expected that xEVs would at some point be integrated into the energy grid to act as energy storage. | EC Gamma relied on partners and suppliers for new solutions (e.g., digital technologies). This enabled synergies as well as economies of scale for individual partners. EC Gamma expected that automotive OEMs would act as a competitor in selected areas using their well-established sales channels to offer charging solutions for xEVs. However, the degree of competition was unclear. EC Gamma partly relied on the same suppliers for xEV infrastructure as competing energy companies. EC Gamma collaborated with large providers of billing solutions to make operating charging infrastructure financially more feasible. Further, providing energy to charge EVs was seen as an attractive business opportunity by informants in EC Gamma. |

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| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| EC Delta<br><br>petrol energy | EC Delta monitored its environment for relevant technological developments to prepare for technological shifts. | - | Technological shifts were expected to lead to a reconfiguration of the EC Delta's energy-supply infrastructure. EC Delta collaborated with other actors (dominantly from the energy sector) to establish a dedicated company providing solutions for electric charging infrastructure. | - |
| EC Epsilon<br><br>petrol energy | EC Epsilon saw itself as an enabler for mobility and gradually extended its scope of operations. | EC Epsilon's technologies were to a large degree determined by OEMs. | Guided by Epsilon's strategy, cooperations with other ecosystem actors were intensified and broadened. | EC Epsilon relied on strategic partnerships (e.g., with OEMs or corporate customers) to explore and test new technologies. |

## h) Case Descriptions of companies for infrastructure

**Table 84:** Overview of gathered empirical data regarding interactions of infrastructure companies with their ecosystem to create value

| Category & Case | Strategic influences on ecosystem interactions | Influence of governance on ecosystem interactions | Influence of ecosystem technology on value creation architecture | Types of ecosystem interactions for technologies |
|---|---|---|---|---|
| INF Alpha | INF Alpha aimed to coordinate the installation of a basic amount of electric charging infrastructure in its area of influence[1]. Further, INF Alpha sought to avoid actors (in particular CPOs) that established a monopoly in offering end-users charging infrastructure. This was done to offer infrastructure users multiple choices and overall better conditions. | INF Alpha needed to coordinate actors to ensure coverage of charging infrastructure in its area of influence. The company set criteria for charging infrastructure that needed to be fulfilled by partnering actors. | - | INF Alpha relied on a limited number of companies that provided electric-charging infrastructure on selected locations in its area of influence. INF Alpha owned locations that could be used to install charging infrastructure and leased them to individual actors (i.e., CPOs) that could then install their individual public charging solutions. |
| INF Beta | Informants in INF Beta saw the company's strength in being faster than OEMs in driving innovation. Informants in INF Beta named the following influences on its interactions: (1) partners' technological capabilities, (2) personal relations, and (3) collaboration in research projects. | Informants in INF Beta saw OEMs clearly in a dominant position for electric charging (e.g., by influencing standards and industry norms). INF Beta required cooperation from OEMs to enable its charging technology for vehicles. INF Beta preferred to establish a minimum viable product before OEMs could slow down solutions with their lower-paced processes. Suppliers influenced INF Beta through technological developments, which could be transformed into new products. | Cooperations with OEMs were stated to be feasible on a long-term basis. Informants in INF Beta perceived OEMs as resistant to adaptions of their technological roadmaps. INF Beta cooperated in strategic projects with Tier 1 and Tier 2 suppliers. INF Beta saw a tendency that with the increased relevance of xEVs, OEMs began to in-source offerings around the vehicle (e.g., charing), subsequently maneuvering INF Beta in competition to OEMs. INF Beta saw a shift away from co-opetition towards differentiation and specialization of involved actors as the market for xEVs started to grow. | Informants in INF Beta saw competition from OEMs that used their access to vehicle technologies to provide additional value to customers. Cooperations with OEMs were seen as difficult due to their dominance and slower process speeds. INF Beta cooperated with energy companies. |
| INF Gamma | INF Gamma actively monitored its environment for technological solutions. Informants in INF Gamma saw the need to provide user-friendly solutions to customers. | INF Gamma was affiliated with an OEM. As a result, INF Gamma was selective about its partners and was able to wield substantial influence over its suppliers. INF Gamma coordinated several specialized suppliers to deliver value to its customers. | Informants in INF Gamma saw the need to integrate solutions from other industries. Long term, informants recognized the potential of *"vehicle to grid"* applications. | Informants in INF Gamma saw a rather low level of competition due to their estimation of the high market growth of xEVs. In order to install infrastructure for its customers, INF Gamma coordinated suppliers and service providers. Further, INF Gamma cooperated with energy providers to be able to provide "green" energy to its customers. Further, INF Gamma cooperated with research institutions for technologies. |
| INF Delta | Infrastructure for xEVs as well as the respective investments and time to establish infrastructure were considered key factors for INF Delta's customers. | Informants in INF Delta perceived different paces of partnering companies. The company coordinated external actors to provide value for customers. | Informants in INF Delta saw their company as a new actor able to influence the ecosystem's overall value creation. | INF Delta partnered with companies for the development and manufacturing of its products. Further, partners were used in order to access markets. Informants in INF Delta perceived rivalry between different stakeholders in its area. |

[1] Austria

## A.3.3 Case descriptions of influences on business models in the ecosystem

### a) Case descriptions of automotive OEMs

**Table 85:** Overview of gathered empirical data on how participating in the xEV ecosystem affected the investigated OEMs' business models

| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| OEM Alpha | The OEM aimed to bring innovations to mass productions to establish a leading position with regard to new technologies on the market. Technology was used to enable new business models. The OEM's size and structure were seen as a hindrance. Consequently, new technologies were developed in a separate organizational unit. | OEM Alpha demonstrated the feasibility of its technology early on. | Informants in OEM Alpha saw xEVs as a niche market. Further, the OEM expected only a slow uptake of the market for xEVs. Due to its xEVs' high costs, OEM Alpha had low revenue expectations with the new technology. Further, OEM Alpha expected that the revenues through maintenance of vehicles would drop with xEVs. | - |
| OEM Beta | Informants in OEM Beta saw building up know-how for xEV-technologies as challenging. Informants further perceived a trend towards shorter product cycles that required organizational changes (e.g., to increase internal collaboration). OEM Beta aimed to establish a substantial share of xEV-sales in the upcoming years while still holding on to ICE technologies. | Informants in OEM Beta saw the availability of charging infrastructure for xEVs and the required resources for technological components as limiting factors. For example, batteries were stated to be not necessarily an attractive energy store due to their costs and high weight. The OEM therefore also investigated technologies using hydrogen as fuel. Informants in OEM Beta perceived the timing of technologies as a critical issue. | According to informants in OEM Beta, the costs and necessary investments in xEV technologies represented a hindrance. In particular, batteries were seen as a cost driver for xEVs. Informants in OEM Beta saw the risk of not earning back investments in xEV technologies in a reasonable amount of time. | Informants in OEM Beta recognized the need to cooperate with other actors for xEVs to make them financially more feasible. Suppliers were in the past not always able to provide necessary components for xEVs on time or within cost limits. Informants in OEM Beta stated the risk of governments reducing incentives for xEVs. |
| OEM Gamma | Decisions regarding technologies for electrified propulsion systems needed to be decided relatively early and relied on predictions. Before OEM Gamma developed a specific model of xEV, it evaluated options for value creation as well as the product's life-cycle. | OEM Gamma needed to ensure the reliability of its vehicles. However, informants in the OEM saw making predictions about the reliability of a technology-based product over its lifetimes as challenging. Further, since decisions needed to be based on predictions, the OEM planned for technological flexibility to adapt these decisions. | The OEM faced the risk of investing resources in a technology that possibly would not prevail. | OEM Gamma pursued to perform co-development activities together with partners. In case unforeseen influences occurred, the OEM relied on fast decision mechanisms. The OEM oriented its business model partly on competitors. |
| OEM Delta | Informants in OEM Delta saw electric drivetrains as a factor that allowed the company to differentiate from competitors - although based on different criteria than ICE-powered vehicles (e.g., costs, range, efficiency, weight, charging times). OEM Delta separated technological competencies in a distinct legal entity that also served other OEMs to establish economies of scale. Management commitment was seen as a major driver of the OEM's xEV-initiatives. Flexibility in the OEMs' (technological) activities needed to be supported by the OEM's culture. | Incremental technological developments were seen as unattractive. The OEM aimed to leapfrog current technological approaches (HEVs) and committed to more radical technological solutions. However, OEM Delta was aware of technological risks due to a lack of experience with xEVs. Informants in OEM Delta saw potential in flexible engineering approaches and shortened development times for xEVs. | Informants in OEM Delta recognized the commercial risks of xEVs. | - |

## b) Case Descriptions of Automotive Suppliers

**Table 86:** Overview of gathered empirical data on how participating in the xEV ecosystem affected the investigated suppliers' business models

| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| SUP Alpha<br>*Tier 1* | SUP Alpha aimed to be a leader in selected technological areas. Its large company-size and rigid processes limited SUP Alpha's speed in reacting to new technologies. SUP Alpha established separate organizational units to address new technologies. SUP Alpha initially acquired technological components for new technologies from its suppliers and competitors while simultaneously building its own capabilities in new areas to decrease dependence on actors and establish a competitive advantage. SUP Alpha built competencies only in selected core-areas while still trying to buy components outside the company's scope from its suppliers. | Informants in SUP Alpha recognized the risk of being too late with new technologies. However, the exact timing of when technologies for xEVs became relevant was still partly unclear. Further, the direction of technological developments was perceived as uncertain. Reduced complexity of electric drivetrains was estimated to have a substantial impact on SUP Alpha's value creation potential and, as a result, overall business. | Informants in SUP Alpha perceived high financial risks related to shifts towards new technologies and business models (e.g., investments in new production infrastructure). In particular, earning back investments was seen as a financial risk. | Large customers' (OEMs) technological requirements had a strong influence on SUP Alpha's technologies and, in turn, respective elements of its business models. Suppliers of SUP Alpha were stated to have only a limited influence on its business models. |
| SUP Beta<br>*Tier 1 Sub-1* | Informants in SUP Beta saw technologies as a central aspect of competitiveness and aimed to establish competencies in relevant technological areas according to customer requirements. Components and services outside SUP Beta's area of core competence were acquired from external actors. | SUP Beta aimed to minimize the overall risk in its product mix (e.g., by modularizing products for multiple applications - electric and non-electric). | Technologies needed to generate sufficient margins to be overall viable. | SUP Beta saw a substantial influence through customer requirements. As a result, necessary changes in products and respective capabilities were perceived as essential. Customers were perceived to be influenced by governmental regulations towards xEVs. |
| SUP Beta<br>*Tier 1 Sub-2* | SUP Beta proactively investigated a broad portfolio of new technologies to be able to react quickly to regulatory changes and be in a favorable position for customers. The more specific a certain development, the higher SUP Beta estimated the related risk. In turn, customer commitment was stated as a prerequisite to commit substantial resources towards new technology. Further, the supplier screened its environment and aimed to be a fast follower to reduce risks. Technologies had to demonstrate a concrete benefit (e.g., functionality, costs). In addition, technologies were partly related (e.g., drivetrains, energy storage technologies). However, existing production capacities represented a limitation in shifting technologies and manufacturing new types of products. | Informants in SUP Beta perceived uncertainty with regards to the dominant technologies for xEVs (battery, hybrid, hydrogen). According to informants in SUP Beta, the feasibility of technologies for xEVs would heavily depend on specific use cases and markets they were applied in. Informants in SUP Beta saw substantial uncertainties regarding electric charging infrastructure and prices for electrical energy. Also, informants perceived a lack of standards with regard to new technologies. Moreover, informants in SUP Beta recognized the need to adapt components related to xEV technologies. | A major criterion for OEMs in selecting their suppliers was the price of offerings. As a result, SUP Beta aimed to modularize its product components to offer them to multiple customers. This enabled the company to establish economies of scale. Reductions in battery prices made xEVs more attractive. Currently, however, they were not financially feasible. The main economic driver towards xEVs for SUP Beta's customers was penalties for not adhering to emission regulations. However, the individual commitment of its customers depended on the concrete business case. | Requirements of existing and new customers influenced SUP Beta's behavior. Customers could also be competitors in selected areas. SUP Beta investigated cooperations with start-ups to access new technologies. However, informants perceived the related volatility in cooperations and technologies as unattractive. |
| SUP Gamma<br>*Tier 2* | SUP Gamma focussed on a niche by supplying specialized components. | Customers in the automotive industry were perceived as risk-averse. | Changes in component technology were generally balanced with potential cost-savings. | Aligning the development efforts for new products and ensuring the quality of delivered components required active exchange with customers. |
| SUP Delta<br>*Tier 2* | SUP Delta actively scouted for new technologies, particularly in the areas of electric mobility and digitalization. SUP Delta considered a technology's readiness, the risks affiliated with a certain technology, as well as lead times of technologies to be able to enter a market at a favorable time. | - | Informants in SUP Delta perceived that the reduction of battery costs made xEVs more attractive. | Informants in SUP Delta saw the customers as well as its partner network as the main influence on its business models. |

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| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| SUP Epsilon<br>*Focus* | SUP Epsilon avoided production of its products/technologies in high volumes to avoid dependence on customers and to be able to offer an overall broad portfolio of products. SUP Epsilon focused on its core technology. The supplier aimed for efficient and fast-paced development of technologies into products. | - | SUP Epsilon performed a holistic (ranging from development to assembly) approach to keep product costs low for a low number of components. | Development was mainly, but not exclusively, performed with regard to customer requirements. |
| SUP Zeta<br>*Focus* | SUP Zeta relied on patents and confidentiality to protect its technologies until entering the market. After entering the market, SUP Zeta aimed to extend its scope to define the market standard in selected areas. The supplier aimed to benefit from its head start in the development of its technology. Due to its comparatively small size, SUP Zeta was able to perform fast-paced development of its technologies. SUP Zeta followed multiple technological approaches simultaneously to be flexible in its solutions. | SUP Zeta supported xEV-operators and OEMs in solving issues of electric charging. However, informants in SUP Zeta saw multiple fruitful technological approaches, depending on specific use cases. Charging times for xEVs were seen as a major issue with regard to electric mobility. | According to SUP Zeta, business cases for electric mobility were not yet feasible. SUP Zeta's customers needed to trade-off additional costs with added functionality. | SUP Zeta performed development efforts in line with its customer's requirements. However, SUP Zeta avoided exclusive cooperation and direct influences from external actors into its business model. |

## c) Case descriptions companies for engineering and technology

**Table 87:** Overview of gathered empirical data on how participating in the xEV ecosystem affected the investigated engineering and technology providers' business models

| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| ETP Alpha<br>General | Informants in ETP Alpha underlined the necessity to anticipate customer requirements and develop appropriate technologies within their company. In addition, management commitment towards new technologies was cited as an important factor. | Informants in ETP Alpha predicted the coexistence of established as well as new technologies. This could be accomplished by using electrified drivetrains combining established (i.e., ICE) and new (fuel cell, batteries, electric motors) technological approaches. This would lead to the coexistence of multiple technologies where the application of a certain technology depended on individual use cases. | ICE technologies were currently generating a large share of ETP Alpha's revenues, enabling it to finance new technological approaches. Informants in ETP Alpha cited the high costs of end-customers as a major disadvantage of xEVs. | Actors along the automotive supply chain applied ETP Alpha's know-how in technology modules. Overall, regulations and the resulting new technologies and technological complexity were seen as positive for ETP Alpha's business. |
| ETP Alpha<br>Sub-1 | New technologies for xEVs had a good fit with ETP Alpha's current business. ETP Alpha developed technologies ahead of market demand to establish a competitive advantage. Increasing customer demand resulted in intensified activities in new technological areas. Due to the increasing demand for new technologies, the competition in these specific areas was perceived as low. ETP Alpha aimed to push technologies by marketing its technological capabilities and the resulting products. | Technological uncertainty was seen as a business opportunity. The attractiveness of new technologies depended on the use case they were applied in. | Use cases for new technologies were partly already financially feasible for customers. With the increasing acceptance of new technologies, the pressure to lower development costs had increased. Financial risks were, to a large degree, carried by customers, not ETP Alpha. | Regulations (e.g., on emissions) influenced ETP Alpha indirectly through changing customer requirements. Customer commitment (financial, risk) towards technologies supported technological innovations provided by ETP Alpha. |

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| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| ETP Alpha Sub-2 | ETP Alpha spent a substantial part of its revenues on R&D. Volatile markets were stated to require a broad portfolio of technologies as well as agile product management. New technologies also required higher degrees of communication and collaboration among ETP Alpha's departments. | Informants in ETP Alpha saw new technologies as inherently risky. This risk was addressed through a broad portfolio of different xEV technologies. | ETP Alpha considered market size as well as expected return for technologies. Customers were perceived to be reluctant to commit to a specific technology, in part due to (1) the substantial investments necessary to industrialize new technologies and (2) regulatory uncertainties. Customers demanded modularity in products and flexibility in pricing. | Informants in ETP Alpha perceived numerous changes in its customer's strategies and their applied technologies. This required ETP Alpha to offer flexible technological solutions. Customers (suppliers, OEMs) needed to get familiar with new technologies before they were able to handle in-depth solutions. ETP Alpha's solutions were partly seen as too detailed by customers. |
| ETP Beta | Informants in ETP Beta saw their company in the position of a technology follower. Market requirements and the environment were stated to determine the timing of ETP Beta's activities for exploring technologies. | Informants in ETP Beta recognized multiple technological approaches becoming relevant for xEVs. | Informants mentioned that investments in new technologies held the inherent risk of the technology not becoming relevant. | Established OEMs were perceived to be late with regards to new technologies, partly due to a lack of funding and commitment towards new technologies. |

## d) Case descriptions of research institutions

**Table 88:** Overview of gathered empirical data on how participating in the xEV ecosystem affected the investigated business models of research institutions

| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| RI Alpha | RI Alpha expected a gradual technological shift towards xEVs. Infrastructure for (electric) charging and hydrogen fuel, as well as availability and costs of the respective vehicles, were seen as limitations by informants. | Technologies for xEVs were perceived as matured since they were already in use. ICE vehicles were stated to be at their performance limit. Informants in RI Alpha recognized that multiple technological solutions for xEVs were available simultaneously. The feasibility of a specific technology was estimated as strongly dependent on a specific use case. | Investments in new technologies and related products were estimated to be a major hindrance in the industry. RI Alpha highlighted the role of pioneering companies that reduced the risk for subsequent ecosystem actors. | New OEMs entering the ecosystem were stated as a major driver of established OEMs towards xEVs. |
| RI Beta | Informants in RI Beta perceived that actors operated xEV partly to communicate an environmentally friendly image as well as to gain experience with the technology. | Informants in RI Beta cited multiple simultaneous technological approaches for xEVs. However, which technology would prevail was stated to be unclear. | Informants in RI Beta saw xEVs currently as financially not feasible. It was stated that automotive actors began to investigate new technologies but also tried to generate as much revenue as possible using current technologies. | xEVs were seen as attractive for corporate customers. OEMs were stated to need to make xEVs more attractive (range, infrastructure) to be able to sell them in high volumes. |

## e) Case descriptions of automotive retailers

**Table 89:** Overview of gathered empirical data on how participating in the xEV ecosystem affected the business models of automotive retailers

| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| RET Alpha | - | Battery lifetime, vehicle range as well as charging infrastructure were named as obstacles for electric vehicles. | Informants in RET Alpha saw financial risks for its customers due to future price-drops of xEVs. Informants further predicted substantial drops in xEV-prices due to technological developments. In addition, RET Alpha was stated to lack experience in reselling xEVs. | Cooperations with external actors for infrastructure were stated to be a necessity for RET Alpha. |
| RET Beta | Informants in RET Beta perceived the availability of xEVs on the market as low. Further, informants expected that the availability of xEVs would improve once OEMs introduced new models in the upcoming years. | Informants in RET Beta stated that developments in the automotive sector (e.g., car-sharing, mobility on demand) were in principle independent from developments regarding xEVs. Subsequently, informants expected a gradual shift from ICE-powered vehicles to xEVs. In particular, HEVs were seen as a viable alternative for customers since they combined environmental sustainability and appropriate vehicle ranges. | Informants in RET Beta saw a threat in losing a large section of its after-sales business with xEVs. This was expected to threaten the existence of automobile retailers. Informants in RET Beta saw the need to find alternative ways of generating revenues from EVs. Further, offering EVs at an attractive price-point was seen as a challenge. | RET Beta and its affiliated OEM increasingly cooperated with start-ups to access xEV technologies. |

## f) Case descriptions of corporate operators of vehicle fleets

**Table 90:** Overview of gathered empirical data on how participating in the xEV ecosystem affected the investigated corporate operators of vehicle fleets' business models

| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| FO Alpha | FO Alpha was required by shareholders and stakeholders to set actions toward being more ecologically sustainable. Integrating xEVs in the company fleet was stated to be in support of these goals. | Availability of xEVs on the market and uncertainty towards their reliability and performance hindered initial commitment towards xEVs. Due to recent performance increases, no extensive improvements in performance were expected in the near future. Thus making investments in xEVs was perceived as attractive. | Fast-paced technological developments in vehicle-performance (e.g., vehicle ranges) of xEVs had the potential risk of a fast devaluation of obtained vehicles. FO Alpha integrated xEVs into its vehicle fleet to build experience with the technology. As a consequence of expected drops in xEV costs, the respective vehicles were not bought but leased. Leasing times were increased (from two years to four years) as FO Alpha gained more experience with xEVs. | - |

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| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| FO Beta | FO Beta was committed to being a forerunner regarding xEV-use and began investigating alternatives to ICE-powered vehicles at an early stage to gain a competitive advantage and satisfy the sustainability demands of large corporate customers (e.g., retail). Compared to ICE-powered vehicles, high investments in xEVs and necessary charging infrastructure required top-management commitment. FO Beta had the goal to reduce the emission of its vehicle fleet to zero by 2030. The company aimed for economies of scale by operating a substantial number of xEVs in its fleet. | The overall reliability of its vehicle fleet was a priority for FO Beta to ensure its daily operations. Although technological leaps in xEV technologies were deemed hard to predict, FO Beta saw fast-paced technological progress regarding xEVs, making them increasingly attractive for the companies' use cases. Another factor in that regard was that ICE vehicles in trying to adhere to emission regulations were perceived to be increasingly falling short in performance. However, the number of available xEV-models and the number of xEVs that OEMs could actually deliver were limited. Informants in FO Beta hoped that until 2022 the overall availability of xEVs would improve. For their vehicle fleet, the company relied on already known car brands. However, OEMs offering xEVs fitting FO Beta's use cases were offered to a large degree by Asian manufacturers the company was less familiar with. This unfamiliarity presented a hindrance to integrating these vehicles. For its operation, FO Beta saw charging infrastructure as a limiting factor. | Initial costs for purchasing xEVs (influenced by battery prices) prevented xEVs from being cost-competitive to ICE-powered vehicles. However, as recurring costs for xEVs were comparatively low while the vehicle's lifespans were estimated to be high (e.g., due to xEVs robust propulsion technologies), xEVs became increasingly attractive from a TCO perspective. FO Beta kept its infrastructure for charging non-public due to cost reasons, as cooperating with providers and operators of charge-point (technology) was seen as substantially more expensive. Installing additional grid lines for charging purposes was not attractive for the company due to the substantial investments necessary. FO Beta tried to avoid these investments by distributing its xEV-charging stations to other locations in line with the availability of charging power. Informants stated that xEVs were perceived to be incentivized to increase their overall financial attractivity. However, FO Beta expected that with an increasing market share, governmental authorities would shift away from their current policy of subsidizing xEVs. | FO Beta was actively in contact with OEMs to test their xEV-models for their use cases - this helped FO Beta build up capabilities to adapt its business models, if necessary. Collaborating with a diverse group of small and innovative suppliers was seen as challenging since they often lacked continuity in their business operations. Collaborations with energy companies were seen as a potential future option but were not actively pursued at the time of data collection. Due to the already established ExV-fleet, FO Beta was able to meet regulatory requirements. |

## g) Case descriptions of companies in the energy sector

**Table 91:** Overview of gathered empirical data on how participating in the xEV ecosystem affected the investigated energy companies' business models

| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| EC Alpha<br><br>electric energy | Informants in EC Alpha saw participating in new areas outside the company's traditional core business as unattractive. Subsequently, the EC decided against operating as a xEV fleet operator itself. EC Alpha focussed on providing solutions for electric charging. The decision was influenced by the overall (technological) uncertainty in the area as well as uncertain profitability. | Informants in EC Alpha saw the need to improve the overall usability of xEV-charging. The introduction of technological standards for xEV charging supported the use of charging technologies in the business model. However, additional standards were necessary (e.g., communication between vehicle and charging infrastructure). | Informants in EC Alpha perceived profit-expectations with regard to the xEV-business in areas other than providing charging infrastructure as inflated. | OEMs only provided a low number of xEVs, slowing down the development of the xEV-market. Informants in EC Alpha expected an increase in available xEVs, as regulations on OEMs would start to tighten. |
| EC Beta<br><br>electric energy | Informants in EC Beta perceived electric mobility as a promising market and aimed for the company to be a first mover in selected xEV-topics. However, due to EC Beta's role as a provider of energy, it needed to ensure the reliability of provided solutions. | EC Beta needed reliable technologies to be able to act as a first mover. Informants in the company saw substantial improvements in xEV-ranges and charging times, making the technologies more attractive. | According to informants in EC Beta, uncertain future development of the xEV-market held risks with regard to new technologies. One concrete risk mentioned was a potentially slow return on investment with new technologies (e.g., charging infrastructure). This could lead to a situation where the infrastructure solutions the company invested in were technologically outdated before EC Beta would be able to break even. | EC Beta depended on automotive OEMs, which were perceived to be reluctant to make large investments in new technologies. However, informants in EC Beta saw the need for business model change in order to react to OEMs entering the energy sector. Further, informants mentioned a strong influence of customer demand, the legal environment, and the overall technological development for electric mobility. |
| EC Gamma<br><br>electric energy | EC Gamma focused on its core competencies while implementing programs to shift its culture and capabilities. This was necessary since EC Gamma saw an increased rate of innovations and volatility in its environment. Informants in EC Gamma recognized that OEMs were starting to enter the energy sector and evaluated the situation. However, taking action to compete in the xEV-fleet business was seen as not attractive. | For EC Gamma technologies for xEVs (charging infrastructure) were starting to become relevant. Subsequently, EC Gamma saw risks in committing to new technologies. For EC Gamma, the development of ecosystem parameters (e.g., availability of resources, energy) were major influences on technological substitution. Currently, inhomogeneous charging standards for charging and billing xEVs represented an obstacle. | Informants in EC Gamma cited risks of stranded investments towards electric mobility. | Informants in EC Gamma underlined the low availability and long delivery-times of xEVs from OEMs as a limitation for the development of the xEV-market. Informants further mentioned a strong influence of competitors, political regulations, and financial incentives for environmental sustainability on its business models for electric mobility. |
| EC Delta<br><br>petrol energy | Exploring alternative energy technologies represented only a small part of EC Delta's total research expenditures. The company focused mainly on its core business centered around petrol energy. EC Delta faced pressure from its shareholders to shift towards new forms of energy. | EC Delta investigated new technologies. However, it would be only feasible for EC Delta to scale them when major ecosystem actors (e.g., OEMs) shifted their technologies. | Informants in EC Delta predicted that a technological shift would be inevitable as soon as a new technology was financially viable. | Major actors in the ecosystem (e.g., OEMs) were perceived to be reluctant to commit resources to new technologies. Subsequently, it was not clear for informants in EC Delta when a technological shift would take place and what the next dominant technology could be. |
| EC Epsilon<br><br>petrol energy | EC Epsilon investigated a broad portfolio of new technologies in-house. EC Epsilon separated large-scale applications of new technologies from its core business. This was done by establishing organisationally and legally separated units that used new technologies in their business models. | According to informants in EC Epsilon, scaling up new technologies required a substantial market share of alternative vehicles. Predictions of large increases in xEV market share were sees as unrealistic. | - | Informants in EC Epsilon saw OEMs as the main driver of technological developments towards xEVs. EC Epsilon tried to engage in joint undertakings with other ecosystem actors to access new technologies. |

## h) Case descriptions of infrastructure companies

**Table 92:** Overview of gathered empirical data on how participating in the xEV ecosystem affected the investigated infrastructure companies' business models

| Category & Case | Strategic considerations for technology related changes in business models | Role of technological feasibility for changing business models | Role of financial feasibility for changing business models | Influence of ecosystem actors on business model change |
|---|---|---|---|---|
| INF Alpha | INF Alpha performed lobbying activities targeted at various interest groups. While stating their commitment to electric charging, INF Alpha informants saw no need to take action towards hydrogen fuelling infrastructure. | Informants in INF Alpha recognized the risk of pushing for xEV charging infrastructure prematurely. This would result in an unattractive business for partners and outdated charging hardware. | Due to INF Apha's politically influenced objectives, it tried to enable charging infrastructure while generating profit was not seen as the main objective. | INF Alpha relied on partnering companies (e.g., energy companies) to establish xEV charging infrastructure coverage. INF Alpha needed to provide infrastructure for xEVs to fulfill targets set by shareholders. |
| INF Beta | INF Beta aimed to transform disruptive innovations provided by network partners into products for use in its business models and tested them (products and business models) on the market. | Informants in INF Beta perceived the need to establish a fit between customer demand with financial and technological feasibility. | Informants in INF Beta perceived earning back investments for new technologies in a short amount of time as uncertain. | Informants in INF Beta recognized a large influence of its shareholders[1] onto the company's overall strategic direction. |
| INF Gamma | INF Gamma was committed to BEVs. Informants in INF Gamma perceived it necessary to address market needs flexibly as well as to establish a company culture that embraces uncertainty. | - | Informants in INF Gamma saw a need for affordable xEVs in appropriate volumes to ensure the viability of xEV technology. | - |
| INF Delta | INF Delta permanently refined its business model using technologies to demonstrate an attractive proposition for customers. The company focussed on a small number of core technologies and relied on external partners for additional capabilities and capacities. INF Delta aimed to set innovations itself using an agile approach. | The company perceived the timing of its technologies as crucial to support its customers in handling significant changes in the industry. However, customers, to a large degree, carried the risk associated with new technologies. | INF Delta used innovative technologies to justify its prices. A major criterion for sourcing decisions was INF Delta's available resources and the associated costs. | Customer requirements were the main driver of INF Delta's innovations. |

[1] Companies form the energy and technology sector

## A.3.4 Case descriptions of actors' business models in the ecosystem

### a) Case descriptions of automotive OEMs

**Table 93:** Overview of gathered empirical data on changes in OEMs' business model elements

| Case | Value creation | Value proposition and delivery | Value capture |
| --- | --- | --- | --- |
| OEM Alpha | Informants in OEM Alpha did not expect that their company would give up its current technological competencies. However, integrating new technologies for xEVs as well as providing the respective services (e.g., energy for charging) would expand the OEM's competencies. | OEM Alpha investigated options to act as an energy provider for charging its xEVs. From the perspective of the OEM, this could be necessary to be able to sell the company's xEVs in the future. Overall, informants in OEM Alpha expected changes in distribution channels (e.g., online sales). However, the changes in distribution channels were seen as independent from developments towards electric mobility. | From the perspective of OEM Alpha, xEVs were used to a large degree by business customers. Informants further mentioned that xEVs were often times not sold but leased. |
| OEM Beta | Informants from OEM Beta saw charging infrastructure as a bottleneck for xEVs. OEM Beta collaborated with other OEMs to establish infrastructure for electric charging to overcome this perceived bottleneck. The OEM further collaborated with research institutions to develop multiple technological solutions for xEVs. OEM Beta expanded its competencies by integrating technologies for electric drivetrains while keeping existing competencies (e.g., for ICEs). For the shift towards xEV technologies, OEM Beta expected substantial changes in its production infrastructure and applied know-how. Currently, the required know-how was provided by partner companies. OEM Beta prefered to establish solutions inside the company - if that was not possible, the OEM collaborated with external partners. Informants stated that the principal procedure for how OEM Beta collaborated with partners did not change. | Informants in OEM Beta expected that all their company's vehicles would be electrified to some degree in the near future. This included vehicles with a low degree of electrification. OEM Beta saw bottlenecks in vehicle ranges. However, these could be addressed by improving vehicles' energy storage capacity or improving charging infrastructure. OEM Beta acted as a provider of charging infrastructure through its subsidies and considered entering the market as an operator of car-sharing solutions. | OEM Beta aimed to establish a modular platform for its xEVs to use synergies and reduce xEV-costs. OEM Beta considered offering this platform to other OEMs. The OEMs xEV-strategy was influenced by the high profit margins of its upper-class vehicles emitting high levels of emissions as well as potential fees for not complying with emission regulations. Subsequently, in order to realize profits by offering high-emission vehicles, the OEM introduced vehicles with low emission values (i.e., xEVs) in its portfolio. |
| OEM Gamma | OEM Gamma shortened its development times and tried to make its development processes more flexible to better address changing requirements (e.g., legal requirements, customer requirements). In turn, informants mentioned that OEM Gamma demanded more flexibility from its suppliers (e.g., technological properties). The OEM selected partners also based on their ethical standards and was transparent about its partners (e.g., suppliers of resources for batteries). | Addressing customer's needs was seen as a central element of the OEM's activities. According to OEM Gamma, predicting markets and customers' requirements at an early stage has become more difficult. This was partly due to political and regulatory influences on the OEM as well as on its customers. Informants stated that the OEM was selective about its partners and used its high standards with regards to its partners to communicate added value to customers. | - |
| OEM Delta | OEM Delta acted as a fleet operator in a separate entity. This enabled the OEM to build up the knowledge to gain experience and user data from their xEVs. Further, the OEM started to offers its drivetrain technology on the market. The OEM avoided dependence on suppliers and aimed to develop technologies in-house. This reduced risks for the OEM but had the potential to slow development efforts. If possible, the OEM acquired companies for their technological know-how. The OEM aimed to bring its vehicles to the customers at an early stage to enable learning potentials. | The OEM's main value proposition was the sale of xEVs. Characteristics of its xEVs that differentiated them from those of its competitors were their design and performance. The OEM investigated "complete" solutions ranging from operating vehicle fleets to providing electrical energy or hydrogen for its vehicles. | Informants in OEM Delta saw it as difficult to recoup initial investments necessary to bring xEVs to the market. From the OEM's perspective xEVs needed to be more affordable, which, in turn, could be achieved (for example) through lower battery costs. |

## b) Case descriptions of automotive suppliers

**Table 94:** Overview of gathered empirical data on changes in suppliers' business model elements

| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| SUP Alpha<br>*Tier 1* | SUP Alpha used its financial resources to perform M&A-activities in order to expand its competence portfolio. Informants saw the need for more flexibility in its activities as well as the activities of its suppliers. SUP Alpha obtained components for new technologies from suppliers while also building capabilities in selected technological areas themselves. This also included shifting employee competencies (through training and recruiting new employees). However, shifting the company's capabilities, particularly in the area of production, was seen as challenging. Overall, informants in SUP Alpha stated that collaborating with other actors in technological areas new to the company was necessary. | On the principle level, SUP Alpha developed and sold products to customers - both with respect to xEVs and conventional vehicles. However, the underlying technology has gradually changed with the emergence of new types of vehicles. According to informants, SUP Alpha investigated using electric drivetrains in already existing products. | Investments in new technologies were (at the time of data collection) perceived as not profitable. Furthermore, SUP Alpha generated revenues to a large degree from the "after-sales" business. These revenues were expected to drop with an increased share of xEVs. |
| SUP Beta<br>*Tier 1 Sub-1* | SUP Beta gradually integrated new technologies (e.g., electronics) into its products. The integration of new technologies required changes in development processes. SUP Beta relied on suppliers as well as engineering and technology providers for non-essential products or areas outside its core competencies. | Although the underlying technologies had changed, the principal approach of selling products stayed largely untouched. Competences were leveraged to be able to deliver an appropriate value proposition to customers. Engineering was seen as a means to an end to be able to sell products. SUP Beta perceived only limited influence on its principal business model through changing customer requirements. | Profit was generated from selling products. SUP Beta used its competencies to generate appropriate turnover and profit margins. |
| SUP Beta<br>*Tier 1 Sub-2* | Overall, the supplier acted as an integrator and subsequent manufacturer of technology-based systems. Informants in SUP Beta saw the need to have capabilities in a wide variety of - partly new - technologies to understand the overall vehicle system. This helped to ensure the appropriate integration of technologies and production capabilities as well as the overall quality of manufactured products. Informants in SUP Beta recognized a reduction of its created value with technologies for xEVs (e.g., electric drivetrain). Informants mentioned that SUP Beta adapted its development processes for xEV technologies. New technologies made it necessary to train employees in a different way. SUP Beta tested and validated new technologies in engineering projects to build up capabilities in new technological areas. These projects typically combined technologies from a number of suppliers with a narrow technological focus. Suppliers needed to be able to provide high volumes of components. Further, SUP Beta also performed M&A-activities to expand its overall competence portfolio. | Informants in SUP Beta perceived the development and production of high-quality products as the company's main value proposition. Although underlying technologies changed on a general level, this did not impact the company's value proposition. SUP Beta's customers also benefited from shared risks when developing and industrializing new technologies. Creating value for customers was ensured through active communication and alignment of interests. | Development capabilities were perceived to improve cost-efficiency in development processes (e.g., by avoiding changes during development). |
| SUP Gamma<br>*Tier 2* | SUP Gamma performed improvements in production processes itself as well as the respective technologies used. Competences outside of SUP Gamma's core areas were outsourced. SUP Beta relied on suppliers for critical raw materials as well as - in part - for production machinery. | SUP Gamma continually improved its products. However, informants perceived little to no change in its overall business model, and the principal function of products and the underlying technology was stated to have remained largely unchanged. SUP Gamma was in direct contact with customers to be able to establish an attractive value proposition. Further, being able to supply customers worldwide was seen as part of the company's value proposition. | - |
| SUP Delta<br>*Tier 2* | Development was seen as an integral part of SUP Delta's activities and continually improved its products and production processes. The supplier cooperated with research institutions as well as with providers of engineering and technologies to develop its technologies. The inclusion of technologies for xEVs required different types of suppliers and led to an increase in the number of the company's overall partners. SUP Delta tried to explore technologies proactively to be in a favorable position for meeting its customer's requirements. | SUP Delta developed and produced critical components for high-performance applications that were needed to be available worldwide. The technology was seen as a central part of the value proposition. Although based on different technologies, the principal value proposition for xEVs was perceived as unchanged. | - |

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| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| SUP Epsilon<br><br>*Focus* | SUP Epsilon was able to perform all steps from development, testing, and production of its technology-based products in-house. Informants in SUP Epsilon saw the need to have highly trained employees. The supplier avoided investments in high-volume production capacities to avoid being dependent on customers and ensure technological flexibility. SUP Beta also offered complementary solutions for its technologies (e.g., charging infrastructure). | SUP Epsilon focused on customer-oriented development as well as on the production of its products in low volumes. The development required SUP Epsilon to understand the overall systems its products were integrated in. The supplier supported customers in the industrialization of its technologies and products. | SUP Epsilon sold its products directly and gave production licenses for its technologies to customers. |
| SUP Zeta<br><br>*Focus* | SUP Zeta kept the development and testing of its technology-based product to a large degree in-house. SUP Zeta required OEMs as well as its suppliers to adopt its technologies. Further, infrastructure companies needed to establish appropriate charging infrastructure. To accomplish that goal, SUP Zeta established a network of actors. SUP Zeta aimed to cooperate with other actors (direct suppliers of SUP Zeta or Tier 1 automotive suppliers) to license its products for high volume production. | SUP Zeta provided a technology-based solution for electric charging that facilitated electric mobility (e.g., by reducing battery sizes and costs or improving infrastructure coverage and practical vehicle range). | SUP Zeta was initially financed through research grants until its technology was protected through patents. Subsequently, SUP Zeta started to generate revenues using projects with customers. Revenues were expected to be generated via licensing the technology. |

## c) Case descriptions of companies for engineering and technology

**Table 95:** Overview of gathered empirical data on changes in providers of engineering and technologies' business model elements

| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| ETP Alpha General | ETP Alpha used a large degree of its turnover to develop and protect technological solutions proactively. Enabling xEV technologies for customers required the application of different technologies and capabilities. In addition to different technological capabilities, ETP Alpha also required knowledge of the vehicle system to integrate technologies required for xEVs. Informants in ETP Alpha recognized the need to adapt the company's competencies (e.g., training and hiring of employees). ETP Alpha also acquired companies to expand its capabilities. | While, on principle level, the value proposition remained unchanged, the technologies ETP Alpha offered in the area of xEVs vastly differed from those provided for ICE-powered vehicles. ETP Alpha used its capabilities to develop and test technologies for its customers. Further, customers were also supported in industrializing new technologies/products. The company used technology prototypes to demonstrate the viability of technologies as well as their capabilities to customers. | Revenues were generated through technology-centered development projects. |
| ETP Alpha Sub-1 | Initially, ETP built capabilities by participating in funded research projects. ETP Alpha relied on its development capabilities, established engineering processes, and its network of suppliers and research institutions in their value creation efforts. The company obtained specific core components necessary for its developments to a large degree from suppliers. Although SUP Alpha aimed to maximize its in-house value creation, minor development tasks were partly outsourced (e.g., in case no internal resources are available). ETP Alpha emphasized the need for highly trained employees to be able to perform high-paced development of technologies. Employee competencies were built up in-house (e.g., through performing R&D) as well as acquired from external sources (e.g., through hires). As new technologies matured, the focus of development efforts shifted from technological properties (e.g., efficiency, durability) towards integrating technologies into vehicle systems of customers. | On a general level, the value proposition of offering technological solutions according to customers' specifications remained unchanged. However, ETP Alpha was reported to have shifted the focus of its sales channels towards new technologies. As a result, new technologies were actively communicated to customers. | ETP Alpha generated revenues through engineering projects. |

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| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| ETP Alpha Sub-2 | ETP Alpha used cooperations (e.g., with start-ups or research institutions) to cover a broader range of technological solutions than it could cover on its own. The company needed to shift its employees' competencies towards new technologies and activities (e.g., through training). Technological reorientations could be performed comparatively fast since ETP Alpha largely did not rely on physical (production-) infrastructure in its activities. | Informants in ETP Alpha saw technology itself as the company's product that it applied to support customers in terms of its capabilities, additional engineering capacities and training of customer's employees. However, the company offered different types of technologies for xEVs. ETP Alpha needed to communicate the solutions it offered for xEVs actively. Informants in ETP Alpha saw connecting ecosystem actors and communicating requirements as part of its value proposition. In addition to technological capabilities, time-to-market had reportedly become a key factor. Informants recognized new customers for its solutions (e.g., new OEMs entering the industry). These new customers tended to act more agile and required ETP Alpha to adapt its sales processes. | Customers in the area of xEVs tended to require more flexibility with regards the billing of ETP Alpha's solutions. |
| ETP Beta | Competencies were to a large degree built up in joint projects with customers. However, ETP Beta entered partnerships with research institutions and performed R&D in selected strategic areas. ETP Beta was largely independent of suppliers. | ETP Beta performed engineering tasks for customers. While ETP Beta did not develop components based on specific technologies itself, it integrated the components into the overall vehicle system. Customers of ETP Beta increasingly demanded flexibility in development projects. | ETP Beta aimed to generate high revenues with its offerings. Informants, however, also cited the need to lower internal costs or terminate activities in technological areas when they were no longer financially feasible. |

## d) Case Descriptions of Automotive Retailers

**Table 96:** Overview of gathered empirical data on changes in business model elements of automotive retailers

| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| RET Alpha | - | RET Alpha sold private charging infrastructure in combination with its vehicles. Informants in RET Alpha saw digital sales channels as suitable for the customer segment interested in xEVs. | Due to their largely unpredictable value loss, electric vehicles were to a large part leased, not sold. Leasing customers were often corporations. Retailers that leased xEVs to (corporate) customers faced the risk of value loss. Consequently, potential value loss was considered when determining leasing rates. Informants in RET Alpha stated that their company would lose revenues with electric vehicles since they required less maintenance compared to conventional vehicles. |
| RET Beta | RET Beta collaborated with subsidies of its affiliated OEM and other ecosystem partners (e.g., energy companies, charging solution providers) to offer solutions for charging infrastructure. RET Beta needed to build internal know-how for new technologies to be recognized as a relevant actor for xEVs. This included the need to shift its employee competencies to be able to provide maintenance and services for xEVs. | RET Beta aimed to offer "complete" solutions, including xEVs and the respective charging infrastructure for xEVs. RET Beta also offered solutions for xEV-customers that covered a limited amount of long-distance travel with ICE-powered vehicles. However, informants in RET Beta saw no principal change in its value proposition of providing mobility through vehicles to customers. | RET Beta supported customers in financing their vehicles. Further, informants in RET Beta expected substantial changes in value capture due to shifts in the after-sales business for xEVs. However, the concrete form of these changes was not yet clear since alternative approaches (e.g., providing mobility as a service) were not yet profitable for the retailer. Selling infrastructure for private electric charging (Wallboxes) was not a relevant business from a financial perspective for RET Beta. |

## e) Case descriptions of corporate operators of vehicle fleets

**Table 97:** Overview of gathered empirical data on changes in business model elements of corporate vehicle operators

| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| FO Alpha | FO Alpha aimed to operate a substantial share of xEVs in its vehicle fleet. This required the company to establish its own non-public infrastructure at strategically chosen locations to allow its xEV-fleet to charge as well as to handle billing. Chargepoints and required digital solutions for billing and booking were acquired from external companies. In the case of highly frequented locations, internal resources were used to upgrade power lines to FO Alphas's charge points to increase the local charging capacities. Cooperations with public charge point operators were used to further increase the density of the available infrastructure. | FO Alpha provided mobility solutions to the company's own employees. Through adding xEVs to its fleet, (internal) customers had additional options for transportation at their disposal. The charging infrastructure was kept non-public to ensure that FO Alpha's xEV-users had charging opportunities readily available. Availability and transparency of the charging infrastructure were further increased through digital solutions for booking and billing the infrastructure. | Initial costs for xEVs were higher than for comparable ICE vehicles. To lower subsequent costs for vehicle operations, charging was to a large degree done in-house with non-public infrastructure. Handling charging purely through cooperations with other charge-point operators was evaluated as a substantially more expensive solution. The company expected its own established infrastructure to be fully occupied with its own xEVs. Employees were able to book charging infrastructure, which required FO Alpha to have direct access to the charge-points. |
| FO Beta | FO Beta started to integrate xEVs comparatively early to gain experience with the technology. The company acquired more than 100 xEVs annually to gradually shift the composition of its vehicle fleet. This gradual shift allowed FO Beta to build capabilities regarding the operation of xEVs on a fleet basis, subsequently allowing for more informed decisions (e.g., through risk-awareness). FO Beta operated a non-public charging infrastructure and investigated "intelligent" solutions (e.g., charging management, buffer batteries) to keep investments in infrastructure low. Activities outside the scope of the company's core operations were outsourced to external actors. For example, the company relied on external actors for the service and maintenance of their xEVs. A major factor when acquiring xEVs was a vehicle supplier's (OEMs and, respectively, their retailers) ability to provide appropriate service and maintenance for the vehicles. | FO Beta acted as a vehicle fleet operator within its company. Vehicles were provided to internal customers on an annual basis to enable the company's operations for a fixed rate. A major goal was a reliable and readily available operation of vehicles and the respective infrastructure. The required infrastructure was kept private due to security reasons and because they were largely situated at locations that were not publicly accessible. | From a cost perspective introducing xEVs was seen as financially attractive only on a long-term basis (e.g., through lower costs for fuel energy). Building up the capabilities to operate an xEV fleet required substantial initial investments - in particular, to establish a charging infrastructure. The internal leasing for xEVs was higher than for ICE-powered vehicles, while (internal) customers benefited from lower fuel costs. |

## f) Case descriptions of companies in the energy sector

**Table 98:** Overview of gathered empirical data on changes in business model elements of energy companies

| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| EC Alpha<br><br>electrical energy | EC Alpha had investigated solutions for public and private xEV charging for approximately a decade. Due to the increased customer demand, EC Alpha improved its internal processes, partly using digital solutions. The company actively investigated options to improve the density of its charging infrastructure. Also, EC Alpha aimed to collaborate with real estate developers to integrate charging solutions in buildings. Further, EC Alpha collaborated with municipalities and start-ups (e.g., for innovative charging solutions) to act as an enabler for charging infrastructure and urban mobility solutions. EC Alpha started to participate in an association connecting multiple energy companies to increase the overall coverage of electric charging infrastructure. Together with suppliers, EC Alpha co-developed digital solutions to monitor and handle their charging infrastructure billing processes. EC Alpha saw digital solutions as a cornerstone to enable value for customers. | EC Alpha differentiated between B2B (e.g., operators of xEV fleets) and B2C customers. The company offered both customer groups access to its own charging infrastructure as well as the charging infrastructure of partnering energy companies. EC Alpha's B2B customers tended to prefer non-public charging infrastructure. Subsequently, EC Alpha specifically addressed B2B customers with "complete" solutions for infrastructure and charging. | The company benefited from non-public models for B2B customers since they predominantly acquired energy for charging their xEVs directly from EC Alpha. Efficiency in billing processes was improved. Billing was handled to a large degree using digital solutions. |

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| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| EC Beta<br><br>electrical energy | EC Beta proactively invested in infrastructure to establish a substantial infrastructure for xEV charging in its area of influence (several hundred charging stations) to be prepared for future market developments. EC Beta cooperated with research institutions for technologies. EC Beta expected that BEVs would be the dominant solution for individual mobility - concurrently, the company shifted its internal vehicle pool towards xEVs (both BEVs and FCEVs) to gain experience with these vehicles. Simultaneously, EC Beta also piloted infrastructure to generate hydrogen as fuel from "green" energy. | EC Beta differentiated between B2B and B2C customers. EC Beta offered solutions for charging xEVs at home. Business customers were offered solutions to manage xEV fleets. EC Beta offered integrated solutions allowing customers to optimize their vehicle usage. EC Beta was able to provide additional value to customers by using "green"[1] energy for charging vehicles. Informants in EC Beta saw potential in integrated digital technologies to bind customers to the company. | Billing, authenticating, and monitoring of charging infrastructure relied on digital solutions. EC Beta saw a potential hindrance in customers' expectations that electric energy needed to be low cost. According to EC Beta, offering low-cost energy for charging vehicles was necessary to drive xEV adoption. However, selling cheap energy was not feasible for EC Beta in the long run due to necessary investments in charging infrastructure for xEVs. A future solution to this issue could be solutions where EC Beta limited the charging times for xEVs to flatten overall energy demand as well as "vehicle to grid" applications, where EC Beta could use vehicles as grid storage in return for cheaper charging energy. |
| EC Gamma<br><br>electrical energy | EC Gamma cooperated with other energy companies to increase the range of the charging infrastructure it can provide to its customers. Access to charging infrastructure and billing/roaming between ECs was handled using digital solutions. Due to the companies' initiatives to integrate solutions for xEVs, the number of suppliers had increased. Specifically, EC Gamma focused on its core competencies and collaborated with suppliers to access additional resources, competencies, and technologies. | EC Gamma (1) operated its own public charging infrastructure (2) served as energy provider for B2C customers (3) acted as an enabler for xEV infrastructure for newly constructed buildings, and (4) provided solutions for xEV-fleets to B2B customers. For B2B customers, FC Gamma acted as a CPO, where it owned and operated the charging infrastructure. For private customers, EC Gamma aimed to offer simple and robust solutions. EC Gamma shifted away from purely selling energy towards acting as a complete provider for energy services in this area. | Selling charging energy for xEVs was seen as a profitable business by informants. Infrastructure for xEV charing was installed proactively without initially being able to recoup investments. |
| EC Delta<br><br>petrol energy | - | - | - |
| EC Epsilon<br><br>petrol energy | EC Epsilon collaborated with other ecosystem actors to pioneer new technologies. The company used these collaborations to build knowledge for new technologies. Offering hydrogen as fuel required EC Epsilon to collaborate with additional suppliers. | EC Epsilon extended the scope of its value proposition by providing hydrogen at selected locations. | - |

[1] Author's remark: Ecologically sustainably produced energy.

## g) Case descriptions of infrastructure companies

**Table 99:** Overview of gathered empirical data on changes in infrastructure companies' business model elements

| Case | Value creation | Value proposition and delivery | Value capture |
|---|---|---|---|
| INF Alpha | INF Alpha coordinated partnering actors for electric charging to provide dense charging infrastructure. INF Alpha set requirements to enable electric charging solutions at an appropriate quality level (e.g., used connectors, access, and availability of charging stations, high power for low charging times, minimum time of operation). INF Alpha pushed to improve the electric infrastructure to enable fast charging. Concretely, two approaches were followed: (1) INF Alpha performed substantial investments into charging infrastructure and increased its partner's rent, or (2) partners were given a free choice with regards to the charging infrastructure they provided as long as they fulfilled criteria defined by INF Alpha. | INF Alpha enabled additional value by ensuring fast charging solutions in its areas of influence. | INF Alpha acted as landlord for infrastructure and collected rent from partners. Partners could achieve profit from electric charging. INF Alpha partly invested in infrastructure and recouped investments through higher rents. |
| INF Beta | INF Beta performed (funded) strategic projects for research and development together with partners to introduce minimum viable products. | The application of (new) technologies was facilitated ny INF Beta to value for customers. INF Beta differentiated between two business model segments: (1) INF Beta established (semi-) public (fast-) charging infrastructure for xEVs. Users affiliated with other infrastructure companies could access INF Alphas charging network for a fee. (2) INF Beta established and operated charging infrastructure for (corporate) customers, subsequently enabling them to provide additional value to their (end-)customers. In that regard, INF Beta also provided "white label" solutions to customers (e.g., energy providers) and supported them with their know-how (e.g., with regard to digital solutions). | In business model (1), INF Beta generated revenues through a "basic fee," fees for actual electric charging of vehicles, as well as through cooperations with automotive OEMs. In business model (2), INF Beta generated revenues through basic fees for providing the infrastructure and/or charging fees. INF Beta optimized the load profiles of its charging infrastructure to be more cost-efficient. |
| INF Gamma | INF Gamma reportedly coordinated several suppliers and service partners to provide its solutions to customers. | INF Gamma sold and operated "one-stop-shop" intelligent electric charging infrastructure to B2C and B2B customers as well as to municipalities. INF Gamma did not directly supply the "green" energy customers could use to charge their vehicles. Although INF Gamma was affiliated with an OEM, its solutions adhered to established standards and were able to be operated for multiple OEMs' vehicles. Informants reported the need to raise awareness and communicate xEV technologies to a broader audience. INF Gamma provided additional value by consulting customers on charging solutions. Access to sales channels from its affiliated OEM helped INF Gamma to scale its solutions. | INF Gamma uses "intelligent" charging solutions to help customers mitigate potential investments into the electricity grid. |
| INF Delta | INF Delta cooperated with external partners to access technologies and manufacture their products. External capabilities were combined with SUP Delta's competencies. Cooperations with customers were used to build competencies. | INF Delta relied on a small number of standardized products to offer energy and data solutions for B2B customers. However, INF Delta consulted customers on technological solutions and performed customer-specific development of its products and technology. INF Delta relied on partners to access markets. | INF Delta generated revenues through the direct sale of its products and by providing licenses for its technologies. |